City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 1: EXECUTIVE SUMMARY
CHAPTER 1: EXECUTIVE SUMMARY

FINAL
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10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

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VOLUME 1: EXECUTIVE SUMMARY
CHAPTER 1: EXECUTIVE SUMMARY

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Chapter 1

EXECUTIVE SUMMARY

1.1 PURPOSE

This Wastewater Collection and Treatment Facilities Integrated Master Plan has been prepared to serve as a planning document for facility planning for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) and collection system. The recommended plan is intended to enable the RWQCP to continue to reliably provide wastewater treatment to the City as the wastewater flow increases due to the projected population growth. This master plan addresses facility needs for projected influent flow through the year 2025.

The purpose of this executive summary is to provide a concise overview of the key issues and alternative analyses of the facility planning for the Integrated Master Plan.

1.2 EXISTING FACILTIES

The City Sewerage System Division is responsible for collection and treatment of wastewater flows generated within the City and the communities of Jurupa, Rubidoux, Edgemont, and Highgrove. The City's collection system consists of approximately 800 miles of gravity sewers ranging from 6 to 48 inches in diameter and 18 wastewater pump stations. The wastewater pump stations range in size from 100 gallons per minute (gpm) up to 2,000 gpm. Treatment is provided at the RWQCP, which provides preliminary, primary, secondary, and tertiary treatment for a rated capacity of approximately 40 million gallons per day (average annual basis).

1.3 GOALS AND OBJECTIVES

The City seeks to develop an Integrated Master Plan for the wastewater collection and treatment facilities to identify and plan for expansion and replacement needs through the year 2025. The Integrated Master Plan evaluates most of the facilities that make up the wastewater collection and treatment facilities, in order to make recommendations to accommodate facility rehabilitation and replacement (R&R) and projected population growth. For facilities not specifically evaluated in this Master Plan, findings and recommendations of previous and ongoing plans and studies are evaluated and included. This combination of recommendations from new facility evaluations and previously made findings and recommendations from other plans provides the City with a Master Plan that is integrated into one document. Specific goals for the Integrated Master Plan include:

1. Develop a capital improvement plan (CIP).
2. Develop an asset management program that will provide capital R&R costs.

3. Perform financial planning and establish user rates and connection fees.
4. Develop an Environmental Impact Report from the proposed facilities.
5. Identify, analyze, and recommend alternatives for various system processes.
6. Create easily updateable Volumes and Chapters.
7. Use the Master Plan Manager™ (MPM™) software so the City can modify the plan based on changes to the planning criteria (i.e., regulatory changes and flow projection changes).

The sections that follow present first the outline of the Integrated Master Plan and then the major findings from the individual master plan volumes, excluding the Environmental Impact Report.

1.4 INTEGRATED MASTER PLAN OUTLINE

The Integrated Master Plan is organized into thirteen Volumes, as shown in Table ES.1.

Table ES.1 Integrated Master Plan Volumes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Volume 1: Executive Summary

Volume 2: Basis of Planning

- Chapter 1: Introduction
- Chapter 2: Regulatory Requirements
- Chapter 3: Population and Flow Projections
- Chapter 4: Basis of Cost Estimates

Volume 3: Wastewater Collection System

- Chapter 1: Review of 1992 Master Plan Update

Volume 4: Wastewater Treatment System

- Chapter 1: Existing Facilities
- Chapter 2: Summary of Planning Studies
- Chapter 3: Process Design and Reliability Criteria
- Chapter 4: Plant Hydraulics
- Chapter 5: Preliminary Treatment
- Chapter 6: Primary Treatment
- Chapter 7: Secondary Treatment
- Chapter 8: Tertiary Treatment
- Chapter 9: Disinfection

Table ES.1 Integrated Master Plan Volumes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside
Chapter 10: Recycle Stream Management
Chapter 11: Plant Utilities and Support Facilities
Chapter 12: Primary Effluent Equalization
Chapter 13: Proposed Expansion Plan and Site Layout
Chapter 14: Implementation Schedule and Cost
Volume 5: Air Quality and Emissions Control
Chapter 1: Review of the 2005 Odor Control Master Plan
Chapter 2: Review of Applicable Regulatory Requirements
Volume 6: SCADA Management and Communications System
Chapter 1: SCADA Management Plan
Volume 7: Reclamation and Reuse
Chapter 1: Reclamation and Reuse
Volume 8: Biosolids Management
Chapter 1: Existing Facilities
Chapter 2: Summary of Planning Studies
Chapter 3: Design Criteria
Chapter 4: Solids Production and Thickening Options
Chapter 5: Solids Processing
Chapter 6: Solids Dewatering
Chapter 7: Solids Disposal
Chapter 8: Implementation Schedule and Cost
Volume 9: Energy Management
Chapter 1: Existing Energy Facilities
Chapter 2: Summary of Planning Studies
Chapter 3: Existing and Future Energy Uses
Chapter 4: Energy Saving Options
Chapter 5: Power Supply Alternatives
Chapter 6: Standby Power
Chapter 7: Implementation Schedule and Cost
Volume 10: CIP and Overall Implementation Schedule
Chapter 1: Capital Costs and Implementation Schedule
Chapter 2: Operations and Maintenance Cost Projections

Table ES.1 Integrated Master Plan Volumes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside
Volume 11: Financial Plan and User Rates and Fees
Chapter 1: Master Plan Manager™
Chapter 2: Financial Planning Tool™
Chapter 3: Master Plan Manager™ User Manual
Volume 12: Asset Management
Chapter 1: Strategic Vision
Chapter 2: Condition Assessment
Volume 13: Environmental Impact Report (EIR)
Public Draft EIR
Final Draft EIR
Final Mitigation Monitoring and Reporting Program Report
Final Response to Comments
Final Statement of Overriding Consideration and Findings of Fact
Notice of Determination

1.5 VOLUME 2: BASIS OF PLANNING

The purpose of the Basis of Planning volume is to document the basic criteria used in facility planning for the City's Integrated Master Plan. In addition to an outline of the Master Plan volumes, three areas are addressed in this volume:

1. Regulatory Requirements.
2. Basis of Cost Estimates.
3. Population and Flow Projections.

For the Regulatory Requirements chapter, a brainstorming session was conducted at the beginning of the project. The purpose of this session was to identify specific regulatory requirements likely to arise over the next 10 to 20 years, and ascertain how these requirements would impact the Integrated Master Plan alternative analyses. Based on the brainstorming session, it was determined that most of the potential future regulatory requirements would be addressed by developing compliance strategies rather than new capital treatment facilities. There were also a few potential regulatory requirements that would require new or improved treatment processes in order to ensure regulatory compliance. These processes included membrane bioreactors, ultraviolet disinfection, ozone disinfection, and odor control for the primary clarifiers. These processes are included in evaluations in the appropriate chapters in Volume 4 - Wastewater Treatment System.

The Basis of Cost Estimates chapter established the procedures and guidelines for estimating operations and maintenance (O&M) and capital costs for the Integrated Master Plan. Tables ES.2 and ES.3 list the cost factors that were applied to the capital and life-cycle cost estimates.

Table ES.2 Capital Cost Estimate Factors
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Category	Factor
Site Work	10% of direct costs
Electrical and Instrumentation	15% of direct costs
Contingency	30% of total direct costs
General Conditions	10%
Contractor OH&P	15%
Escalation	6% (first 5 years), 4% thereafter
Bid Market Allowance	15%
Project Costs	30% of total Construction Cost

Table ES.3 Life-Cycle Cost Estimate Factors
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Category	Factor
Escalation	6% (first 5 years), 4% thereafter
Discount Rate	6%

The Population and Flow Projections chapter developed the projected flow for the planning period. This is summarized in the following section.

1.5.1 Projected Flow

Based on information supplied by the City, the increase in the plant flow is anticipated to grow at a rate of 1.09 percent between 2006 and 2025. Because flow projection is not an exact science, a 90-percent confidence interval for the flow was developed. This is approximately equal to an annual flow increase range of between 0.75 percent (low growth scenario) and 1.5 percent (high growth scenario). It was decided in the August 2006 monthly meeting that the 1.5 percent rate increase was to be used to project the year 2025 flow. This resulted in a projected average daily flow (ADF) of 52.2 mgd.

Subsequently, all the alternative analyses for the facilities were performed assuming they would need to meet the 52.2-mgd capacity. After the analyses were performed, the City noticed a slow down in the population/housing growth, and decided the low growth scenario

would be more appropriate for scheduling projects and determining user rates and connection fees. This decision was made at the August 2007 meeting.

The alternative analyses of this Master Plan are based on a 2025 flow of 52.2 mgd. However, as a result of the August 2007 decision, the capital costs, O&M costs, CIP, and schedule for the projects have been revised to reflect the low growth scenario (2025 flow of 47.3 mgd).

The following peaking factors are used for the Master Plan:

1. Peak wet weather: 2.2.
2. Minimum dry weather: 0.5.
3. Peak dry weather: 1.8.
4. Tertiary peak: 1.5.

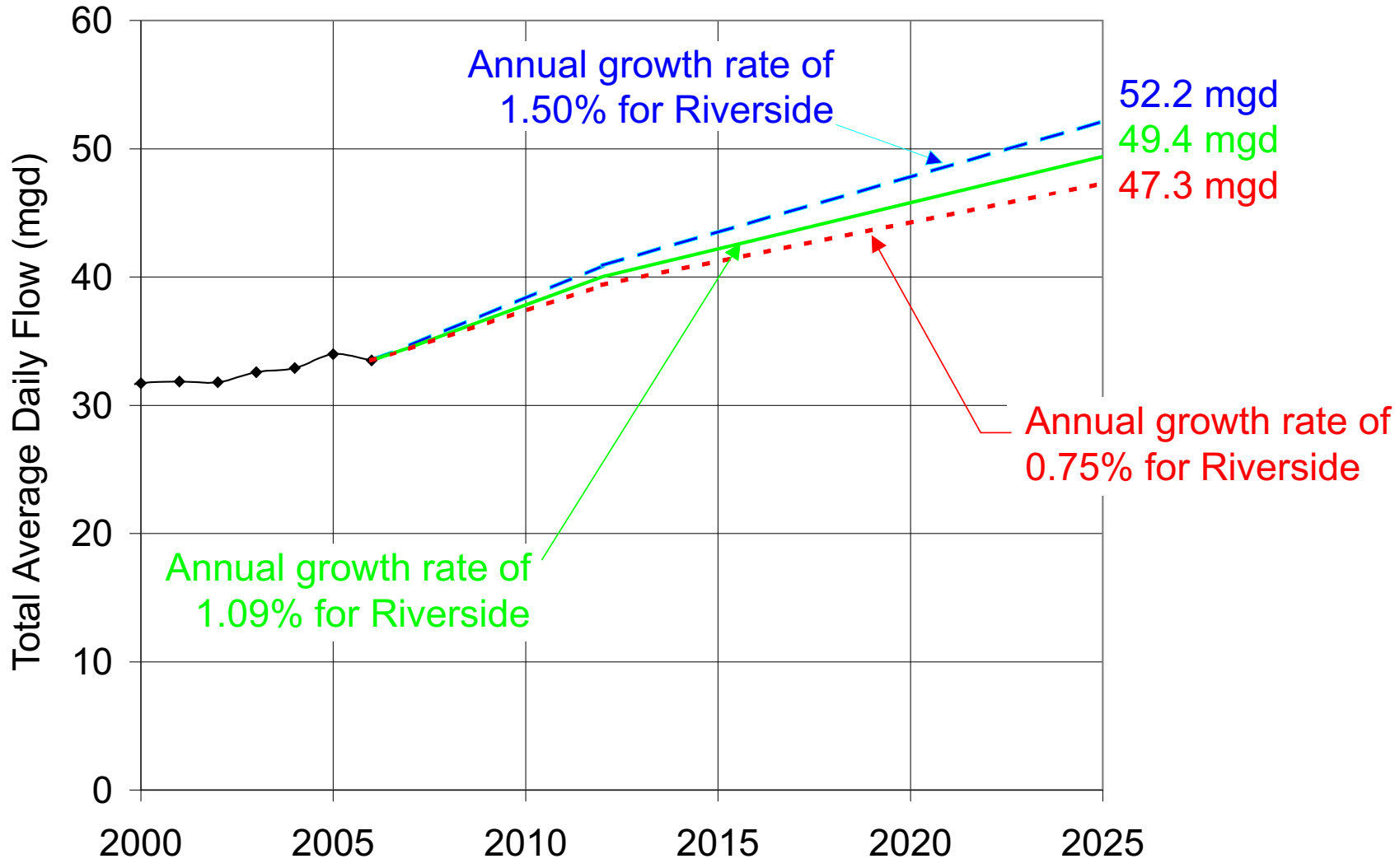
Please see Figure ES.1 for the projected flow for the planning period.

1.6 VOLUME 3: WASTEWATER COLLECTION SYSTEM

The purpose of the Wastewater Collection System volume is to evaluate and summarize the collection system master plans (CSMPs) that were completed by Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) between 2002 and 2006. The capital improvements and costs that were proposed in the CSMPs are updated in this volume to reflect completed projects, and future project costs are adjusted and scheduled out to 2025 based on detailed costs and schedules provided by the City.

Overall the CSMPs are sufficient with a few recommended additional efforts the City should pursue. The main recommendation is to update the CSMPs by incorporating infiltration and inflow (I/I) into the collection system model and adjusting capital improvement projects accordingly.

The CSMPs identified a total of 50 capital projects and the City identified an additional 24 R&R projects for sections of the collection system that are more than 50 years old. Of the 50 capital projects identified from the CSMPs, the City has either started or allocated budgets for 12 of them; therefore, these projects are not included in the master plan CIP. The costs for the rest of these capital projects are spread over 10 years. The costs for the City's 24 R&R projects are spread over 50 years.



TOTAL PROJECTED AVERAGE DAILY FLOWS FOR RWQCP

FIGURE ES.1

1.7 VOLUME 4: WASTEWATER TREATMENT SYSTEM

The purpose of the Wastewater Treatment System volume is to identify the deficiencies in the existing treatment systems at the RWQCP and to recommend projects that would meet the year 2025 flow projections. The treatment areas evaluated are listed in Table ES.1 under the heading Volume 4. As mentioned above, the alternative analyses were based on the high growth scenario, a resulting capacity need of 52.2 mgd. The following summarizes the major recommendations of each treatment area process chapter in Volume 4.

1.7.1 Plant Hydraulics

The purpose of the hydraulic analysis was to evaluate the ability of the existing RWQCP to convey flows up to the peak wet weather flow (PWWF) through the facilities and to identify any bottlenecks. No hydraulic bottlenecks were identified during hydraulic model runs using the existing facility ADF treatment capacity (40 mgd) and the existing ADF (33 mgd). However, four hydraulic bottlenecks were identified for the PWWF (88 mgd). Table ES.4 lists the identified bottlenecks and the respective management strategy to correct the bottlenecks.

Table ES.4 Hydraulic Bottlenecks and Management Strategies
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Hydraulic Bottlenecks	Management Strategy
Plant 2 (24-inch) control valves/meters at the headworks.	Install an additional 24-inch control valve at the headworks.
A 42-inch pipe connecting the Plant 2 primary clarifiers splitter box and aeration basin influent splitter box.	Upsizing the existing pipe to 54 inches.
Plant 1A/1B Distribution Channel.	Will be eliminated when the 2008 expansion project is constructed.
A 54-inch pipe connecting Junction Box 13A and Junction Box 14.	Installing a new 48-inch pipeline between Distribution Box 3 and Junction Box 13A and modifying the boxes.

1.7.2 Preliminary Treatment

1. The existing headworks facility is re-rated at a capacity of 37 mgd on an ADF basis, based on the grit removal capacity of the grit chambers. The hydraulic capacity is approximately 46 mgd. Based on the grit removal capacity, an additional separate headworks facility is planned for an ADF of 15 mgd.
2. Two mechanical bar screens (one duty and one standby) and one manual bypass bar screen are recommended for the new headworks.

3. Climber-type and chain-and-rake-type are two alternatives for the bar screens. They should be further evaluated during preliminary design.

4. A shaftless screw conveyor is recommended over a belt conveyor for screenings conveyance.

5. A sloped-bottom vortex grit basin is recommended over a flat-bottom grit basin because the accumulation of settled grit can be minimized, and also because the equipment can be bid instead of sole-sourced.

6. The headworks will be covered for odor control and foul air will be continuously withdrawn and treated in a biofilter.

1.7.3 Primary Treatment

1. The existing Plant 2 primary clarifiers have a capacity of 20 mgd on an annual average (AA) flow basis. New primary clarifiers will have an AA flow capacity of 32.2 mgd and replace the existing Plant 1A and Plant 1B primary clarifiers. The total Plant 1 and Plant 2 primary clarifier capacity will then be 52.2 mgd.

2. Rectangular and circular alternatives were compared. The life-cycle costs for the two alternatives are similar. Circular primaries will be used, given that the costs are similar, circular clarifiers are easier to maintain, and circular units will fit on the site.

3. The type of primary sludge pumps will be decided during preliminary design based on flow quantity and pumping head.

4. Biofilters will be used for odor control for the primary clarifiers (new Plant 1 and existing Plant 2) and for the new headworks facilities. The primary clarifiers will be covered with low profile aluminum domes for odor control. The biofilter is estimated to be 150 feet by 200 feet. The biofilter will be located at the existing Plant 1A primary clarifiers. Therefore, it will be built after the new clarifiers are put in service and the Plant 1A clarifiers are demolished.

1.7.4 Secondary Treatment

1. The existing secondary treatment system was evaluated and the plant capacity is 40 mgd AA.

2. For future increases in capacity, Plant 1 will be expanded since some of the process units have aged and there is enough room for future units adjacent to Plant 1, whereas Plant 2 has limited room for future expansion.

3. The ultimate expansion would increase Plant 1 capacity to 32.2 mgd AA and the total RWQCP treatment capacity to 52.2 mgd AA.

4. Four options for expanding the RWQCP secondary treatment plant were considered: Conventional Activated Sludge (CAS), Conventional Activated Sludge-High SRT (CAS-SRT), Membrane Bioreactor (MBR), and Integrated Fixed Film Activated Sludge (IFAS).

5. CAS, CAS-SRT, MBR, and IFAS options can all achieve the required expanded capacity. The IFAS option presents more risks than the other alternatives due to the limited experience and number of installations using this technology.

6. For meeting current effluent limits, CAS is the most cost-effective alternative, followed by IFAS, CAS-SRT, and MBR in that order. However, in order to meet future potential endocrine disrupting compound (EDC) chemical limits, a high SRT process is preferred. The two options that include a high SRT process and have many installations are the MBR and CAS-SRT options. Their life-cycle costs are nearly the same, within the uncertainty of the cost estimate.

Based on the ability to achieve better effluent quality, the City chose the MBR alternative for the future expansion at a meeting on November 17, 2006. It was decided the MBR facility would be completed in two phases. The first phase will convert Plant 1 from a 20-mgd CAS facility to a 26-mgd MBR facility. The second phase will add the remaining 6-mgd capacity for a Plant 1 secondary capacity of 32.2 mgd, and a total RWQCP capacity of 52.2 mgd AA.

1.7.5 Tertiary Treatment

1. The volume of the existing tertiary influent equalization basins is 6.0 million gallons (MG). It is estimated that an additional equalization volume of 6.1 MG will be required based on the simulated Riverside wet-weather diurnal curves. The additional equalization basins can be built either as tertiary influent equalization basins or as primary effluent equalization basins.

2. The existing filters are rated to have a capacity of 28.2 mgd on an ADF basis. If MBRs are used for secondary expansion, no tertiary facility expansion is needed. If MBRs are not used, an additional tertiary capacity of 24.0 mgd will be required to meet the 52.2-mgd ADF.

3. Cloth-disk filters are recommended over conventional dual-media filters because of their lower life-cycle cost and ease of operation.

There is no tertiary facility expansion required since MBR is selected as the secondary treatment method.

1.7.6 Disinfection

1. Existing NaOCl should continue to be used as the disinfection method unless future regulations require removal of pollutants that only advanced disinfection systems can provide. The total existing disinfection capacity is 44 mgd; therefore, an additional 8 mgd would be required to increase the capacity to 52.2 mgd.

2. Ozone or ozone plus UV should be considered for disinfection if removal of EDCs is required by future regulations. These alternatives have been developed as alternate treatment scenarios for the MPM^{TM}.

3. UV alone will not be used as the disinfection method because it is incapable of removing EDCs.

4. A tracer test should be performed for each existing chlorine contact basin (CCB) in order to determine the size requirement for the new basin. Depending on the results of the tracer tests, it is possible that a new CCB will not be required.

1.7.7 Recycle Stream Management

The following four recycle stream treatment alternatives were evaluated for treating recycle flows from the dewatering process:

1. Equalization (EQ) Alternative.

2. Single Reactor High-Activity Ammonia Removal Over Nitrite (SHARON) Alternative.

3. SHARON combined with Anaerobic Ammonia Oxidation (ANAMMOX) Alternative.

4. Centrate and Return Activated Sludge (RAS) Re-Aeration Basin (CaRRB) Alternative.

After extensive evaluations of each alternative, none of the alternatives are economically feasible for use at the RWQCP.

1.7.8 Plant Utilities and Support Facilities

1. The utility water system, which includes the pump station and distribution piping, is not adequate. PBS&J has designed an upgrade to the distribution piping, and Lee and Ro is currently designing a new pump station, which will be located in CCB No. 2. Upsizing and looping of the distribution piping in the vicinity of CCB No. 2 will be necessary to accommodate the new pump station location.

2. The communication system includes a phone system, plant radio system, and public address system. The public address system is old and should be upgraded.

3. Based on *Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities*, published by the Water Environment Federation, the site security level should be evaluated for access control, cyber security, monitoring for flammable/toxic substances, and backup power.

4. The existing storm drain system drains to a pump station and is pumped to the Plant 1 aeration basins. In the future, an option to pump upstream of primaries will be added.

5. A new maintenance building will be located south of the existing maintenance building. Additional parking space will be added east of the existing parking lot.

6. All new buildings over 5,000 square feet will be designed to meet the Leadership in Energy and Environmental Design (LEED) standard.

7. Based on an analysis of the existing levee that protects the RWQCP from the river, it is possible that the levee will have to be raised. The City will have a hydrology study performed to determine if the levee needs to be raised.

1.7.9 Primary Effluent Equalization

1. Primary effluent equalization will be used to provide better control for downstream processes and a reduction in project costs for the MBRs. In addition, the reduction in project costs for the MBR facility is more than the project cost of providing primary effluent equalization.

2. Two equalization basins with a total volume of 12.1 MG will be required based on the Riverside wet-weather diurnal curves.

3. Hypalon liners will be used for the basin liner material because of its lower cost compared to concrete and better durability than polypropylene.

4. Basin covers will not be used because of cost and cleaning issues. To minimize odors, the basins will need to be dewatered and cleaned daily.

1.7.10 Proposed Expansion Plan and Site Layout

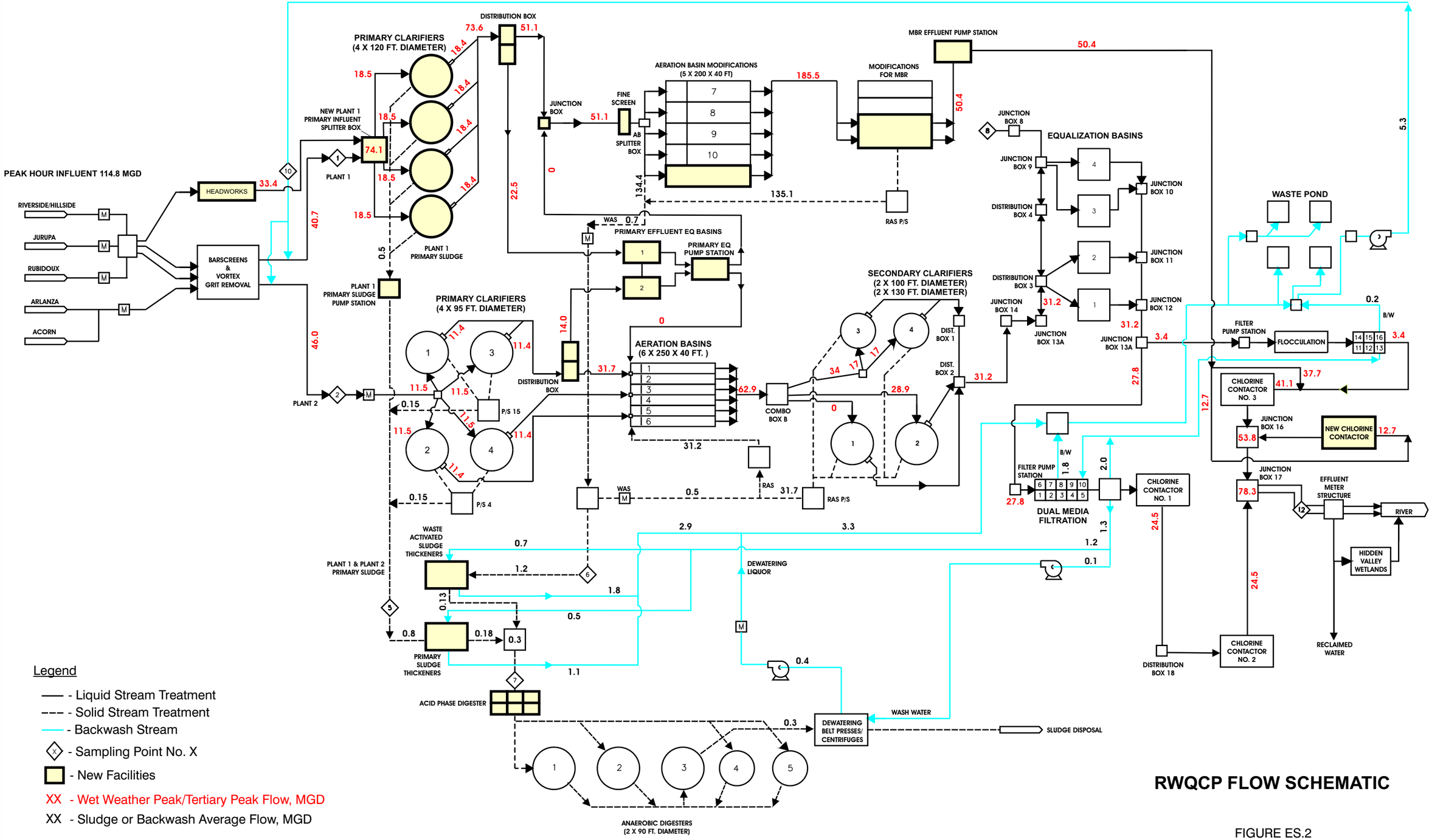
Based on the evaluations performed in this volume, a revised RWQCP flow schematic and site layout have been developed for the ultimate expansion to 52.2 mgd on an AA basis (Figures ES.2 and ES.3).

1.8 VOLUME 5: AIR QUALITY AND EMISSION CONTROL

The purpose of this volume is to provide a review of the 2005 Odor Control Master Plan (2005 Report by Brown and Caldwell) and applicable regulatory requirements for the RWQCP. In general, the 2005 report provides the City with adequate guidance for addressing odor issues. Therefore, the report is generally sufficient for odor control planning at the RWQCP.

1.9 VOLUME 6: SCADA MANAGEMENT AND COMMUNICATIONS SYSTEM

The Supervisory Control and Data Acquisition (SCADA) Management Volume provides a review of the SCADA plan written by WaterHammer, Inc., of Upland, CA. Overall, the SCADA Plan covers the existing system and makes general recommendations for future support. The Plan provides good descriptions of existing hardware. It provides adequate analysis and recommendations in some areas.



RWQCP FLOW SCHEMATIC

FIGURE ES.2

Key

1 New Headworks
2 Biofilters
3 Plant 1 New Primary Clarifiers
4 Primary Sludge Pump Station
5 Primary Effluent Equalization Basins
6 Plant 1 Aeration/Anoxic Basins Additions
7 Plant 1 Membrane Bioreactor
8 New Chlorine Contact Basin
9 Primary Sludge Thickeners
10 New Waste Activated Sludge Thickeners
11 Acid Phase Digester
12 New Maintenance Building
13 Parking Lot Expansion
14 Fine Screens
15 MBR Equipment

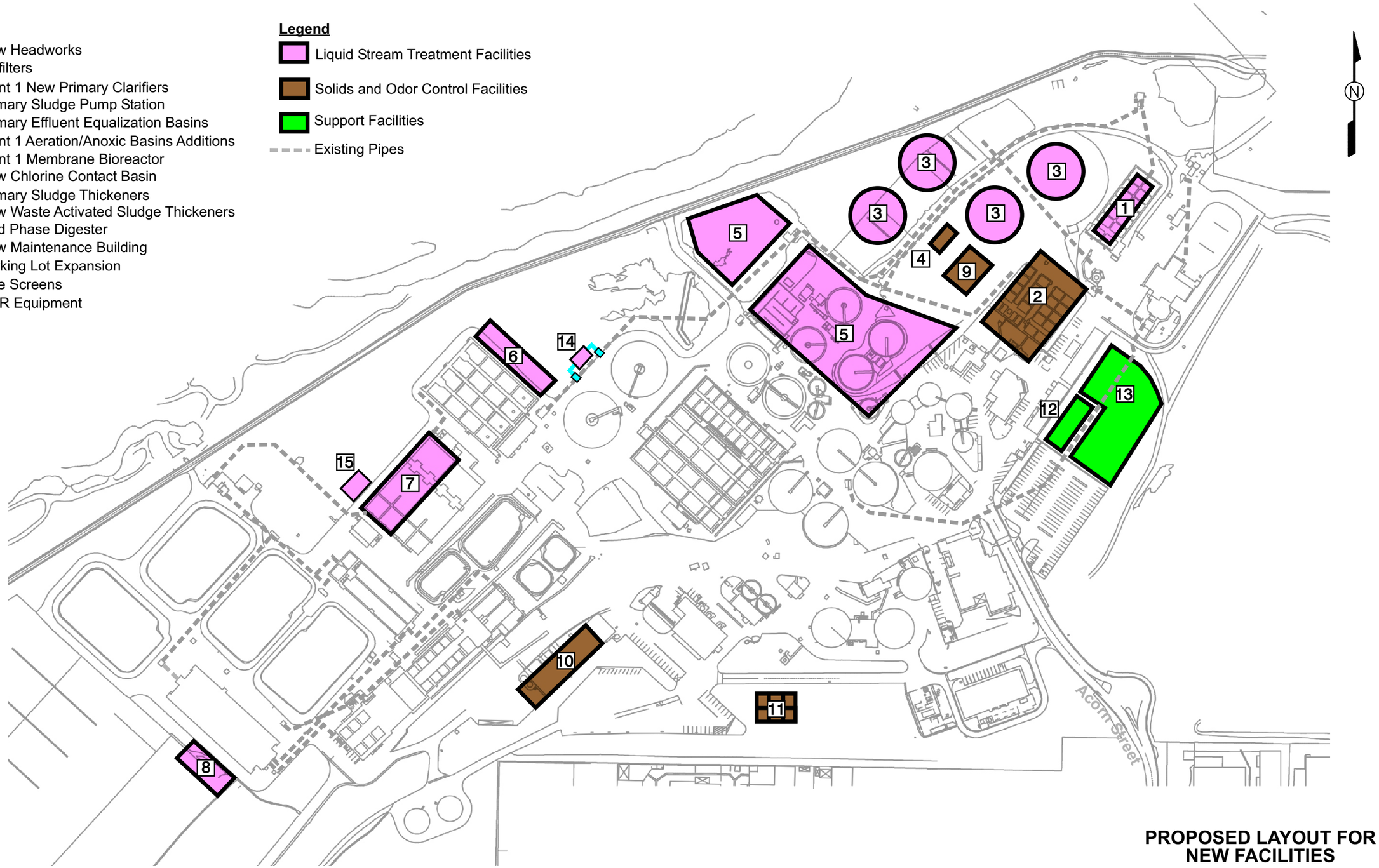
Legend

Liquid Stream Treatment Facilities

Solids and Odor Control Facilities

Support Facilities

Existing Pipes



PROPOSED LAYOUT FOR NEW FACILITIES

FIGURE ES.3

The main deficiency of the SCADA plan is that it is not integrated with other Master Plan documents and does not include planning recommendations or costs for future SCADA expansion to accommodate the RWQCP expansion. It was decided in the May monthly meeting to include $1 million (August 2006 dollars) in the CIP to allow for future SCADA upgrade projects, spread evenly over the planning period. The $1 million would make up for SCADA deficiencies that are not already being covered in the RWQCP treatment system projects. A list of priority enhancements that the City might want to consider to add to the existing SCADA Plan is also provided.

1.10 VOLUME 7: RECLAMATION AND REUSE

The purpose of the Reclamation and Reuse volume is to review the information in the existing City of Riverside Recycled Water Phase I Feasibility Study and Citywide Master Plan (Parsons, September 2003), present an update to the existing Master Plan regarding the planned recycled water pump station, and develop costs for the planned pump station that can be used in the overall CIP for the Integrated Master Plan. A new recycled water pump station is to be constructed at the discharge end of CCB No. 2. The pump station will be used to supply the on-site and off-site demands for recycled water. The new pump station will include a cover over CCB No. 2 to help reduce chlorine demand and prevent wind-born trash from entering the basin.

1.11 VOLUME 8: BIOSOLIDS TREATMENT AND HANDLING

This volume addresses the expansion needs in the biosolids treatment and handling area and incorporates findings and recommendations from the 2003 Bio-Solids Handling Improvements report by Brown and Caldwell, along with alternative analyses results done for this Integrated Master Plan. Since the City plans to continue with the dewatering implementation plans recommended from the 2003 Report, no analyses are done for the dewatering facility, but the findings of the 2003 Report are presented in the volume. Furthermore, for solids disposal, the City has decided to dispose its solids at the EnerTech Environmental California, LLC in Rialto facility, based on an agreement with EnerTech Environmental California, LLC to participate in the Rialto Regional Biosolids Project as a component of the City's long-term biosolids management strategy.

The following subsections summarize the recommendations for the thickening and digestion facilities for the Integrated Master Plan.

1.11.1 Solids Thickening Options

1. Based on the dissolved air flotation thickeners (DAFTs) design criteria and current operating conditions, the capacity of the DAFTs (without polymer addition) with both units in service was estimated to be 36.3 mgd on an ADF basis, which are operating

near their rated capacity. With polymer addition, and both units in operation, the DAFTs would have a capacity of 48.4 mgd ADF.

The City has chosen to provide separate thickening facilities for primary thickening and secondary thickening, using gravity belt thickeners (GBTs) for both types of solids.

1.11.1.1 Solids Processing

1. The City could reduce digestion construction to a minimum of one 90-foot digester and possibly not have to build any additional digestion during the Master Plan planning period by using acid-phased anaerobic digestion (APAD) versus conventional anaerobic digestion.
2. It is recommended that the City use Digester No. 3 for downstream digester sludge storage, as this would provide the City with 3 days of storage versus 2 days, if the City were to use Digester No. 5, instead.

The City has selected the APAD system with a new multi-compartment acid-phase digester for their digestion facilities.

1.12 VOLUME 9: ENERGY MANAGEMENT

The energy management volume evaluates the existing and future energy uses, power saving options and power alternatives, as well as the RWQCP standby power system. The following summarizes the main recommendations of these areas.

1.12.1 Existing and Future Energy Uses

1. Historical data for electrical power demand and consumption at the RWQCP show that the average power demand is 2,456 kW and a peak demand of 3,096 kW.
2. The anticipated future loads based on the low growth scenario for the RWQCP are listed in Table ES.5.

Table ES.5 Anticipated Future Loads for RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Treatment Facility	Future Loads
Headworks	Additional 186 kW in year 2023
Primary Clarifier, Primary EQ, MBR and Sludge Thickening	Additional 1,955 kW in year 2013; increase to 3,047 kW in year 2025
Acid Digester	Additional 186 kW in year 2013
Disinfection	Additional 8 kW in year 2020

Table ES.5 Anticipated Future Loads for RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Treatment Facility	**Future Loads**
UV/Ozone	Possible addition of 583 kW in year 2020
WAS Thickeners	Additional 34 kW in year 2027

3. Future heat uses will include additional digester heating required because of increased plant loading and flow. Projections of future digester heating through 2025 were made. The estimated 2025 digester heat demand based on the low growth scenario is as follows:

Table ES.6 Estimated 2025 Digester Heat Demand Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Year	Flow, mgd	No Grease: Average Heat Demand, Btu/hr	No Grease: Peak Heat Demand, Btu/hr	Grease Addition: Average Heat Demand, Btu/hr	Grease Addition: Peak Heat Demand, Btu/hr
2025	47.3	4,421,000	6,896,000	5,221,000	7,896,000

1.12.2 Selected Energy Management Projects

1. Install a 1,000-kW digester gas-fueled fuel cell. This project is currently under construction.
2. Add an additional digester gas-fueled 1,200-kW fuel cell cogeneration system prior to 2012 to replace the three existing 3,300-kW engine generator cogeneration systems, and retrofit the existing engine generators to become natural gas fueled standby generators.
3. Install a low-pressure digester gas holder to assist with digester gas control.
4. Upgrade the existing RWQCP cogeneration, control, and electrical systems to provide standby power and distribution reliability.
5. Retrofit the existing eddy-current drives with variable frequency drives (VFDs) for the three 250-hp filter influent pumps and two 100-hp waste backwash pumps. Replace the pump motors with premium efficiency motors.

1.13 VOLUME 10: CIP AND OVERALL IMPLEMENTATION SCHEDULE

The purpose of this volume is to present the CIP for the RWQCP. This includes the wastewater treatment plant upgrades (low growth scenario) as well as the collection system capital improvement projects. Table ES.7 is a summary of the improvement projects

recommended for this integrated master plan and presents the implementation schedule of the CIP, as well as the total project costs in August 2006 dollars.

Table ES.7 Implementation Schedule for Treatment System Projects - Low Growth Scenario
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project	Total Project Cost[(1)] ($ Million)	Project Duration	Date	
			Start	Completion
2008 Expansion Project	$185.0	5.5	Jan-08	Jul-13
Plant 1 Primary Expansion ($64M)				
MBR ($108 M)				
APAD ($13M)				
1.2-MW Fuel Cell	$13.2	4	Jan-08	Dec-11
Low-Pressure Digester Gas Holder	$1.2	3	Jan-08	Dec-10
42-inch Pipe Upgrade (54-inch dia. from Connecting Plant 2 Splitter Box to Aeration Basins	$0.1	1.5	Jul-08	Dec-09
Waste Gas Burner	$0.5	1.5	Jul-08	Dec-09
24-inch Meter Control Valve	$0.5	1.5	Jul-08	Dec-09
New Boilers	$3.0	1	Jan-14	Dec-14
Biofilter Nos. 1 and 2 Media	$2.1	1.5	Jul-14	Dec-15
O&M Building	$2.1	1.5	Jul-14	Dec-15
Influent Metering Project	$5.9	1.5	Jul-14	Dec-15
Power System Projects	$5.1	2	Jan-16	Dec-17
New Chlorine Contact Basin	$4.0	3.5	Jul-16	Dec-20
New Headworks	$10.0	3.5	Jan-19	Jul-22
Additional MBR Equipment	$12.0	4	Aug-19	Jul-23
Building-Headquarters for Sewer Line Maintenance	$0.3	1.5	Jul-14	Dec-15
WAS Thickening Facility	$17.0	3.5	Jul-23	Dec-26
SCADA System Upgrades	$1.0	No specific projects have been assigned at this time		
Total	**$263.00**			

Notes:
(1) Costs are in August 2006 dollars.

As mentioned earlier, only 38 of the 50 expansion projects identified from the CSMPs, along with the 24 projects identified by the City, are included in the City's CIP. There are no

set schedules for the 62 collection system projects. The project costs are assumed to be distributed evenly over a 10-year period from FY 2007/2008 through FY 2016/2017 for the CSMP derived projects (total of $37.7 million, August 2006 dollars), and over a 50-year period from FY 2007/2008 through FY 2055/2056 for the 24 projects identified by the City (total of $418 million, August 2006 dollars). For the 24 projects identified by the City, only costs for up to FY 2024/2025 are included in the CIP.

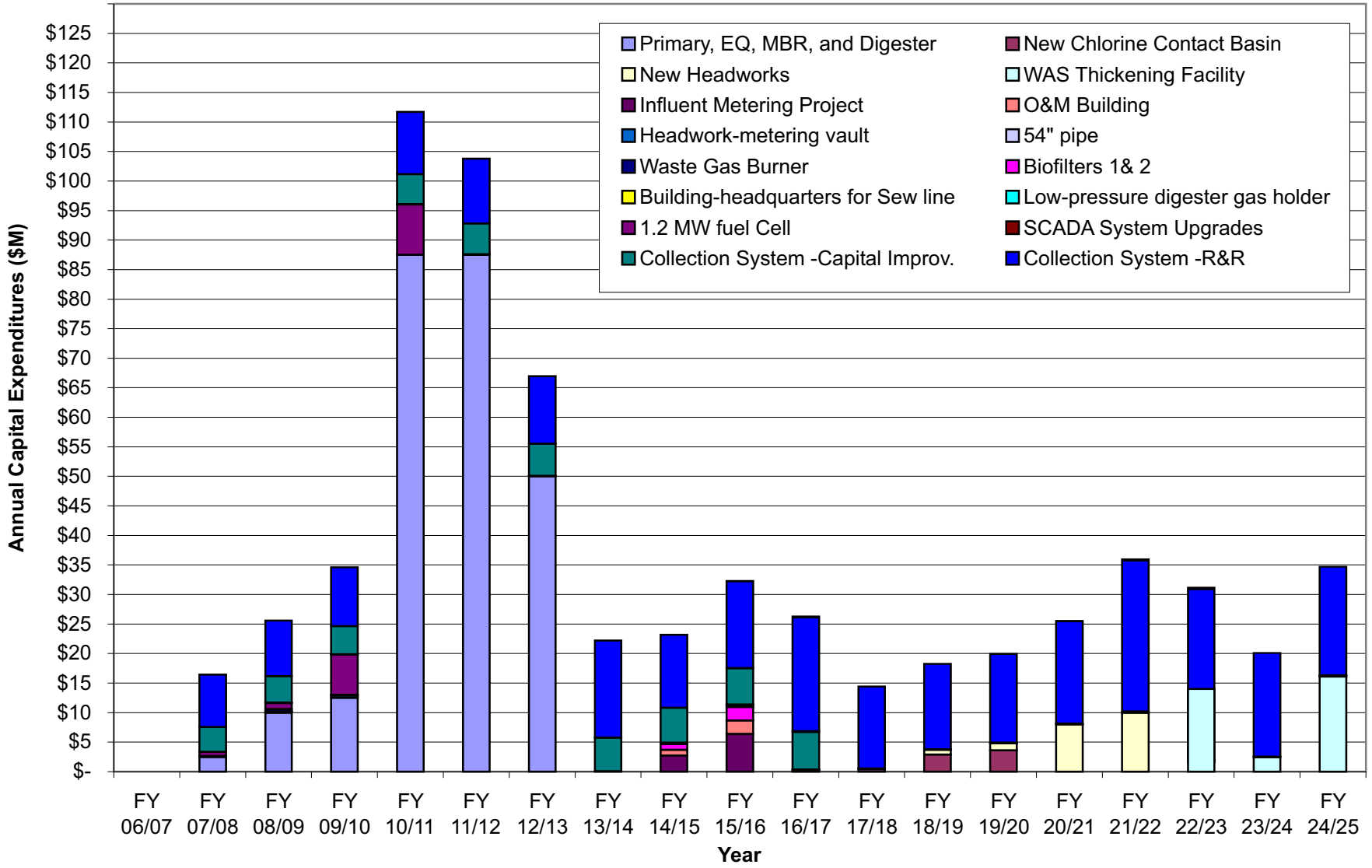
For the treatment systems, the total estimated capital costs in inflated dollars through FY 2024/2025 are approximately $373 million. For the collection system, the total estimated capital costs in inflated dollars for the CSMP derived projects over the 10-year period are approximately $53 million, and the estimated costs for the 24 projects identified by the City through FY 2024/2025 are approximately $239 million. The total estimated CIP project costs in inflated dollars for the Integrated Master Plan is approximately $666 million. About 44 percent of the $666 million CIP comes from the collection system. Figure ES.4 shows the annual capital expenditures.

1.14 VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES

Volume 11 presents the MPM™ and the results of assessments made using the Financial Planning Tool™. It presents the recommendations in regards to the user rates and connection fees.

1.14.1 Master Plan Manager™

The purpose of this chapter is to explain the overall functionality of the MPM™ and how the City can use it in the future to meet their needs. MPM™ allows the user to create and update numerous options for growth and regulatory assumptions that can be combined in a variety of ways to create many scenarios. The software provides immediate scenario results that can be compared and evaluated against one another. These analyses can help the City identify and understand planned trigger points for various projects, the impacts to capacity and effluent quality from the different growth options, and the relative impacts to the CIP in terms of cost and scheduling. All together, the City can understand potential future capacity bottlenecks, and potential failures to meet effluent quality requirements based on various growth options and selection of treatment processes. This information will allow the City to plan for flexibility and react to uncertainty. MPM™ results will allow the City to implement projects just in time, save their customers money, and continue to provide high quality, uninterrupted service.



ANNUAL CAPITAL EXPENDITURES

FIGURE ES.4

1.14.2 Financial Planning Tool™

The purpose of this chapter is to present the results of an assessment of the rates charged to the treatment and collection system customers to determine if they are adequate to address current and future O&M and capital costs. The following summarizes the recommendations presented to the City in regards to the user rates and connections fees:

1. Connection Fees - Implement the recommended methodology of calculating connection fees for commercial and industrial customers on an equivalent dwelling unit (EDU) basis and flow and load basis, respectively. It is recommended that the City increase the Residential Connection Fees from $2,684 to $3,472 per EDU. Based on this fee per EDU, Commercial and Industrial Connection Fees would be revised according to each category/users EDU contribution to the system. In subsequent years, it is recommended that the Connection Fees be increased based on construction cost inflation.
2. User Rates - In order to meet future annual debt coverage requirements and financial obligations for O&M, it is recommended that the City increase the annual sewer user rate from $13.05 to $19.77 per EDU in FY 2008/09. It is also recommended that the City implement annual increases of between 5.5 and 17 percent in the subsequent 4 years. This projection should be revised on a periodic basis, as the City updates its O&M and capital cost projections.

1.15 VOLUME 12: ASSET MANAGEMENT

The purpose of the asset management volume is to provide repair/replacement recommendations for the existing facilities for the overall CIP that is produced as a result of the work completed in the Integrated Master Plan. A prioritized list of R&R projects was developed based on the condition assessment and analyses of each asset's condition, risk, vulnerability, remaining useful life, and associated costs. Accordingly, it was recommended that assets in poor condition (Condition 4 or 5) be assessed annually and a comprehensive assessment of all of the aboveground RWQCP assets be conducted every 3 to 5 years. Based on the information obtained in the condition assessment, 26 R&R projects with Condition 4 or 5 have been identified for inclusion in the City's CIP. Most of the 26 projects will be bundled with the planned projects described in other volumes of the master plan.

Besides identifying the list of R&R projects, the information collected has been input and populated in the Water/Wastewater Asset Manager™ (WAM™) software for City staff to access and update in the future.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 1: INTRODUCTION

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 1: INTRODUCTION

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Chapter 1

INTRODUCTION

1.1 PURPOSE

The purpose of this Basis of Planning volume is to document the basic planning criteria used in facility planning for the City of Riverside (City) Integrated Master Plan. This volume should be periodically reviewed and updated as needed. Revisions may be required to reflect new operational modes, changes in influent flow quantities or characteristics, changes in discharge requirements that could impact the level of treatment, and/or new design philosophies.

This Chapter 1 of the Basis of Planning Volume provides an introduction to the volume. It outlines the goals and objectives for the Integrated Master Plan and presents the organizational structure of the Master Plan Volumes.

1.2 BACKGROUND

The City Sewerage System Division is responsible for collection and treatment of wastewater flows generated within the City and the communities of Jurupa, Rubidoux, Edgemont, and Highgrove. The City's collection system consists of over 800 miles of gravity sewers ranging from 6 to 48 inches in diameter and 18 wastewater pump stations. The wastewater pump stations range in size from 100 gallons per minute (gpm) up to 2,000 gpm. Treatment is provided at the Regional Water Quality Control Plant (RWQCP), which provides preliminary, primary, secondary, and tertiary treatment for a rated capacity of approximately 40 million gallons per day (mgd).

1.3 GOALS AND OBJECTIVES

The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities, including both treatment and collection system facilities, to identify and plan for expansion and replacement needs. The Integrated Master Plan will incorporate the findings and recommendations of previous and ongoing plans and studies. More specific goals for the Integrated Master Plan include:

- Develop a wastewater system capital improvement plan (CIP).
- Develop an asset management program that will provide capital rehabilitation and replacement schedules and costs.
- Perform financial planning and establish rates to fund operations, maintenance, and the CIP.
- Develop an Environmental Impact Report.

- Identify, analyze, and recommend alternatives for various wastewater treatment system processes.
- Create easily updateable Volumes and Chapters within the Integrated Wastewater Master Plan.
- Use the Master Plan Manager™ (MPM™) software so the City can modify the CIP, financial plan, and rates based on needed changes to the planning criteria (i.e., regulatory and influent flow projection changes).

1.4 ORGANIZATIONAL STRUCTURE

The Integrated Master Plan is organized into thirteen Volumes, as described in Table 1.1.

Table 1.1 Integrated Master Plan Volumes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Volume 1: Executive Summary

Volume 2: Basis of Planning

Chapter 1: Introduction
Chapter 2: Regulatory Requirements
Chapter 3: Population and Flow Projections
Chapter 4: Basis of Cost Estimates

Volume 3: Wastewater Collection System

Chapter 1: Wastewater Collection System

Volume 4: Wastewater Treatment System

Chapter 1: Existing Facilities
Chapter 2: Summary of Planning Studies
Chapter 3: Process Design and Reliability Criteria
Chapter 4: Plant Hydraulics
Chapter 5: Preliminary Treatment
Chapter 6: Primary Treatment
Chapter 7: Secondary Treatment
Chapter 8: Tertiary Treatment
Chapter 9: Disinfection
Chapter 10: Recycle Stream Management
Chapter 11: Plant Utilities and Support Facilities
Chapter 12: Primary Effluent Equalization

Table 1.1 Integrated Master Plan Volumes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Chapter 13: Proposed Expansion Plan and Site Layout

Chapter 14: Implementation Schedule and Cost

Volume 5: Air Quality and Emissions Control

Chapter 1: Review of the 2005 Odor Control Master Plan

Chapter 2: Review Applicable Regulatory Requirements

Volume 6: SCADA Management Plan

Chapter 1: SCADA Management Plan

Volume 7: Reclamation and Reuse

Chapter 1: Reclamation and Reuse

Volume 8: Solids Treatment and Handling

Chapter 1: Existing Facilities

Chapter 2: Summary of Planning Studies

Chapter 3: Design Criteria

Chapter 4: Solids Production and Thickening Options

Chapter 5: Solids Processing

Chapter 6: Solids Dewatering

Chapter 7: Solids Disposal

Chapter 8: Implementation Schedule and Cost

Volume 9: Energy Management

Chapter 1: Existing Energy Systems

Chapter 2: Summary of Planning Studies

Chapter 3: Existing and Future Energy Uses

Chapter 4: Energy Saving Options

Chapter 5: Power Supply Alternatives

Chapter 6: Standby Power

Chapter 7: Implementation Schedule and Cost

Volume 10: Capital Improvement Plan and Overall Implementation Schedule

Chapter 1: Capital Costs and Implementation Schedule

Chapter 2: Operation and Maintenance Cost

Table 1.1 Integrated Master Plan Volumes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Volume 11: Financial Plan and User Rates and Fees

- Chapter 1: Master Plan Manager™
- Chapter 2: Financial Planning Tool
- Chapter 3: Master Plan Manager™ Help Menu

Volume 12: Asset Management

- Chapter 1: Strategic Vision
- Chapter 2: Condition Assessment

Volume 13: Environmental Impact Report (EIR)

- Public Draft EIR
- Final Draft EIR
- Final Mitigation Monitoring and Reporting Program Report
- Final Response to Comments
- Final Statement of Overriding Consideration and Findings of Fact
- Notice of Determination

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 2: REGULATORY REQUIREMENTS

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 2: REGULATORY REQUIREMENTS

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Chapter 2

REGULATORY REQUIREMENTS

2.1 PURPOSE

This City of Riverside (City) Integrated Master Plan will be used to guide the City's decisions regarding expansion and modernization of the wastewater collection and treatment facilities. In addition to estimating the additional treatment capacity required to service the needs of a growing population, the master plan attempts to anticipate the level of treatment required to comply with state and federal regulations now and in the future.

Current regulations are identified in the City's existing permits. The purpose of this chapter is to assess how these permits are likely to change over the next 10 to 20 years, and how those changes will affect design, construction, operations, and maintenance decisions at the City's Regional Water Quality Control Plant (RWQCP). The focus of this assessment is on regulations relating to the City's National Pollutant Discharge Elimination System (NPDES) and air quality permits.

2.2 CONCLUSION AND RECOMMENDATIONS

The regulatory brainstorming sessions that were held identified the following issues as high priority regulatory concerns that would need to be addressed during the master planning period:

- More restrictive residual chlorine limits may necessitate alternative disinfection strategies and/or continuously effective dechlorination controls. These limits may also require changes in operations and maintenance practices.
- More restrictive limits on disinfection byproducts (including trihalomethanes, cyanide, and dechlorinating compounds) may necessitate alternative disinfection strategies and/or additional treatment to reduce the concentration of these byproducts in the final effluent.
- New effluent limits for *E. coli* may necessitate alternative disinfection strategies.
- New collection system, Sanitary Sewer Overflow (SSO); Capacity, Management, Operation, and Maintenance (CMOM); and stormwater requirements may impact wastewater collection and treatment capacity and maintenance programs.
- Long-term trends in influent salinity may make it more difficult to comply with the existing Total Dissolved Solids (TDS) limitations specified in the NPDES permit.
- Increasing regulatory concern over excess nutrient loading may result in more stringent effluent limits for nitrogen and phosphorous. Ammonia limits may also become more restrictive.

- Continued compliance with Whole Effluent Toxicity (WET) limits may be adversely affected by increasing use of treatment compounds such as alum and polymers.
- More restrictive effluent limits for aluminum may necessitate revisions to the pretreatment program, changes to in-plant treatment strategies, adoption of advanced waste treatment alternatives and/or efforts to develop site-specific water quality criteria.
- Additional odor control and emission measures may be necessary due to more stringent South Coast Air Quality Management District (SCAQMD) rules.
- New electronic reporting requirements may necessitate upgrades to Supervisory Control and Data Acquisition (SCADA) systems and other database management tools.
- More restrictive water quality standards for pesticides may necessitate additional advanced waste treatment.
- More stringent limits on bacterial concentrations in stormwater may cause Municipal Separate Storm Sewer Systems (MS4s) agencies to intercept and divert dry-weather flows and first-flush storm flows to sanitary sewers for treatment.

Participants in the brainstorming session concluded that many of the high priority issues could be dealt with most effectively by remaining actively engaged with the Regional Water Quality Control Board's (Regional Board) watershed-wide planning efforts. Participants also agreed that the City's ongoing efforts with other dischargers in the region were essential to ensure that new regulatory requirements reflect relevant local factors based on the best available scientific information.

It was also clear that some regulatory issues may require new or improved treatment processes in order to ensure continued compliance. It was decided that the following treatment alternatives should be evaluated when developing the master plan:

- Microfiltration/Membrane Bioreactors (MBR) - MBR would be evaluated because it can help the City address the regulatory issues of compliance with pathogens, toxicity testing and endocrine disruptors.
- Ultraviolet (UV) disinfection - UV would be evaluated because it can help the City address the regulatory issues of compliance with disinfection byproducts, cyanide formation in the chlorine contact basin and TDS.
- Ozone disinfection - Ozone would be evaluated because, in conjunction with MBR, it can help the City address the regulatory issues of compliance with endocrine disruptors and also addresses disinfection byproducts and cyanide formation in the chlorine contact basin.
- Alum precipitation - All processes that add aluminum will be scrutinized because of the regulatory issue of compliance with an NPDES permit aluminum limit.

- Continued use of wetlands treatment for effluent polishing - Continued wetlands treatment, at the existing level, will be addressed because it changes the chemical signature of the effluent, which addresses the regulatory issue of compliance with Total Inorganic Carbon (TOC) limits.
- Odor control for primaries - Odor control would be evaluated because it can help the City address the regulatory issues of compliance with future SCAQMD regulations and address potential odor complaints from neighbors.

2.3 BACKGROUND

Environmental regulations are constantly evolving and, with limited exceptions, nearly always become more stringent, potentially requiring more advanced treatment to assure higher levels of water quality. Because these regulations are often discussed for several years prior to being incorporated into wastewater or air quality permits, it is possible to anticipate some future requirements.

Carollo Engineers contracted with Risk Sciences, a firm specializing in water quality standards regulation, to conduct a "brainstorming session" with City staff. The purpose of this session was to identify specific requirements likely to arise over the next 10 to 20 years, and ascertain whether the probability of new discharge limitations was sufficiently high to merit inclusion in the master plan.

Carollo Engineers and Risk Sciences prepared a summary table (Appendix A) describing more than two dozen areas in which state and federal regulators were presently considering significant changes to water quality standards and/or NPDES permitting. This table was used to stimulate discussion among the assembled experts.

The brainstorming session was successful in establishing a consensus about which new regulatory requirements should be considered in development of the master plan. Results from the session were documented in a Conference Memorandum distributed to the participants on September 15, 2006 (Appendix B).

2.4 DISINFECTION ISSUES

2.4.1 More Restrictive Residual Chlorine Limits

The State Water Resources Control Board is presently developing a new policy which is likely to result in significantly more restrictive effluent limits for residual chlorine. That policy, if adopted, would also eliminate existing provisions in the City's NPDES permit that allow infrequent, short-duration increases in residual chlorine concentration to occur without violating an effluent limitation. These "pulses" are an unavoidable result of normal maintenance activities and an inherent limitation in the water quality monitoring equipment

to continuously monitor and control chlorine residuals at the low levels required by their NPDES permit.

The master plan will evaluate alternative disinfection processes (including UV and ozone) and hybrid processes that combine such alternatives with limited use of chlorine. In addition, as a regulatory strategy, the City will consider the utility of seeking a revised point-of-compliance for measuring residual chlorine concentrations near the end of the effluent channel before it merges with the Santa Ana River.

2.4.2 Disinfection Byproducts

More restrictive chlorine limitations may necessitate increased use of dechlorinating compounds. These compounds may interfere with normal reproduction and growth among standard organisms used to perform whole effluent toxicity tests. Therefore, the master plan will investigate alternative disinfection strategies that eliminates the need for dechlorination.

Recent research indicates that cyanide concentrations may be increased as a result of the chlorination process. Therefore, it is important to ensure the City is collecting the data needed to properly assess this risk. In particular, more information is needed to characterize the concentration of free cyanide versus total cyanide before and after the chlorination process.

2.4.3 Bacteria

In 2007, it is likely that the Regional Board will adopt new water quality standards for E. coli to protect recreational uses in freshwater streams. No changes in treatment strategy are expected to be necessary to meet the new standard if it is added to the NPDES permit as an effluent limit. However, new Department of Health Services (DHS) regulations may require the City to meet Title 22 reuse disinfection requirements of a 450 Concentration X Time (CT) for both recycled water and discharges to the river. The master plan will, therefore, evaluate how best to achieve compliance with such a requirement.

2.5 NUTRIENT CONTROL

The Environmental Protection Agency (EPA) continues to develop and publish new guidance on establishing appropriate water quality standards for nutrients. If state authorities implement this guidance, it is possible that more stringent effluent limits for phosphorous and nitrogen will be enacted. However, it is unlikely that such requirements would be imposed in the near future.

The Santa Ana River is not presently listed as impaired by excessive nutrient concentrations. The process of adopting new water quality standards, gathering data needed to add the River to the state 303(d) list of impaired water bodies, and developing a Total Maximum Daily Load (TMDL) with more restrictive waste load allocations will require

at least 10 years to complete. Final compliance with any projected waste load allocation would not be mandated for approximately 10 years beyond that.

Therefore, this issue was deemed a "low priority" for the current planning horizon. However, it will be included in the master plan as a "minor factor" that may affect selection of other treatment alternatives. The master plan design criterion for effluent nitrogen will be 8.0 mg/L as total inorganic nitrogen.

2.6 SALINITY CONTROL

Long-term trends in supply quality and greater use of home water-softening units will continue to increase TDS concentrations in the final effluent. Therefore, it is important to avoid treatment processes that may further increase effluent salinity. In particular, the continued use of common disinfection chemicals must be reassessed to determine whether such a treatment strategy is sustainable over the long-term without violating the TDS limitations in the permit. This is especially true if the 450 CT requirement were applied to all discharges. The master plan will evaluate alternative disinfection strategies with respect to their impact on meeting salinity limitations.

2.7 METALS CONTROL

2.7.1 Aluminum

Effluent discharged by the City consistently complies with all existing permit limitations for trace metals. However, permits recently adopted for Eastern Municipal Water District contain more restrictive effluent limits for aluminum that may be difficult to comply with if added to the City's permit at some future date. The City believes the most appropriate strategy is to develop a site-specific water quality objective for aluminum. In addition, the possibility of more restrictive aluminum limits will be considered before recommending increased use of alum to control phosphorous or to improve flocculation.

2.7.2 Other Trace Metals

Elsewhere in the region and in the state, more restrictive effluent limits are being considered for mercury, selenium, arsenic, and other trace metals. None of these are deemed to be a high priority concern for the City. The City will continue to maintain its active monitoring program, especially the fish flesh assessment, to demonstrate the absence of mercury impairment in the Santa Ana River.

2.8 TOXICITY CONTROL

The City consistently passes the whole effluent toxicity tests that are performed on final effluent samples. Consequently, the current NPDES permit does not contain a WET limit. However, the State Water Resources Control Board is developing a new policy to govern

application of toxicity limits in NPDES permitting. It is likely that WET limits may be made a default requirement for Publicly Owned Treatment Works (POTWs).

Therefore, the master plan will carefully consider how various treatment alternatives may adversely affect compliance with WET requirements. Specifically, higher salinity concentrations, as might result from increased use of common disinfection chemicals, is known to interfere with normal reproduction in the toxicity test. Similarly, chemicals used to enhance treatment efficiency and effectiveness (e.g., alum or polymers) may also cause inadvertent toxicity to standard test organisms. Unintended side-effects of various treatment alternatives will be considered when developing the master plan.

In addition, more restrictive limitations on pesticide residuals are being imposed in this region (e.g., Newport Bay) and in other regions (e.g., San Francisco). Previous experience at other local dischargers (e.g., Inland Empire Utilities Agency (IEUA)) indicates that it may be necessary to enhance treatment performance to reduce pesticide concentrations in the final effluent in order to continue passing the whole effluent toxicity test consistently. To date, this has not been an issue at the City; however, the master plan will consider this as a "minor factor" when evaluating treatment alternatives for long-term compliance.

2.9 CARBON CONTROL

The City presently owns and operates a constructed wetlands in the Hidden Valley area. Originally developed to aid in nutrient removal, such wetlands may also be useful for reducing trace metals, complex organics, and providing a carbon matrix in the final effluent that is more similar to that found in natural streams. Due to the present regulatory environment, it is unlikely that the wetlands can be expanded at this time. However, the City plans to continue to use the existing wetlands as an effluent polishing treatment process.

2.10 PERMIT REPORTING

The State Board is committed to adopting an electronic compliance monitoring and reporting system. Field-testing of the new California Integrated Water Quality System (CIWQS) project is nearly complete and the Regional Board will require all dischargers to begin using the new system in the next year or so.

Therefore, it is advisable to reevaluate the capability of the City's current SCADA and Laboratory Information Management Systems (LIMSs) to ensure that they are well integrated and able to support the new electronic reporting requirements. This will be a high priority consideration as the master plan is developed.

2.11 AIR QUALITY COMPLIANCE

It is anticipated that air quality regulations will become more stringent in the master plan timeframe. These regulations include new air dispersion modeling requirements, revised

risk assessments for toxic air contaminants, more stringent Best Available Control Technology (BACT) requirements, and more stringent diesel engine requirements. In addition, the master plan will address more stringent odor control requirements, including covering primary clarifiers.

2.12 OTHER ISSUES

A number of other issues were identified as likely to affect NPDES permit requirements in the distant future. These include adoption of sediment objectives, effluent limits on endocrine disrupters, and dry weather diversions from the MS4 system. However, in each instance, it was believed that more stringent limits were unlikely to be imposed for at least 15 to 20 years. Therefore, the revised Master Plan will not address these concerns.

Appendix A

WATER QUALITY ISSUES SUMMARY TABLE

Brainstorming Future Water Quality Issues at Riverside Wastewater Treatment Plant

Regulatory Issue	Priority	Compliance Implications
Chlorine	High	
Disinfection By-products a) Dechlorinating Compounds b) Trihalomethanes c) Cyanide	High	
Pathogens a) E. coli limits b) "Regrowth" studies	High High	
Sanitary Sewer Overflows	High	
Electronic DMR Reporting	High	
CMOM Implementation	High	
OCWD Water Rights Application	High	
Stormwater Program Coordinated Implementation	High	
Watershed Monitoring Programs	High	

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Brainstorming Future Water Quality Issues
at Riverside Wastewater Treatment Plant
(continued)

Regulatory Issue	Priority	Compliance Implications
Total Organic Carbon	Medium	
Dry Weather Runoff Treatment	Medium	
Pesticides a) Organophosphates b) Pyrethrins	Medium	
Nutrients a) Phosphorous b) Nitrogen c) Nitrates	Medium	
Perchlorate	Medium	
Santa Ana Sucker Habitat	Medium	
Stormwater Treatment	Medium	
Revised Ammonia Standards	Medium	
Capacity Requirements a) 85% rule b) I & I c) Jurupa d) Largest process offline rule	Medium	
Salinity a) TDS b) Individual Ions (chloride)	Medium	
Whole Effluent Toxicity (WET) a) Ionic interference b) Pesticides c) Treatment Polymers d) Alum	Medium	
Terrorism & Security Precautions	Medium	

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Brainstorming Future Water Quality Issues

at Riverside Wastewater Treatment Plant

(continued)

Regulatory Issue	Priority	Compliance Implications
Endocrine Disrupters a) Pharmaceuticals b) Treatment Polymers c) Pesticides d) Hormones e) Caffeine, Acetametaphin	Low	
Metals a) Copper b) Lead c) Mercury d) Arsenic e) Selenium f) Cadmium g) Chromium h) Silver i) Aluminum	Low	
Legacy Remediation	Low	
Sediment Objectives	Low	
TMDLs a) Receiving water > 0 b) Load Allocations c) Mandatory Offsets	Low	
Low Level Organics (detection driven limits)	Low	
Viruses & Protozoa a) Direct Virus Assessment b) Giardia & Cryptosporidium	Low	
Oil & Grease	Low	
Biosolids Disposal a) Disinfection b) Trace Organics c) Trace Metals d) Loss of Disposal Sites	Medium	

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Advanced Waste Treatment Probability Assessment

Treatment Technology	Driving Factor	Planning Priority
Reverse Osmosis		
Microfiltration		
Activated Carbon		
Ion Exchange		
Equalization Basins		
UV Disinfection		
Ozone Disinfection		
Biological Nutrient Removal		
Polymer Management		
Chlorination Contact		
Alum Precipitators		
Wetlands Polishing		
CIWQS Reporting System		
Biosolids Disinfection		

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Appendix B

CONFERENCE MEMORANDUM

ROUTE

CONFERENCE MEMORANDUM

Project:	City of Riverside Integrated Master Plan	**Conf. Date:**	September 6, 2006
Client:	City of Riverside (City)	**Issue Date:**	September 15, 2006
Location:	City of Riverside Office		

Attendees:

City of Riverside:	Risk Sciences:	Carollo:
Sandy Caldwell (SC)	Tim Moore (TM)	Naray Anan
Rod Cruze (RC)		Jeff Berlin
Steve Schultz (SS)		Petros Dimitriou
		Doug Lanning (DJL)
		Susanna Li (SL)
		Coenraad Pretorius (CFP)
		Toby Weissert (TW)

Purpose:	Regulatory Brainstorming Meeting		
Distribution:	Attendees, Mark Bartlett, Tracy Clinton, Shawn Dent, Robert Grantham, Tom Mossinger, Amily Zhang, Steve McDonald, Priscilla Bloomfield	**File:**	7472A.00

Discussion:
The following is our understanding of the subject matter covered in this conference. If this differs with your understanding, please notify us.

SUMMARY OF DECISIONS MADE

The brainstorming session lead to two conclusions:

1. Most of the future regulatory issues will need to be addressed by developing regulatory strategies.

2. Some future regulatory issues will require treatment processes to meet them. It was decided that the following treatment processes would be used as alternative treatment scenarios in the master plan evaluations:
   A. Microfiltration/MBR.
   B. Equalization basins.
   C. UV disinfection.
   D. Ozone disinfection.
   E. Alum precipitators for alum control.
   F. Need cover for chlorine contact basin.
   G. Wetlands Polishing: Keep wetlands as treatment process.

H. Alternatives to handle biosolids.
I. Late process aeration system.
J. Odor control for primaries.

ACTION ITEMS - CITY

Item	Actions	Responsible Party	Due Date
9-06-01	Need to decide whether the dry weather runoff will be included in the Master Plan.	SC	9/15/2006

ACTION ITEMS - CAROLLO

No actions required of Carollo.

MEETING MINUTES

1. Introductions:
   A. TW introduced everyone who attended the meeting and the individual's responsibility for the brainstorming session.
   B. TW presented the purposes and goals of the meeting. He stated the following as the main goals:
      1) Purpose:
         a) To brainstorm potential future regulations.
         b) To decide on the likelihood of the particular regulation being implemented.
         c) To decide upon a method for handling that regulation (compliance strategy). The compliance strategy could be an advanced treatment process or a regulatory approach strategy.
         d) To decide upon a list of the compliance strategies that will be included as alternative treatment scenarios in the master plan.
      2) Goal:
         a) The ultimate goal is to develop a list of alternative treatment scenarios for the master plan.

2. Expectations:
   A. TW stated that each of attendees has a specific focus area that the group is relying on to provide the expertise that would allow the group to meet the ultimate goal of developing the list of alternative treatment scenarios for the master plan.
   B. TW briefly described each of the person's role:
      1) City Personnel: After participating in the discussions of regulations, to make the final decision about which regulations are likely to be implemented. After those decisions are made, to further participate in the discussions and make the final decision about which compliance strategies to include in the list of alternative treatment scenarios for the master plan.
      2) Carollo Personnel: Act as the main source of knowledge for the treatment processes that will comprise part of the compliance strategies. To provide suggestions on processes that will allow the future facilities to meet those anticipated new standards.

3) Tim Moore: Facilitate and participate in the discussion about likelihood and compliance strategies for each of the regulations, lend his experience of water quality regulatory issues and to facilitate decisions.

3. Regulatory Brainstorming and Compliance Strategies:
   A. Regulatory issues were divided into three categories, high, medium and low priorities. The prioritize scheme was based on the potential changes in regulation in relation to the permit cycle. Issues that were listed as high priority are likely to happen during this permit cycle. Issues that were listed as medium priority are likely to happen in the next two permit cycles; while the low-priority issues would probably take place no sooner than two permit cycles. The following tables summarize the highlights of discussions and compliance strategies of each regulatory issue.

Table 1 Summary of Discussions on Water Quality Regulatory Issues (High Priority)

Regulatory Issue	Discussions and Compliance Implications
Chlorine	Discussions: • Cannot consistently measure low levels of chlorine in the field accurately. • Use alternative analyzers such as ORP. Compliance Strategies: • Use an alternative permit strategy of adding a point of compliance for chlorine a long distance down the effluent channel. • Use an alternative disinfection process (hybrid chlorine and UV systems combined).
Disinfection By-Products	Discussions: • THMs are low priority. • Measuring free cyanide is a concern. • Review where sampling should take place. Compliance Strategies: • Add a point of compliance for cyanide a long distance down the effluent channel. • Site-specific objective for cyanide. • Post-aeration structure.

Table 1 Summary of Discussions on Water Quality Regulatory Issues (High Priority)	
Regulatory Issue	**Discussions and Compliance Implications**
Pathogens	Discussions: • *E. coli* limits will likely be instituted and total + fecal coliform will be for performance basis in future. • Purely a regulatory strategy. • May need to meet 450 CT for both discharges and recycled water. Compliance Strategies: • Multiple Barriers: UV, ozone. • Use MBR to reduce particle size.
Sanitary Sewers Overflows/CMOM	Discussions: • One of the biggest problems for the City. • Master Plan is only addressing capacity issue. • Failure due to pump station problems. Compliance Strategies: • Better maintenance.
Electronic DMR Reporting	Discussions: • Will happen. • Potential SCADA issue with implementation.
OCWD Water Rights Application	Discussions: • Need to protect future right to reclaim. • City should expand reclaim/reuse. • Need City legal department involvement. Compliance Strategies: • Satellite treatment strategies-to keep OCWD at bay.
Stormwater Program Coordination Implementation	Discussions: • Will impact on staffing/information gathering and sharing. • Need to know what type of chemicals in the storm water.

Table 1 Summary of Discussions on Water Quality Regulatory Issues (High Priority)	
Regulatory Issue	**Discussions and Compliance Implications**
Watershed Monitoring Programs	Discussions: • Will lead to the issues such as requiring high SRT treatment if mercury is an issue. • More restrictive nutrient limits might occur: TIN and phosphorous. Compliance Strategies: • Be present in regulatory process to make sure City defends status quo, as much as possible.

Table 2 Summary of Discussions on Water Quality Regulatory Issues (Medium Priority)	
Regulatory Issue	**Discussions and Compliance Implications**
Total Organic Carbon	Discussions: • Use wetlands to help change organic carbon signature of discharge.
Dry Weather Runoff Treatment	Discussions: • This is inevitable but will it occur in 5 to 10 or 10 to 15 years. • Will be a capacity issue. • Flood control board needs to look at how to control storm water. • Need a study to determine the storm flow quantity and quality - should this be part of the master plan? Compliance Strategies: • Separate treatment train just for storm water or treat in RWQCP processes.
Pesticides	Discussions: • Main concerns are organophosphates and Pyrethrins. • San Francisco Regional Board might want to switch to numeric limits on oganophosphates; might eventually get in our permits also. Compliance Strategies: • Use of High SRT and high MLSS concentrations. • Use big clarifiers. • Use MBR at high MLSS.

Table 2 Summary of Discussions on Water Quality Regulatory Issues (Medium Priority)	
Regulatory Issue	**Discussions and Compliance Implications**
Nutrients	Discussions: • 10+ years timeline. • Phosphorus is the main concern; will be driven by new EPA guidance.
Perchlorate	Discussions: • Communities may force regulators to turn to zero tolerance. • Currently mainly wellhead treatment.
Santa Ana Sucker Habitat	Discussions: • Need to keep them out of the wetlands, will be difficult because hydraulics have changed. • Need to add fish screens/net to keep fish out.
Revised Ammonia Standards	Discussions: • Standard will go below 1 mg/L; currently at 5 mg/L. Compliance Strategies: • If nutrient levels are met, this will also be met.
Capacity Requirements	Discussions: • Nothing specific.
Salinity	Discussions: • Potential issue if TDS rises. • If 450 CT is required/enforced, TDS will become an issue. • Need to conduct study to determine TDS/salinity level before and after chlorination to see if 450 CT will cause violation. • Chloride levels if >200 mg/L could cause toxicity test failures.
Whole Effluent Toxicity (WET)	Discussions: • Might have issues with treatment polymers and alums. • EPA implementation guidance for WET. Compliance Strategies: • Side stream treatment.
Terrorism and Security Precautions	Discussions: • Not an issue.

Table 3 Summary of Discussions on Water Quality Regulatory Issues (Low Priority)	
Regulatory Issue	**Discussions and Compliance Implications**
Endocrine Disruptors	Discussions: • Most likely two permit cycles away. Compliance Strategies: • Ozone can be used to treat these constituents with 3 mg/L and 60-minute contact time. • MBR is the likely choice for the City in the future because high SRTs will likely remove many endocrine disruptors.
Metals	Discussions: • Aluminum is hardness dependent and will be regulated more closely in the future. Compliance Strategies: • Regulatory strategies, i.e., site-specific objectives.
Legacy Remediation	Discussions: • TDS, nitrogen, and bacteria.
Sediment Objectives	Discussions: • Inevitable but beyond 10 years. • Most likely metals related (i.e., copper).
TMDLs	Discussions: Nothing specific.
Low-Level Organics	Discussions: Detection driven limits.
Viruses and Protozoa	Discussions: Technology driven limits.
Oil and Grease	Discussions: Nothing specific.
Biosolids Disposal	Discussions: Current plan is to work with Enertech.

Table 4 Summary of Discussions on Air Quality Regulatory Issues	
Regulatory Issue	**Discussions and Compliance Implications**
Odor Nuisance (High)	Discussions: • Primary clarifier covers for Plant 1 may be needed. • City would like to evaluate the option of equalization basins after primaries.
Major Source Status (High)	Discussions: • RWQCP is a Title 5 plant. Need to look at numbers of continuous run time.
• Air Dispersion Modeling (High) • Risk Assessment for Toxic Air Contaminants (High) • More Stringent BACT Requirements (High) • Diesel Emission (Likely)	Discussions: • These items are currently required or inevitable in the near future. • There is technology to address these issues, however, it can be expensive.
Cap on CO_2 Emission (Unlikely)	

4. Summary
   A. Regulatory strategies can be developed to handle most issues that were presented.
   B. Chlorine: Need to determine what are the alternative disinfectants.
      1) City would like to get rid of bringing chemicals on site, i.e., if continue with chlorine, City would like to generate on site or replace with UV or ozone.
   C. City needs to decide how to handle the extra capacity, which the dry weather runoff could bring to the plant.
      1) Currently this is not included in the Master Plan.
      2) **Action: City will make decision by September 15 whether to include this in the Master Plan.**
   D. Covering the new primaries for odor control purposes may be needed.
   E. Evaluate installation of MBR as a future treatment.

5. Treatment Assessment:
   A. The group went over a list of possible treatment alternatives and discussed the priority of including these technologies as alternative treatment scenarios for the master plan. The following is a list of technologies that were discussed:
      1) With Low Planning Priority:
         a) Reverse osmosis.
         b) Ion exchange.

c) Biological nutrient removal.
d) Activated carbon.

2) With High Planning Priority:
a) Microfiltration/MBR.
b) Primary equalization basins.
c) UV disinfection.
d) Ozone disinfection.
e) Alum precipitators for alum control.
f) Chlorine contact basin covers.
g) Wetlands Polishing: Keep wetlands as treatment process.
h) Alternatives to handle biosolids disposal.
i) Post disinfection aeration tank or other form of post aeration.
j) Odor control for primaries.

Prepared By:

Susanna Li, P.E.

SL:blm

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 3: POPULATION AND FLOW PROJECTIONS

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 3: POPULATION AND FLOW PROJECTIONS

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Chapter 3

POPULATION AND FLOW PROJECTIONS

3.1 PURPOSE

The purpose of this chapter is to present population projections developed by others and to use these population projections to help develop a projection of the influent wastewater flow quantities and characteristics through the year 2025 for the Riverside Regional Water Quality Control Plant (RWQCP). The flow quantities and characteristics projections will be used as a basis for the design criteria in the Integrated Master Plan. A separate set of flow projections for the collection system is presented in Volume 3, Chapter 1 - Wastewater Collection System. These flow projections are for the City of Riverside's (City) collection system and reasonably agree with the RWQCP influent flow projections that are presented in this chapter.

3.2 BACKGROUND

The Riverside RWQCP is currently providing treatment and disposal of wastewater generated within the City and from the Jurupa, Rubidoux, and Edgemont Community Services Districts (CSDs). Treatment for wastewater will also be included for the community of Highgrove, beginning in 2008.

The RWQCP wastewater flow quantities and characteristics assumed in the Integrated Master Plan are developed by examining and projecting historic population information and wastewater flows and characteristics. There are two growth scenarios for the flow projections, which are based on applying a 90-percent confidence interval to the projected RWQCP influent wastewater flows. The upper end of the 90-percent confidence interval is labeled the high-growth scenario and the lower end of the 90-percent confidence interval is labeled the low-growth scenario. At the beginning of the Integrated Master Plan process, the City decided that the high-growth scenario should be used as the design basis for all process alternative evaluations. However, after the process alternative evaluations were completed, during the rate setting process, it was determined that the slow down in the housing market would cause wastewater flows into the RWQCP to increase at a slower rate than was originally projected. Because of this slow down, the City decided that the low-growth scenario should be used for establishing the capital improvement plan (CIP), operation and maintenance (O&M) costs, and user rates and connection fees.

3.3 HISTORIC AND CURRENT POPULATION

Table 3.1 presents the historic population of Riverside from 2000 to 2006. The population of Riverside has increased at an average annual rate of 1.7 percent during the past 6 years, and it composed the majority of the population in the current RWQCP service area. The estimated year 2006 population for the CSDs is also shown in Table 3.1.

Table 3.1	Historic Population for Riverside, Edgemont, Rubidoux, and Jurupa Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside						
Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Riverside[1]	259,738	262,264	270,944	277,459	281,775	287,321	287,820
Edgemont[2]	-	-	-	-	-	-	6,600
Rubidoux[2]	-	-	-	-	-	-	26,000
Jurupa[2]	-	-	-	-	-	-	72,000

Notes:
(1) From the City.
(2) From CSDs. Data not available for 2000-2005.

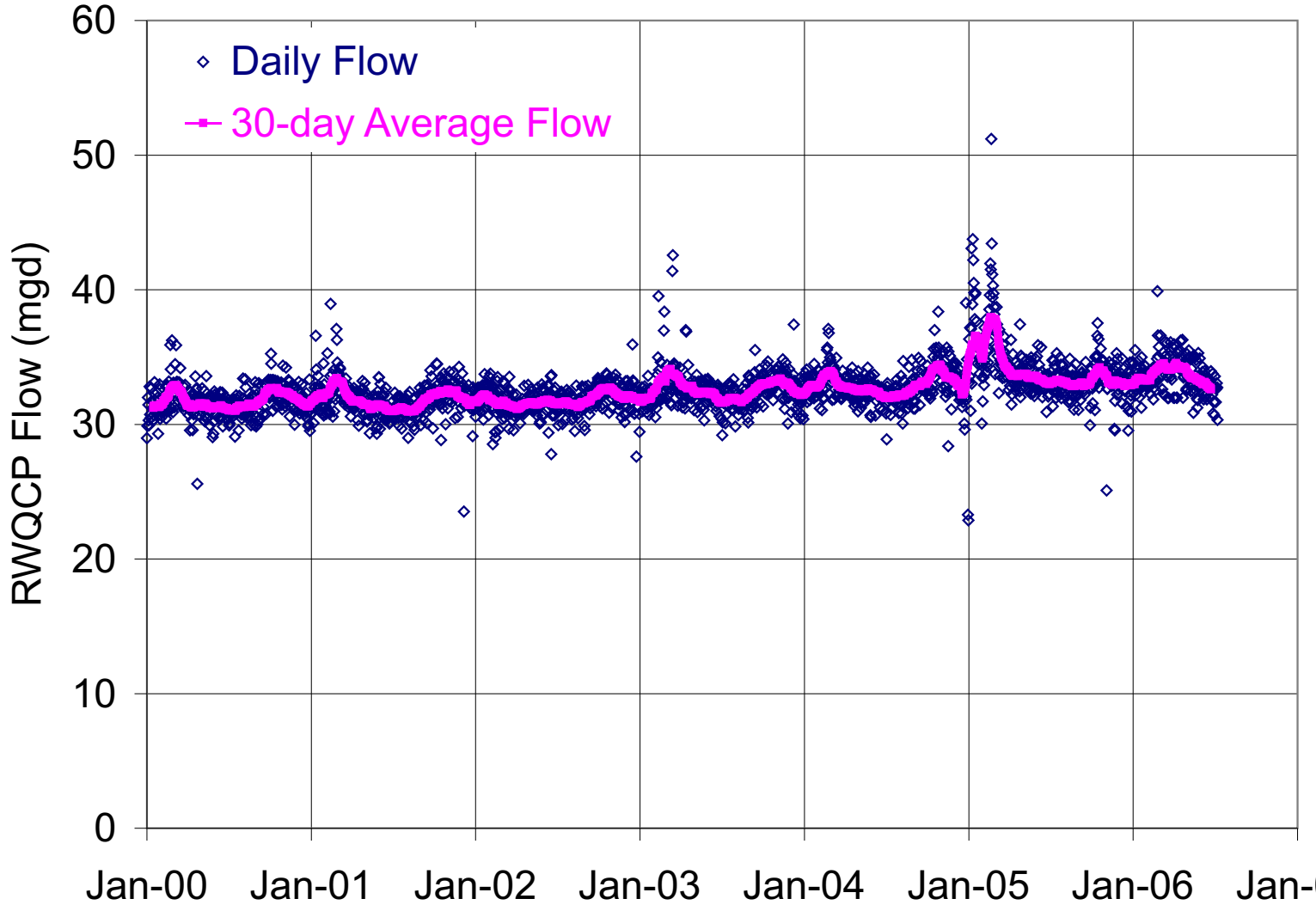
3.4 HISTORIC FLOW CHARACTERISTICS

Figure 3.1 shows the assumed average daily influent flow and the 30-day running average influent flow at RWQCP for the past 6 years. It should be noted that due to the existing influent metering configuration there is concern that the RWQCP influent flow may not be measured accurately. For this reason, the effluent meter reading, adjusted for the amount of recycled water that is pumped offsite, is used as the assumed RWQCP influent flow, and the CSD meters are used as the assumed CSD influent flows for the flow projection analysis.

The highest 30-day average flow was approximately 38 mgd in both February and March 2005. The overall average daily flow is 32.6 mgd. The flow for just the City (excluding Jurupa, Rubidoux, and Edgemont) is also presented in Table 3.2. This is calculated by subtracting the metered flows of the CSDs from the RWQCP flows.

Table 3.2	Average Daily Flow and Flow per Capita for Riverside Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside							
Parameter	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**Average**
RWQCP Flow (mgd)[1]	31.7	31.9	31.8	32.6	32.9	34.0	33.5	-
Edgemont Flow (mgd)[2]	0.7	0.6	0.6	0.6	0.6	0.6	0.6	-
Jurupa Flow (mgd)[2]	3.3	3.3	3.2	3.2	3.2	3.7	3.5	-
Rubidoux Flow (mgd)[2]	2.0	2.0	2.0	2.0	2.1	2.1	2.1	-
Riverside Flow (mgd)[3]	25.7	26.0	25.9	26.7	27.0	27.6	27.4	-
Flow per Capita (Gallon/d/capita)[4]	99.1	98.9	95.5	96.2	95.7	95.9	95.1	96.6

Notes:
(1) Based on effluent flowmeter readings.
(2) From CSDs.
(3) Calculated by subtracting CSDs' flows from RWQCP flows before rounding.
(4) Calculated by dividing the Riverside Average Daily Flow by Population (City of Riverside only).



DAILY INFLUENT FLOW AND 30-DAY RUNNING AVERAGE FLOW AT RWQCP

FIGURE 3.1

Based on the historic population presented in Table 3.1, and the flow for the City during the same period, the flow per capita from 2000 to 2006 is shown in Table 3.2. The historic average flow is 96.6 gallons per capita per day.

3.5 HISTORIC WASTEWATER QUALITY CHARACTERISTICS

Figures 3.2 and 3.3 present the Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) for a daily average and a 30-day running average for the RWQCP influent for the past 6 years, respectively. Figure 3.4 shows the results of sampling for influent ammonia for the same period. There was an increase in influent BOD, TSS, and ammonia concentrations during the period. Based on the values presented in Table 3.3, a pronounced increase in influent BOD and TSS values occurred between 2003 and 2004. Although not as pronounced, a similar increase occurred in the influent ammonia. The two averages presented in Table 3.3 (one for the period 2000 to 2006 and one for the period 2004 to 2006) demonstrate this difference.

Table 3.3 Average Influent Water Quality Data at RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

								Average	
Parameter	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**7-Year(1)**	**3-Year(2)**
BOD (mg/L)	217	210	226	234	259	237	257	234	250
TSS (mg/L)	217	216	228	226	247	253	238	232	248
Ammonia (mg-N/L)	24.7	27.7	29.6	29.1	32.0	30.1	30.1	29.0	30.8

Notes:
(1) Average from 2000 to 2006.
(2) Average from 2004 to 2006.

3.6 PROJECTED INFLUENT FLOW QUANTITIES

Based on information supplied by the City, the population (City only) is projected to be 353,397 in the year 2025. This is an annual average increase of approximately 1.09 percent, between 2006 and 2025. Figure 3.5 presents the historic population and the population projection for the City of Riverside. A linear increase is applied to the projected population for the years between 2006 and 2025. These values are presented in Table 3.4. Based on the assumption that the future flow per capita will be the same as the historic average of 96.6 gallons per day per capita, the projected flows for the City of Riverside are calculated, as shown in Table 3.4.

Table 3.4	Projected Populations and Average Daily Flows for Riverside Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Parameter	**2006**	**2010**	**2015**	**2020**	**2025**
Population[1]	287,820[3]	301,626	318,883	336,140	353,397[3]
Flow[2] (mgd)	27.4	29.2	30.8	32.5	34.2

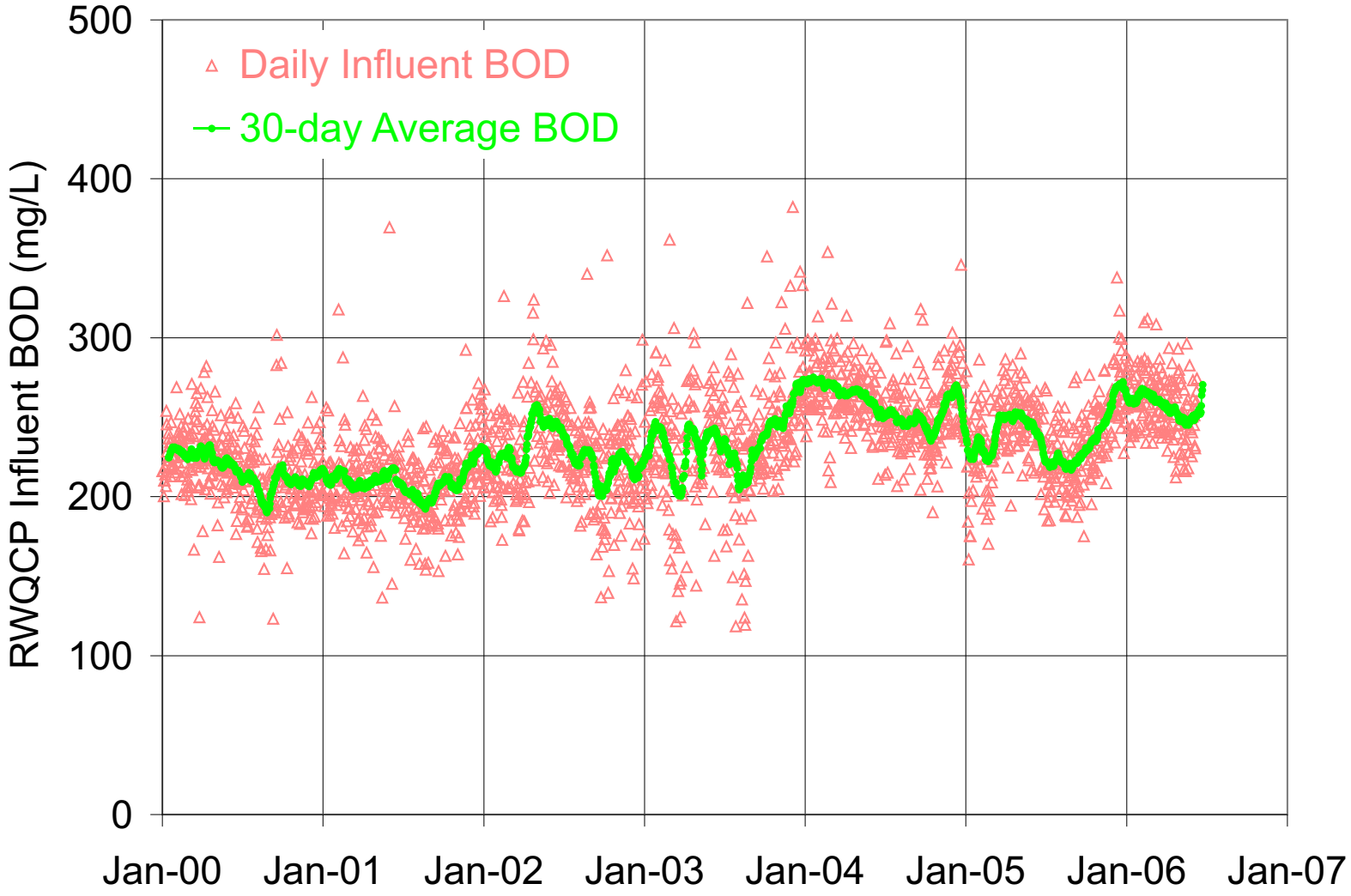
Notes:
(1) Linear increase for population projections.
(2) Future flow per capita is assumed to be 96.6 gallons per day per capita. Annual flow increase equals 1.09 percent.
(3) From the City.

The maximum expected flows from Jurupa, Rubidoux, and Edgemont are expected to be 6.9 mgd, 3.1 mgd, and 0.9 mgd, respectively, in 2025. The flows are derived by assuming that each CSD's discharge will increase linearly so that they will discharge by 2025, to the limit of their existing purchased capacity. (This applies to all CSDs except Jurupa, who is expected to increase their purchased capacity from 4.0 mgd to 6.9 mgd.) Assuming a linear increase in flows between 2006 and 2025, the intermediate year flows for Jurupa, Rubidoux, and Edgemont are presented in Table 3.5.

Table 3.5	Projected Flows for Jurupa, Rubidoux, Edgemont, and Highgrove (mgd) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Area	**2006**	**2010**	**2015**	**2020**	**2025**
Jurupa[1]	3.5	4.2	5.1	6.0	6.9
Rubidoux[1]	2.1	2.3	2.5	2.8	3.1
Edgemont[1]	0.6	0.6	0.7	0.8	0.9
Highgrove[2]	0.0	1.6	3.0	3.7	4.4

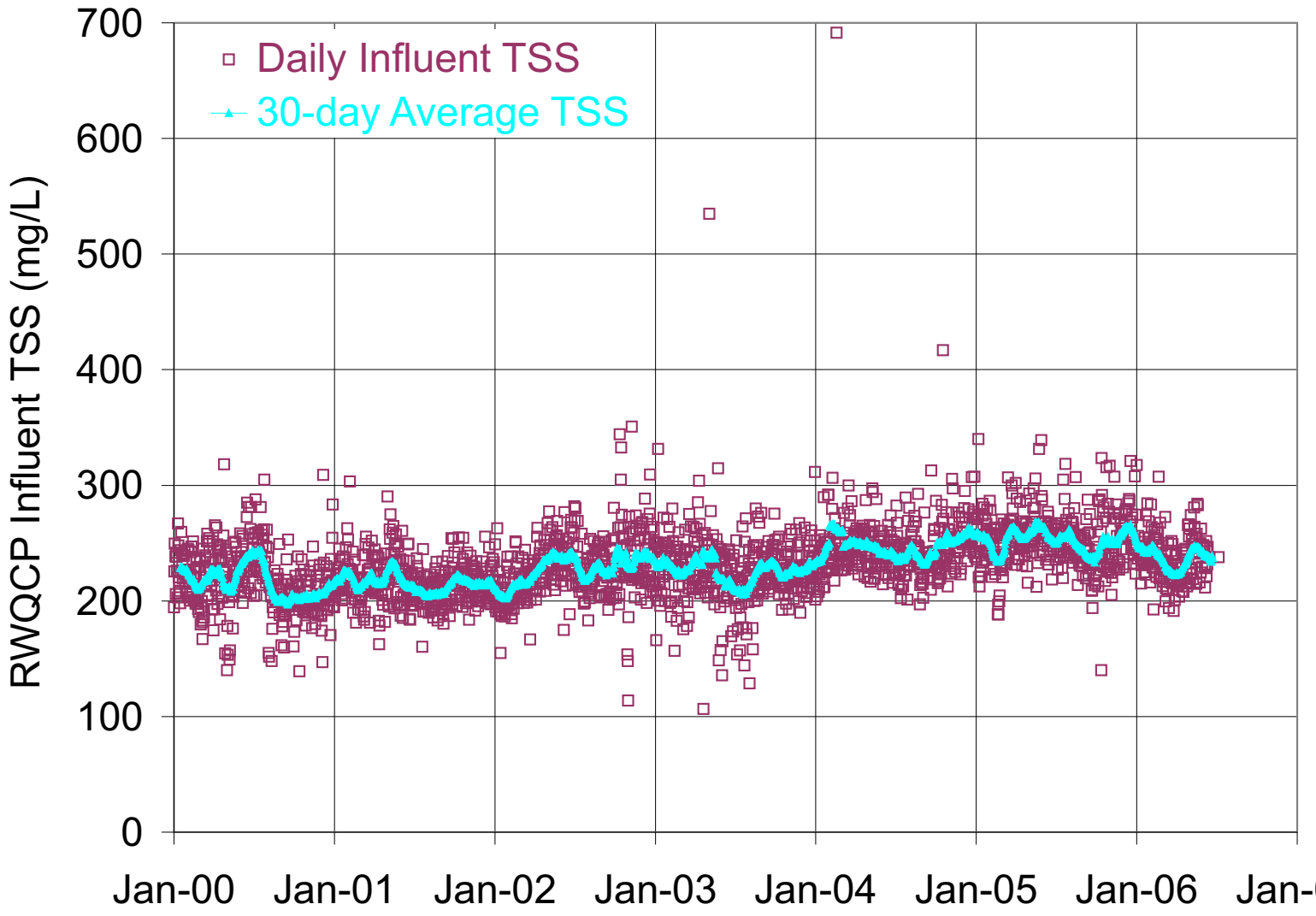
Notes:
(1) Flows for 2006 and 2025 were supplied by the City for the CSDs. Intermediate flows are calculated based on a linear increase.
(2) Flows for 2006, 2012, and 2025 are assumed to be 0.0, 2.6 and 4.4, respectively. These flows were supplied by the City. Intermediate flows are calculated based on a linear increase.

The community of Highgrove is not currently sewered, but the flows of 2.6 mgd and 4.4 mgd in the years 2012 and 2025, respectively, are expected, as the community connects to the collection system. Using a linear increase the projected flows in 5-year increments are calculated for Highgrove, as shown in Table 3.5.



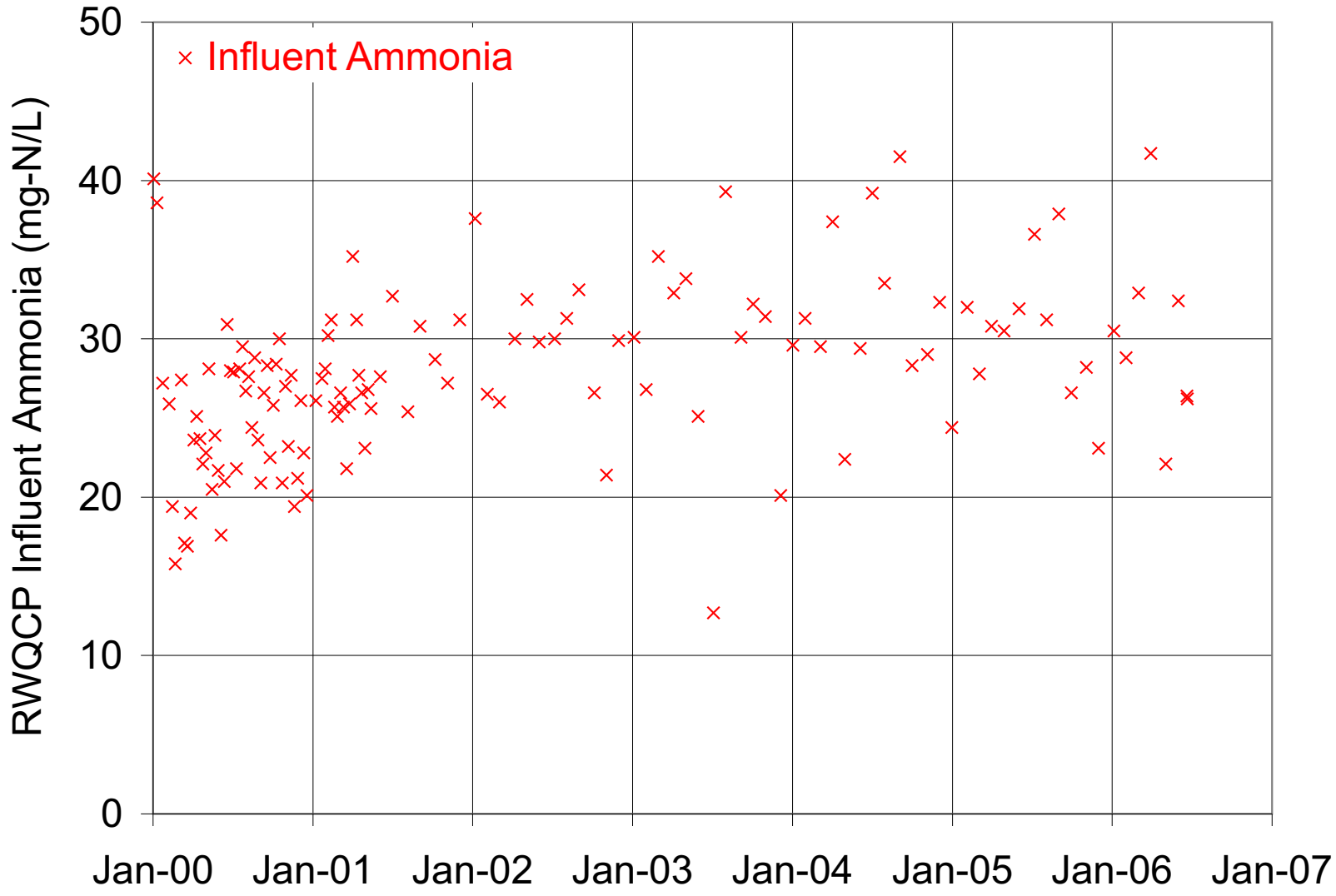
DAILY AVERAGE INFLUENT BOD AND 30-DAY RUNNING AVERAGE BOD AT RWQCP

FIGURE 3.2



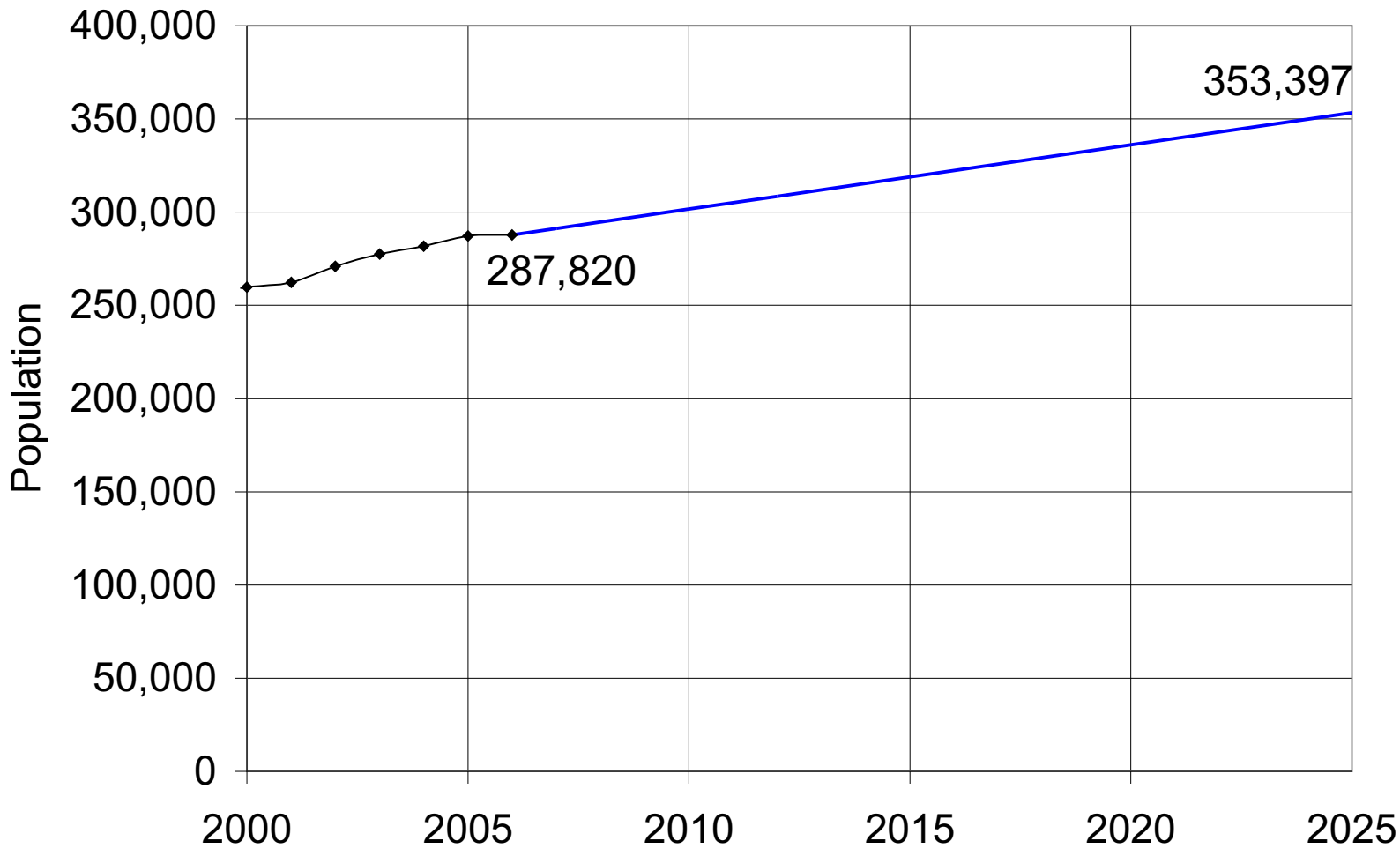
DAILY AVERAGE INFLUENT TSS AND 30-DAY RUNNING AVERAGE TSS AT RWQCP

FIGURE 3.3



INFLUENT AMMONIA AT RWQCP

FIGURE 3.4



HISTORIC AND PROJECTED POPULATION FOR THE CITY OF RIVERSIDE

FIGURE 3.5

The projected flows for Riverside, the CSDs, Highgrove, and the total flow for the planning period, 2006 to 2025, are presented in Table 3.6.

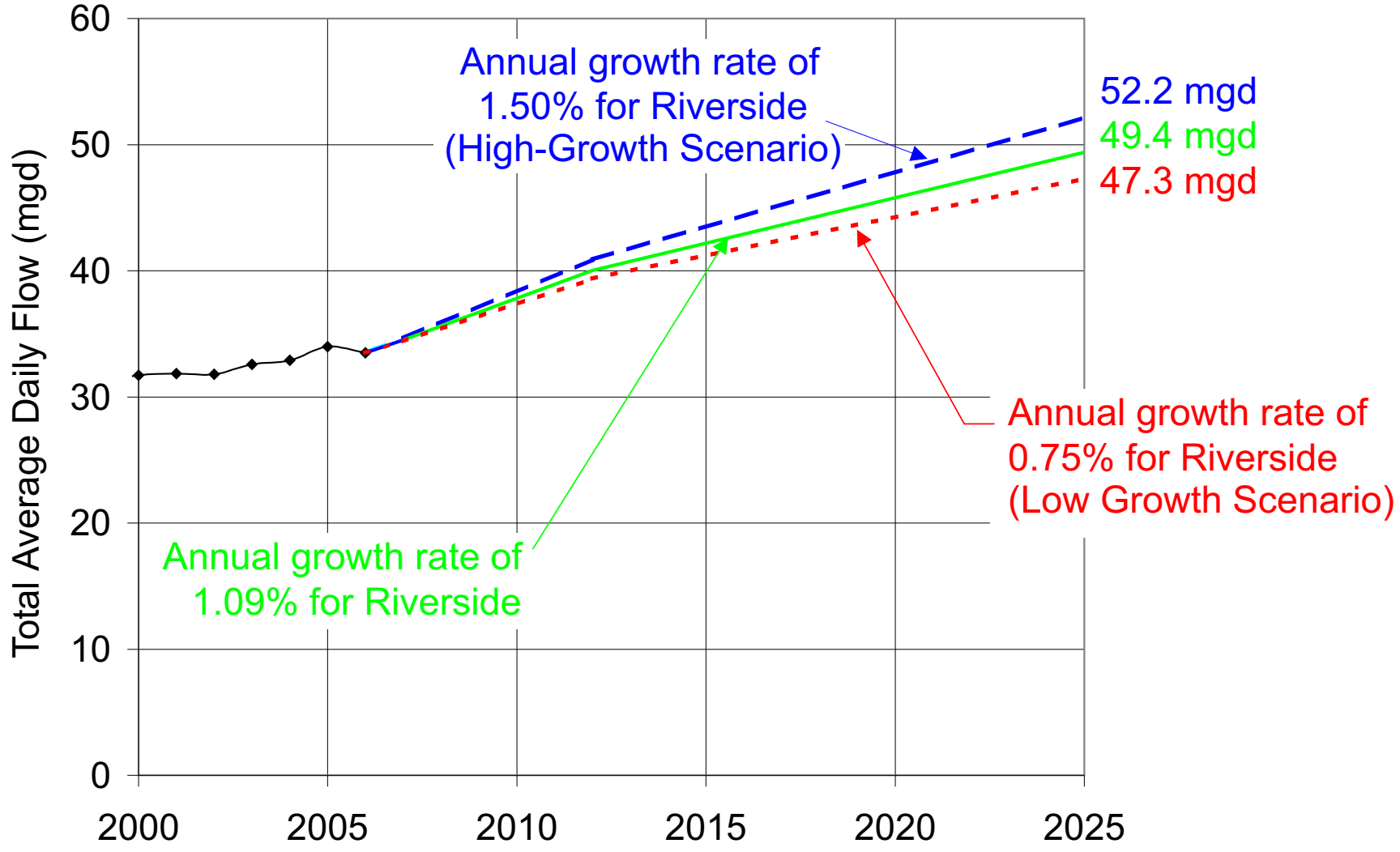
**Table 3.6 Projected Average Daily Flows for RWQCP (mgd)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside**

Area	2006	2010	2015	2020	2025
Riverside[(1)]	27.4	29.2	30.8	32.5	34.2
Jurupa	3.5	4.2	5.1	6.0	6.9
Rubidoux	2.1	2.3	2.5	2.8	3.1
Edgemont	0.6	0.6	**0.7**	0.8	0.9
Highgrove	0.0	1.6	**3.0**	3.7	4.4
Total Average Flow[(1)]	**33.5**	**37.8**	**42.2**	**45.8**	**49.4**

Notes:
(1) Annual increase equals 1.09 percent for City.

Figure 3.6 shows the total projected average daily flows for the RWQCP. As stated previously, the annual flow increase percentage is approximately 1.09 percent. Based on the daily flows in the past 6 years, a 90-percent confidence interval for the flow in the year 2025 was calculated. The calculation results in an approximate flow range of between 47.3 and 52.2 mgd. These are labeled the high-growth and low-growth scenarios, respectively, in Figure 3.6. (A 90-percent confidence interval means that, based on the historical flow data, there is a 90-percent chance of the future flows falling within range of 47.3 to 52.2 mgd in the year 2025.) The 90-percent confidence interval is equal to an annual flow increase range of between 0.75 and 1.5 percent.

The City has no control over how fast the CSDs and the Highgrove area increase their flows into the RWQCP. And, based on recent activity, there is a concern that residential development may grow faster than is currently predicted. If these occur there is a good chance that RWQCP flows will tend toward the high-growth scenario. In addition, for a master planning process it is more prudent to plan based on conservative assumptions about future growth. For these reasons, the City chose to use the high-growth scenario (52.2 mgd and an annual growth rate of 1.5 percent) as the basis of the process alternative evaluations for the Integrated Master Plan. This decision was made at a meeting on August 31, 2006. Since that time, a slow down in the housing market has occurred, which caused the City to reevaluate the potential RWQCP influent flows for the master plan planning period. Based on the reevaluation, the City, at a meeting on September 20, 2007, decided that the lower end of the 90-percent confidence interval would be more appropriate as the basis for 2025 RWQCP flow projections. This results in an average daily flow of 47.3 mgd, which corresponds to an annual growth rate of 0.75 percent (low-growth scenario).



TOTAL PROJECTED AVERAGE DAILY FLOWS FOR RWQCP

FIGURE 3.6

Because the process alternative evaluations were completed before September 20, 2007, the City, at a meeting on August 24, 2007, decided not to revise the process evaluations to reflect the change from the high-growth to the low-growth scenario, but instead to revise the CIP, O&M costs, user rates and connection fees assuming the low-growth scenario.

Table 3.7 presents the projected flows for the Master Plan planning period, applying the following peaking factors to the average daily flow of 52.2 mgd:

- Peak wet weather: 2.2.
- Minimum dry weather: 0.5.
- Peak dry weather: 1.8.
- Tertiary peak: 1.5.

Table 3.7 Projected Influent Average Daily Flows for RWQCP with Seasonal Variations
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	2006	2010	2015	2020	2025
Annual Average Daily Flow(1)	33.5	38.4	43.5	47.8	52.2
Peak Wet Weather Flow	73.7	84.5	95.7	105.2	114.7
Minimum Dry Weather Flow	16.8	19.2	21.7	23.9	26.1
Peak Dry Weather Flow	60.3	69.1	78.3	86.1	93.9
Tertiary Peak Flow	50.3	57.6	65.2	71.7	78.2

Notes:
(1) Annual increase equals 1.50 percent for City.

3.7 TEMPORARY WASTEWATER TREATMENT FOR A PORTION OF THE CITY OF COLTON

During the preparation of this Integrated Wastewater Master Plan, the City of Colton had requested and was negotiating with the City of Riverside to provide temporary wastewater treatment for a portion of Colton's service area. The amount of wastewater to be treated will be 1,850,000 gallons per day at a maximum peak flow rate of 4.50 cubic feed per second (cfs). These flows were not included with the "Projected Influent Flow Quantities". If in the future these flows are permanently directed into the City of Riverside's wastewater collection and treatment facilities, the Integrated Wastewater Master Plan will need to be revised.

3.8 PROJECTED INFLUENT FLOW CHARACTERISTICS

Influent water quality characteristics for the RWQCP, such as concentrations of BOD, TSS, and ammonia, are assumed to be the same until 2025. Because there seemed to be an increase between the year 2003 and 2004 in the influent BOD, TSS, and ammonia concentrations, the average as presented in Table 3.3 for the years 2004 through 2006 will be used for the Integrated Master Plan evaluations. These values are as follows:

- Influent BOD: 250 mg/L.
- Influent TSS: 248 mg/L.
- Influent Ammonia: 30.8 mg/L.

It should be noted that urban runoff flows are not included in the Master Plan projected flow quantities or characteristics. Due to the present regulatory environment, it is possible that the RWQCP would have to treat dry weather urban runoff in the future. If that occurs, the Integrated Master Plan would have to be updated to account for these flows.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
CHAPTER 4: BASIS OF COST ESTIMATES

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 2: BASIS OF PLANNING
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Chapter 4

BASIS OF COST ESTIMATES

4.1 PURPOSE

The purpose of this chapter is to summarize the procedures and guidelines for estimating Operations and Maintenance (O&M) and capital costs for the Integrated Master Plan. In addition, procedures for applying the O&M and capital costs in a life-cycle cost analysis to compare alternatives are summarized.

4.2 BACKGROUND

The Riverside Regional Water Quality Control Plant (RWQCP) Integrated Master Plan, when completed, will present a plan that will meet the expansion and replacement needs of the RWQCP's facilities through 2025. In order to complete this plan, consistent assumptions and criteria for development of O&M and capital costs and life-cycle cost analyses are necessary.

4.3 LEVEL OF ACCURACY

The expected level of accuracy for the cost estimates for the Integrated Master Plan is Class 4, as classified by the Association for the Advancement of Cost Engineering International (AACEI, 1999). The expected accuracy range of a Class-4 estimate is within 30 percent over the estimate to 15 percent under the estimate. In order to reduce the risk of the impact of underestimation, for capital costs, a contingency as described below is applied to the developed estimates.

4.4 OPERATIONS AND MAINTENANCE COSTS

O&M costs include the labor, supplies and utility costs for operations, preventive and corrective maintenance, inspections, and repair and replacement of parts. O&M costs are based on the information provided by the following:

- Historical costs from recent Carollo Engineers (Carollo) projects.
- Vendor supplied costs.
- Costs supplied by RWQCP staff (i.e., power, labor, chemicals, and natural gas).
- Calculations as necessary to supplement other sources.

The cost estimates are generally based on applying the above information to flow diagrams for main process systems, plant schematic layouts, and equipment lists that will be

developed for the Integrated Master Plan. O&M costs are escalated for inflation as described in the capital cost section that follows.

4.5 CAPITAL COSTS

Capital costs consist of all the items that will be constructed/purchased for the projects that are being evaluated for the Integrated Master Plan. The direct cost of each equipment item or process area will be based on the following:

- Vendor-quoted information.
- Cost curves based on historical costs from other Carollo Projects or scale-up or scale-down of similar sized projects.
- Scale-up of costs to account for inflation, using a base ENR value of 8,570 (Los Angeles, August 2006).
- Quantity take-off and unit prices when applicable information is necessary and available.

For most projects, depending on applicability, general factors will be added to the direct costs derived from the information listed above. These factors include the following:

- The costs of Site Work and Electrical and Instrumentation are estimated as percentages of the subtotal direct cost. Typical percentages are 10 percent and 15 percent, respectively.
- The contingency is an amount added to the construction cost estimate to provide for undefined project elements and to reduce the risk for underestimation. The contingency usually ranges from 0 to 30 percent. The contingency is estimated as 30 percent of the total direct cost in the Integrated Master Plan.
- The added amount for General Conditions include the costs of mobilization/demobilization, bonds and insurance, contractor temporary project facilities and supervisory personnel, testing, start-up, and other constraints. A General Conditions of 10 percent of the total direct cost plus contingency is added.
- General Contractor Overhead and Profit refers to the general contractor's home office overhead and profit. It is estimated to be 15 percent of the subtotal of the above costs.
- The cost of the project at approximate midpoint of construction is predicted by escalating August 2006 costs. The escalation rate is assumed to be 6 percent for years 1 through 5 of the life-cycle period and 4 percent thereafter.
- Sales Tax is estimated at 7.75 percent on materials, based on material cost equaling 50 percent of the total direct cost and contingency.

- Bid Market Allowance is included in the total construction cost due to the volatile nature of the current bidding market throughout the United States and especially California. It is estimated to be 15 percent of the subtotal cost of all above items.
- Engineering, Management, and Legal are also included to determine the total project cost. This covers Engineering, Planning, design and construction oversight costs, legal fees, as well as City administration expenses to oversee the project from planning through construction. For this project, a factor of 30 percent of the total construction cost is used, including all above items.

4.6 LIFE-CYCLE COSTS

In order to evaluate different alternatives for upgrading or replacement of the RWQCP facilities, life-cycle cost analyses will be performed to distinguish which alternative is the best from an economic standpoint. Life-cycle cost analyses determine the present worth of both capital costs and annual O&M costs for each alternative. Factors considered in the life-cycle costs include the escalation rate, cost of capital (discount rate), and the life-cycle period. These values are as follows:

- Escalation rate of 6 percent for years 1 through 5 of the life-cycle period and 4 percent thereafter.
- Discount rate of 6 percent for computing present worth values.
- Life-cycle period of 19 years from 2006 till the end of 2025.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 3: WASTEWATER COLLECTION SYSTEM
CHAPTER 1: WASTEWATER COLLECTION SYSTEM

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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Chapter 1

WASTEWATER COLLECTION SYSTEM

1.1 PURPOSE

The purpose of the wastewater collection system volume is to summarize the collection system master plans (CSMPs) that were completed by PBS&J between 2002 and 2006. The capital improvements and costs that were proposed in the CSMPs are updated in this volume to reflect completed projects, and future project costs are adjusted and scheduled out to 2025 based on detailed costs and projects provided by the City. The projects and costs were not laid out like a typical master plan, but reconfigured by the City to calculate rate schedules.

1.2 RECOMMENDATIONS

The following recommendations should be considered by the City to further develop the CSMPs and associated capital improvement projects:

- Update the CSMPs by incorporating infiltration and inflow (I/I) into the collection system model and adjusting the capital improvement projects accordingly. The five CSMPs and the I/I Study provide a basis for estimating collection system costs for the City of Riverside. However, most CSMPs need to be updated approximately every five years. The Spruce Basin CSMP is already five years old. The five CSMPs also did not explicitly include I/I flows in the analysis. Depending on the City's actual rehabilitation and replacement (R&R) plan, I/I could get worse in the future if deterioration of existing sewers, especially sewers older than 50 years, is not kept in check. It is recommended that the collection system model be updated to include I/I and calibrated to the two significant rain events measured during the I/I study. Since quantifying I/I using the monitored wet weather data may increase the scope and cost of certain capital improvements, future capital improvements should be adjusted based on these results.
- Further investigate I/I in specific areas that suffer from significant I/I. Although I/I does not appear to be significant throughout the system, specific areas that suffer from significant I/I should be further investigated.
- Use the Sewer System Management Plan (SSMP) as the basis for future updates of current collection system studies. For the System Evaluation and Capacity Assurance Plan (SECAP), one component of the SSMP, the City will need to utilize the results of the I/I study and project flows based on a design storm (e.g., 10-year storm) to update projects in the Capital Improvement Plan (CIP). This further analysis should be completed within a schedule defined by the SSMP. Since I/I is not excessive throughout the collection system, it is unlikely that extensive changes to the CIP will

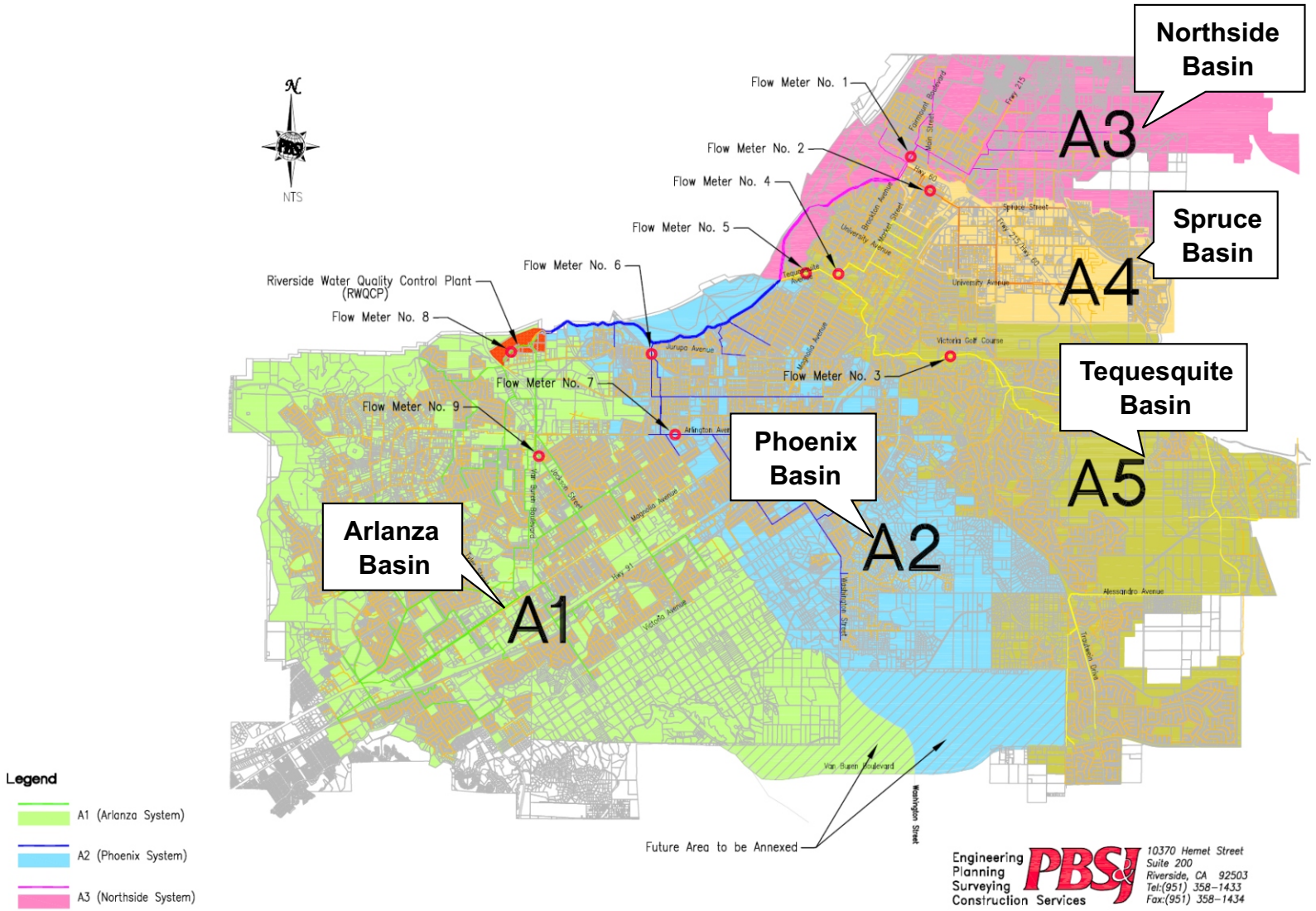
be needed. However, the scope of certain projects could be extended, as well as the need for some additional projects.

- Complete a more detailed analysis of the City's pipe R&R needs and costs. The R&R estimates made for this Integrated MP are a good start at determining the need and cost of system-wide pipeline upgrades due to pipelines exceeding their useful life. However, the costs associated with these initial estimates are based on a fairly simple analysis and could be improved with a more detailed analysis of the City's R&R needs. Details from the City's inspection programs should be coupled with probabilistic methods to comprehensively determine the most cost effective plan for R&R. A comprehensive R&R plan could significantly reduce the estimated costs of the current plan.
- Document the calibration results for the CSMPs. The CSMPs for the five basins mention that dry weather flow (DWF) calibration was completed. However, these documents do not include tables, statistics, or figures that illustrate the results of calibration. It is recommended that the results of the calibration of the DWFs be documented.
- Update the collection system model and capital projects with new flow metering data. The City should consider remonitoring the flows in the Basins on a rotating schedule or on a permanent basis. This effort does not have to start immediately, but the flows monitored for Spruce Basin are already five years old. Coupled with the flow metering problems detailed later in this chapter, the City could use the new flow metering data to update the model, update the CIP, and refine future projects. Better flow information along with more accurate model results will provide increased confidence in determining the need for projects and can avoid significant capital costs that may not be necessary.

1.3 BACKGROUND

The City of Riverside (City) has an extensive collection system that was divided into five basins for the purpose of master planning. PBS&J completed collection system master plans for each basin. Figure 1.1 illustrates the wastewater collection system layout with the five basins color-coded and labeled. The basins, the date of report completion, and the appendix in which these reports are documented are summarized below:

- Spruce Basin, June 2002, Appendix A.
- Tequesquite Basin, December 2003, Appendix B.
- Arlanza Basin, August 2006, Appendix C.
- Phoenix Basin, August 2006, Appendix D.
- Northside Basin, September 2006, Appendix E.



Engineering Planning Surveying Construction Services PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

WASTEWATER COLLECTION SYSTEM LAYOUT

FIGURE 1.1

A separate Infiltration and Inflow (I/I) study was also completed by PBS&J for all five basins in the collection system in May 2005. This report is included in Appendix F. The results of the I/I study were not incorporated into the collection system master plans.

The City is currently completing a Sewer System Management Plan (SSMP). Components of the SSMP that directly influence the collection system studies include the requirements for a System Evaluation and Capacity Assurance Plan (SECAP) and a Rehabilitation and Replacement (R&R) Plan. A SECAP is basically a master plan with a detailed CIP, and requires the incorporation of I/I into the analysis to size future pipe improvements. To update projects in the collection system CIP, the City will need to utilize the results of the I/I study and project flows based on a design storm (e.g., 10-year storm).

1.4 FLOW MEASUREMENTS

Monitoring existing flows provides a basis for examining existing discharges from residential, commercial, and industrial customers. Calibration of the collection system model also requires measured flows. Flow metering was conducted throughout each basin to provide hourly flow data and hourly rainfall data (during the I/I study). Metering methods and monitoring periods are discussed below.

1.4.1 Metering Methods

Measurement of sewer flows can be accomplished using several methods. Most treatment plants use Parshall flumes to measure influent and effluent flows. However, permanent flumes are not cost effective for temporary metering programs. Therefore, portable meters that measure depth and velocity measurements were used for the CSMPs.

Downstream Services (DS) measured flows throughout the collection system as a subcontractor to PBS&J. They installed portable flow meters that measured depth (to compute flow area) and velocity. Flow rates are typically calculated by multiplying flow area by velocity. However, DS and PBS&J found inconsistencies in many of the velocity measurements and decided to calculate flows using Manning's equation. Manning's equation is an empirical equation that allows flow calculations based on pipe diameter, pipe slope, and measured depth of flow. Pipe slope was calculated using record drawings of pipes upstream and downstream of the meter locations, and a Manning's n of 0.013 was assumed.

While the use of Manning's equation is standard practice for designing pipes, this equation can produce inaccurate estimates of flow based on measured depths because it assumes the flow regime is uniform. Uniform flow is usually not the case in actual sewers (e.g., a single depth can produce different flow rates because the velocities will be different if the flow is subcritical or supercritical). Estimating Manning's n for an existing sewer is also a best guess and may not represent the specific friction losses due to field conditions.

However, when velocity measurements are in error, the only option (other than remonitoring) is to use Manning's equation. For the purposes of dry weather flow (DWF) measurements, Manning's equation probably provides acceptable estimates of flow assuming there were no obstructions near the sensors. During the winter monitoring periods, as described in the I/I study, the majority of the flow calculations did use velocity measurements. Therefore, the dry weather flows measured during the I/I study could be compared to identify if the DWF's estimated using Manning's equation are in error.

1.4.2 Monitoring Periods

Flow metering was generally conducted during dry periods to capture DWF and during the winter to capture I/I. DWF monitoring in all but the Spruce Basin was completed during a period with minimal base infiltration. In total, 31 meters measured DWF. This monitoring period ranged from two to three weeks per basin.

The I/I monitoring period was conducted over an eight and one-half week period using nine meters. Each basin included one to three meters. Table 1.1 summarizes the flow monitoring periods and statistics.

Table 1.1 Flow Monitoring Periods
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	Arlanza Basin	Phoenix Basin	Northside Basin	Spruce Basin	Tequesquite Basin
Dry Weather Flow Monitoring Period					
Number of Sites	8	5	3	10	5
Weeks Monitored	2.5	3	2	2	2
Dates	10/3/05 - 10/20/05	10/1/05 - 10/19/05	9/30/04 - 10/13/04	11/20/01 - 12/4/01	7/29/03 - 8/5/03
Infiltration/Inflow (I/I) Monitoring Period					
Number of Sites	2	2	1	1	3
Weeks Monitored	8.5	8.5	8.5	8.5	8.5
Dates	01/7/05 - 02/28/05	01/7/05 - 02/28/05	01/7/05 - 02/28/05	01/7/05 - 02/28/05	01/7/05 - 02/28/05

1.5 LAND USE AND FLOW ESTIMATES

This section describes the unit flows and peaking factors reported in the CSMPs. Existing and future land use, ADWF, DWF calibration, and I/I are also discussed. This section concludes with a comparison of CSMP flows to flows at the RWQCP.

1.5.1 Unit Flows and Peaking Factors

Unit flows and peaking factors are typically used to estimate the flows from new development. The City publishes guidelines for estimating these flows entitled, "*Criteria for Sewer Facility Design, City of Riverside Public Works Department, Engineering Diversion*" (updated May 2004). Specific guidelines for estimating flows from residential, commercial, and industrial sources are summarized below:

- Flow estimates based on land use from the City's General Plan.
- Per capita living unit should be taken from recent census (no less than 2.75 capita per unit).
- Unit flows of 65 gallons per capita per day (gpcd).
- Peaking factors (PF) taken from curve based on population or average dry weather flow (ADWF) (range from 1.5 to 3.0).
- Industrial peak flow (PF): 0.012 cfs/acre.
- Commercial PF: 0.010 cfs/acre.
- Offices and Schools unit flows: 30 gpcd.
- Laundromat: 580 gal/machine/day.

These numbers were used in the CSMPs. These factors provide a starting point for estimating existing flows and comparing to measured flows. More discussion on DWF calibration is included in section 1.4.4.

1.5.2 Existing and Future Land Use Characteristics

The five CSMPs reported both existing and future land use based on General Plan estimates. Existing land use was represented by the year 2005 and future land use as 2020 for the Arlanza, Phoenix, and Northside basins. The Spruce and Tequesquite basins were completed several years earlier, so the existing estimates came from 2001 and 2003 respectively. The future land use for these two basins were projected to 2015 and 2018 respectively. Table 1.2 summarizes the land use statistics by basin and year.

Table 1.2 Basin Land Use
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	Arlanza	Phoenix	Northside	Spruce	Tequesquite
Existing Land Use (Year)	**2005**	**2005**	**2005**	**2001**	**2003**
Single-Family Residential (acres)	7,220	4,500	700	1,136	6,744
Multi-Family Residential (acres)	880	76	72	189	241

Table 1.2 Basin Land Use
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

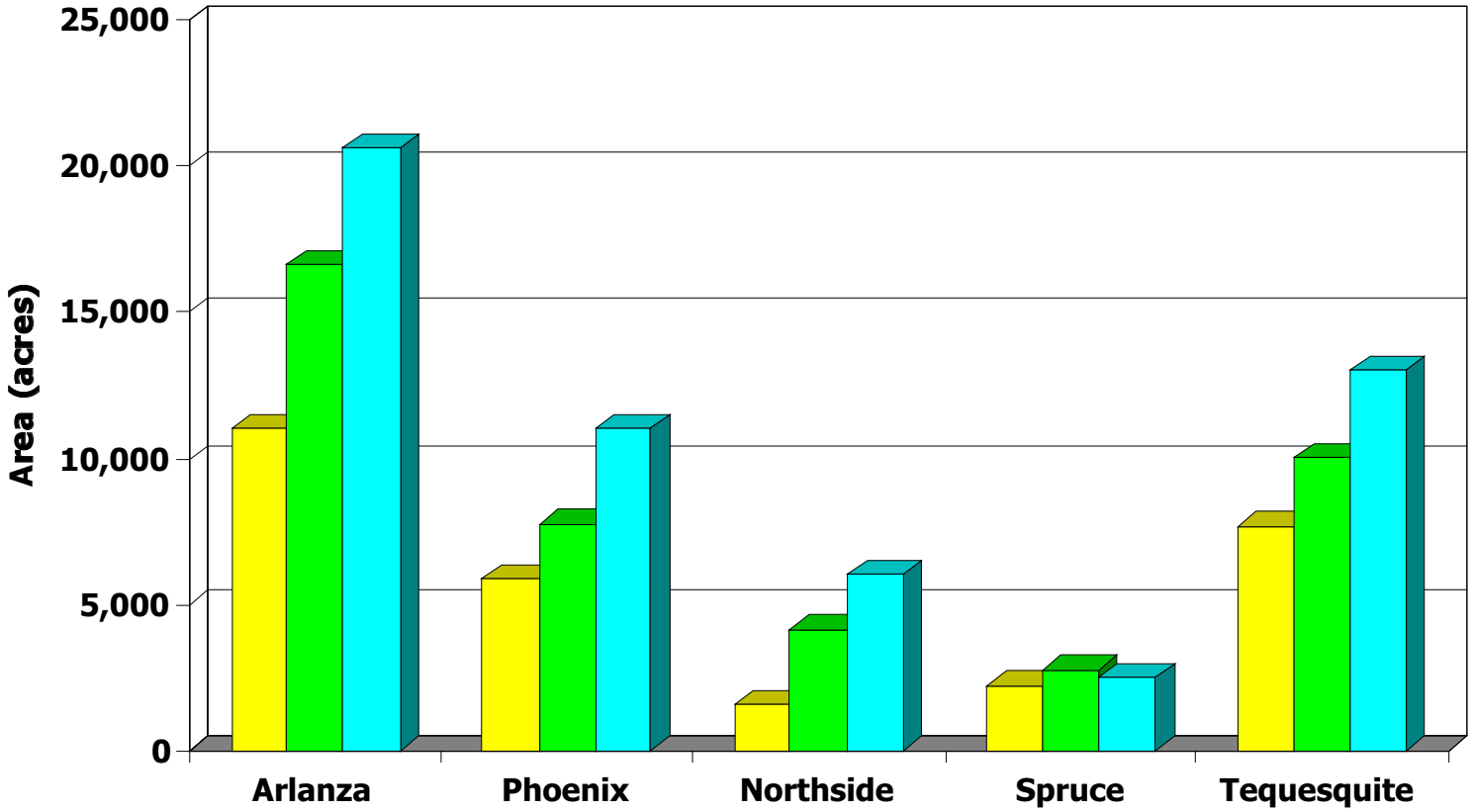
Statistics	Arlanza	Phoenix	Northside	Spruce	Tequesquite
Commercial (acres)	2,735	1,100	108	284	849
Industrial (acres)	190	190	738	170	54
University of CA, Riverside (acres)	-	-	-	471	-
Total (acres)	11,025	5,866	1,618	2,250	7,671
Future Land Use (Year)	**2020**	**2020**	**2020**	**2015**	**2018**
Single-Family Residential (acres)	12,240	6,230	2,250	1,294	7,530
Multi-Family Residential (acres)	960	78	157	203	274
Commercial (acres)	3,190	1,210	213	377	2,191
Industrial (acres)	215	215	1,512	170	60
University of CA, Riverside (acres)	-	-	-	706	-
Total (acres)	16,605	7,733	4,132	2,750	10,055
Total Basin Area (acres)	20,650	11,000	6,000	2,500	13,000

Notes:
(1) All statistic above provided by the City based on CSMPs.

According to the future total acreage, and the total basin acreages estimated from the CSMP study areas, the City has additional area to expand beyond the 2020 estimates, except in the Spruce Basin. Details on the Spruce Basin expansion can be found in Appendix A. Figure 1.2 illustrates a summary of the land use statistics by basin.

1.5.3 Existing and Future Average Dry Weather Flows

The total population in the service area is estimated to increase by approximately 28 percent from 2005 to 2025. The total ADWF in the service area is estimated to increase from 32.8 mgd in 2005 to 49.5 mgd in 2020, approximately a 51 percent increase. These statistics indicate a significant increase in commercial and/or industrial growth in the service area. Table 1.2 illustrates a significant anticipated increase in commercial acreage in the future which accounts for this flow increase (industrial acreage is estimated to change little in future years).



Total Developed Area (acres)

Existing Year	**2005**	**2005**	**2005**	**2001**	**2003**	**28,450**
Future Year	**2020**	**2020**	**2020**	**2015**	**2018**	**41,275**

Total System Area (acres) = 53,150

Existing Developed Area
Future Developed Area
Total Basin Area

LAND USE STATISTICS BY BASIN

FIGURE 1.2

Table 1.3 summarizes the population and flow statistics by basin and in total for the service area. The statistics listed in Table 1.3 are not included in the individual CSMPs. These numbers were provided to Carollo by the City and are based on the CSMPs.

Table 1.3 Existing and Future ADWFs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	Arlanza Basin	Phoenix Basin	Northside Basin	Spruce Basin	Tequesquite Basin	Total
Existing Flows (Year 2005)[1]						
Population	103,620	51,590	9,680	46,380	64,899	276,169
ADWF (mgd)[3]	9.7	12.8	1.1	2.5	6.7	32.8
Calculated[4] average gallons per capita per day (gpcd)	94	248	114	54	103	119
PHF (mgd)[5]	18.4	24.4	1.6	6.7	12.5	63.6
PHF/ADWF	1.9	1.9	1.9	1.9	1.9	1.9
Future Flows (Year 2020)[1]						
Population[2]	128,696	64,075	12,023	68,000	80,604	353,398
ADWF (mgd)[3]	12.5	18.4	3.8	3.4	11.4	49.5
Calculated[4] average gallons per capita per day (gpcd)	97	287	316	50	141	140
PHF (mgd)[5]	23.6	35.1	3.1	6.4	21.6	89.8
PHF/ADWF	1.9	1.9	1.9	1.9	1.9	1.8

Notes:
(1) Flows do not include estimates for Inflow/Infiltration (I/I).
(2) Population projected to year 2025.
(3) ADWF = Average Dry Weather Flow.
(4) Calculated gpcd = ADWF (gallons)/population.
(5) PHF = Peak Hour Flow.
(6) All data provide by the City based on CSMPs.

1.5.4 Dry Weather Flow Calibration

Calibration of a collection system model to measured DWFs is necessary to provide confidence in model results. Typical steps in the DWF calibration process include:

- Compile existing and future land use and population.
- Estimate unit flow factors for each type of land use and match model generated DWFs on an hourly basis with measured DWFs for existing conditions.
- Adjust unit flow factors by basin to account for variations in basin land use.

- Report statistics of calibrations to evaluate fit between measured and modeled flows (e.g., tables comparing peaks, averages, R^2, and hourly graphs).
- Project future DWFs based on calibrated unit flow factors.

The CSMPs for the five basins mention that DWF calibration was completed. However, these documents do not include tables, statistics, or figures that illustrate the results of calibration. It is recommended that the results of the calibration of DWFs be documented.

1.5.5 Infiltration and Inflow

PBS&J completed an I/I study for the City in May 2005, separate from the CSMPs. The monitoring effort captured four storms, two of which were significant. Based on the two large storm events, the report found I/I to be significant in certain areas of the system. Refer to the I/I Study in Appendix F for details. Because this study was done after the first of the CSMPs, it was decided that the results would not be included in the basin CSMPs at this time. No modeling of the I/I was completed as part of the I/I study or the CSMPs.

I/I tends to be average to above average throughout most of the system, while specific areas suffer from significant I/I and should be further investigated. The City has taken an initial step to account for I/I in these areas by qualitatively examining I/I through historic inspections. The City has adjusted potential capital improvements based on this qualitative analysis. However, the system has not been examined using a design storm approach (e.g., 5-year storm event). Therefore, it is recommended that the model be updated to include the I/I and calibrated to the two significant events measured during the I/I study. Future capital improvements can then be adjusted based on these results, especially since quantifying I/I using the monitored wet weather data may increase the scope and cost of certain capital improvements.

1.5.6 Flow Comparison at RWQCP

A flow comparison was completed between the flows estimated in the CSMPs and those estimated by Carollo at the Regional Water Quality Control Plant (RWQCP) (see Volume 2, Chapter 3 - Population and Flow Projections). The flows from the collection system should correlate well with the flows measured at the RWQCP. Because the analyses were completed independently, some differences are expected. Table 1.4 summarizes the comparison of flows for 2006 and Table 1.5 summarizes the comparison flows for 2020.

Table 1.4 Comparison of CSMP Flows to RWQCP Flows - 2006
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	RWQCP	Total from CSMPs	Percent Difference[3]
ADWF (mgd)	-	32.8	
AADF (mgd)	33.5	-	2%[1]

Table 1.4 Comparison of CSMP Flows to RWQCP Flows - 2006
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	RWQCP	Total from CSMPs	Percent Difference[3]
PDWF (mgd)	60.3	63.6	-5%
DWF Peaking Factor (PDWF/ADWF)	1.8	1.9	-
Peak Wet Weather Flow (mgd)[2]	73.7	-	-
WWF Peaking Factor (PWWF/ADWF)	2.2	-	-

Notes:
(1) Percent difference between AADF and ADWF.
(2) Based on historical flow analysis (Carollo, Vol. 2, Ch. 3).
(3) Percent Difference = (RWQCP - CSMP)/(RWQCP) flows.

Table 1.5 Comparison of CSMP Flows to RWQCP Flows - 2020
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	RWQCP	Total from CSMPs	Percent Difference[3]
ADWF (mgd)	-	49.5	
AADF (mgd)	45.8	-	-8%[1]
PDWF (mgd)	86.1	89.8	-4%
DWF Peaking Factor (PDWF/ADWF)	1.8	1.8	-
Peak Wet Weather Flow (mgd)[2]	105.2	-	-
WWF Peaking Factor (PWWF/ADWF)	2.2	-	-

Notes:
(1) Percent difference between AADF and ADWF.
(2) Based on historical flow analysis (Carollo, Vol. 2, Ch. 3).
(3) Percent Difference = (RWQCP - CSMP)/(RWQCP) flows.

The ADWF for 2006 estimated in the CSMPs is 32.8 mgd, while the average annual daily flow (AADF) estimated at the RWQCP is 33.5 mgd. This is a difference of about 2 percent. The AADF contains I/I and should be greater than the ADWF since the ADWF is estimated during the dry season where little I/I should be present in the sewers. The ADWF for 2020 is estimated at 49.5 mgd for the collection system, while the AADF is estimated at 45.8 mgd at the RWQCP. This is a difference of about -8 percent. These comparisons show that the compared flows, from different data sources, are relatively close.

The PDWF estimated for the collection system is approximately 5 percent higher than that estimated at the RWQCP for 2006, and approximately 4 percent higher for 2020. Since I/I was not accounted for in the collection system flow estimates, peak wet weather flows (PWWF) were not reported in the CSMPs.

1.6 WASTEWATER COLLECTION SYSTEM MODEL

A collection system model was constructed for each basin to route flows and analyze hydraulics within the system. The software XP SWMM version 9.1 was used. This software allows for dynamic simulation of flows to account for attenuation, time of travel, surcharge, etc. The specifics of the model structure as well as the performance criteria used to identify deficiencies are included in this section.

1.6.1 Model Structure

The collection system hydraulic model includes the main interceptors and trunk sewers in the system, but does not include every pipe in the system. This type of representation of the system is typical in collection system modeling to simplify the model results and reduce run times. The majority of the system improvements due to hydraulic deficiencies can usually be identified with this type of “backbone” system.

The modeled system consists of 101.1 miles of gravity pipeline, 7.2 miles of force main, and 1,795 manholes. The pipe diameters range from 8-inches to 51-inches. Two pump stations are simulated and include Pierce Street lift station in the Arlanza basin and Wood Road lift station in Tequesquite basin. There are a total of 121 subbasins where flows are input to the modeled system and average about 235 acres per subbasin. Table 1.6 summarizes the statistics for each basin.

Table 1.6 Modeled Sewer System Statistics
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Statistics	Arlanza Basin	Phoenix Basin	Northside Basin	Spruce Basin	Tequesquite Basin
Gravity Sewer Length (miles)	38.0	23.0	10.0	8.3	21.8
Force Main Length (miles)	5.6	-	-	-	1.6
Sewer Diameters (inches)	8 - 51	8 - 48	8 - 36	8 - 18	8 - 42
No. of Manholes	691	379	176	152	397
No. of Pump Stations	1	-	-	-	1

Table 1.6 Modeled Sewer System Statistics Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
Statistics	**Arlanza Basin**	**Phoenix Basin**	**Northside Basin**	**Spruce Basin**	**Tequesquite Basin**
Subbasins (flow input points)	34	21	26	9	31
Notes: (1) Total modeled gravity sewer length = 101.1 miles. (2) Total modeled force main length = 7.2 miles. (3) Total modeled manholes = 1,795.					

1.6.2 Performance Criteria

The hydraulic model is used to analyze the hydraulics of existing and future flows. Performance criteria are used to judge the capacity deficiencies within pipelines. The assumptions for the CSMPs are summarized below:

- "Deficient" if pipes flowing at greater than 90 percent full.
- "Marginally Deficient" if pipes flowing between 75 percent and 90 percent full.
- "Velocity Deficient" if velocities are less than 2 feet per second (fps) or greater then 10 fps.

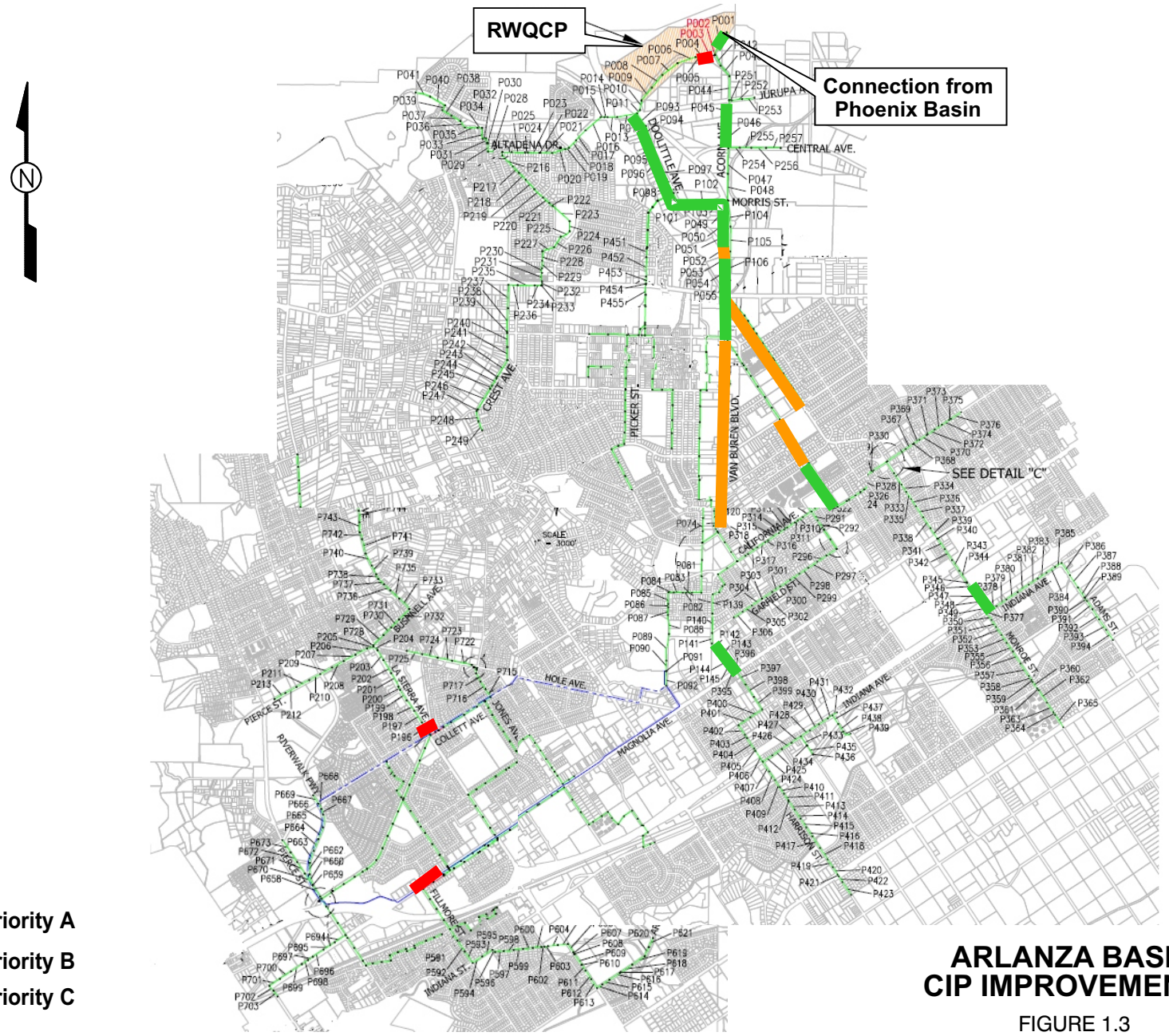
These criteria were used to examine existing and future flow conditions, and identify the pipelines in need of upgrades. Deficient sewer lines were classified into three priority groups, as follows:

- "Priority A" pipes were "deficient" at the time of the study: 2002 for Spruce, 2003 for Tequesquite, and 2005 for the remaining basins.
- "Priority B" pipes were projected to be "deficient" by 2015.
- "Priority C" pipes were projected to be "marginally deficient" by 2020.

Pipeline improvement projects were identified in each CSMP according to these priorities, along with a schedule for replacement/rehabilitation of deficient pipes.

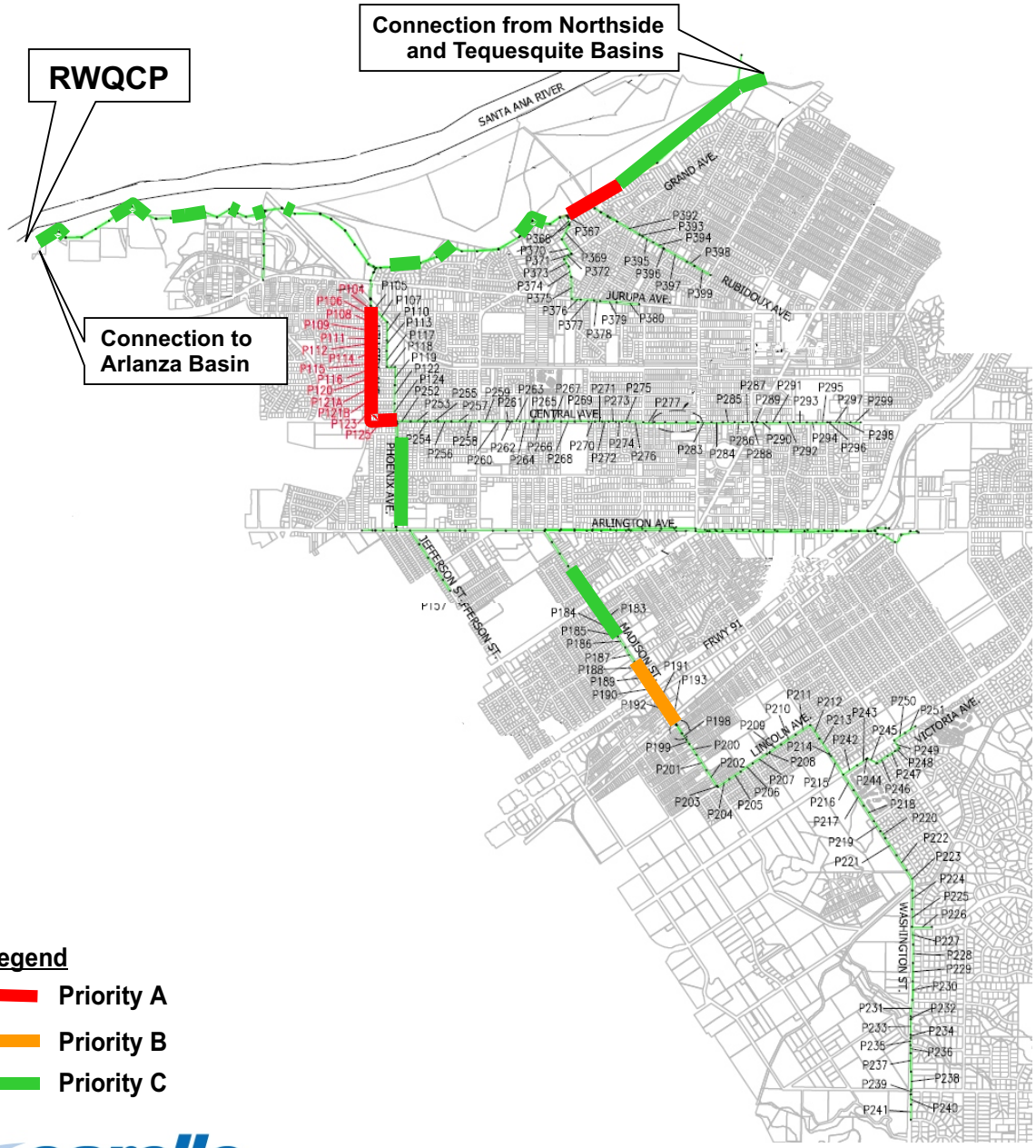
1.7 CAPITAL IMPROVEMENT PLAN

A CIP was developed in the CSMPs to identify pipeline projects that required upgrades based on the modeling and the above performance criteria. The CIP projects identified by the CSMPs are illustrated in Figures 1.3 through 1.7. The pipeline improvements are color coded for the three priorities defined above. The specifics on each project can be found in the accompanying reports included in the appendices.



ARLANZA BASIN CIP IMPROVEMENTS

FIGURE 1.3



Legend

- Priority A
- Priority B
- Priority C

PHOENIX BASIN CIP IMPROVEMENTS

FIGURE 1.4

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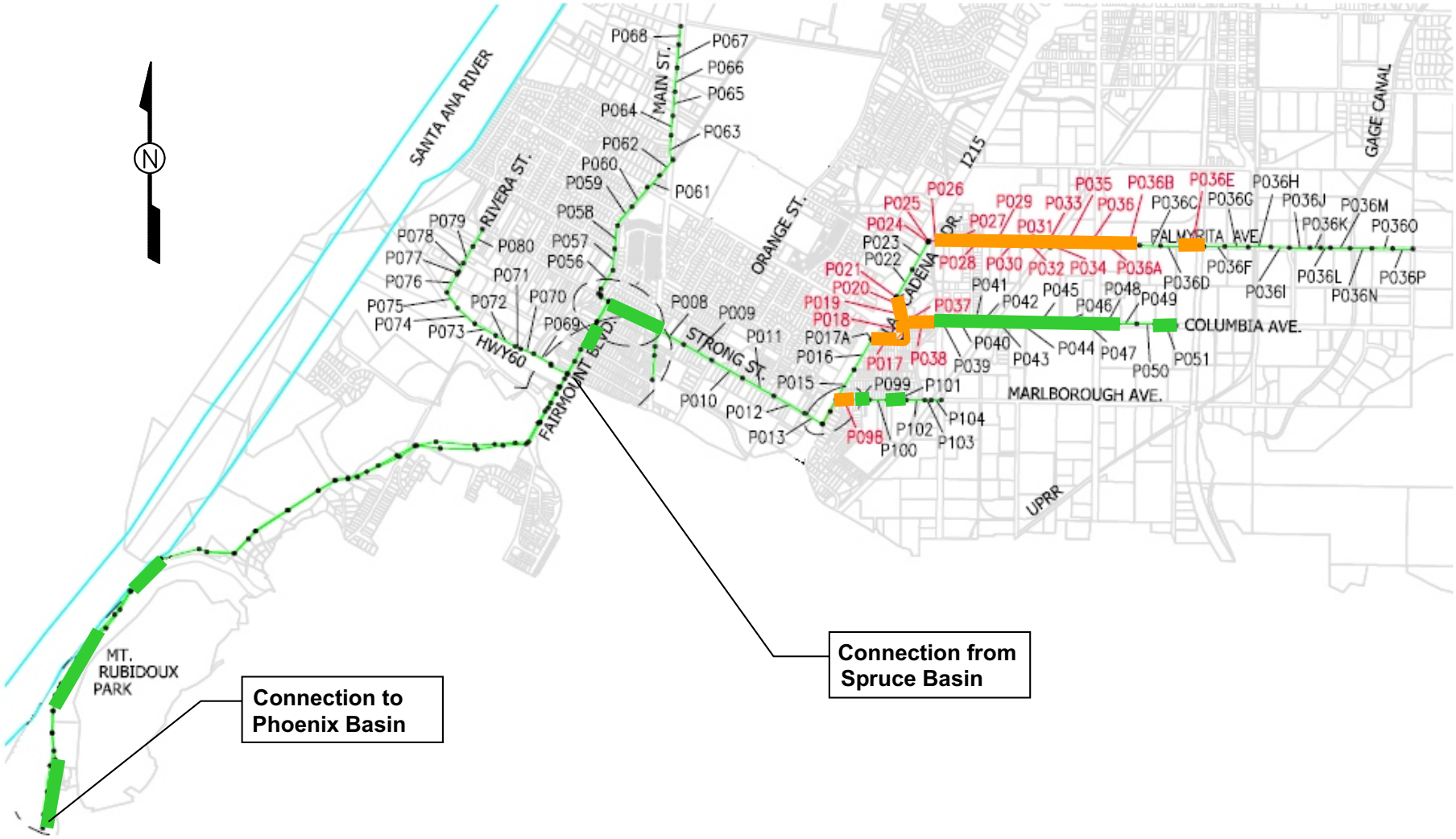

Legend

- **Priority A**
- **Priority B**
- **Priority C**

NORTHSIDE BASIN CIP IMPROVEMENTS

FIGURE 1.5

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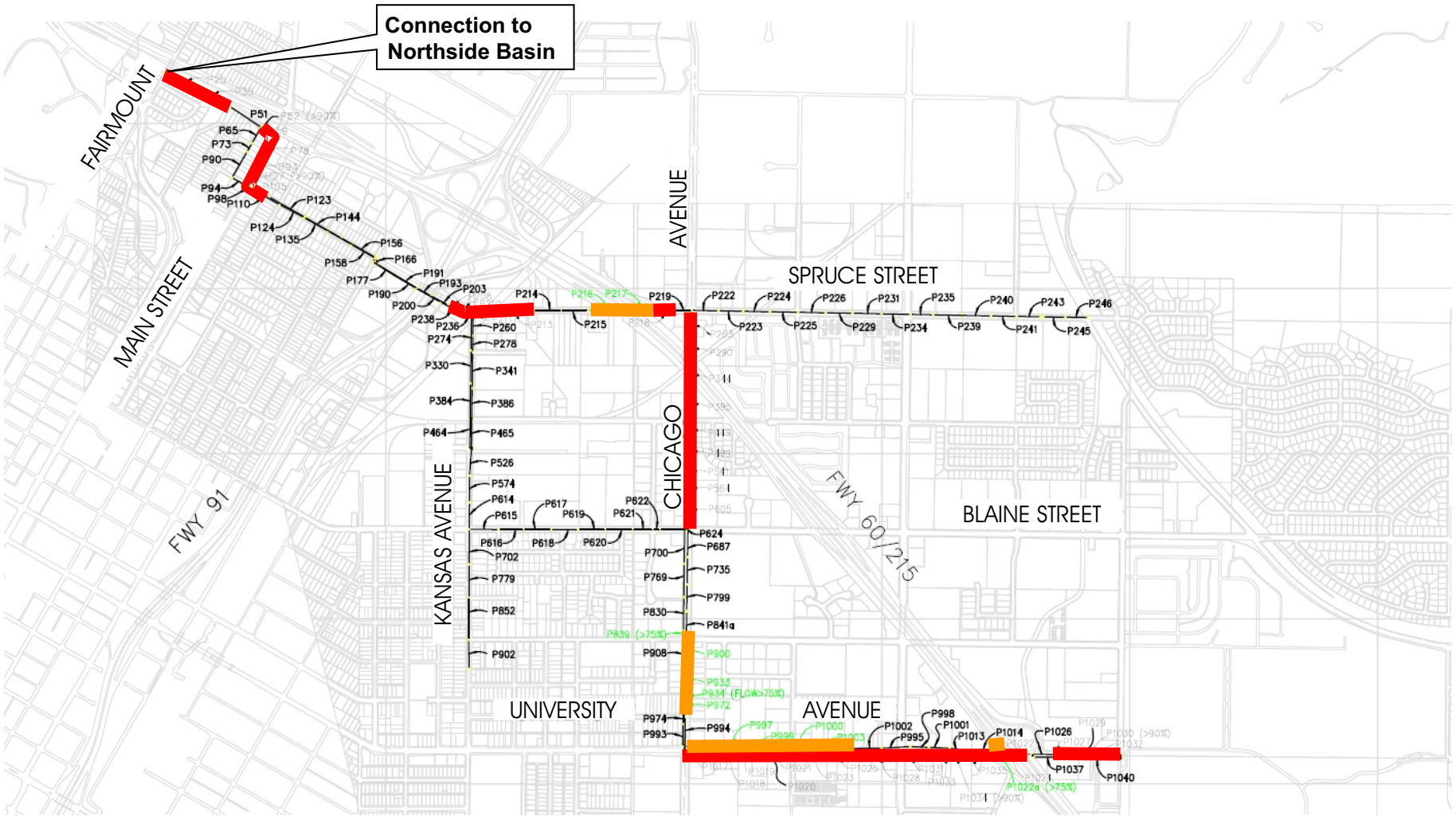

Legend

- **Priority A**
- **Priority B**
- **Priority C**

SPRUCE BASIN CIP IMPROVEMENTS

FIGURE 1.6

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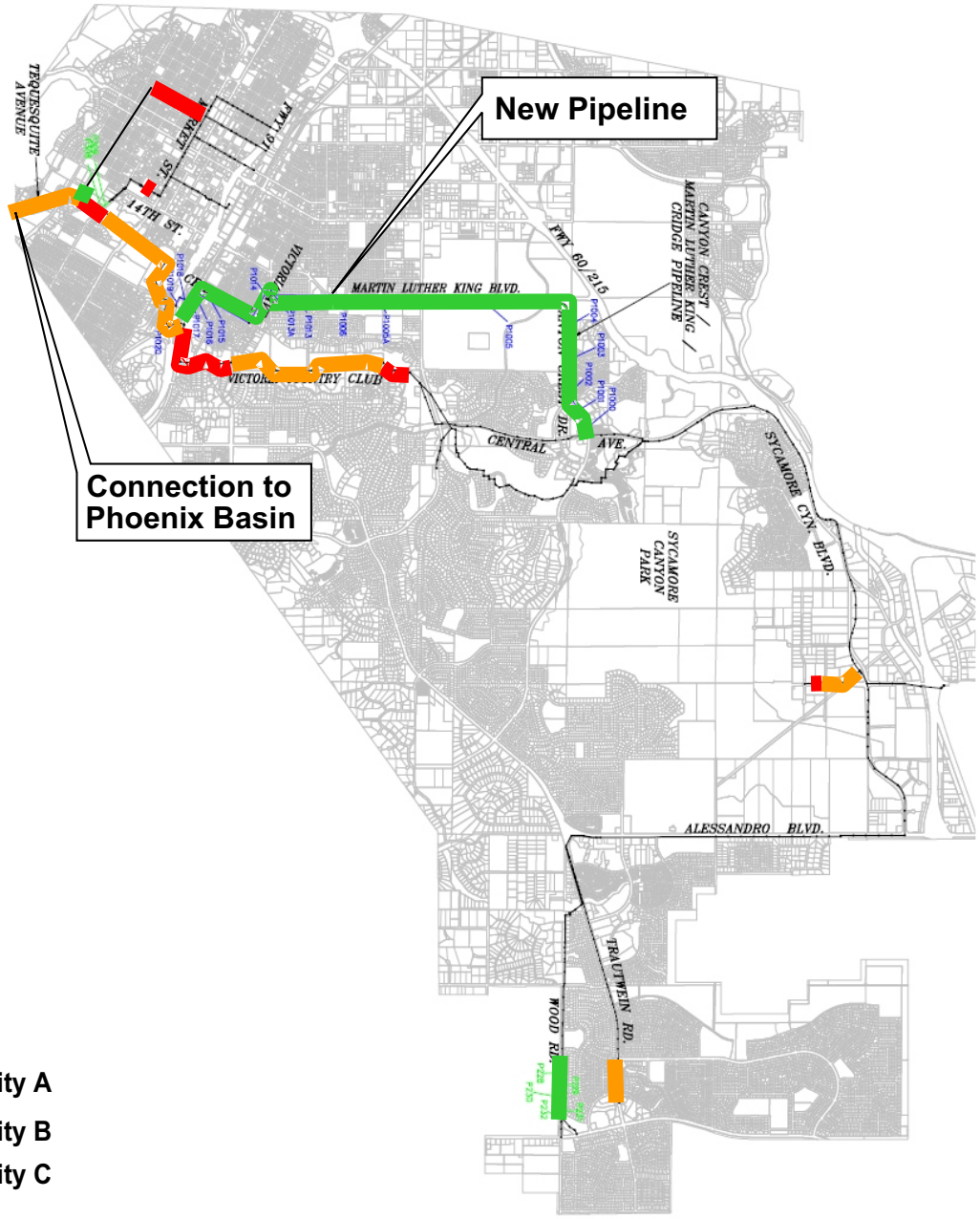
WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

CITY OF RIVERSIDE



Legend

- Priority A
- Priority B
- Priority C

TEQUESQUITE BASIN CIP IMPROVEMENTS

FIGURE 1.7

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CITY OF RIVERSIDE

Since the Spruce and Tequesquite CSMPs were completed several years ago, the City has already completed several of the proposed projects. These projects include:

- Spruce Street East Kansas and Sewer Easement Northbend (Spruce Basin)
- 13th Street (Tequesquite Basin).
- 5th Street Upgrade and New Pipeline (Tequesquite Basin).
- Brockton Avenue (Tequesquite Basin).

Other projects identified in the CSMPs are assumed to be needed in the future, although further investigation is recommended before these projects go into design.

1.8 CAPITAL IMPROVEMENT PLAN COST ESTIMATES

CIP cost estimates are included in each of the CSMPs. This section compares the pipe unit costs and cost estimation methods, and reports the total year cost estimates for the collection system CIP, and rehabilitation and replacement (R&R). The cost estimates included in this section are based on information provided by the City based on the CSMPs.

1.8.1 Unit Costs

The pipeline unit costs developed for the CSMPs are included in Table 1.7. These unit costs were compared to those estimated by Carollo for the Riverside area. Generally, the unit costs are similar. Therefore, the direct costs estimated in the CSMPs were retained for the CIP cost estimates.

Table 1.7 Unit Cost Estimates
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Item	Unit	Unit Cost[(1)]
Pipe (Diameter)		
8-inch	LF	-
10-inch	LF	$100
12-inch	LF	$110
15-inch	LF	$115
18-inch	LF	$145
21-inch	LF	$170
24-inch	LF	$200
27-inch	LF	$205
30-inch	LF	$220
33-inch	LF	$245

Table 1.7 Unit Cost Estimates Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Item	**Unit**	**Unit Cost[(1)]**
36-inch	LF	$260
39-inch	LF	$275
42-inch	LF	$300
45-inch	LF	$320
48-inch	LF	$340
51-inch	LF	$360
54-inch	LF	$390
Manhole	EA	$5,500
Lateral (reconnection)	EA	$1,650

Notes:
(1) PBS&J unit cost estimates for year 2005, used for Arlanza, Northside and Phoenix CSMPs.

1.8.2 Methods

The cost estimation methods used for the CSMPs differed from the methods applied to projects that are evaluated for other volumes of the Integrated Master Plan. Table 1.8 summarizes the items that are accounted for in each method. The cost estimates in the CSMPs ended at the construction costs and did not include site work, sales tax, bid market allowance, engineering, management, legal, escalation, R&R, and O&M, which are all included in the Integrated MP method. The Integrated MP method was therefore applied to the CSMP direct costs (based on unit costs described above) to determine total project costs. Costs were escalated to August 2006 dollars using the Engineering News Record Construction Cost Index (ENR CCI) for Los Angeles.

Table 1.8 Cost Estimation Methods Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Item	**CSMP Method[(1)]**	**Integrated MP Method**
Site Work	None	10%
General Conditions	15%	10%
Contractor's overhead and profit	15%	15%
Construction contingency[(2)]	25%	30%
Sales Tax	None	7.75%
Bid Market Allowance (of total construction costs)	None	15%

Table 1.8 Cost Estimation Methods Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Item	**CSMP Method(1)**	**Integrated MP Method**
Engineering, Mgmt, Legal (of total construction cost)	None	30%
Escalation(3)	None	6% (first 5 yrs), 4% (after)
R&R and O&M costs	None	Yes

Notes:
(1) Percentages applied to Arlanza, Northside and Phoenix CSMPs.
(2) Does not include ROW acquisition, permits, soil remediation, and bypass pumping.
(3) First 5 years are 2007 through 2011.

1.8.3 Cost Estimates

The total cost estimates for years 2008 through 2025 are included in Table 1.9. These estimates include costs derived from the projects listed in the CSMPs, costs for replacement and rehabilitation of pipes that are greater than 50 years old, and total costs by year. These costs were provided by the City. On the direction of the City, these costs were adjusted using the Integrated MP method detailed in Table 1.8. The costs that are derived from the projects listed in the CSMPs are distributed evenly over a 10-year period from 2008 through 2017. These costs were escalated at a rate of 6 percent through 2011 and then 4 percent for the remaining years. The total estimated CSMP project costs over the 10-year period are $53.35 million. Details on the cost estimates can be found in Appendix G.

Table 1.9 Collection System Cost Estimates by Year Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside			
Year	**CSMP Project Costs (millions)**	**Replacement and Rehabilitation Project Costs (millions)**	**Total Costs (millions)**
2008	$4.24	$8.85	$13.09
2009	$4.49	$9.39	$13.88
2010	$4.76	$9.95	$14.71
2011	$5.05	$10.54	$15.59
2012	$5.25	$10.97	$16.21
2013	$5.46	$11.41	$16.86
2014	$5.68	$11.86	$17.54
2015	$5.90	$12.34	$18.25
2016	$6.14	$12.83	$18.96
2017	$6.39	$13.34	$19.73

Table 1.9 Collection System Cost Estimates by Year
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Year	CSMP Project Costs (millions)	Replacement and Rehabilitation Project Costs (millions)	Total Costs (millions)
2018	-	$13.88	$13.88
2019	-	$14.43	$14.43
2020	-	$15.01	$15.01
2021	-	$15.61	$15.61
2022	-	$16.23	$16.23
2023	-	$16.88	$16.88
2024	-	$17.56	$17.56
2025	-	$18.26	$18.26
Totals	$53.35	$239.29	$292.64

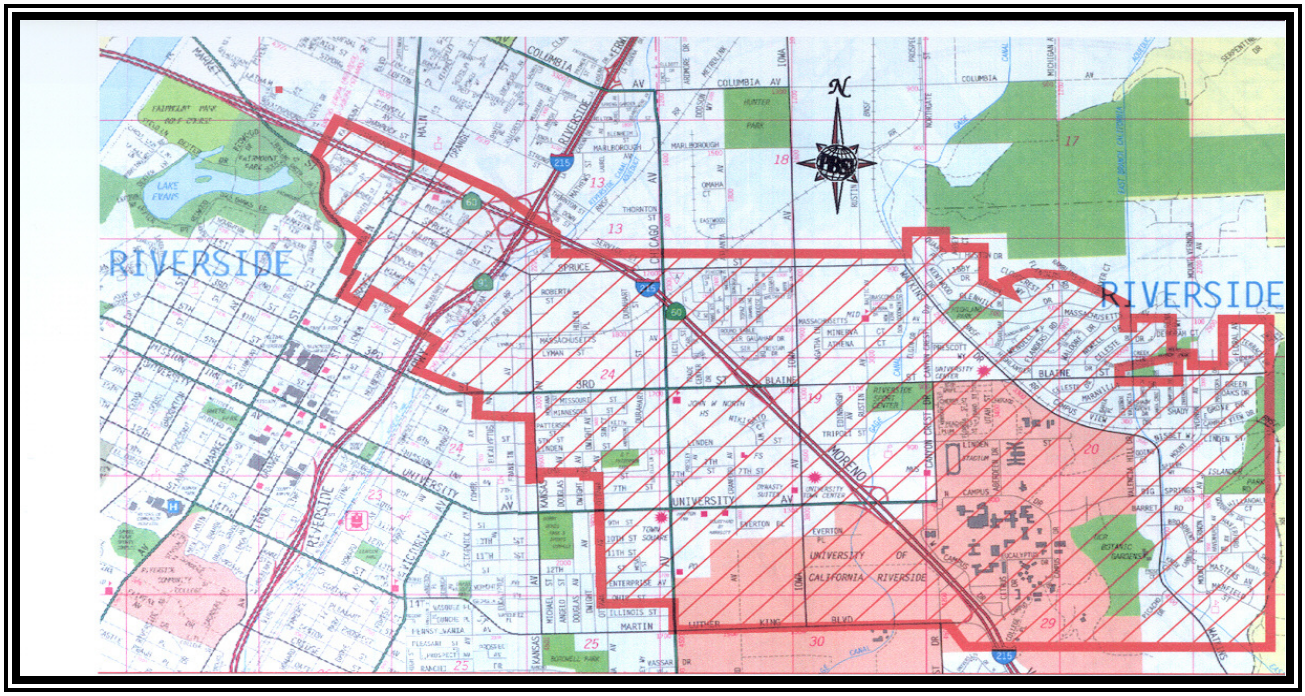
Notes:
(1) Budgeted.
(2) Costs beyond FY 2015 were not supplied by the City.
(3) All costs provided the City.

The rehabilitation and replacement costs summarized in Table 1.9 were provided by the City, using a replacement strategy based on pipe age. Pipes were categorized as either being constructed before 1943, or between 1944 and 1956 as documented in the City's geographic information system (GIS). All pipes that are 50 years or older were assumed to be replaced. These pipes were sorted by diameter and the lengths were reported. Unit costs for the pipeline diameters and manholes documented in Table 1.7 were then applied. These construction costs were then increased according to the Integrated MP method detailed in Table 1.8. Costs were distributed evenly over 50 years, and were escalated at 6 percent through 2011 and 4 percent thereafter. The total rehabilitation and replacement costs for the period from 2008 through 2025 are $239.29 million dollars. Details on the rehabilitation and replacement cost estimates can be found in Appendix G.

The total cost of collection system projects over the next ten years (2008 through 2017) are estimated at $164.80 million. Since the CSMP project costs are only estimated over this 10-year period, the total costs after 2017 may not be all inclusive.

Appendix A
SPRUCE STREET SEWER CAPACITY STUDY

City of Riverside
Spruce Street Sewer Capacity Study



Prepared By:

PBS&J
3610 Central Avenue, Suite 500
Riverside, CA 92506
(909) 341-6380

June 15, 2002

SPRUCE STREET
SEWER CAPACITY STUDY

City of Riverside

Client Representative: Sandy Caldwell

PBS&J

Project Manager Louis Atwell

Technical Advisory: Gary Eikermann

Technical Support: Dave Youngblood
Barmeshwar Rai

J.N. 590031

June 15, 2002

PBS&J 3610 Central Avenue, Suite 500, Riverside, CA 92506

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Appendix A – Flow Data at Meter Locations

Appendix B – City of Riverside, Sewer Design Guidelines

Appendix C - UCR Student Population

Executive Summary

This report presents the results of a comprehensive Sewer System Capacity Study of the Spruce Street Trunk System prepared by PBS&J for the City of Riverside. The report contains recommendations regarding system deficiencies as identified by hydraulic model XP-SWMM (XP Software, Version 8.0).

The City of Riverside is located in the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. The study area encompasses approximately 2,500 acres of mixed land use development and is generally bounded by Spruce Street to the North, Watkins Drive to the East, Martin Luther King Boulevard to the South and Fairmount Boulevard to the West. The study area is essentially a fully developed community, comprising single family residential, multi family residential, commercial and light industrial areas with small pockets of vacant land to be developed in future. The University of Riverside, California (UCR) is one of the major contributors of wastewater flow to the sewer system.

The existing trunk sewer system within the study area is comprised of approximately 8.3 miles of sewer main ranging in size from 8 inches to 36 inches in diameter, and 152 manholes. The sewers are essentially VCP and the manholes are typically brick lined. The City of Riverside owns and operates the sewer system.

For determination of current wastewater flows, flow monitoring was performed at ten strategic locations. These meter locations were chosen to observe actual flow characteristics for various sub areas with a distinct land use pattern within the study area. The flow monitoring was accomplished over a two-week period. The flow results were carefully evaluated for their accuracy and some adjustments have been made based on depth of flow at meter locations.

A theoretical estimate of current and future wastewater flow was estimated based on factors from the City of Riverside “Criteria for Sewer Facility Design”. Residential wastewater flow was determined by using current and future projected population, whereas commercial and industrial flow was determined based on acreage and City estimated flow coefficients. Flow from UCR was estimated using the Draft Long Range Development Plan of University of California, Riverside.

The Computer Model Simulation Analysis involved evaluation of available capacity in the existing collection system under present and future development conditions. Based on the results of model runs, system deficiencies were identified and a phased facility improvement plan was developed to allow for the projected growth within the study area.

Deficient and marginally deficient pipes were identified from the results of model runs. The pipes currently flowing more than 90% full under maximum flow conditions are grouped in priority “A”, pipes flowing more than 90% full in the future under maximum flow conditions are priority “B” and pipes flowing between 75% full and 90% full in future under maximum flow conditions are classified as priority “C”. Some adjustment of priorities and combining of improvements was done based on the need for continuity and efficiency of implementation. Within priority “A”, two alternatives were evaluated to identify the most feasible solution. Alternative 2 was recommended as the preferred alternative.

The time phased improvements for various priorities are listed in table 7-2. The approximate cost of recommended improvements is summarized in tables 7-5, 7-6 and 7-7.

Under existing flow conditions, a total of 1,935 linear feet of priority “A” deficiencies were identified, requiring near term attention. Additional deficiencies predicted under ultimate flow conditions (Priority “B”) include an additional 9,660 linear feet of inadequate sewer lines. The estimated capital cost to remedy these identified deficiencies (in year 2000 $’s) is $686,500 for Priority “A” and $2,200,000 for priority “B”. However, it may be that not all of the priority “B” improvements will need to be actually implemented. Only those where surcharging and other problems are deemed imminent. Periodic flow monitoring is also recommended to verify anticipated deficiencies and need for improvements.

1.0 INTRODUCTION

1.1 Background

On 10/16/2001 the City of Riverside retained PBS&J to prepare a Sewer System Capacity Study. The study is necessitated by the fact that the City is experiencing sewer capacity issues along the Spruce Street Sewer Trunk Line and its adjoining areas.

1.2 Study Area

The City of Riverside is located in the northwest corner of the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. Founded in 1870, the City is known for its citrus industry, world famous Mission Inn and other historical monuments. Figure-1 is a Vicinity Map depicting the City's location and its accessibility. Figure 2 shows the study area. The study area shown in Figure 2 encompasses approximately 2,500 acres and is generally bounded by Spruce Street to the North, Fairmount Boulevard to the West, Martin Luther King Boulevard to the South and Watkins Drive to the East. The area has been divided into nine tributary sub-areas, where downstream sub-areas intercept sewage flow from upstream sub-areas. To obtain "real" flow information for this study, sewage flow meters were placed at strategic locations to monitor flows contributed from the tributary sub-areas.

In general, the study area is considered to be a mature community comprised of single family residential, multi-family residential, commercial and light industrial uses. The University of California, Riverside (UCR) is one of the major contributors of the sewage flow within the study area.

1.3 Objective

The objective of this Sewer System Capacity Study is to provide a comprehensive evaluation of the capacity of the sewer system within the study area, identify deficiencies in the current system, and evaluate alternatives to enhance the conveyance capacity to accommodate ultimate wastewater flows anticipated to be generated in the study area.

1.4 Scope and Study Approach

Specific work tasks under this study are summarized as follows:

N

Engineering
Planning
Surveying
Construction Services

PBSJ

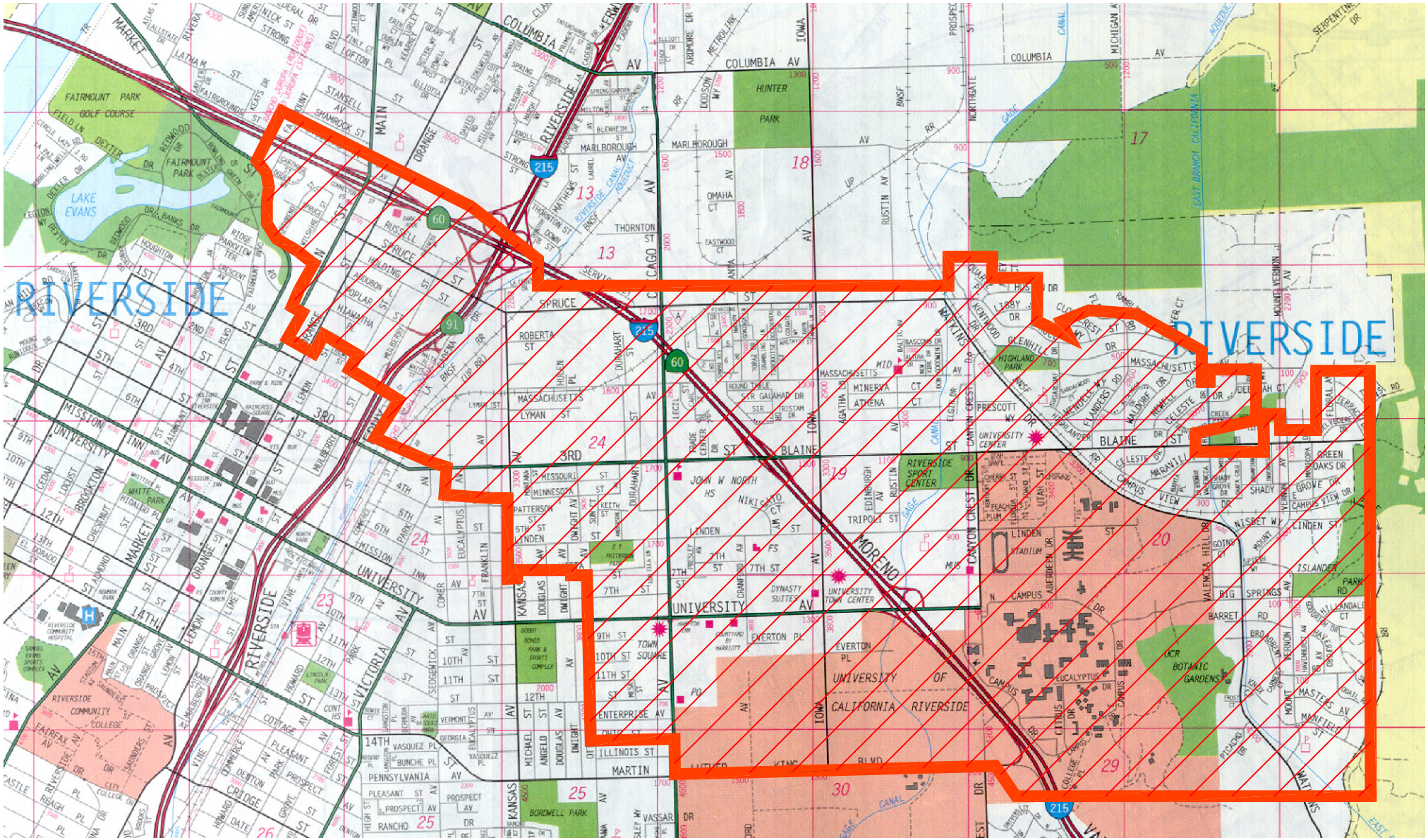
3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER

VICINITY MAP

JUNE 2002

FIGURE 1



LEGEND

STUDY AREA

N

Engineering
Planning
Surveying
Construction Services

PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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CITY OF RIVERSIDE
SPRUCE STREET SEWER

STUDY AREA

JUNE 2002

FIGURE 2

- Kickoff Meeting

  The initial meeting to introduce PBS&J personnel and sub-contractors working on this project to the City, discussion of project scope, communication protocol, scheduling of flow monitoring dates and explanation of methodology involved, and field data and other digital files to be provided by the City.

- Progress Meetings

  Monthly Project Progress Meetings to discuss on going issues and progress of study.

- Flow Monitoring and Hydrograph Development

  The sub-consultant, Downstream Services is to install, maintain, and collect flow data from ten monitoring stations throughout the study area. They would then submit the collected raw data in electronic/hard copy format to PBS&J. PBS&J would then process this information and create a hydrologic database. The City is to provide a copy of City's General Plan for estimation of current and future flows. Other information like Long Range Development Plan (LRDP) of University of California, Riverside and Traffic Analysis Zones (TAZ) data is to be considered for making future flow projections.

- Model Development

  Model development includes input data collection, conversion of data and calibration. The City's GIS staff would make available data pertaining to roads, sewers, land use and other utilities in Arc/View format on a CD. As built plans for trunk line sewer is to be reviewed. Data available from GIS system and as built plans is placed in a database system (MS Access 2000) as a pre-processor for XP-SWMM model development. Calibration of model is done after construction of the model and additional data input.

- Draft Report

  Based on the calibrated model and City's criteria for Sewer Facility Design, a Draft Report is to be prepared which would summarize existing and future capacity problems. Alternatives are to be suggested for additional or alternate sewer improvements along with probable costs. The draft report is to be reviewed by the City personnel for their comments and suggestions.

- Final Report

  Draft Report review comments from the City are to be incorporated into the Final Report along with and additional information or research in order to reflect a final level of study completion. The Final Report will include data and information assembled, alternatives evaluated, capital improvement recommendations to remediate anticipated deficiencies, and approximate cost.

A comprehensive evaluation of the sewage collection system to accomplish the above summarized scope entails the following multi-step approach:

- Review of as built plans provided by the City to determine system configuration, inverts, pipe sizes and slopes.
- Use of detailed database provided by the City in Arcview format.
- Creation of computer hydraulic model using existing sewer system to study project area.
- Identification of flow monitoring station locations.
- Identification of tributary areas contributing sewage flow to meter locations.
- Installation of flow meters and monitoring of flows at the selected locations on continuous basis for two-week period.
- Review of current land use in study area per GIS information from the City and determination of existing land use, population and vacant land.
- Assessment of ultimate land use and projected population.
- Review of current land use pattern for UCR, student population.
- Review of Long - Range Development Plan, future land use pattern for UCR and student population.
- Review and evaluation of metered data from flow monitoring stations.
- Development of flow coefficients and representative diurnal flow patterns based on typical curves for various land uses and observed flows from monitored sub areas which are dominated by a specific land use.
- Modeling of sewer system, deficiency identification, and model simulation of remedial alternatives using above -mentioned information as input data.
- Evaluation of alternatives, optimization, cost comparison.
- Prioritization of recommended improvements, including identification of critical pipelines which need immediate attention.
- Draft Report and recommendations including phased improvements and costs.
- Review by the City, comments and discussion.
- Final Report

2.0 LAND USE

2.1 Existing Land Use

Land use is the basis for estimating sewage flow from the majority of the study area. The land use pattern for this study (with the exception of UCR) was developed from the GIS information provided by the City. Figure 3 shows land use for the City (non-UCR) portion of the study area based on the City's "Ultimate Land Use" GIS layer. For the purposes of this study, land uses in the study area have been broadly classified into five categories: Single Family Residential (SFR), Multi Family Residential (MFR), Commercial, Industrial and University of California Riverside (UCR) Academic and Residential.

2.2 Proposed Land Use

The study area is primarily a mature community. With the exception of UCR owned property, there is very little vacant land (approximately 265 acres). The majority of the remaining growth is planned to take place as part of the UCR expansion. UCR is currently developing a "Long Range Development Plan" (LRDP) projecting through year 2015. Based on an estimate of student population (approximately 25,000 by 2015), the University remains a major contributor of sewage flow within the Spruce Street Sewer System. It is assumed that the majority of vacant lots within the study area would be fully developed by year 2015. Wastewater generating (developed) land use within the study area is generally summarized in the following table:

Table 2-A
Summary of Wastewater
Generation based on Land Use
(Acres)

Category	Existing	Future (Year 2015)	Change
Single-Family Residential (SFR)	1,136	1,294	+158
Multi-Family Residential (MFR)	189	203	+14
Commercial	284	377	+93
Industrial	170	170	0
University of California (UCR)	471	706	+235

2.3 UCR Existing Land Use

Existing land use within the UCR campus is a mixture of academic facilities (and related support), as well as, housing (including residence halls and apartments and related support). UCR owns approximately 1,106 acres generally bounded by Chicago Street on the west, Watkins Drive on the east, Blaine Street on the north, and a line extending east from La Conte Drive on the south. As shown in table 2A, 471 acres is currently developed. Most of the developed campus area is located east of I-215/Hwy 60, whereas large sections of UCR owned vacant land located west of the I-215/Hwy 60 is slated to become part of the developed campus in the future.

Existing campus population is approximately 23,000, of which 14,000 are students and 9,000 are faculty and support personnel.

2.4 Draft UCR Long Range Development Plan (LRDP)

The UCR campus is experiencing rapid growth, which is expected to continue into the future. Expected "build-out" or ultimate capacity is projected to occur in the year 2015 to 2020 timeframe.

To accommodate the expected growth, UCR is in the process of updating its Long-Range Development Plan, which was last updated in 1990. The LRDP planning process is a comprehensive evaluation of facility needs to support the objectives set forth in the UCR Academic Plan. The previous 1990 LRDP addressed a projected student population of 18,050, while the current LRDP contemplates a population of 25,000. Both versions acknowledge a possible ultimate student population of 30,000. For purposes of this sewer capacity evaluation, a 2015 build-out population of 25,000 students and 15,000 faculty and support personnel is used. After interviews with UCR planning personnel and research of other similar universities, a 50/50 split was assumed for student on-campus housing and off-campus housing. Thus, approximately 12,500 students would be living on-campus and approximately 12,500 students would be living off campus, but within the study area.

A preliminary land use plan for ultimate UCR development is shown in Figure 4. Note that both academic and residential facilities are added west of the I-215/Hwy 60, while many of the existing older residential and academic facilities east of the I-215/Hwy 60 are expanded or replaced. No development is shown south of Martin Luther King Jr. Boulevard. Also, approximately 93 acres of University-owned property west of Iowa Avenue is considered to be developed in future. However, this acreage may one day become part of a future expansion, perhaps to support an LRDP amendment which would bring the campus to a capacity of 30,000 students.

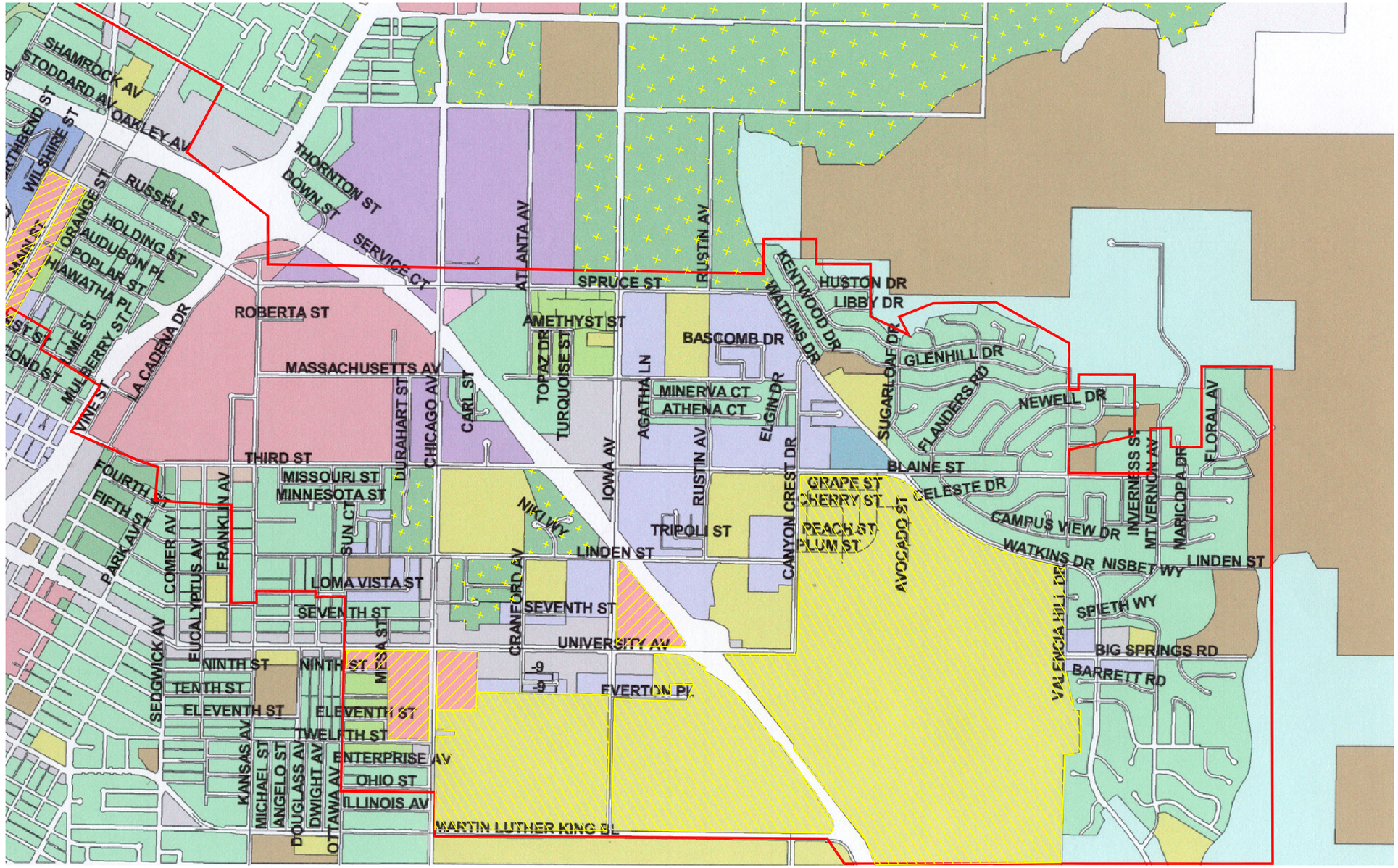
3.0 EXISTING SEWER SYSTEM

3.1 System Overview

As previously described, the Spruce Street Trunk Sewer System serves approximately 2,500 acres, which, for this study, has been divided into nine tributary sub-areas (See Figure 5); each area contributing sewage flow to a meter location or multiple meter locations (accumulated sub-area flows). The modeled gravity conveyance system is approximately 44,000 linear feet (8.33 miles), with pipe sizes varying from 8 inches to 18 inches in diameter (See Figure 6). The majority of pipelines within the system are vitrified clay (VCP).

3.2 Collection System

The wastewater generated within the study area flows in a northerly or westerly direction depending on general topography. The major trunk lines are along Spruce Street, University Avenue, and Chicago Avenue. The trunk line in Chicago Avenue picks up sewage flow from Single Family Residences in the Box Springs Area, UCR and some commercial/multi family residences along University Avenue. The trunk lines in Spruce Street east of Chicago Avenue convey flow from single-family residences north-east of Watkins Avenue, multi family residences east of the I-215/60 Freeway and some commercial/industrial areas south of Spruce Street. The trunk line in Kansas Avenue conveys sewage flow generated by medium to high-density single-family residences north of Martin Luther King Boulevard and some commercial and industrial properties on both sides of Third Street. The majority of flow from the study area converges into two parallel trunk lines along Spruce Street west of Kansas Avenue. The sewer lines along University Avenue, Chicago Avenue and Kansas Avenue have parallel lines in some of the reaches and split flow situations at some manhole locations. Pipe size, length, and number of manholes have been tabulated for each major segment of the modeled trunk system (See Table 3-1).



LEGEND

- INDUSTRIAL–LIGHT
- INDUSTRIAL BUSINESS PARK
- PARKS PUBLIC
- RESIDENTIAL HILLSIDE
- INDUSTRIAL GENERAL
- PUBLIC FAC. & OPEN SPACE
- MIXED USE OFFICE
- COMMERCIAL CENTER
- RESIDENTIAL MEDIUM DENSITY
- RESIDENTIAL MEDIUM HIGH DENSITY
- COMMERCIAL BUSINESS OFFICE
- RESIDETIAL HIGH DENSITY
- STUDY AREA BOUNDARY

SOURCE – CITY OF RIVERSIDE GIS

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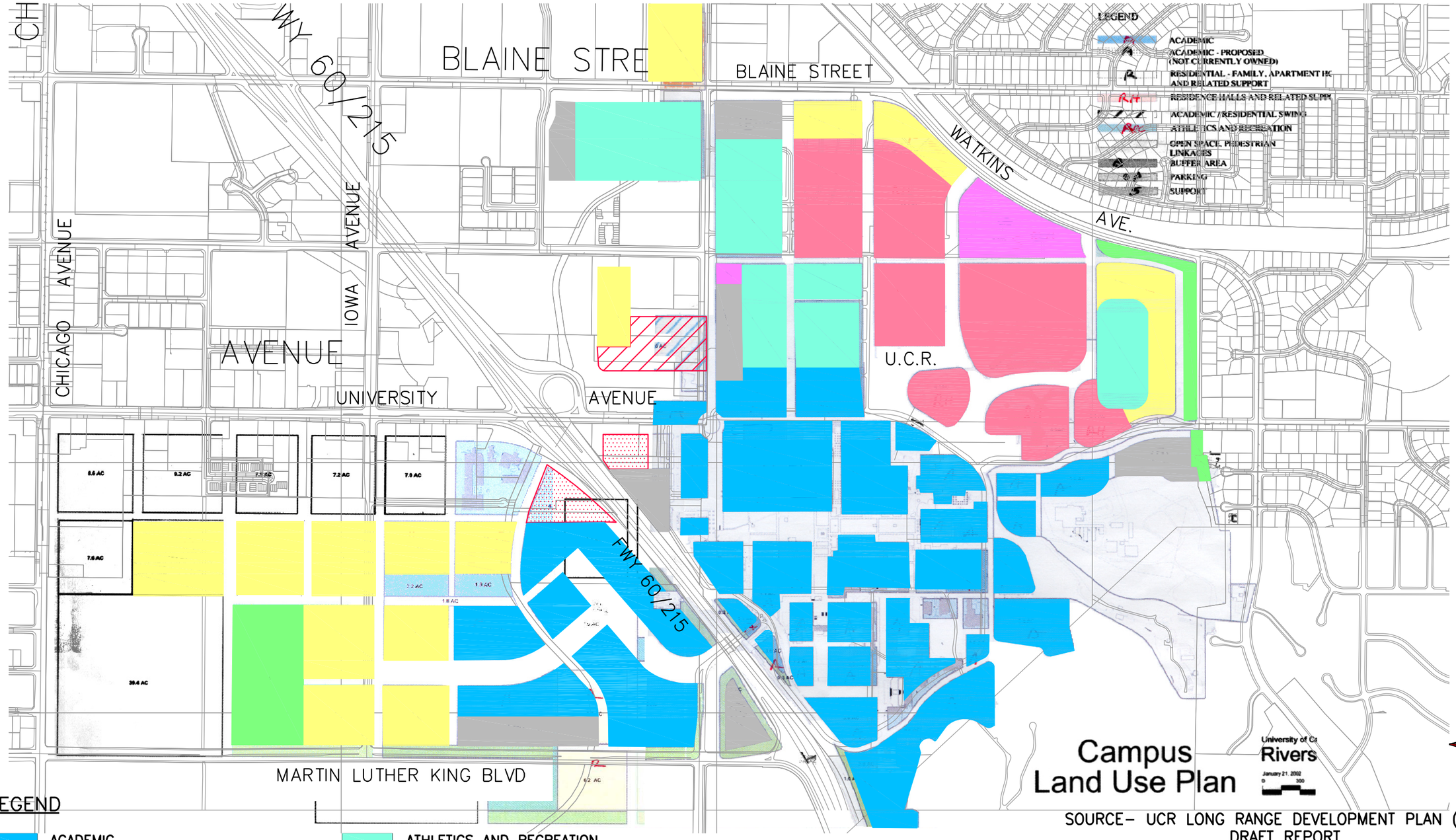
3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341–6380
Fax:(909) 341–6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER

GENERAL LAND USE PLAN

JUNE 2002

FIGURE 3



LEGEND

- ACADEMIC
- ACADEMIC–PROPOSED (NOT CURRENTLY OWNED)
- RESIDENTIAL–FAMILY. APARTMENT NO. AND RELATED SUPPORT
- RESIDENCE HALLS AND RELATED SUPPO
- ACADEMIC/RESIDENTIAL SWING
- ATHLETICS AND RECREATION
- OPEN SPACE. PEDESTRIAN LINKAGES
- BUFFER AREA
- PARKING
- SUPPORT

SOURCE– UCR LONG RANGE DEVELOPMENT PLAN (LRDP) DRAFT REPORT

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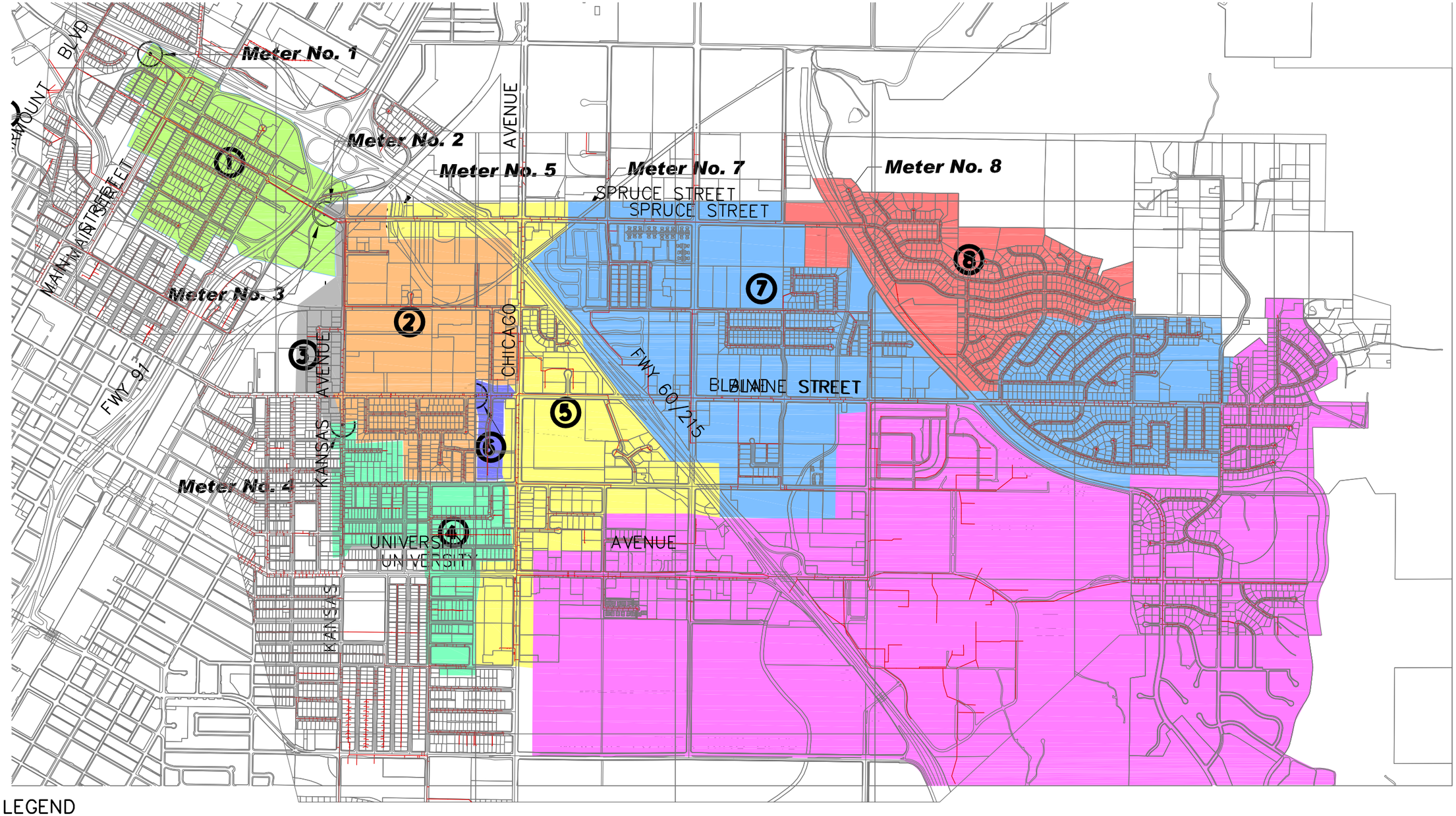
Planning
Surveying
Construction Services
PBS&J
3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER

UNIVERSITY OF CALIFORNIA LAND USE PLAN

JUNE 2002 | FIGURE 4



LEGEND

①	SUB AREA 1
②	SUB AREA 2
③	SUB AREA 3
④	SUB AREA 4
⑤	SUB AREA 5
⑥	SUB AREA 6
⑦	SUB AREA 7
⑧	SUB AREA 8
⑨	SUB AREA 9

N

GRAPHIC SCALE

1500 0 750 1500

(IN FEET)

1 inch = 1500 ft.

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3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER CAPACITY STUDY

TRIBUTARY AREAS AND MONITORING STATIONS

JUNE 2002

FIGURE 5

Table 3-1

City of Riverside
Summary of Modeled Sewer Lines within Study Area

Location	Pipe Dia. (Inches)	Length (Feet)	Number of Manholes
University Avenue	8	4,480	16
	12	3,847	13
	15	1,460	6
Spruce Street	8	2,149	9
	10	5,540	19
	15	2,997	8
	18	6,360	24
Chicago Avenue	10	1,413	6
	12	2,143	8
	15	1,850	6
	18	2,598	8
Third Street	10	2,649	10
Kansas Avenue	8	1,688	4
	10	2,597	9
	15	1,653	6
TOTAL		**43,784**	**152**

3.3 System Hydraulics

The existing trunk sewer system, which is the subject of this evaluation, is shown on Figure 6A and 6B. The sewer collection system was constructed over a period of many years as needed; to accommodate increasing sewer flows. The as-built plans provided by the City were studied to ascertain characteristics of the system. The sewer system, from upstream to downstream end, is briefly described as follows:

- *University Avenue Study Area Sewer Line*: The sewer lines along University Avenue begin just west of Canyon Crest Avenue with a 15-inch diameter UCR trunk line flowing from the east. Two parallel sewer lines (15-inch on the northern side and 8-inch on the southern side) run along University Avenue. They both then converge at manhole No. 1024 (east of Freeway I-215/60) where a single 15-inch diameter sewer line picks up their flows and crosses the I-215/60 freeway. Upon crossing the freeway, the 15-

Meter No. 1
Meter No. 2
Meter No. 3
Meter No. 4
Meter No. 5
Meter No. 6
Meter No. 7
Meter No. 8
Meter No. 9
Meter No. 10
FAIRMOUNT BLVD
MAIN STREET
FWY 91
SPRUCE STREET
SPRUCE
STREET
AVENUE
CHICAGO
3RD. STREET
KANSAS AVENUE
UNIVERSITY
AVENUE
FWY 60/215
BLAINE STREET
WATKINS AVE.
U.C.R.
MARTIN LUTHER KING BLVD

MODELLED TRUNK LINES
- 8" DIA. PIPE
- 10" DIA. PIPE
- 12" DIA. PIPE
- 15" DIA. PIPE
- 18" DIA. PIPE
- 36" DIA. PIPE

LEGEND
- EXISTING SEWER
- STUDY AREA BOUNDARY
- METER

N

GRAPHIC SCALE
600 0 300 600 1200 2400
(IN FEET)
1 inch = 600 ft.

H:\Client\Riverside_SAOW\7472A00\Rpt\Volume 03\Appendices\Ch01-AppxA-Spruce Report.pdf

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Planning
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PBSJ
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Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
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CITY OF RIVERSIDE
SPRUCE STREET SEWER CAPACITY STUDY

SEWER SYSTEM AND PIPE DIAMETERS

JUNE 2002

FIGURE 6A

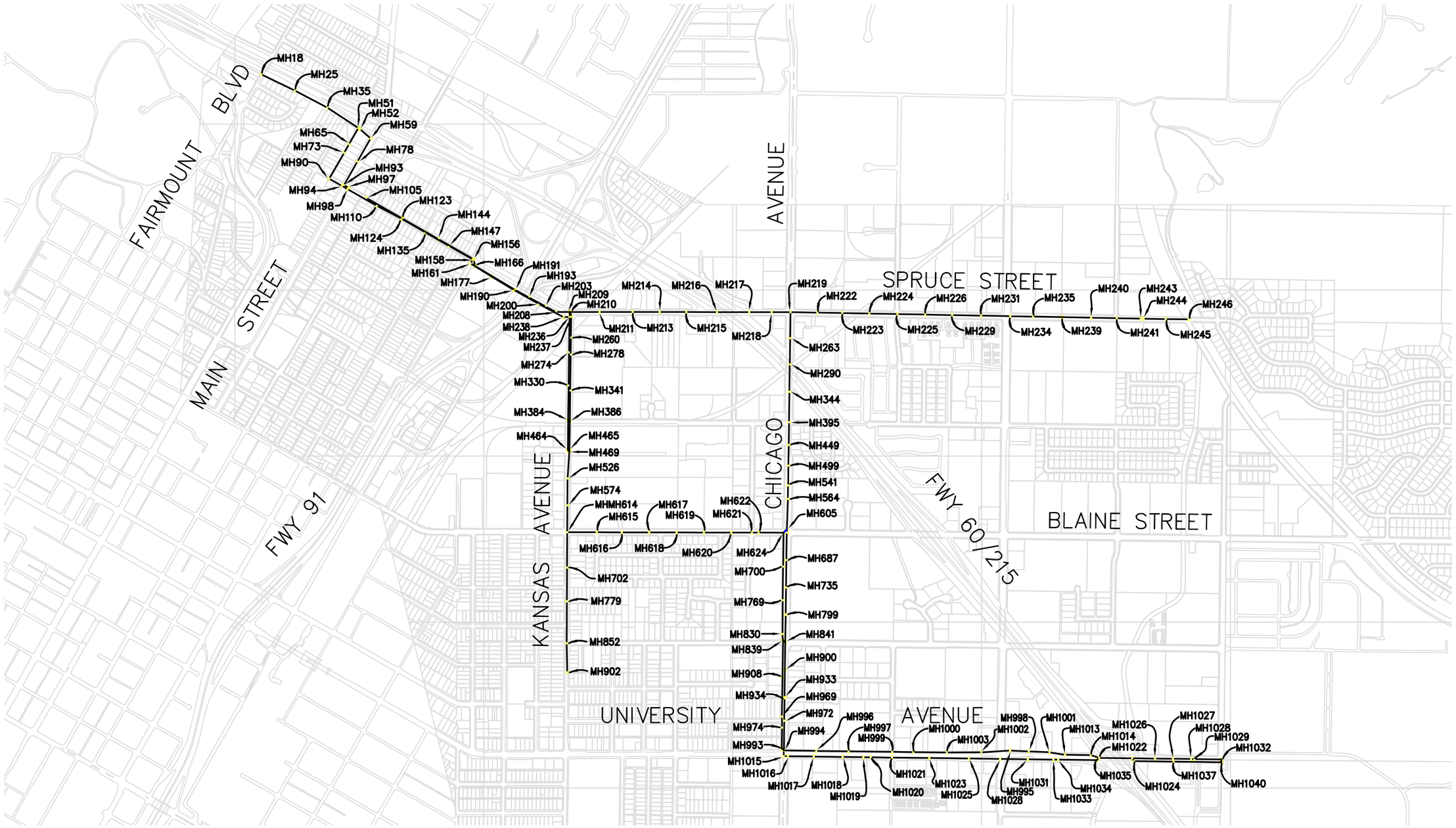
inch line connects to manhole No. 1022 where once again, the flow splits between two pipes (8-inch and 12-inch). Manhole No. 1022 has a split flow weir which diverts part of the flow into the 8-inch sewer line once the depth of flow reaches 3 inches in the 15-inch sewer line. Metered flow at meter locations 9 and 10 indicate that approximately 60% of total flow through manhole No. 1022 passes through the 12-inch sewer line, while about 40% passes through the 8-inch sewer line. The two pipes then continue to parallel one another along University Avenue flowing towards the west with the 12-inch line on the north side and the 8-inch on the south side of the street.

- *Chicago Avenue Study Area Sewer Line*: In Chicago Avenue, between University Avenue and Third Street, two parallel sewer lines flow to the north; however, there are two flow split situations – one at manhole No. 994 (intersection of University Avenue and Chicago Avenue) and another at manhole No. 841 (intersection of Linden Street and Chicago Avenue). From Linden Street, the flows continue north along Chicago Avenue, where they converge at manhole No. 605. From manhole No. 605, flows continue north in a single 12-inch diameter pipe to manhole No. 499. From manhole No. 499, the flows continue north in a 15-inch diameter pipe to Spruce Street, where they empty into the Spruce Street Trunk Sewer.

- *Third Street Study Area Sewer Line*: The sewer line along Third Street between manhole Nos. 624 and 614 is a 10-inch diameter VCP which collects wastewater flow from a commercial/light industrial area. Flow is in a westerly direction.

- *Kansas Avenue Study Area Sewer Line*: The sewer line along Kansas Street begins north of University Avenue at manhole No. 902. The wastewater flows northerly in a pipe, which progressively increases in size from a 8-inch to 10-inch to 12-inch to 15-inch diameter. The 8-inch pipe is from manhole No. 902 to manhole No. 614; the 10-inch from manhole No. 614 to manhole No. 237; 12-inch from manhole No. 469 to manhole No. 384 and 15-inch in the reach 384-236. There are three flow split situations at manhole Nos. 469, 386 and 236 respectively, thereby creating a parallel pipe scenario from approximately Lyman Street to Spruce Street.

- *Spruce Street Study Area Sewer Line*: The line along Spruce Street begins just west of Watkins Avenue and



N

GRAPHIC SCALE

1200 0 600 1200

(IN FEET)

1 inch = 1200 ft.

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3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
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EXISTING MANHOLES

JUNE 2002

FIGURE 6B

ends just east of Fairmount Boulevard. The flow in this sewer line is generally in a westerly direction. The sewer trunk line along Spruce Street collects the majority of its flows from the trunk lines along Chicago Avenue and Kansas Avenue. The pipe sizes vary from 8-inch to 18-inches in diameter. The diameter of pipe from manhole No. 246 to manhole No. 234 is 8-inch; from manhole No. 234 to manhole No. 225 is 10 inch; from manhole No. 225 to manhole No. 215 is 15 inch, and from manhole No. 215 to manhole No. 18 is 18 inch. Parallel pipe conditions exist from Kansas Avenue to where the pipes converge at the intersection of Wilsher Street and the 60 Freeway (City has an easement adjacent and parallel to the freeway). The pipe on the north of Spruce Street is 18 inches in diameter from manhole No. 210 to manhole No. 251, while the pipe on the south side is 10-inches in diameter and runs from manhole No. 236 to manhole No. 251. The 15-inch diameter pipe runs from manhole No. 51 to manhole No. 35 (parallel to Freeway I-215/60). The 18-inch diameter pipe runs from manhole No. 35 to manhole No. 18 (parallel to Freeway I-215/60).

3.4 Tributary Areas

The identified sewer tributary sub-areas are distinct areas characterized by the sewer system draining to a particular meter location (Meter locations were selected based on tributary areas) (See Figure 5). However, some meter locations (meters 1,2,5, and 7) measure flows from several tributary sub-areas (cumulative flows). Because of their strategic locations, meters upstream of a cumulative meter can be subtracted out to deduct cumulative effects. Following is a listing of tributary sub-areas contributing to each meter location, starting with the upstream sub areas.

- Sub-area 8 is tributary to meter No. 8 at Spruce Street.
- Sub-area 8 and 7 are tributary to meter No. 7 at Spruce Street.
- Sub-area 9 is tributary to meter No. 9 and No. 10 at University Avenue (Split flow situation).
- Sub-area 8, 9, 7 and 5 are tributary to meter No. 5 at Spruce Street.
- Sub-area 6 is tributary to meter No. 6 at Third Street. (Split flow situation).
- Sub-area 3, 4 and 6 are tributary to meter No. 3 at Spruce Street (Split flow situation).
- Sub-area 2, 5, 7, 8 and 9 are tributary to meter No. 2 at Spruce Street.
- Sub-area 1, 2, 3, 4, 5, 6, 7, 8, and 9 are tributary to meter No. 1 (parallel to freeway 215 on south side)

Within each sub-area is generally a distinct mixture of land uses, which generates a unique quantity and diurnal pattern of wastewater flows. UCR has been characterized as a separate land use pattern based on its unique wastewater generation quality. For identification of land use patterns, data provided by the City of Riverside in GIS Arcview format was used. The following table summarizes land uses within each sub-basin.

Table 3-2

Tributary Areas and Current Land Use

Sub Area	SFR (Acres)	MFR (Acres)	Commercial (Acres)	Industrial (Acres)	UCR (Acres)	Total (Acres)
1	1,295	201	377	171	471	2,515
2	1,124	165	291	141	471	2,192
3	75	39	39	6		159
4	75	39	4			118
5	1,020	188	277	56	471	2,012
6			6	6		12
7	523	141	89			753
8	189					189
9	454	34			471	1,014

SFR – Single Family Residential
MFR – Multi Family Residential

4.0 DETERMINATION OF SEWER FLOWS

4.1 Flow Monitoring

Flow Monitoring was conducted at ten sites in order to accomplish the following: (See Figures 5 and 6 for locations of Flow Monitoring Stations).

- Establish current flow levels.
- Verify or adjust flow coefficients.
- Establish characteristic flow patterns (Diurnal Curves) for the model (See Figures 15, 16, 17, 18).
- Confirm peak to average flow relationships.
- Help prioritize recommend improvements.

Meter locations were chosen to observe actual flow characteristics for the various sub-basins and to provide a continuous record of measured flows over a period of time (two weeks for this study). Meter locations were also chosen in such a manner that current flow quantities along the Spruce Street Trunk Sewer could be quantitatively determined. Following is an amplification of the logic for placement of each flow meter.

- Meter No. 1 location (adjacent to I-215/60 Freeway, west of Main Street) - This location was chosen because it carries all of the flow generated within the study area.

- Meter No. 2 and 3 location (South of Spruce Street Bridge, east of 91 Freeway) - These locations were chosen to measure all of flows within the sub area east of Freeway 91. Also, by subtracting flows for meter location No. 4 and No. 5 from this flow, flow for the area generally bounded by north of Linden Street, south of Spruce Street, west of Chicago Avenue and east of Kansas Avenue could be determined.

- Meter No. 4 location (On Kansas Ave. south of Third Street) - This location was chosen to measure flow generated by the area generally bounded by south of Third Street, north of Martin Luther King Boulevard, east of Chicago Avenue east of Kansas Street and west of Chicago Avenue. The land use within its tributary area is primarily medium to high density residential.

- Meter No. 5 location (on Spruce Street just west of I-215/60 Freeway) - This location was chosen to determine sewage flow generated by the area generally bounded by east of Chicago Avenue, west of I-215/60 Freeway and north of

Seventh Street. The land use within its tributary area is characterized by light and business park industrial, open space commercial and mixed use. Very few residences are located within this sub-basin.

- Meter No. 6 location (on Third Street west of Durahart Street) - This location was chosen to verify flow exchange from Meter Number 5 sub-basin west of Chicago Avenue. The land use in this area is primarily industrial and commercial.

- Meter No. 7 location (On Spruce Street, west of Atlanta Avenue) - This location was chosen to measure sewage flow generated by the area generally bounded by south of Spruce Street, east of 215/60 Freeway, north of Linden Avenue and west of Canyon Crest Drive. The land use within its tributary area is primarily single family residential with some multi family residential and light commercials.

- Meter No. 8 location (On Spruce Street, near Watkins Drive) - This location was chosen to determine flow generated by the area generally bounded by north of Massachusetts Avenue (extended Massachusetts Avenue east beyond Watkins), south of Spruce Street, west of Spruce Street. The land use within this sub basin is primarily Single Family Residential.

- Meter No. 9 and 10 locations (On University Avenue, west of Cranford Avenue) - These meter locations were chosen to measure sewage flow primarily generated by University of California, Riverside. The area is generally bounded by Martin Luther King Boulevard on south side, Third Street on north side and Spruce Street on east side. Although the sub-basin is comprised mostly of UCR properties some City single-family residential acreages is served on the east side.

4.2 Results of Flow Monitoring

Measurement of sewer flows is an imprecise science, as the in-line equipment is placed in a harsh environment and is subject to solids interference, calibration, solids, and turbulence and other problems, which can impede the accuracy. Installed equipment must be frequently inspected and maintained, and monitoring results interpreted, evaluated for reasonableness, and sometimes adjusted. In this particular application, metered flow information was generally quite good. However, some flows at specific meter locations did not display consistent values. Graphical results at each site were carefully reviewed for consistency and reasonableness, using the following general guidelines.

- Where the magnitude or daily pattern varies significantly from one non-holiday weekday to the next, the data is likely to be flawed.
- Where the base (low) flows are rising during the flow monitoring period, the data is suspect.
- Where the algebraic sum of flows from meters in series are significantly out of sync, the data from one or more meters may be faulty.
- Where minimum (nighttime) flows are abnormally high or algebraically inconsistent, the data is suspect.

Metered flows displaying one or more of the above flaws were purged or adjusted based on reasonable assumptions.

At each meter location the flow-monitoring device measures depth of flow and velocity. Upon reviewing the report submitted by Downstream Services, and from discussions with their staff, it was determined that the depth-of-flow reading was more reliable than the velocity data. By using depth of flow readings and inputting pipe characteristics (slope, size and roughness "n" values), sewage flow can be calculated using Manning's equation. These values more closely resemble theoretically sewage flows calculated using land use information and flow coefficients. It was determined to perform additional flow monitoring for sub-area 2 at two different locations for a period of two days. Flow data have been included in the Appendix.

The flow monitoring hydrographs at each meter site, adjusted based on the depth measurement, are shown in Figures 7 through 14. The following relevant observations were made from evaluation of the measured flows:

- Flows from the study area are atypical in many ways, probably due to the dominating influence of UCR.

- Weekend hydrographs show generally smaller flows and lesser peaks than weekday patterns, probably due to a slightly lesser study area population on weekends. Weekday flows (with UCR in session) thus produce the critical modeling values in this area.

- Holiday flows (i.e., Thanksgiving occurred during the metering period) generally exhibit increased values in most developed areas around the nation; however, in this study, the holiday and preceding week displayed depressed flows; again likely due to the net out-migration of the resident population (influenced by UCR) during the days surrounding the holiday.

Figure 7

Adjusted Flow at Meter 2

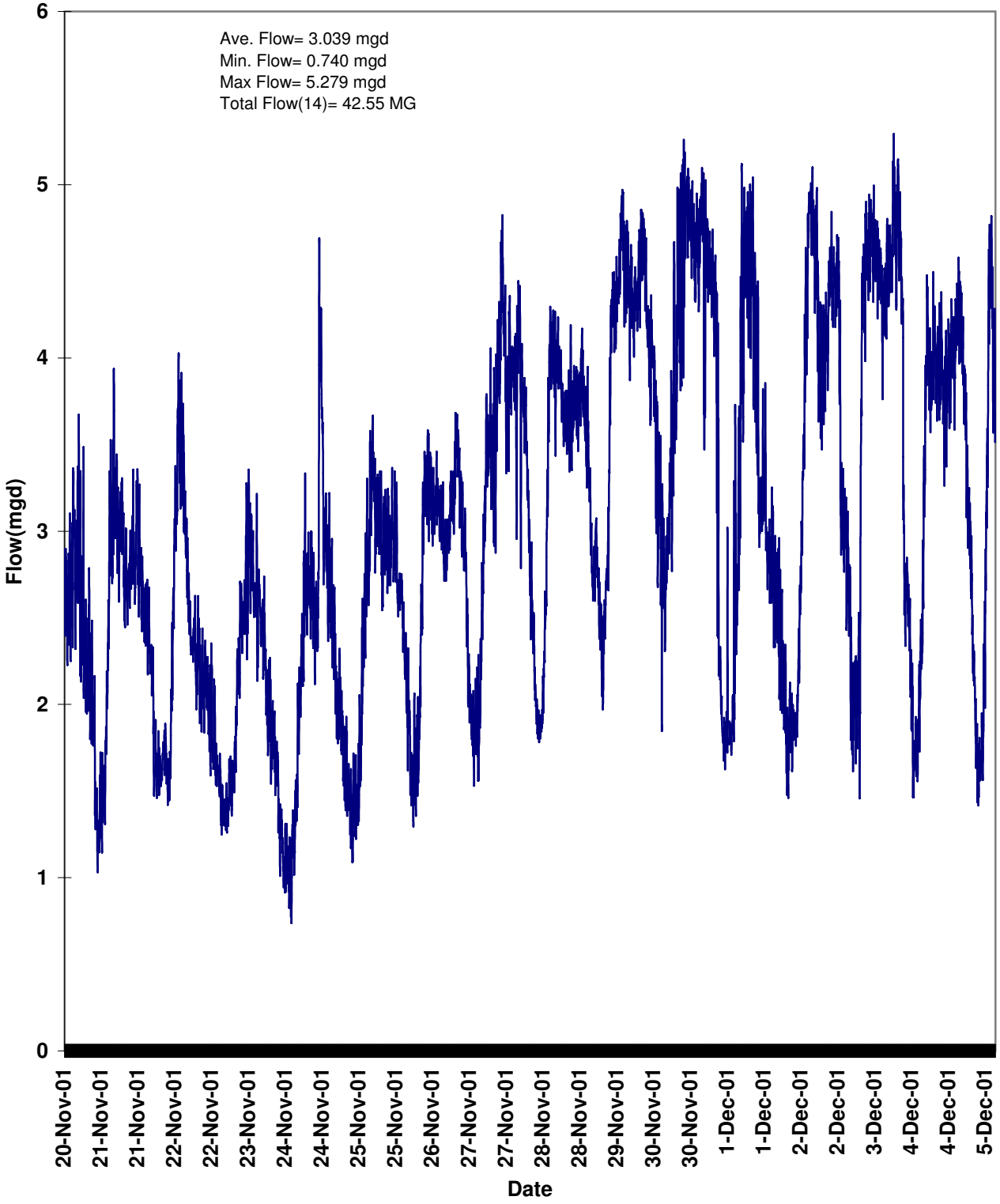


Figure 8

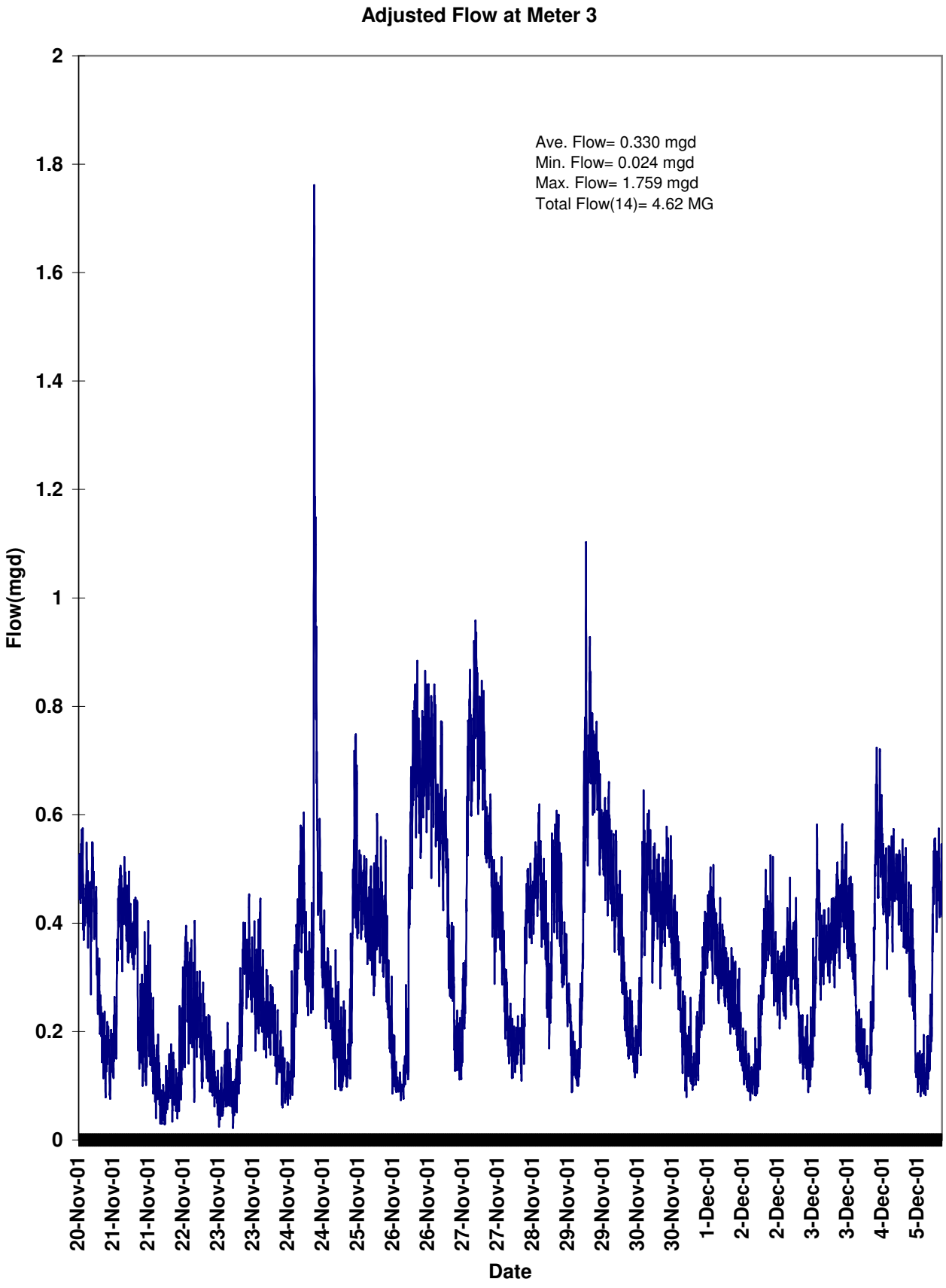

Adjusted Flow at Meter 3
Ave. Flow= 0.330 mgd
Min. Flow= 0.024 mgd
Max. Flow= 1.759 mgd
Total Flow(14)= 4.62 MG
Flow(mgd)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
20-Nov-01
21-Nov-01
21-Nov-01
22-Nov-01
23-Nov-01
23-Nov-01
24-Nov-01
24-Nov-01
25-Nov-01
26-Nov-01
26-Nov-01
27-Nov-01
27-Nov-01
28-Nov-01
29-Nov-01
29-Nov-01
30-Nov-01
30-Nov-01
1-Dec-01
2-Dec-01
2-Dec-01
3-Dec-01
3-Dec-01
4-Dec-01
5-Dec-01
Date

Figure 9

Adjusted Flow at Meter 4

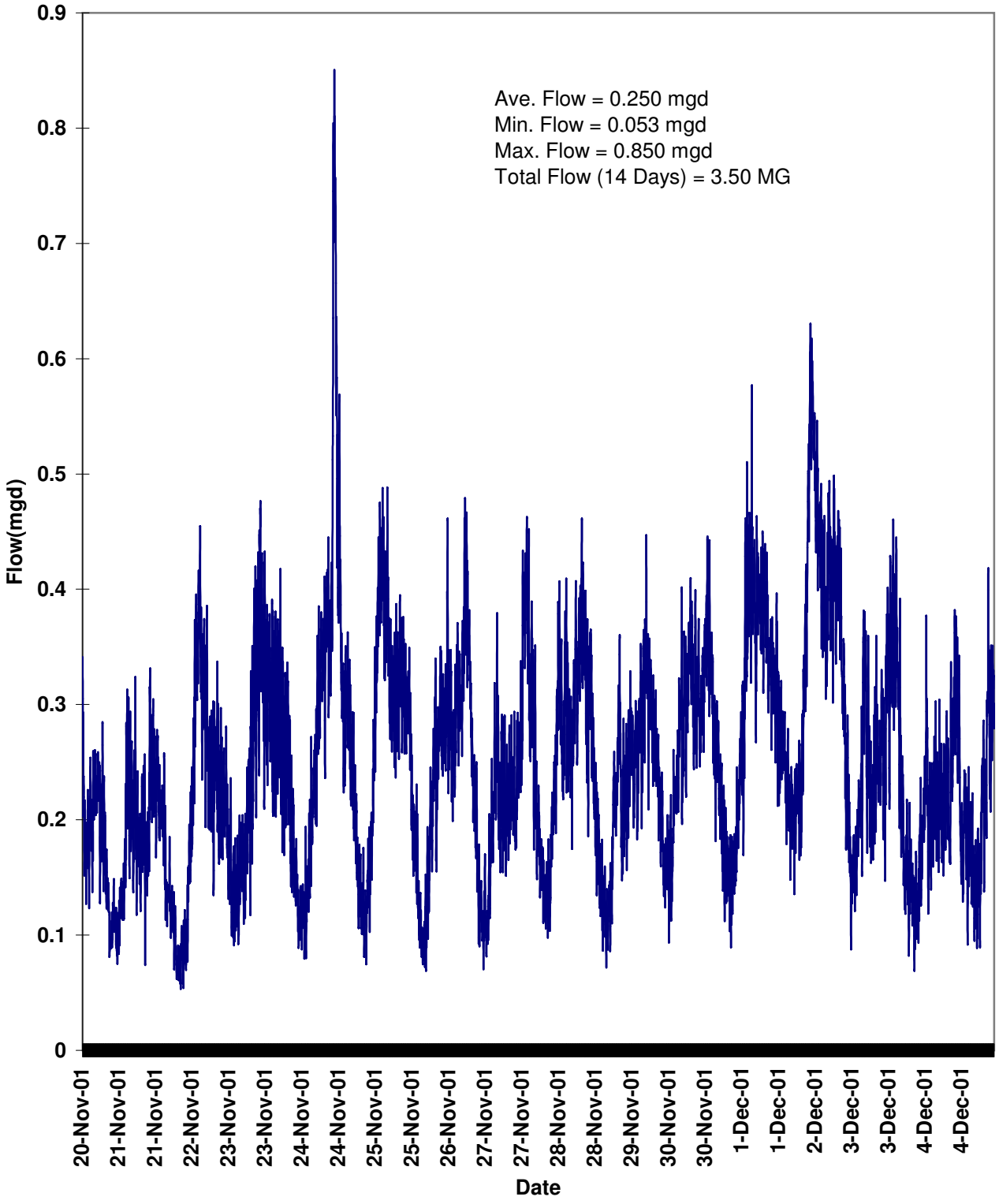


Figure 10

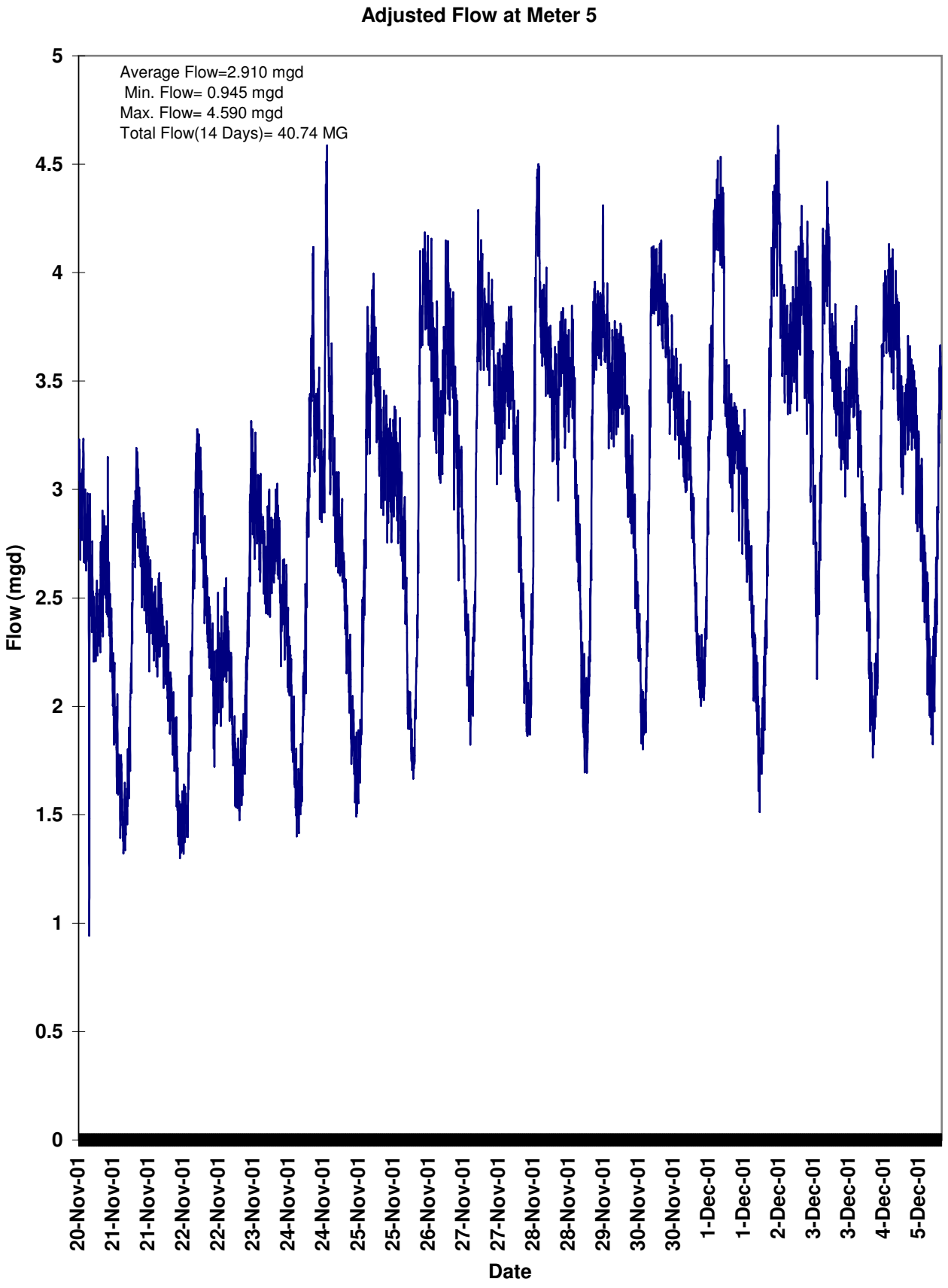

Adjusted Flow at Meter 5
Average Flow=2.910 mgd
Min. Flow= 0.945 mgd
Max. Flow= 4.590 mgd
Total Flow(14 Days)= 40.74 MG
Flow (mgd)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
20-Nov-01
21-Nov-01
21-Nov-01
22-Nov-01
22-Nov-01
23-Nov-01
24-Nov-01
24-Nov-01
25-Nov-01
25-Nov-01
26-Nov-01
27-Nov-01
27-Nov-01
28-Nov-01
28-Nov-01
29-Nov-01
30-Nov-01
30-Nov-01
1-Dec-01
1-Dec-01
2-Dec-01
3-Dec-01
3-Dec-01
4-Dec-01
5-Dec-01
Date

Figure 11

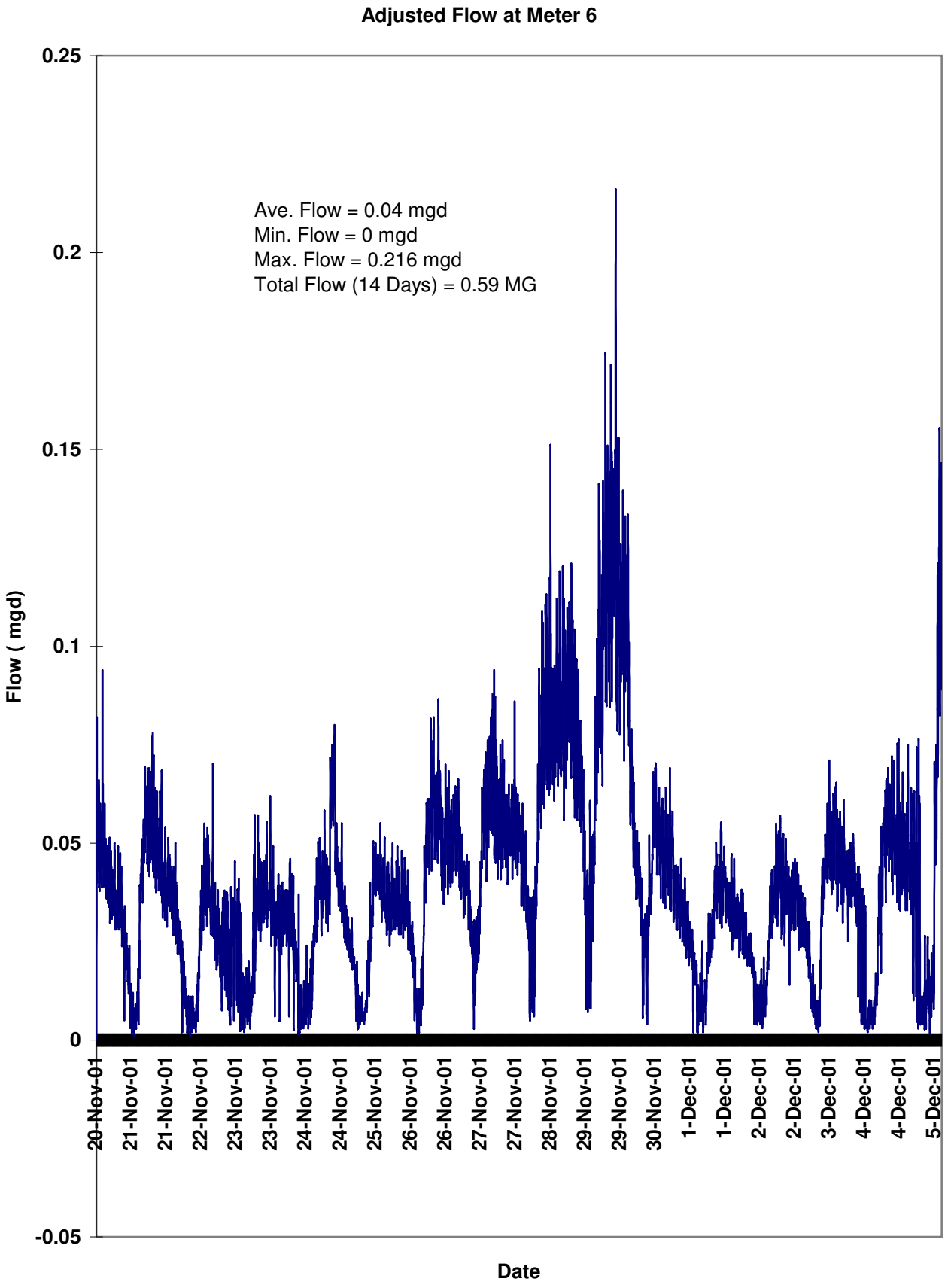

Adjusted Flow at Meter 6
Ave. Flow = 0.04 mgd
Min. Flow = 0 mgd
Max. Flow = 0.216 mgd
Total Flow (14 Days) = 0.59 MG
Flow (mgd)
0.25
0.2
0.15
0.1
0.05
0
-0.05
20-Nov-01
21-Nov-01
21-Nov-01
22-Nov-01
23-Nov-01
23-Nov-01
24-Nov-01
24-Nov-01
25-Nov-01
26-Nov-01
26-Nov-01
27-Nov-01
27-Nov-01
28-Nov-01
29-Nov-01
29-Nov-01
30-Nov-01
1-Dec-01
1-Dec-01
2-Dec-01
2-Dec-01
3-Dec-01
4-Dec-01
4-Dec-01
5-Dec-01
Date

Figure 12

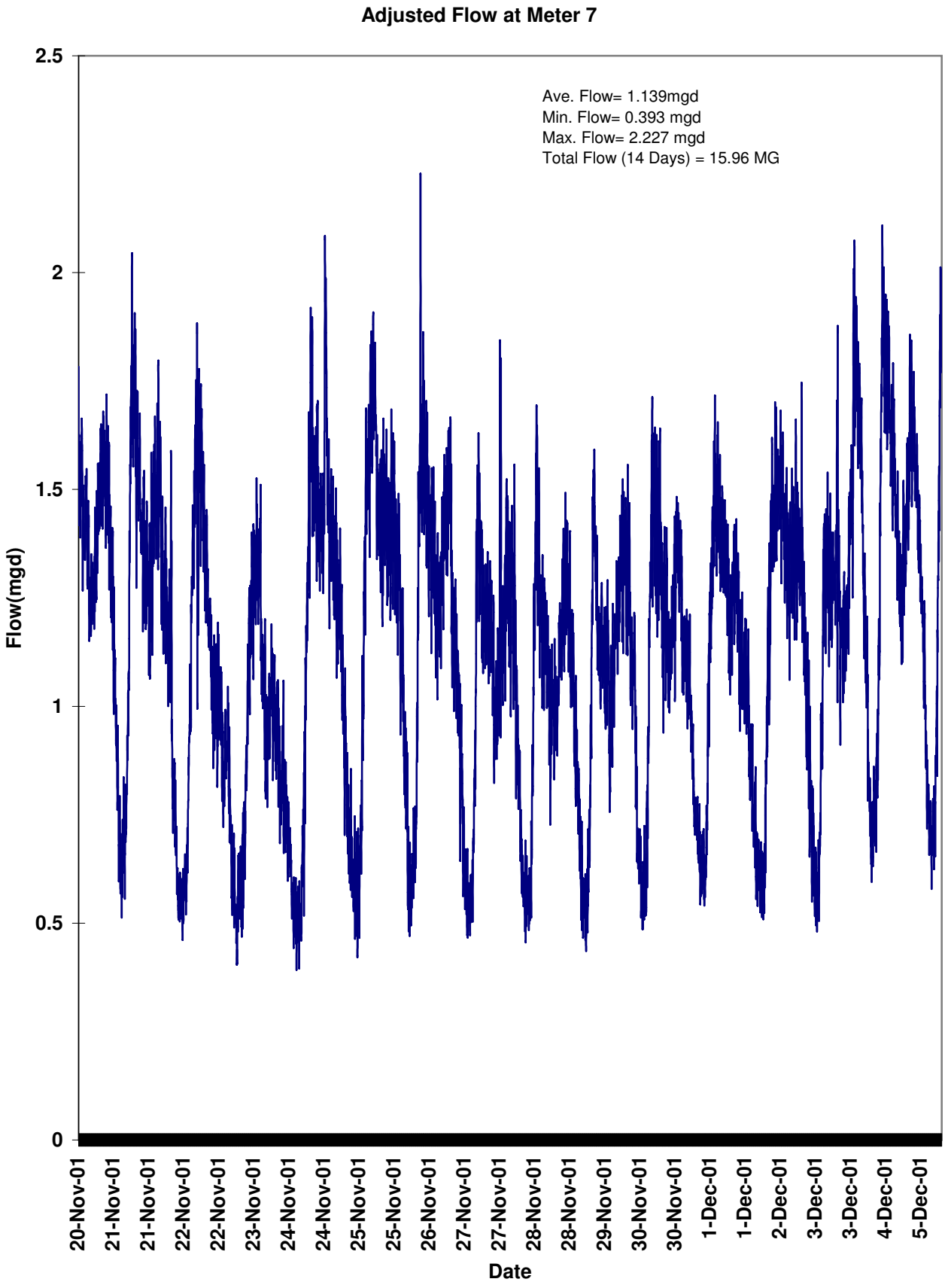

Adjusted Flow at Meter 7
Ave. Flow= 1.139mgd
Min. Flow= 0.393 mgd
Max. Flow= 2.227 mgd
Total Flow (14 Days) = 15.96 MG
Flow(mgd)
2.5
2
1.5
1
0.5
0
20-Nov-01
21-Nov-01
21-Nov-01
22-Nov-01
22-Nov-01
23-Nov-01
24-Nov-01
24-Nov-01
25-Nov-01
25-Nov-01
26-Nov-01
27-Nov-01
27-Nov-01
28-Nov-01
28-Nov-01
29-Nov-01
30-Nov-01
30-Nov-01
1-Dec-01
1-Dec-01
2-Dec-01
3-Dec-01
3-Dec-01
4-Dec-01
5-Dec-01
Date

Figure 13

Adjusted Flow at Meter 8

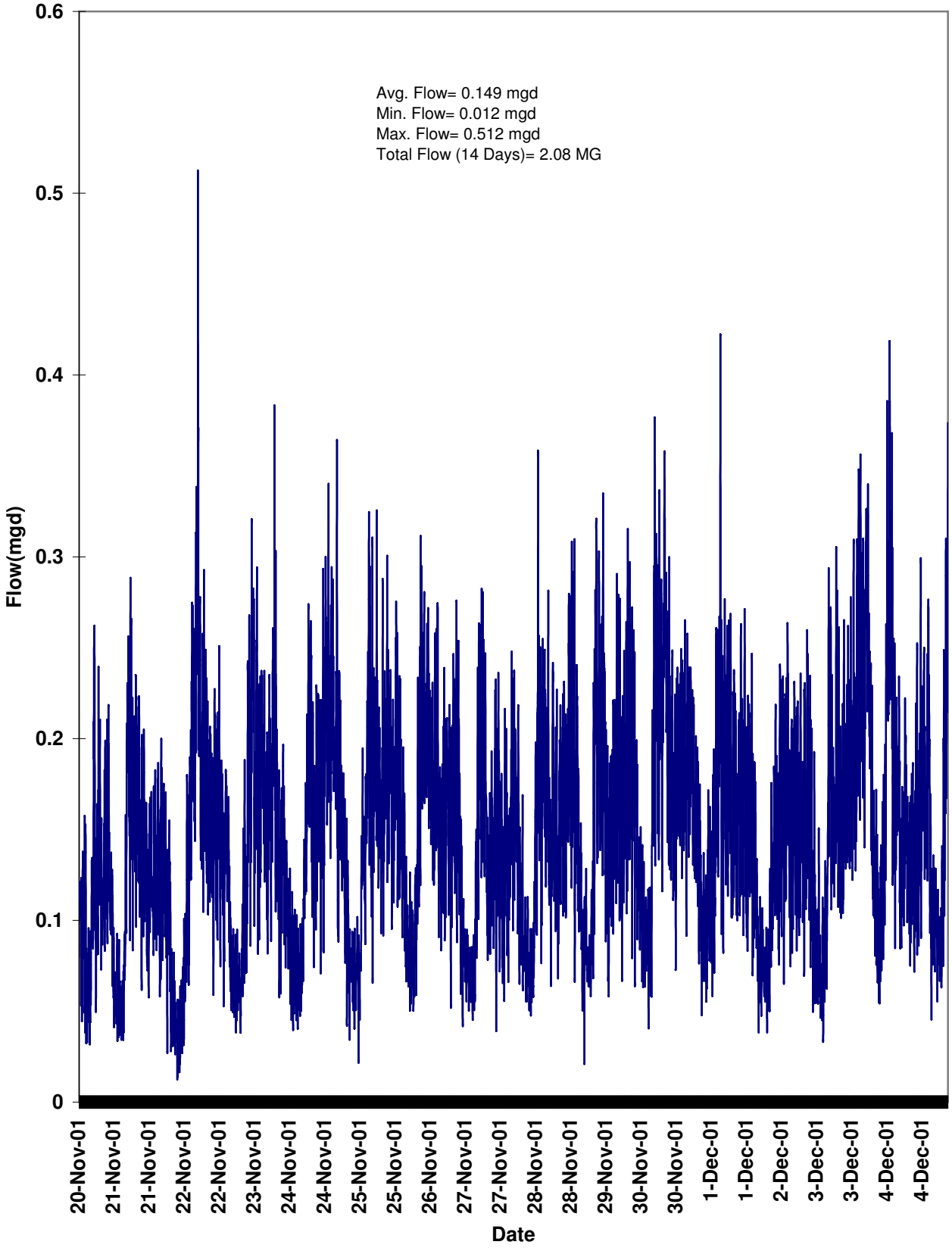
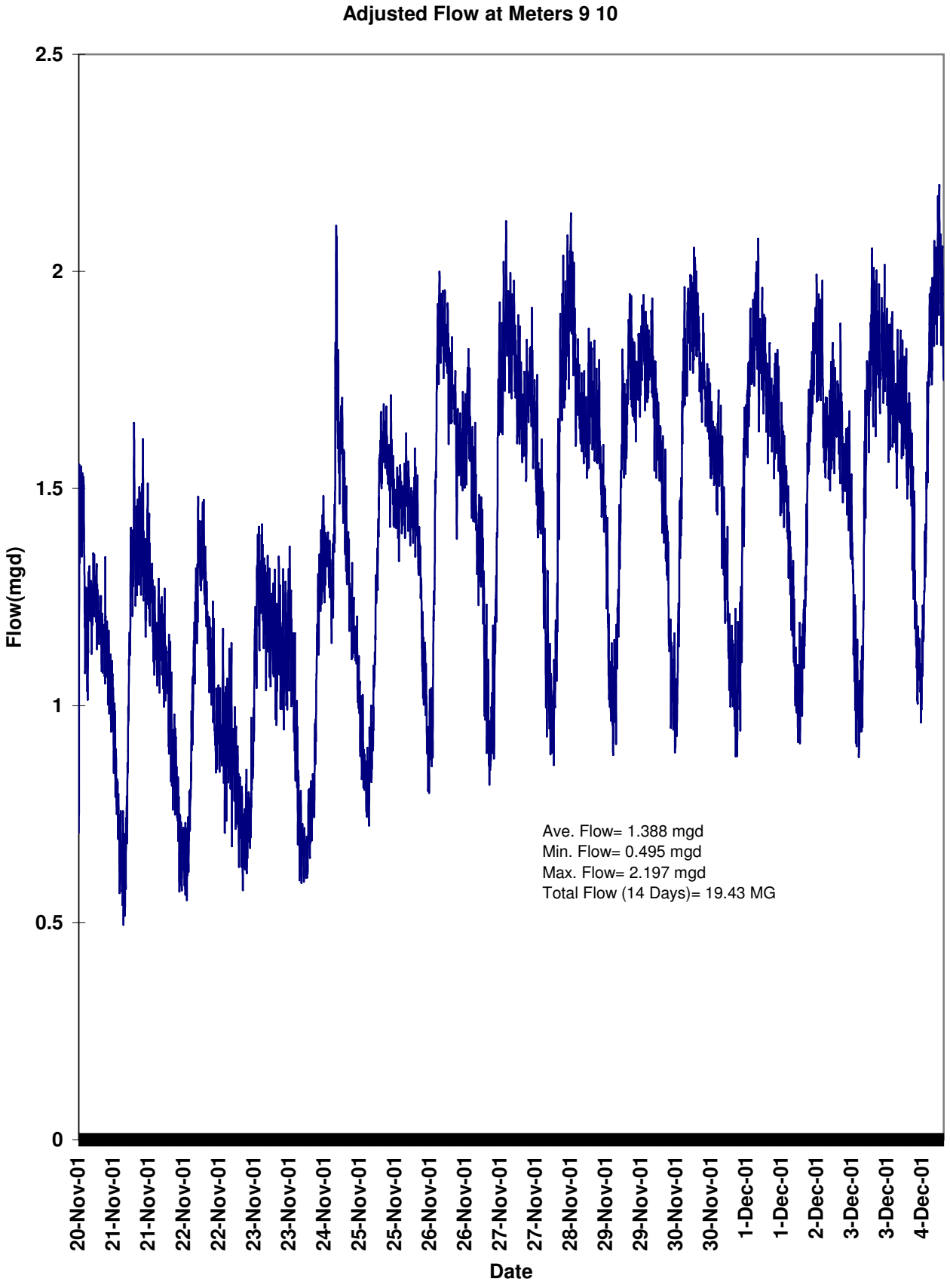


Figure 14


Adjusted Flow at Meters 9 10
2.5
2
1.5
1
0.5
0
Flow(mgd)
Ave. Flow= 1.388 mgd
Min. Flow= 0.495 mgd
Max. Flow= 2.197 mgd
Total Flow (14 Days)= 19.43 MG
20-Nov-01
21-Nov-01
21-Nov-01
22-Nov-01
22-Nov-01
23-Nov-01
23-Nov-01
24-Nov-01
25-Nov-01
25-Nov-01
26-Nov-01
26-Nov-01
27-Nov-01
27-Nov-01
28-Nov-01
29-Nov-01
29-Nov-01
30-Nov-01
30-Nov-01
1-Dec-01
1-Dec-01
2-Dec-01
3-Dec-01
3-Dec-01
4-Dec-01
Date

- Diurnal flow patterns reveal a surprising duration and magnitude of nighttime flows, particularly for high density residential and UCR. This can probably be explained by the general nocturnal habits of the student population in and around the UCR campus.

- From the storm which occurred on November 24, a brief rainfall "spike" was evident at several of the meters (meter Nos. 3, 4, 5 and 10), indicating that there is some rainfall-generated inflow to the system; possibly from inundated manhole covers or illicit connections (roof drains, etc.).

- Observed flows at Meter No. 4 are significantly higher than expected from land use. This is likely attributable to a higher than anticipated resident population, or "overcrowding" in this particular area. The recent U.S. census data reveals somewhat greater numbers than would be expected in this zoning category. Actual population may be even higher, due to residents who did not report. An upward adjustment was made to the land use/population in this tributary area to account for the higher occupancy. However, sub-area 4 is relatively minor in its contribution to flows in the trunk system.

5.0 ESTIMATED ULTIMATE FLOW

5.1 Methodology

Future wastewater flows in the study area are estimated by applying unit (per acre or per capita) flow factors to the projected "ultimate" land use acreage or population in each sub area. As discussed in Section 2, ultimate land uses within the study area are estimated based on the City's current General Plan (which governs future development/redevelopment), and the UCR Long Range Plan (currently being updated). As shown in Figure 5, the growth potential within the City (non UCR) portion of the study area is relatively small, limited by the available land, while the planned growth for UCR is substantial (See Figure 4).

Since this study does not evaluate the internal collection system within the UCR campus, the composite flow at the point where UCR flows enter the City's trunk system (on University Avenue) constitutes key input to the model. Flows from on-campus uses are estimated based on population rather than land use. This is appropriate since the ultimate specific facilities and locations have not been firmly established, but the student population and on-campus resident numbers are essentially agreed upon.

Thus, future wastewater flows are estimated based on a hybrid methodology which employs population-based coefficients for the UCR portion, and land use-based coefficients for the remainder of the study area.

5.2 Flow Coefficients

A review of commonly used flow coefficients (or unit factors) was made to arrive at preliminary criteria which would be an appropriate starting point for the study area.

Flow coefficients are commonly expressed in terms of cubic feet per second (cfs) of average dry weather flow (ADWF) per acre of a specific land use type. For population based estimates, flows are expressed in gallons per capita per day (gpcd). Peak flow generation rates estimated by applying peaking factors to the average flow, (with factors often based on observed peak-to-average ratios from previous studies) are of little value in simulating flows within the collection system, since peaks for various uses are not simultaneous, but rather staggered throughout the day. Also, peaks are blended and attenuated by lag times and in-pipe storage as the flows move downstream. Notwithstanding the above, diurnal peaking factors are also

estimated for each land use type to estimate peak generation rates.
For preliminary estimation of wastewater flow, the document "Criteria for Sewer Facility Design, Public Works Department, City of Riverside" was used. The following is a general guideline for estimation of theoretical wastewater flows within the study area:

Flows from Land Use Categories:

Residential sewage flows are determined by using the following sources of information and criteria:

- Land use shown in the City's General Plan.
- Based on land use determine the number of living units per acre.
- Persons per living unit determined from the latest census data for the study area. However, it should not be less than an average of 2.75 persons per living unit.
- Average wastewater flow based on 65 gallons per capita per day.
- Peak to average flows to be determined from the graphs.

Peak flows from non-residential developments shall be

determined using the following criteria:

- Industrial Developments – 0.012 cfs/acre
- Commercial Developments – 0.010 cfs/acre
- Offices – 30 gallons per capita (employee on site) per day
- Schools – 30 gallons per capita per day
- Laundromat – 580 gallons per machine per day.

The City of Riverside Criteria for Sewer Facility Design is attached as Appendix B.

UCR Flows

Per capita flow from student population living on campus is 65 gallons per capita per day

Per capita flow from faculty and visitors who reside off campus - 30 gallons per capita per day

Peaking Factor - City of Riverside, population vs. peaking factor chart

As previously discussed, based on meetings with UCR Planning staff, a student population of 13,930 plus 8,700 faculty and visitors was assumed for year 2001. According to the draft Long Range Development Plan for year 2015, a student population of 25,000

Table 5-1
Summary of Theoretical Flow

METER	CONTRIBUTORY	LANDUSE FLOW												Total
	AREA	Residential (SFR & MFR)				Commercial		Industrial		UCR				Peak Flow
	(ac)	Pop.	Avg. flow	PF	Peak flow	area	Peak flow	area	Peak flow	Pop.	Avg. flow	PF	Peak flow	
CURRENT FLOW:(Year 2001)			(cfs)		(cfs)	(ac)	(cfs)	(ac)	(cfs)		(cfs)		(cfs)	(cfs)
8	164	922	0.093	3.0	0.278	0.00	0.000	0.00	0.000					0.278
7	645	9,694	0.975	2.3	2.242	87.74	0.877	0.00	0.000					3.119
9 &10	947	4,152	0.418	3.0	1.253	38.43	0.384	0.00	0.000	23,200	1.31	1.6	2.100	3.736
5	1,812	14,938	1.502	1.9	2.854	235.47	2.355	56.18	0.674	23,200	1.31	1.6	2.100	7.982
2	1,971	14,938	1.502	1.9	2.854	229.91	2.299	141.18	1.694	23,200	1.31	1.6	2.100	8.947
3	145	4,485	0.451	3.0	1.353	37.84	0.378	6.25	0.075					1.81
4	104	4,055	0.408	3.0	1.223	2.71	0.027	0.00	0.000					1.250
6	11	0	0.000	3.0	0.000	5.13	0.051	6.25	0.075					0.13
1	2,249	20,845	2.096	1.7	3.459	283.57	2.836	170.47	2.046	23,200	1.31	1.6	2.100	10.439
FUTURE FLOW:(Year 2015)														
8	189	1,097	0.110	3.0	0.331	0.00	0.000	0.00	0.000					0.331
7	753	11,536	1.160	2.2	2.552	88.74	0.887	0.00	0.000					3.439
9 &10	1,014	4,941	0.497	3.0	1.490	55.20	0.552	0.00	0.000	40,000	2.53	1.5	3.800	5.842
5	2,012	17,776	1.787	1.8	3.217	277.30	2.773	56.18	0.674	40,000	2.53	1.5	3.800	10.464
2	2,192	17,776	1.787	1.8	3.217	291.22	2.912	141.18	1.694	40,000	2.53	1.5	3.800	11.624
3	159	5,337	0.537	3.0	1.610	38.53	0.385	6.25	0.075					2.070
4	118	4,825	0.485	3.0	1.456	3.40	0.034	0.00	0.000					1.490
6	11	0	0.000	3.0	0.000	5.13	0.051	6.25	0.075					0.13
1	2,500	24,806	2.494	1.6	3.866	376.64	3.766	170.47	2.046	40,000	2.53	1.5	3.800	13.478

Notes:

For flow calculation of SFR and MFR population count as per City of Riverside GIS has been used.
For population growth a 12.65% growth for every ten year has been assumed based on population data for City of Riverside.
Per capita sewage flow- 65 gpcd
Commercial Peak Flow- 0.01 cfs/ac
Industrial Peak Flow- 0.012 cfs/ac
Peaking Factor as per City of Riverside Population vs Peak to Average Ratio Chart.
For calculation of sewage flow from UCR following assumptions have been made:
Per capita average flow from student population on campus - 65 gpcd = 0.0001005 cfs/capita.
Average flow from faculty and visitors - 30 gpcd = 0.0000464 cfs/capita.
For year 2001, flow has been calculated based on student population of
14,500 students and 8,700 faculty and visitors. (30% students live on campus.)
For year 2015 flow has been calculated based on 25,000 student population and 15,000
faculty and visitors. 50% students live on campus.

UCR Avg. Flow Calculation:

Present:(Year 2001)
Residential 0.44 cfs
Academics 0.87 cfs

Future:(Year 2015)

Residential 1.26 cfs
Academics 1.28 cfs

Abbreviations:

Pop. - Population, Avg. - Average, PF - Peaking Factor, cfs - Cubic feet per second, ac - Acre, SFR - Single Family Residential, MFR - Multi Family Residential
UCR - University of California, Riverside.

plus 15,000 faculty and visitors is assumed. It is further assumed, based on input from UCR Planning, that 50% of the students will reside on campus. Official numbers received from UCR for student population is attached as Appendix –C.

Table 5-1 summarizes present and future sewage flow quantities based on land use. For Single Family and Multi-Family residential, sewage flow generated in a sub-area has been calculated based on land use converted to population. Flows for commercial/industrial are computed based on land use acreage and representative flow coefficients.

5.3 Representative Diurnal Hydrographs

The study area is comprised of a variety of unique land uses. For the purpose of defining characteristic diurnal patterns, flow from each sub-basin was analyzed and percentage of flow contribution from each land use type was estimated. Tables 5-2 and 5-3 summarize percentage of flow from each land use category contributing to each meter location for current and future conditions, respectively. Although none of the tributary sub areas flowing to the meter locations are comprised of a single land use category, several are dominated by one or two categories, and are thus selected as being representative to the diurnal flow patterns for those land uses. Based on this table, the following diurnal patterns were used for the modeled peak flow evaluation.

- Flow at meter location 8 : Single Family Residential (SFR).
- Flow at meter location 7 : Multi-Family Residential (MFR).
- Flow at meter location 6 : Commercial / Industrial.
- Flow at meter location 9 : UCR.

These representative diurnal hydrographs are shown in Figures 15-18. The flow patterns are used in the model to estimate for each land use type; the percentage of Average Dry Weather Flow (ADWF) contributed at specific times throughout the day.

Figure 19 graphically depicts the existing and future conditions and illustrates the increasing influence of UCR-contributed flows.

Table 5-2

Current(2001) Peak Flow and Percentage Contribution from Different Land Use Categories

METER	LOCATION	Current Trib. Area	Vacant Area	Total Area	Current Peak Flow	Land Use Categories Peak Flows							
						Residential		Commercial		Industrial		UCR	
		(ac)	(ac)	(ac)	(cfs)	(cfs)	%	(cfs)	%	(cfs)	%	(cfs)	%
8	MH-245 AT SPRUCE STREET	164	24	189	0.278	0.278	100	0.000	0	0.000	0	0.000	0
7	MH-224 AT SPRUCE STREET	645	108	753	2.924	2.047	70	0.877	30	0.000	0	0.000	0
9 &10	MH-996 AT UNIVERSITY AVE.	947	67	1,014	3.679	1.253	34	0.384	10	0.000	0	2.042	56
5	MH-213 AT SPRUCE STREET	1,812	201	2,012	7.870	2.854	36	2.299	29	0.674	9	2.042	26
2	MH-203 AT SPRUCE STREET	1,971	221	2,192	8.945	2.854	32	2.355	26	1.694	19	2.042	23
3	MH-200 AT SPRUCE STREET	145	14	159	1.806	1.353	75	0.378	21	0.075	4	0.000	0
4	MH-702 AT KANSAS AVE.	104	14	118	1.250	1.223	98	0.027	2	0.000	0	0.000	0
6	MH-620 AT THIRD STREET	11	-	11	0.126	0.000	0	0.051	41	0.075	59	0.000	0
1	MH-35 AT SWR LINE 59-18	2,249	251	2,500	10.382	3.459	33	2.836	27	2.046	20	2.042	20

Table 5-3

Future(2015) Peak Flow and Percentage Contribution from Different Land Use Categories

METER	LOCATION	Current Trib. Area	Vacant Area	Future Trib Area	Future Peak Flow	Land Use Categories Peak Flows							
						Residential		Commercial		Industrial		UCR	
		(ac)	(ac)	(ac)	(cfs)	(cfs)	%	(cfs)	%	(cfs)	%	(cfs)	%
8	MH-245 AT SPRUCE STREET	164	24	189	0.331	0.331	100	0.000	0	0.000	0	0.000	0
7	MH-224 AT SPRUCE STREET	645	108	753	3.207	2.320	72	0.887	28	0.000	0	0.000	0
9 &10	MH-996 AT UNIVERSITY AVE.	947	67	1,014	5.842	1.490	26	0.552	9	0.000	0	3.800	65
5	MH-213 AT SPRUCE STREET	1,812	201	2,012	10.464	3.217	31	2.773	26	0.674	6	3.800	36
2	MH-203 AT SPRUCE STREET	1,971	221	2,192	11.624	3.217	28	2.912	25	1.694	15	3.800	33
3	MH-200 AT SPRUCE STREET	145	14	159	2.070	1.610	78	0.385	19	0.075	4	0.000	0
4	MH-702 AT KANSAS AVE.	104	14	118	1.490	1.456	98	0.034	2	0.000	0	0.000	0
6	MH-620 AT THIRD STREET	11	-	11	0.126	0.000	0	0.051	41	0.075	59	0.000	0
1	MH-35 AT SWR LINE 59-18	2,249	251	2,500	13.478	3.866	29	3.766	28	2.046	15	3.800	28

Note:

Residential peak flow was determined by population rather than landuse because of demographics of the area.

Abbreviations:

Trib. Area - Tributary Area
ac - Acre
cfs - Cubic feet per second.
UCR - University of California, Riverside.
SWR - Sewer
AVE. - Avenue

Table 5.2
Table 5.3

Figure 15

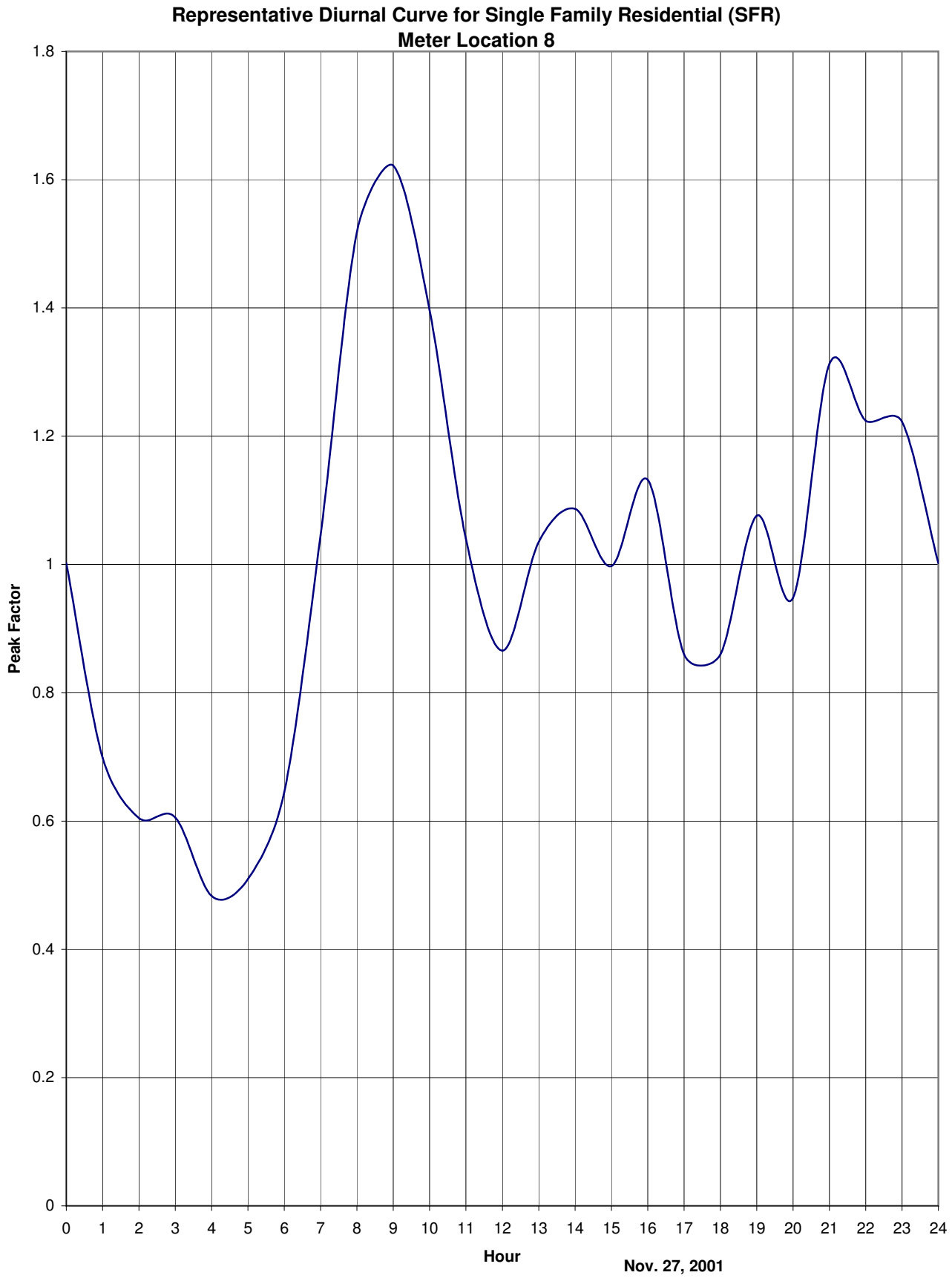

Representative Diurnal Curve for Single Family Residential (SFR)
Meter Location 8
Peak Factor
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Nov. 27, 2001

Figure 16

Representative Diurnal Curve for Multi-Family Residential (MFR)
Meter Location 7

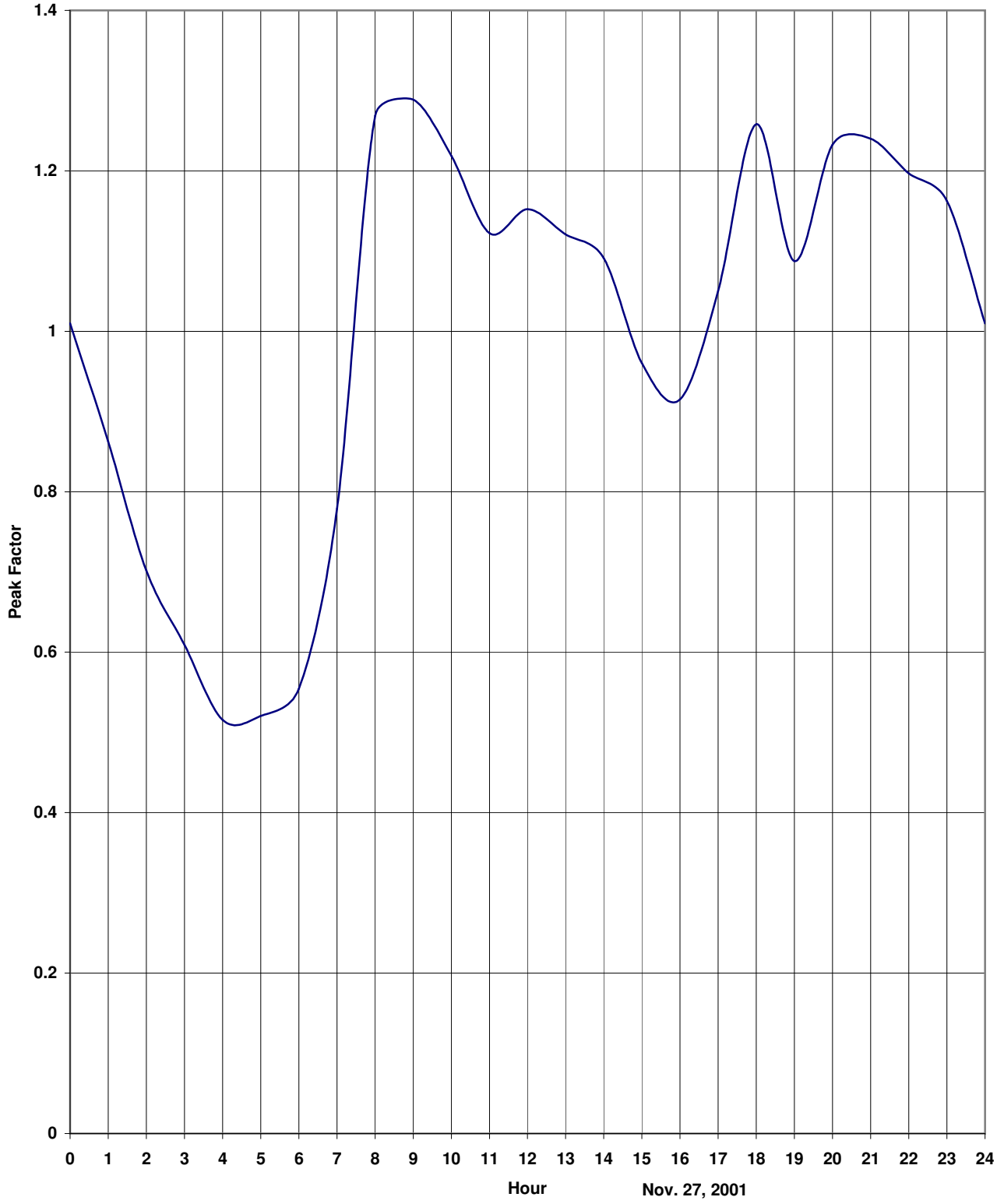


Figure 17

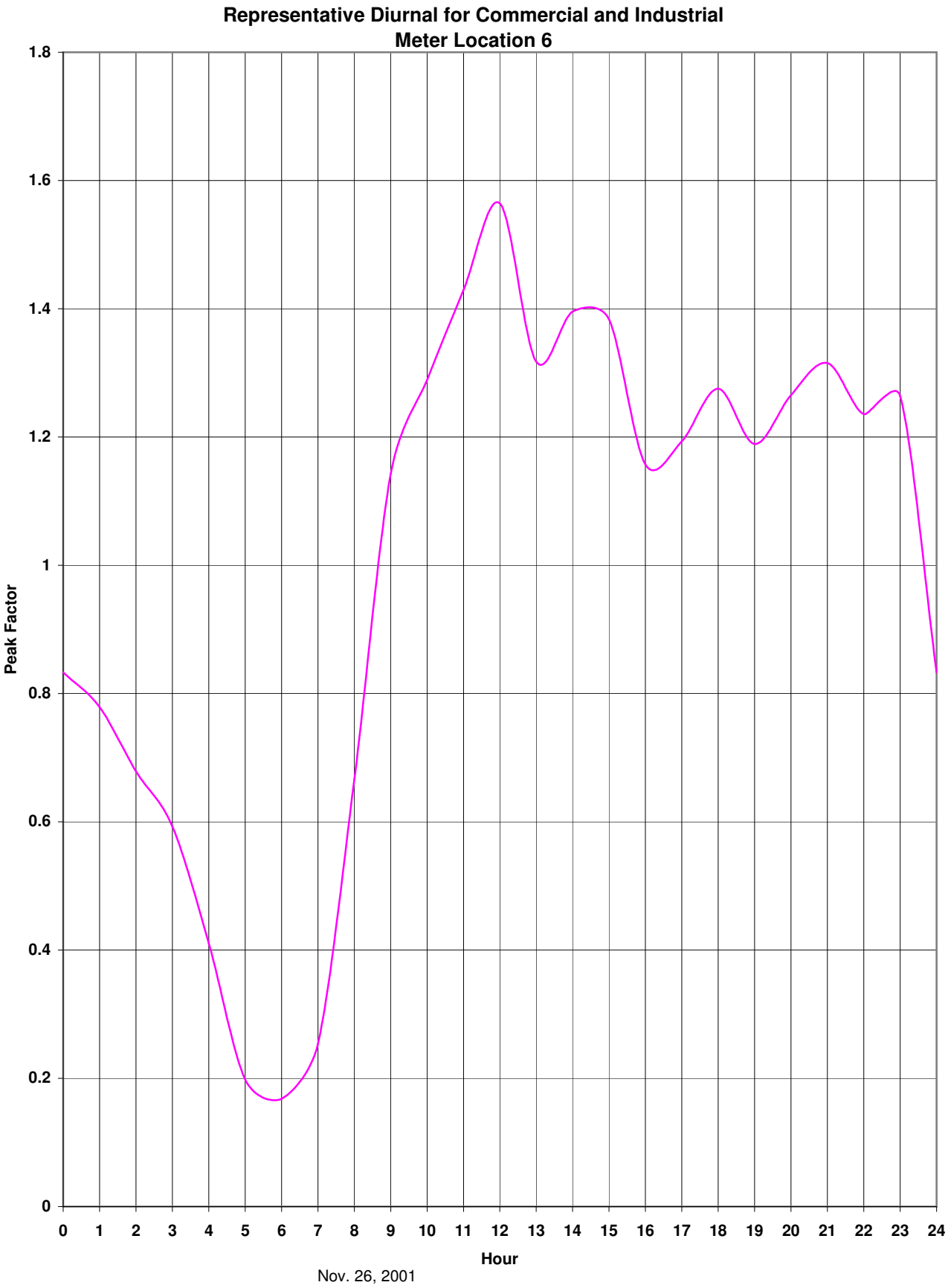

Representative Diurnal for Commercial and Industrial
Meter Location 6
Peak Factor
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Nov. 26, 2001

Figure 18

Representative Diurnal Curve for UCR Meter Locations 9 and 10

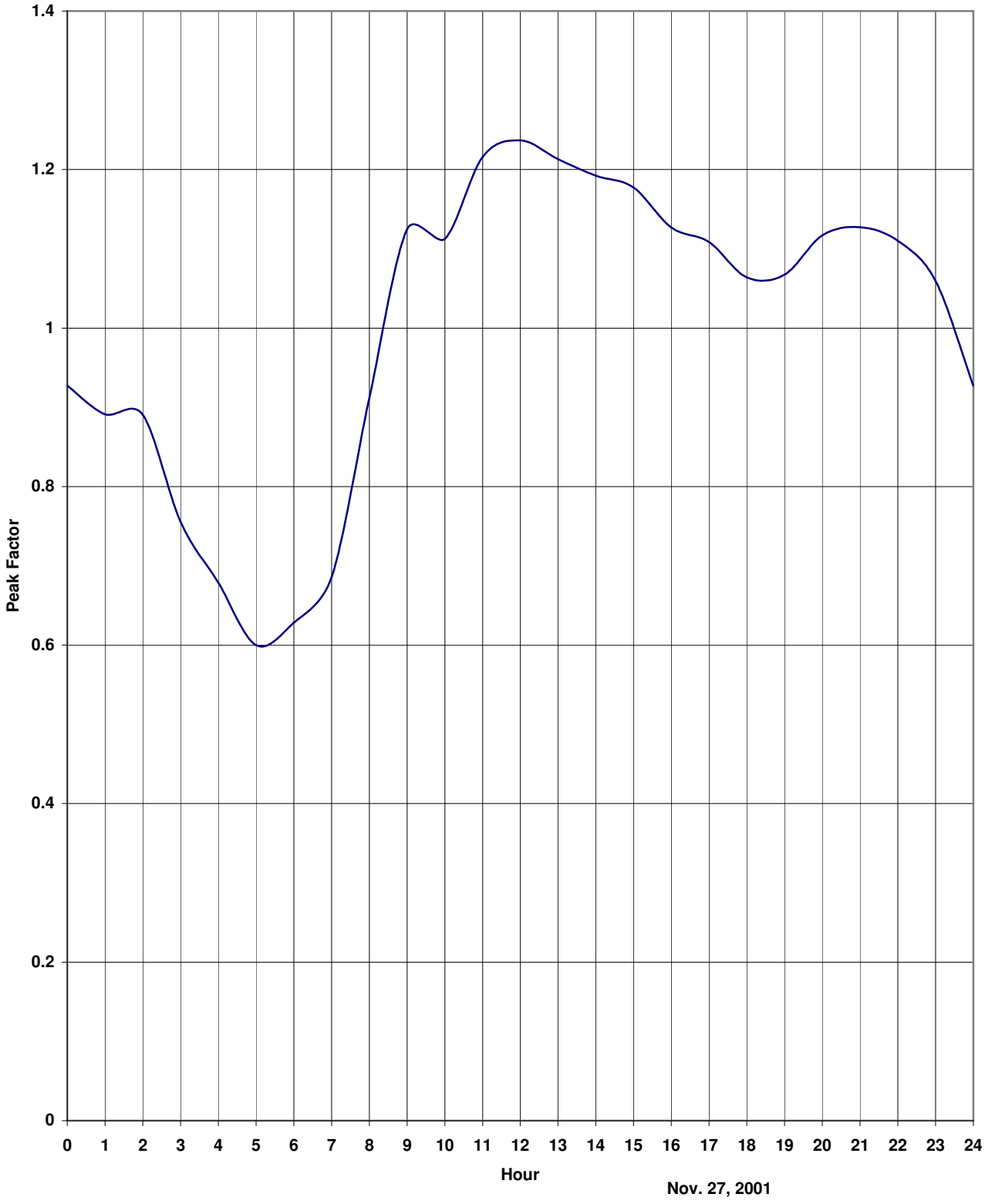
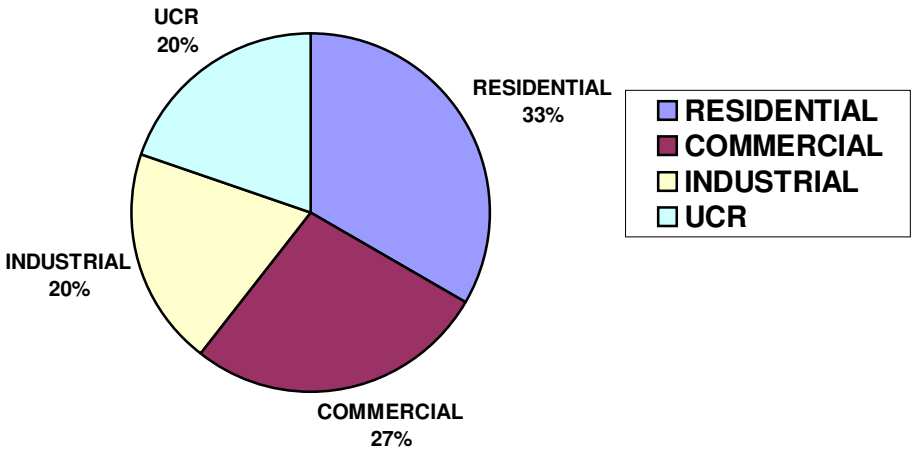
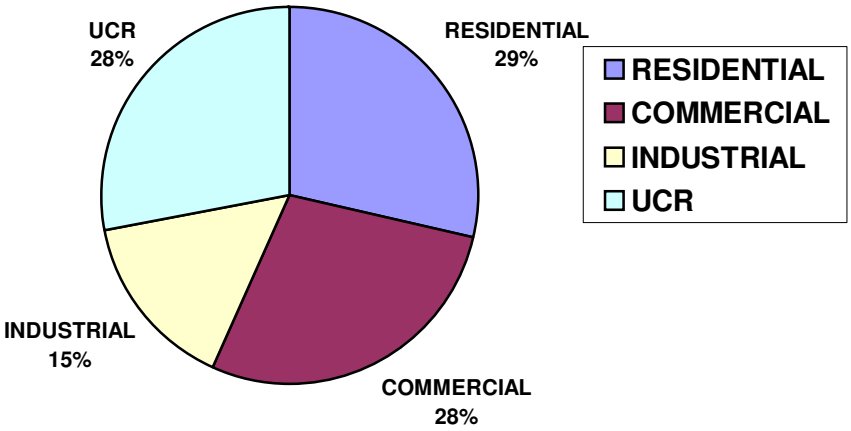


Figure 19
Existing and Ultimate Flow Contributions from Various Land Uses
Meter Location 1

EXISTING (2001) CONTRIBUTING FLOWS AT METER LOCATION 1



FUTURE (2015) CONTRIBUTING FLOWS AT METER LOCATION 1



6.0 COMPUTER MODEL SIMULATION ANALYSIS

6.1 Methodology

Capacity analysis involved evaluation of the available capacity in the existing collection system under present and future development conditions. Based on results of the analysis, phased facility improvements were identified to allow for projected growth within the service area.

This Section describes the analytical methodology and hydraulic model development, and summarizes the results of the analyses.

The principal tool utilized in the capacity analysis was a hydraulic model that simulates flow conditions using demand and piping characteristic input data. With this input information, the model is able to output sewage depth of flow, rate of flow, and velocity of flow, within selected pipes and manholes during different times of the day. The model selected for use in this study is XP-SWMM (XP Software, Version 8.0); this modeling software belongs to a class of software referred to as “dynamic wave models”. These types of models provide an accurate simulation of hydraulic flow conditions over an extended period of time.

Data required to create the model include information describing the physical wastewater collection system, such as pipe diameters and reach lengths, manhole invert elevations, and estimated pipe roughness coefficients. Additionally, data describing the sewage loading at selected manholes, expressed as a varying flow rate over time (i.e. a diurnal curve), must be provided. Model output consists of a variety of hydraulic parameters, most importantly peak flow depths and discharge rates.

Calibration of the model consisted of simulating existing sewer flow conditions and comparing the modeled and recorded flows at the meter locations. The assumed diurnal curves that serve as input to the model were iteratively adjusted until the simulated and recorded sewage flow hydrographs achieved reasonable agreement.

Simulations of future sewage flow conditions were performed by developing input data sets that included sewage generation projections for the assumed ultimate conditions. Pipe reaches in which simulated peak flows exceeded a specified trigger criteria were identified as potential improvement reaches. Improvements required to provide adequate capacity for projected flows are then determined through an iterative modeling process. The process

consists of simulating flow conditions after increasing the diameter of downstream portions of the identified reaches. In subsequent iterations, additional lengths of pipe are increased in diameter until the projected peak flow can be conveyed through the reach without exceeding the specified design flow criteria.

6.2 Limitations of Modeling

The hydraulic model, which was utilized as the primary planning tool for the sewer capacity analysis, provides an accurate simulation of actual flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation, however, is directly related to the accuracy of the model input data, including physical parameters and sewage loading projections. For example, in a case where roots had entered the pipeline, thereby causing a restriction of flow, the model would be unable to predict the reduction in flow through this obstruction. Consequently, a general understanding of the data sources is critical in interpreting the modeling results.

The physical parameters of the model, including pipe diameter, slope, and roughness coefficients were based principally on City database information. Where this data appeared to be inaccurate, construction drawings were reviewed and the input data corrected. Network connectivity refers to the flow path followed by sewage within the sewer system. The connectivity is a function of the relative slope of each sewer pipe and the relative invert elevations of the incoming and outgoing sewer pipes at manholes. For example, a manhole may have two or more sewer pipes, which could convey flow away from the manhole. If the invert (bottom) of one of these pipes is lower than the other, the downstream flow path at this manhole would follow the lower pipe.

Sewage loading projections were based on calibrated flow rates. As previously described, flow rates used for calibration were based on actual monitored flows at key points in the trunk system over a 2-week period in November 2001. This period included the Thanksgiving holiday as well as two weekends. Additional flow anticipated to enter the sewer system due to wet weather infiltration was not considered, and is assumed to be accommodated by surplus hydraulic capacity in the pipelines or temporary dampening in the manholes.

Since a degree of uncertainty exists in both the physical data and the sewage loading projections used as model inputs, reaches identified by model simulations as near or at capacity should be subject to additional engineering evaluation prior to improvement. Such evaluation may include field inspection, video monitoring, and flow metering.

7.0 CONCLUSIONS

7.1 Deficient and Marginally Deficient Pipes

The City's design criteria for sewer lines allows pipes to flow at a ratio of 75% of "full" hydraulic capacity. Assuming that "full" capacity is the maximum hydraulic capacity of a pipe flowing under gravity (non-pressure) conditions, Mannings equation shows that maximum flow occurs when a pipe reaches a flow depth ratio of about 95% d/D.

Pipe reaches which fail the "75% full" criteria for both existing and future flow conditions are shown in Table 7-1 and Figures 20 and 21. It is seen that portions of the modeled trunk system are already flowing at greater than "75% full", and several reaches are computed to be over 100% full (surcharge conditions). At ultimate conditions, numerous additional reaches are shown to surcharge or exceed the "75% full" criteria.

7.2 Project Prioritization Methodology

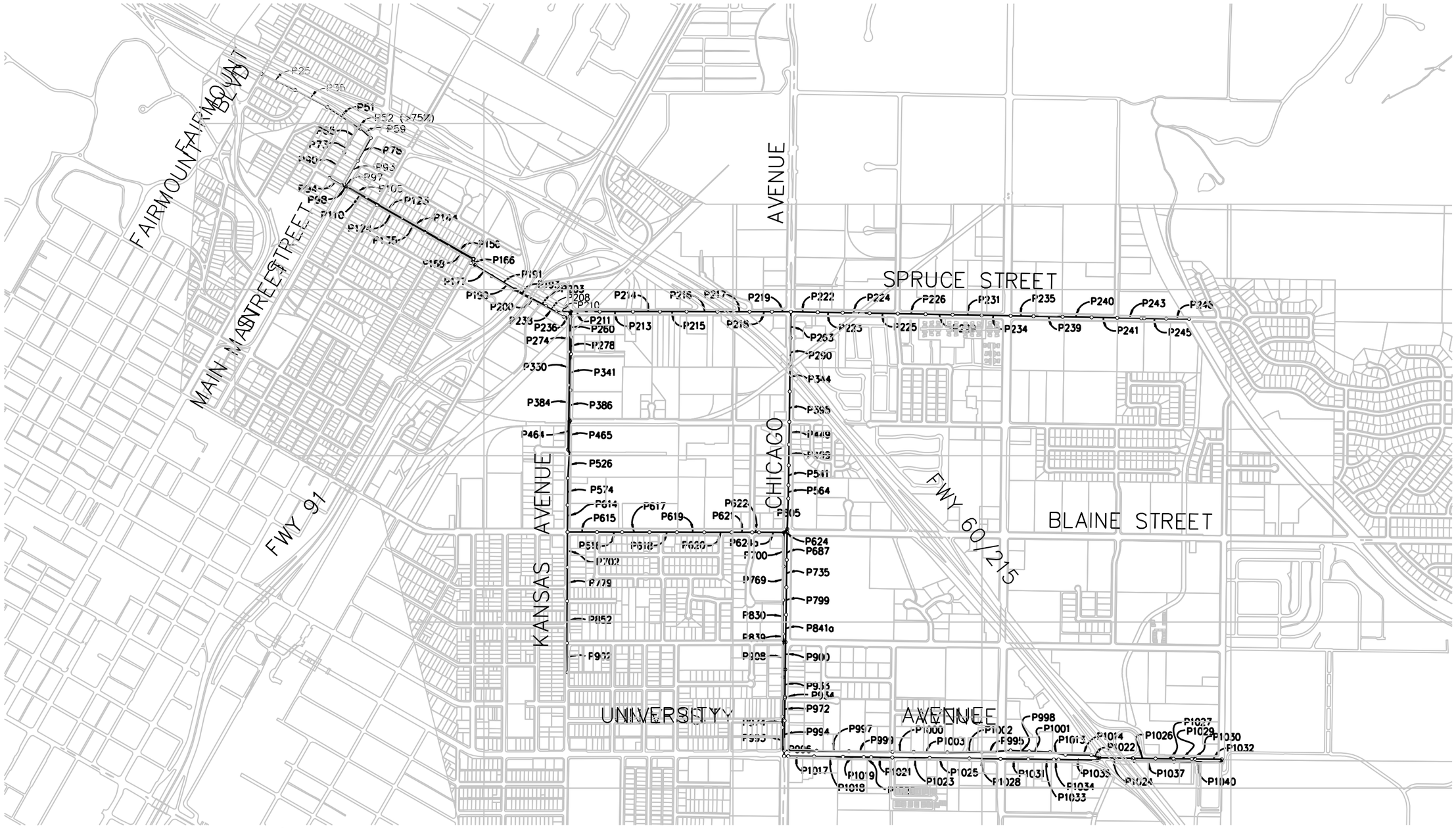
The 75% full criteria is useful for analyzing deficient pipes and as a basis for sizing new facilities. However, the criteria is not necessarily the trigger point for replacement or augmentation of an existing sewer line.

In most cases, a sewer entity would not implement a relief project until capacity problems are actually observed or known to be imminent.

A recommended system of project prioritization is the categorization of deficient sewer lines in different priorities, where the "A" priority projects are imminently needed and the "B" and "C" projects require further considerations for replacement. Priority classifications are described as follows:

Priority "A" – The pipes listed within this priority are currently deficient and are flowing more than 90% full under maximum flow condition. These pipes need immediate replacement.

Priority "B" – The pipes listed in this priority would be flowing more than 90% full in the future under maximum flow condition. These pipes need evaluation as new development takes place in the tributary area. Flow monitoring of the pipes within 5 years might be considered and the priority ranking re-evaluated.



LEGEND

EXCEEDS 90% FULL

EXCEEDS 75% FULL

GRAPHIC SCALE

1200 0 600 1200

(IN FEET)

1 inch = 1200 ft.

Engineering
Planning
Surveying
Construction Services

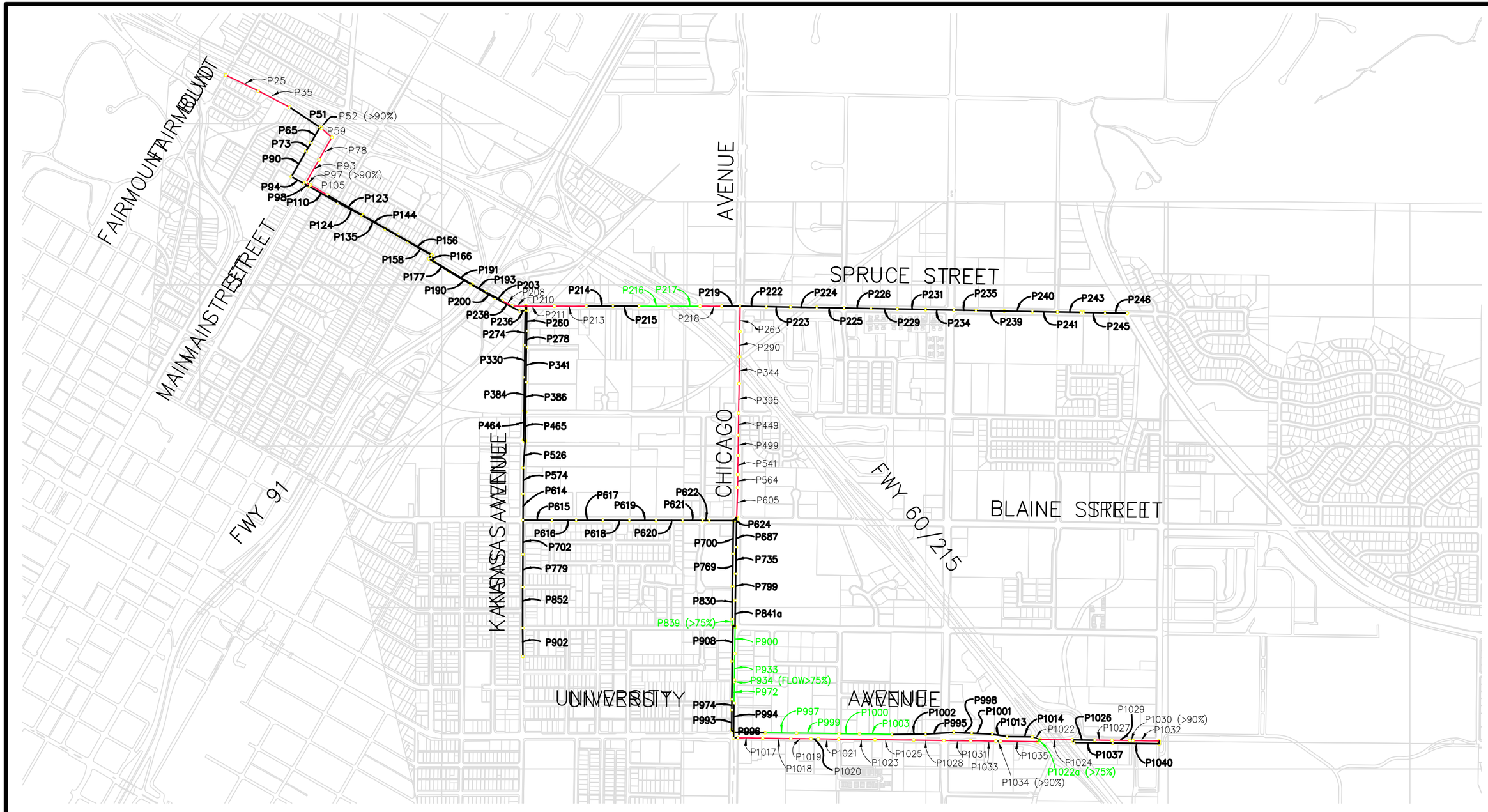
PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER CAPACITY STUDY

EXISTING SYSTEM DEFICIENCIES

JUNE 2002 | FIGURE 20



LEGEND

EXCEEDS 90% FULL

EXCEEDS 75% FULL

N

GRAPHIC SCALE

1200 0 600 1200

(IN FEET)

1 inch = 1200 ft.

Engineering
Planning
Surveying
Construction Services

PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
SPRUCE STREET SEWER CAPACITY STUDY

ULTIMATE SYSTEM DEFICIENCIES

JUNE 2002

FIGURE 21

Priority "C" – The pipes listed under this priority would be flowing between 75% to 90% full in future under maximum flow condition. Periodic flow monitoring or visual inspection should be considered for these pipes every five years.

7.3 Improvement Plan for Problem Areas

Table 7-3 lists project priority, project location, problem, solution and approximate cost for problem reaches. This table identifies immediate and future problems in the sewer lines and suggested solutions for that. The approximate project cost is in year 2002.

7.4 Grouping of Projects

Proposed improvements under different priorities have been combined or grouped into projects to improve deficient and marginally deficient pipes based on following criteria:

- Pipes identified as either deficient (Priority A) or marginally deficient (Priority B), located geographically close to one another and requiring improvements within 1 to 5 years (year 2002-2007) are grouped to reduce improvement costs.
- Some pipe reaches identified as marginally deficient (Priority B) and marginally deficient in future (Priority C) are grouped together for the same reason as mentioned above. However, improvements of these reaches would not be required until approximately before year 2007.

7.5 Construction Schedule

A summary of proposed construction prioritization and recommended scheduling is shown in table 7-2. This table lists construction priorities and the year in which these pipes will flow 90% full as per model run. The pipes falling under priority "A" need immediate replacement whereas priority "B" and "C" pipes would need re-evaluation before their replacement.

7.6 Alternatives

A surcharge condition exists in the pipes P25 and P35 for maximum flow conditions. The sewer lines within priority "A" need

Table 7-1
Sewer Analysis Results
Deficient Pipe Summary
(Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical Full Flow Capacity (cfs)	Modeled Existing Max Flow (cfs)	Existing % Full	Modeled Future Max Flow (cfs)	Future % Full	Replacement Diameter (ft)	Theoretical New "Full" Flow Capacity (cfs)[1]	Theoretical New % Full
P25	1.50	0.53	7.63	7.45	98%	9.94	130%	1.67	15.80	63%
P35	1.50	0.53	7.66	7.45	97%	9.94	130%	1.67	15.87	63%
P36	3.00	0.23	31.78	7.45	23%	9.94	31%			
P48	3.00	0.22	30.98	7.45	24%	9.94	32%			
P51	1.25	4.25	13.27	8.02	60%	9.44	71%			
P52	1.50	0.72	8.89	6.78	76%	9.15	103%	1.75	14.45	63%
P59	1.50	0.74	9.01	6.78	75%	9.15	101%	1.75	14.65	62%
P65	0.83	0.66	1.75	0.28	16%	0.30	17%			
P73	0.83	0.36	1.30	0.28	21%	0.30	23%			
P78	1.50	0.76	9.16	6.78	74%	9.15	100%	1.75	14.89	61%
P90	0.83	1.30	2.46	0.28	11%	0.30	12%			
P93	1.50	0.72	8.90	6.78	76%	9.15	103%	1.75	14.46	63%
P94	0.83	0.61	1.69	0.28	16%	0.30	18%			
P97	1.50	0.72	8.89	6.78	76%	9.15	103%	1.75	14.45	63%
P98	0.83	0.49	1.52	0.28	18%	0.30	20%			
994a	1.25	2.00	9.11	2.03	22%	3.48	38%			
P105	1.50	0.72	8.90	6.78	76%	9.15	103%	1.75	14.47	63%
P110	0.83	1.44	2.59	0.28	11%	0.30	12%			
P123	1.50	1.48	12.75	6.78	53%	9.16	72%			
P124	0.83	0.49	1.52	0.28	18%	0.30	20%			
P135	0.83	1.44	2.59	0.28	11%	0.30	12%			
P144	1.50	1.48	12.76	6.78	53%	9.15	72%			
P147	0.83	1.43	2.58	0.28	11%	0.30	12%			
P156	1.50	1.40	12.41	6.78	55%	9.15	74%			
P158	0.83	1.44	2.59	0.28	11%	0.30	12%			
P161	0.83	1.74	2.85	0.28	10%	0.30	11%			
P166	1.50	2.18	15.47	6.78	44%	9.15	59%			
P177	0.83	1.64	2.76	0.28	10%	0.30	11%			
P190	0.83	1.53	2.67	0.28	10%	0.30	11%			
P191	1.50	1.70	13.67	6.78	50%	9.15	67%			
P193	1.50	1.79	14.00	6.78	48%	9.15	65%			
P200	0.83	2.44	3.37	0.28	8%	0.30	9%			
P203	1.50	2.67	17.12	6.78	40%	9.15	53%			
P208	1.50	0.66	8.51	6.34	75%	8.50	100%	1.75	13.83	61%
P210	1.50	0.66	8.51	6.34	75%	8.50	100%	1.75	13.83	61%
P211	1.50	0.66	8.52	6.16	72%	8.31	97%	1.75	13.84	60%
P213	1.50	0.67	8.54	6.16	72%	8.31	97%	1.75	13.89	60%
P214	1.50	0.88	9.81	4.84	49%	6.84	70%			
P215	1.50	0.89	9.89	4.84	49%	6.84	69%			
P216	1.25	1.41	7.65	4.84	63%	6.85	89%	1.50	13.40	51%
P217	1.25	1.41	7.65	4.84	63%	6.84	89%	1.50	13.41	51%
P218	1.25	1.12	6.81	4.84	71%	6.85	100%	1.50	11.94	57%
P219	1.25	3.25	11.60	4.84	42%	6.84	59%			
P222	1.25	0.88	6.03	2.11	35%	2.27	38%			
P223	1.25	1.15	6.91	2.10	30%	2.27	33%			
P224	1.25	1.74	8.50	2.10	25%	2.27	27%			
P225	1.25	1.17	6.97	0.16	2%	0.18	3%			
P226	0.83	2.66	3.52	0.16	4%	0.18	5%			
P229	0.83	2.22	3.21	0.16	5%	0.18	5%			
P231	0.83	2.72	3.56	0.16	4%	0.18	5%			
P234	0.83	1.85	2.93	0.16	5%	0.18	6%			
P235	0.67	2.31	1.85	0.16	8%	0.18	9%			
P236	0.83	1.88	2.96	0.28	9%	0.30	10%			
P237	0.67	6.55	3.12	0.18	6%	0.21	7%			
P238	0.83	1.68	2.80	0.28	10%	0.30	11%			
P239	0.67	2.30	1.85	0.16	8%	0.18	10%			
P240	0.67	2.30	1.85	0.16	8%	0.18	10%			
P241	0.67	2.26	1.83	0.16	9%	0.18	10%			
P243	0.67	3.46	2.27	0.16	7%	0.18	8%			
P244	0.67	3.61	2.31	0.16	7%	0.18	8%			

Table 7-1
Sewer Analysis Results
Deficient Pipe Summary
(Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical Full Flow Capacity (cfs)	Modeled Existing Max Flow (cfs)	Existing % Full	Modeled Future Max Flow (cfs)	Future % Full	Replacement Diameter (ft)	Theoretical New "Full" Flow Capacity (cfs)[1]	Theoretical New % Full
P245	0.67	3.30	2.21	0.16	7%	0.18	8%			
P246	0.67	2.37	1.88	0.00	0%	0.00	0%			
P260	0.83	0.53	1.57	0.18	12%	0.20	13%			
P263	1.25	0.65	5.20	2.91	56%	4.80	92%	1.50	9.10	53%
P274	1.25	0.49	4.53	0.28	6%	0.30	7%			
P278	0.83	0.56	1.62	0.18	11%	0.20	12%			
P290	1.25	0.66	5.23	2.91	56%	4.81	92%	1.50	9.17	52%
P330	1.25	0.49	4.52	0.28	6%	0.30	7%			
P341	0.83	0.51	1.54	0.18	12%	0.20	13%			
P344	1.25	0.66	5.24	2.91	56%	4.84	92%	1.50	9.19	53%
P384	1.25	0.47	4.41	0.28	6%	0.30	7%			
P386	0.83	5.69	5.15	0.18	4%	0.20	4%			
P395	1.25	0.66	5.24	2.91	56%	4.86	93%	1.50	9.18	53%
P449	1.25	0.66	5.23	2.91	56%	4.86	93%	1.50	9.16	53%
P464	1.00	1.14	3.79	0.28	7%	0.30	8%			
P465	0.83	1.10	2.26	0.18	8%	0.20	9%			
P469	0.83	0.56	1.61	0.18	11%	0.20	13%			
P499	1.25	0.66	5.24	2.91	56%	4.86	93%	1.50	9.19	53%
P526	0.83	0.94	2.09	0.46	22%	0.51	24%			
P541	1.00	2.24	5.31	2.91	55%	4.86	92%	1.25	10.38	47%
P564	1.00	2.13	5.18	2.91	56%	4.86	94%	1.25	10.12	48%
P574	0.83	0.50	1.53	0.46	30%	0.51	33%	1.00	2.71	19%
P605	1.00	2.16	5.22	2.91	56%	4.86	93%	1.25	10.20	48%
P614	0.83	0.53	1.57	0.46	29%	0.51	32%			
P615	0.83	1.37	2.52	0.10	4%	0.10	4%			
P616	0.83	2.22	3.25	0.10	3%	0.10	3%			
P617	0.83	2.00	3.08	0.10	3%	0.10	3%			
P618	0.83	1.14	2.31	0.10	4%	0.10	4%			
P619	0.83	1.14	2.30	0.10	4%	0.10	4%			
P620	0.83	1.10	2.26	0.10	4%	0.10	4%			
P621	0.83	1.64	2.79	0.00	0%	0.00	0%			
P622	0.83	1.64	2.79	0.00	0%	0.00	0%			
P623	1.00	1.83	4.79	0.44	9%	0.70	15%			
P624	1.25	1.45	7.75	2.47	32%	4.16	54%			
P687	0.83	0.60	1.67	0.44	26%	0.70	42%			
P700	1.50	0.32	5.91	2.47	42%	4.17	71%			
P702	0.67	1.80	1.63	0.38	24%	0.43	26%			
P735	0.83	0.50	1.53	0.44	29%	0.70	46%			
P769	1.50	0.32	5.94	2.47	42%	4.18	70%			
P779	0.67	1.06	1.25	0.00	0%	0.00	0%			
P799	1.00	0.20	1.59	0.44	28%	0.70	44%			
P830	1.50	0.32	5.91	2.47	42%	4.18	71%			
P839	1.50	0.25	5.24	2.47	47%	4.18	80%	1.75	8.51	49%
P841	1.00	0.20	1.59	0.44	28%	0.70	44%			
P852	0.67	1.05	1.25	0.00	0%	0.00	0%			
P900	1.00	0.20	1.59	0.88	56%	1.39	88%	1.25	3.10	45%
P902	0.67	0.53	0.88	0.00	0%	0.00	0%			
P908	1.50	0.43	6.84	2.03	30%	3.48	51%			
P933	1.00	0.20	1.59	0.88	56%	1.39	88%	1.25	3.10	45%
P934	1.00	0.20	1.57	0.88	56%	1.39	89%	1.25	3.10	45%
P969	1.50	0.45	6.99	2.03	29%	3.48	50%			
P972	0.83	0.56	1.62	0.88	55%	1.39	86%	1.00	2.86	49%
P974	1.50	0.47	7.15	2.03	28%	3.48	49%			
P993	1.50	0.44	6.96	2.03	29%	3.48	50%			
P994	0.83	0.76	1.90	0.88	46%	1.39	73%			
P995	1.00	1.85	4.83	2.46	51%	3.33	69%			
P996	1.00	2.26	5.33	2.46	46%	3.32	62%			
P997	1.00	1.50	4.35	2.46	57%	3.32	76%	1.25	8.50	39%
P998	1.00	1.85	4.83	2.46	51%	3.33	69%			
P999	1.00	1.50	4.34	2.46	57%	3.32	76%	1.25	8.49	39%
P1000	1.00	1.50	4.35	2.46	57%	3.32	76%	1.25	8.50	39%
P1001	1.00	1.87	4.85	2.46	51%	3.33	69%			
P1002	1.00	1.85	4.83	2.46	51%	3.33	69%			
P1003	1.00	1.52	4.37	2.46	56%	3.32	76%	1.25	8.55	39%
P1013	1.00	1.85	4.83	2.46	51%	3.34	69%			
P1014	1.00	1.85	4.83	2.46	51%	3.34	69%			
P1015	0.83	1.56	2.69	0.46	17%	1.57	58%			

Table 7-1
Sewer Analysis Results
Deficient Pipe Summary
(Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical Full Flow Capacity (cfs)	Modeled Existing Max Flow (cfs)	Existing % Full	Modeled Future Max Flow (cfs)	Future % Full	Replacement Diameter (ft)	Theoretical New "Full" Flow Capacity (cfs)[1]	Theoretical New % Full
P1016	0.67	10.52	3.95	0.46	12%	1.57	40%			
P1017	0.67	1.38	1.43	0.46	32%	1.57	110%	0.83	2.73	57%
P1018	0.67	1.45	1.47	0.46	32%	1.57	107%	0.83	2.80	56%
P1019	0.67	1.45	1.47	0.46	32%	1.57	107%	0.83	2.80	56%
P1020	0.67	1.46	1.47	0.46	31%	1.57	106%	0.83	2.81	56%
P1021	0.67	1.45	1.47	0.46	32%	1.57	107%	0.83	2.80	56%
P1022	1.00	1.08	3.69	2.46	67%	3.34	90%	1.25	7.21	46%
P1023	0.67	1.69	1.58	0.32	20%	1.42	90%	0.83	3.02	47%
P1024	1.25	0.50	4.53	2.78	61%	4.82	106%	1.50	7.94	61%
P1025	0.67	1.68	1.58	0.32	20%	1.42	90%	0.83	3.02	47%
P1026	1.25	1.42	7.68	2.66	35%	4.67	61%			
P1027	1.25	0.51	4.60	2.66	58%	4.43	96%	1.50	8.06	55%
P1028	0.67	1.71	1.59	0.32	20%	1.43	90%	0.83	3.04	47%
P1029	1.25	0.51	4.60	2.66	58%	4.41	96%	1.50	8.06	55%
P1030	1.25	0.54	4.73	2.66	56%	4.40	93%	1.50	8.30	53%
P1031	0.67	1.69	1.58	0.32	20%	1.44	91%	0.83	3.02	48%
P1032	1.25	0.51	4.60	2.66	58%	4.38	95%	1.50	8.06	54%
P1033	0.67	1.66	1.57	0.32	20%	1.45	92%	0.83	3.00	48%
P1034	0.67	1.67	1.58	0.32	20%	1.46	93%	0.83	3.01	49%
P1035	0.67	1.66	1.57	0.32	20%	1.47	93%	0.83	3.00	49%
P1036	0.67	3.43	2.25	0.12	5%	0.43	19%			
P1037	0.67	1.13	1.29	0.12	9%	0.38	29%			
P1040	0.67	0.25	0.61	0.12	20%	0.38	62%			
P469a	1.00	1.39	4.18	0.28	7%	0.30	7%			
P841a	1.00	0.20	1.59	0.44	28%	0.70	44%			
P1022a	0.67	3.13	2.16	0.32	15%	1.68	78%	0.83	4.11	41%
P1040a	0.67	1.15	1.31	0.12	9%	0.38	29%			

1. n value in Manning's equation for a PVC pipe is assumed 0.013 , per manufacturer's request.

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Existing % Full	Future % Full	Priority	Approximate Replacement Year (Flowing 90% Full)
P25	98%	130%	A	2002
P35	97%	130%	A	2002
P36	23%	31%		
P48	24%	32%		
P51	60%	71%		
P52	76%	103%	B	2002_1
P59	75%	101%	B	2002_1
P65	16%	17%		
P73	21%	23%		
P78	74%	100%	B	2002_1
P90	11%	12%		
P93	76%	103%	B	2002_1
P94	16%	18%		
P97	76%	103%	B	2002_1
P98	18%	20%		
994a	22%	38%		
P105	76%	103%	B	2002_1
P110	11%	12%		
P123	53%	72%		
P124	18%	20%		
P135	11%	12%		
P144	53%	72%		
P147	11%	12%		
P156	55%	74%		
P158	11%	12%		
P161	10%	11%		
P166	44%	59%		
P177	10%	11%		
P190	10%	11%		
P191	50%	67%		
P193	48%	65%		
P200	8%	9%		
P203	40%	53%		
P208	75%	100%	B	2010
P210	75%	100%	B	2010
P211	72%	97%	B	2010
P213	72%	97%	B	2010
P214	49%	70%		
P215	49%	69%		
P216	63%	89%	C	2010_2
P217	63%	89%	C	2010_2
P218	71%	100%	B	2010
P219	42%	59%		
P222	35%	38%		
P223	30%	33%		

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Existing % Full	Future % Full	Priority	Approximate Replacement Year (Flowing 90% Full)
P224	25%	27%		
P225	2%	3%		
P226	4%	5%		
P229	5%	5%		
P231	4%	5%		
P234	5%	6%		
P235	8%	9%		
P236	9%	10%		
P237	6%	7%		
P238	10%	11%		
P239	8%	10%		
P240	8%	10%		
P241	9%	10%		
P243	7%	8%		
P244	7%	8%		
P245	7%	8%		
P246	0%	0%		
P260	12%	13%		
P263	56%	92%	B	2015
P274	6%	7%		
P278	11%	12%		
P290	56%	92%	B	2015
P330	6%	7%		
P341	12%	13%		
P344	56%	92%	B	2015
P384	6%	7%		
P386	4%	4%		
P395	56%	93%	B	2015
P449	56%	93%	B	2015
P464	7%	8%		
P465	8%	9%		
P469	11%	13%		
P499	56%	93%	B	2015
P526	22%	24%		
P541	55%	92%	B	2015
P564	56%	94%	B	2015
P574	30%	33%		
P605	56%	93%	B	2015
P614	29%	32%		
P615	4%	4%		
P616	3%	3%		
P617	3%	3%		
P618	4%	4%		
P619	4%	4%		
P620	4%	4%		
P621	0%	0%		
P622	0%	0%		

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Existing % Full	Future % Full	Priority	Approximate Replacement Year (Flowing 90% Full)
P623	9%	15%		
P624	32%	54%		
P687	26%	42%		
P700	42%	71%		
P702	24%	26%		
P735	29%	46%		
P769	42%	70%		
P779	0%	0%		
P799	28%	44%		
P830	42%	71%		
P839	47%	80%	C	
P841	28%	44%		
P852	0%	0%		
P900	56%	88%	C	
P902	0%	0%		
P908	30%	51%		
P933	56%	88%	C	
P934	56%	89%	C	
P969	29%	50%		
P972	55%	86%	C	
P974	28%	49%		
P993	29%	50%		
P994	46%	73%		
P995	51%	69%		
P996	46%	62%		
P997	57%	76%	C	
P998	51%	69%		
P999	57%	76%	C	
P1000	57%	76%	C	
P1001	51%	69%		
P1002	51%	69%		
P1003	56%	76%	C	
P1013	51%	69%		
P1014	51%	69%		
P1015	17%	58%		
P1016	12%	40%		
P1017	32%	110%	B	2015
P1018	32%	107%	B	2015
P1019	32%	107%	B	2015
P1020	31%	106%	B	2015
P1021	32%	107%	B	2015
P1022	67%	90%	B	2015
P1023	20%	90%	B	2015
P1024	61%	106%	B	2010
P1025	20%	90%	B	2015
P1026	35%	61%		
P1027	58%	96%	B	2015

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Existing % Full	Future % Full	Priority	Approximate Replacement Year (Flowing 90% Full)
P1028	20%	90%	B	2015
P1029	58%	96%	B	2015
P1030	56%	93%	B	2015
P1031	20%	91%	B	2015
P1032	58%	95%	B	2015
P1033	20%	92%	B	2015
P1034	20%	93%	B	2015
P1035	20%	93%	B	2015
P1036	5%	19%		
P1037	9%	29%		
P1040	20%	62%		
P469a	7%	7%		
P841a	28%	44%		
P1022a	15%	78%	C	2010_2
P1040a	9%	29%		

Project Priorities	
Priority A	>90% Full Flow in Existing Model
Priority B	>90% Full Flow in Future Model
Priority C	>75% Full and <90% Full Flow in Future Model

Note:
1. Although pipes P52, P59, P78, P93, P97 and P105 are flowing more than 75% full but not more than 90% full, it would be advantageous to replace these pipes in conjunction with adjacent priority "A" pipes.
2. Although pipes P216, P217, P1022a would not be flowing 90% full, these are proposed to be under priority "B" to maintain continuity and maintain efficiency of improvements.

Table 7-3
Improvement Plan for Problem Areas

Priority No.	Location	From / To	Problem	Solution	Total Project Cost (2002$'s)
A	Spruce Street East of Kansas Ave., Sewer easement east of Northbend St.	Manhole 105-48	Immediate Capacity Problem in the reach 35-18 due to flat slopes, Future Capacity Problem in reach 105-51 due to flat slopes and increasing flow from UCR , surcharge within manholes 35,25 and 18	Replace existing pipes P105 and P97 with a 21" PVC pipe, new 21" PVC pipe in the reach 93-84, replace pipes P84, P77,P69, P61 and P56 with an 18" PVC pipe and connect reaches 45-48 with a 21" PVC pipe.	$686,500
B	Spruce Street, Chicago Ave., University Ave.	Manhole 218-215, Manhole 213-203, Manhole 624- 219, Manhole 1032-1022, Manhole 1022-1014, Manhole 1022-1016	Future Capacity Problem due to increased flow in the system. Main contributor will be UCR.	Replace future deficient pipes with PVC pipes. See table 7-6 for replacement diameter of pipes. A flow monitoring within 5 years should be considered to re-evaluate the system.	$2,199,200
C	Chicago Ave., University Ave.	Manhole 1003-996, Manhole 972-839	Future Capacity Problem due to increased flow in the system. Main contributor will be UCR.	Replace future deficient pipes with PVC pipes. See table 7-7 for replacement diameter of pipes. Visual inspection of the system and inspection every five years should be done.	$450,000

replacement at the earliest possible time. Two alternatives were considered to replace these currently deficient pipes. Alternative 1 features replacement of pipes P25 and P35 by pipe bursting and replacement of pipes P105, P97, P93, P78, P59 and P52 by open trench cutting. Pipe bursting was considered for reach 35-18 due to its proximity to freeway, access problems and pipeline running close to back yard fences of houses in that reach. Total cost of this alternative is $822,200. See figure 22 for pipe layout exhibit and table 7-4 for approximate cost estimate. Alternative 2 features diversion of wastewater flow from Spruce Street Trunk Sewer along Spruce Street, the sewer easement and finally connecting to the 36-inch trunk sewer line along Fairmount Boulevard. These pipes are proposed to be replaced by conventional open trench cutting. Additional sewer easement would be required in the reach 69-56 to accommodate new sewer line. See figure 23 for pipe layout exhibit and table 7-5 for approximate cost estimate.

7.7 Cost Estimate

Unit costs of pipes are based on rates obtained from the contractors over telephone, bid prices for similar projects and from web site www.get-a-quote.net. The cost of construction includes labor, materials, excavation, backfill and all other items associated with pipe laying. To estimate total cost, cost of mobilization / demobilization (7%), traffic control (7%), bond (1%), contractor's profit (15%) and construction contingency (20%) is added to the cost of construction. For priorities "B" and "C", the cost estimate is based on current year prices and no escalation has been added to estimate future cost. Following is the summary of cost for the various priorities. See tables 7-4, 7-5, 7-6 and 7-7 for a breakdown of these costs.

- Priority "A", Alternative 1 - $822,200
- Priority "A", Alternative 2 - $686,500
- Priority "B" - $2,200,000
- Priority "C" - $450,000

Table 7-4
Cost Estimate For Priority "A" Projects (Alternative 1)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2002 $'s)
Reach 35-18	Replace Pipe P35 by pipe bursting	18	20	LF	440	$400	$176,000
(Parallel to Fwy)	Replace Pipe P25 by pipe bursting	18	20	LF	447	$400	$178,800
Reach 105-51	Replace pipe P105	18	21	LF	248	$110	$27,280
(Spruce St./Main St)	Replace pipe P97	18	21	LF	62	$110	$6,820
	Replace pipe P93	18	21	LF	326	$110	$35,860
	Replace pipe P78	18	21	LF	218	$110	$23,980
	Replace pipe P59	18	21	LF	169	$110	$18,590
	Replace pipe P52	18	21	LF	25	$110	$2,750
	Replace Manholes			EA	10	$3,000	$30,000
	Drainage Ditch Rehabilitation			LS			$25,000
	Reconnect sewer laterals			EA	4	$500	$2,000
						Total =	$527,080
Mobilization / Demobilization (7%)							$36,896
Traffic Control (7%)							$36,896
Bond (1%)							$5,271
Contractor's Profit(15%)							$79,062
Subtotal:							$685,204
Construction Contingency(20%)							$137,041
Total Cost							**$822,245**

Table 7-5
Cost Estimate For Priority "A" Projects (Alternative 2)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2002 $'s)
Reach 105-48	Replace pipe P105	18	21	LF	248	$110	$27,280
(Spruce St.)	Replace pipe 97	18	21	LF	62	$110	$6,820
	New Pipe (MH93 - MH84)		21	LF	430	$110	$47,300
	Replace pipe P84	8	18	LF	201	$95	$19,095
	Replace pipe P77	8	18	LF	218	$95	$20,710
	Replace pipe P69	8	18	LF	220	$95	$20,900
	Replace pipe P61	8	18	LF	127	$95	$12,065
	Replace pipe P56	8	18	LF	297	$95	$28,215
	New pipe (MH45 - MH48)		21	LF	38	$110	$4,180
	Rehab / Replace Manhole			EA	12	$3,000	$36,000
	Reconnect Sewer Laterals			EA	35	$500	$17,500
	Land Acquisition for Sewer Easement			LS			$200,000
						Total =	$440,065
Mobilization / Demobilization (7%)							$30,805
Traffic Control (7%)							$30,805
Bond (1%)							$4,401
Contractor's Profit(15%)							$66,010
Subtotal:							$572,085
Construction Contingency(20%)							$114,417
Total Cost							**$686,501**

Table 7-6
Cost Estimate For Priority "B" Projects (Replace Future Deficient Pipe)

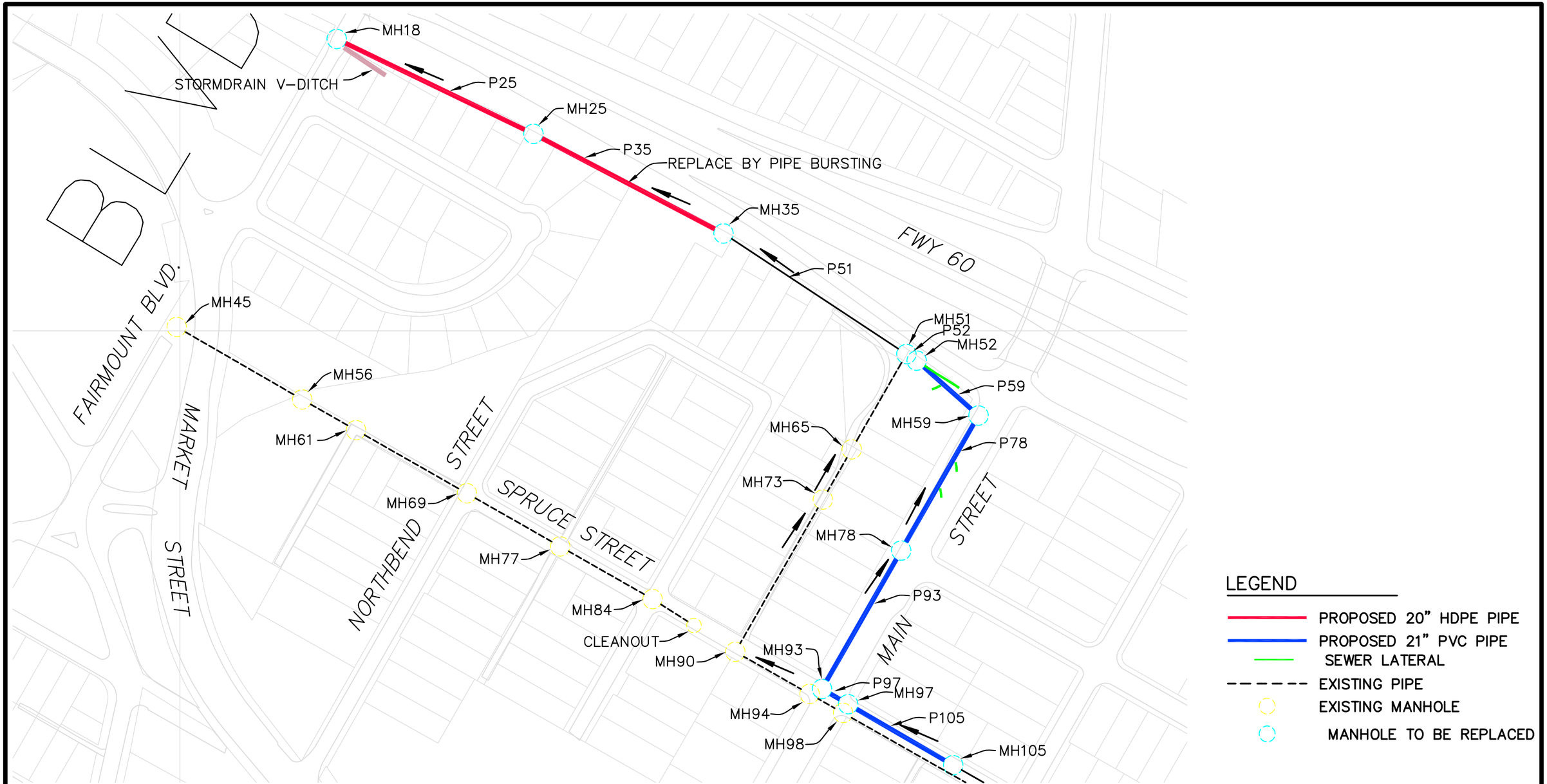
Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost (2002$'s)
Spruce Street	Replace Pipe P208	18	21	LF	138	$110	$15,180
	Replace Pipe P210	18	21	LF	177	$110	$19,470
	Replace Pipe P211	18	21	LF	348	$110	$38,280
	Replace Pipe P213	18	21	LF	400	$110	$44,000
	Replace Pipe P216	15	18	LF	388	$95	$36,860
	Replace Pipe P217	15	18	LF	269	$95	$25,555
	Replace Pipe P218	15	18	LF	269	$95	$25,555
	Rehab / Replace Manhole			EA.	12	$3,000	$36,000
	Reconnect Sewer Laterals			EA.	6	$500	$3,000
	Jack and bore for railroad crossing -Pipe211			LF	348	$900	$313,200
Chicago Ave.	Replace Pipe P263	15	18	LF	315	$95	$29,925
	Replace Pipe P290	15	18	LF	315	$95	$29,925
	Replace Pipe P344	15	18	LF	330	$95	$31,350
	Replace Pipe P395	15	18	LF	366	$95	$34,770
	Replace Pipe P449	15	18	LF	274	$95	$26,030
	Replace Pipe P499	15	18	LF	250	$95	$23,750
	Replace Pipe P541	12	15	LF	238	$90	$21,420
	Replace Pipe P564	12	15	LF	162	$90	$14,580
	Replace Pipe P605	12	15	LF	367	$90	$33,030
	Rehab / Replace Manhole			EA.	17	$3,000	$51,000
	Reconnect Sewer Laterals			EA.	18	$500	$9,000
University Ave.	Replace Pipe P1017	8	10	LF	311	$80	$24,880
	Replace Pipe P1018	8	10	LF	347	$80	$27,760
	Replace Pipe P1019	8	10	LF	249	$80	$19,920
	Replace Pipe P1020	8	10	LF	89	$80	$7,120
	Replace Pipe P1021	8	10	LF	253	$80	$20,240
	Replace Pipe P1022	12	15	LF	105	$90	$9,450
	Replace Pipe P1023	8	10	LF	449	$80	$35,920
	Replace Pipe P1024	15	18	LF	400	$95	$38,000
	Replace Pipe P1025	8	10	LF	478	$80	$38,240
	Replace Pipe P1027	15	18	LF	215	$95	$20,425
	Replace Pipe P1028	8	10	LF	374	$80	$29,920
	Replace Pipe P1029	15	18	LF	221	$95	$20,995
	Replace Pipe P1030	15	18	LF	37	$95	$3,515
	Replace Pipe P1031	8	10	LF	333	$80	$26,640
	Replace Pipe P1032	15	18	LF	323	$95	$30,685
	Replace Pipe P1033	8	10	LF	309	$80	$24,720
	Replace Pipe P1034	8	10	LF	58	$80	$4,640
	Replace Pipe P1035	8	10	LF	465	$80	$37,200
	Replace Pipe P1022a	8	10	LF	39	$80	$3,120
	Rehab / Replace Manhole			EA.	35	$3,000	$105,000
	Reconnect Sewer Laterals			EA.	39	$500	$19,500
						Total =	$1,409,770

Table 7-6
Cost Estimate For Priority "B" Projects (Replace Future Deficient Pipe)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost (2002$'s)
Mobilization / Demobilization (7%)							$98,684
Traffic Control (7%)							$98,684
Bond (1%)							$14,098
Contractor's Profit(15%)							$211,466
Subtotal:							$1,832,701
Construction Contingency(20%)							$366,540
Total Cost							**$2,199,241**

Table 7-7
Cost Estimate For Priority "C" Projects (Replace Future Deficient Pipe)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	ApproxTotal Cost(2002$'s)
Chicago Ave.	Replace Pipe P839	18	21	LF	76	$110	$8,360
	Replace Pipe P900	12	15	LF	330	$90	$29,700
	Replace Pipe P933	12	15	LF	330	$90	$29,700
	Replace Pipe P934	12	15	LF	17	$90	$1,530
	Replace Pipe P972	10	12	LF	269	$85	$22,865
	Rehab / Replace Manhole			EA	9	$3,000	$27,000
	Reconnect Sewer Laterals			EA	28	$500	$14,000
University Ave.	Replace Pipe P997	12	15	LF	389	$90	$35,010
	Replace Pipe P999	12	15	LF	526	$90	$47,340
	Replace Pipe P1000	12	15	LF	254	$90	$22,860
	Replace Pipe P1003	12	15	LF	405	$90	$36,450
	Rehab / Replace Manhole			EA	7	$3,000	$21,000
	Reconnect Sewer Laterals			EA	28	$500	$14,000
						Total =	$295,815
Mobilization / Demobilization (7%)							$20,707
Traffic Control (7%)							$20,707
Bond (1%)							$2,958
Contractor's Profit(15%)							$20,707
Subtotal:							$374,894
Construction Contingency(20%)							$74,979
Total Cost of Construction							**$449,873**



N

GRAPHIC SCALE

200 0 100 200

(IN FEET)

1 inch = 200 ft.

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PBSJ

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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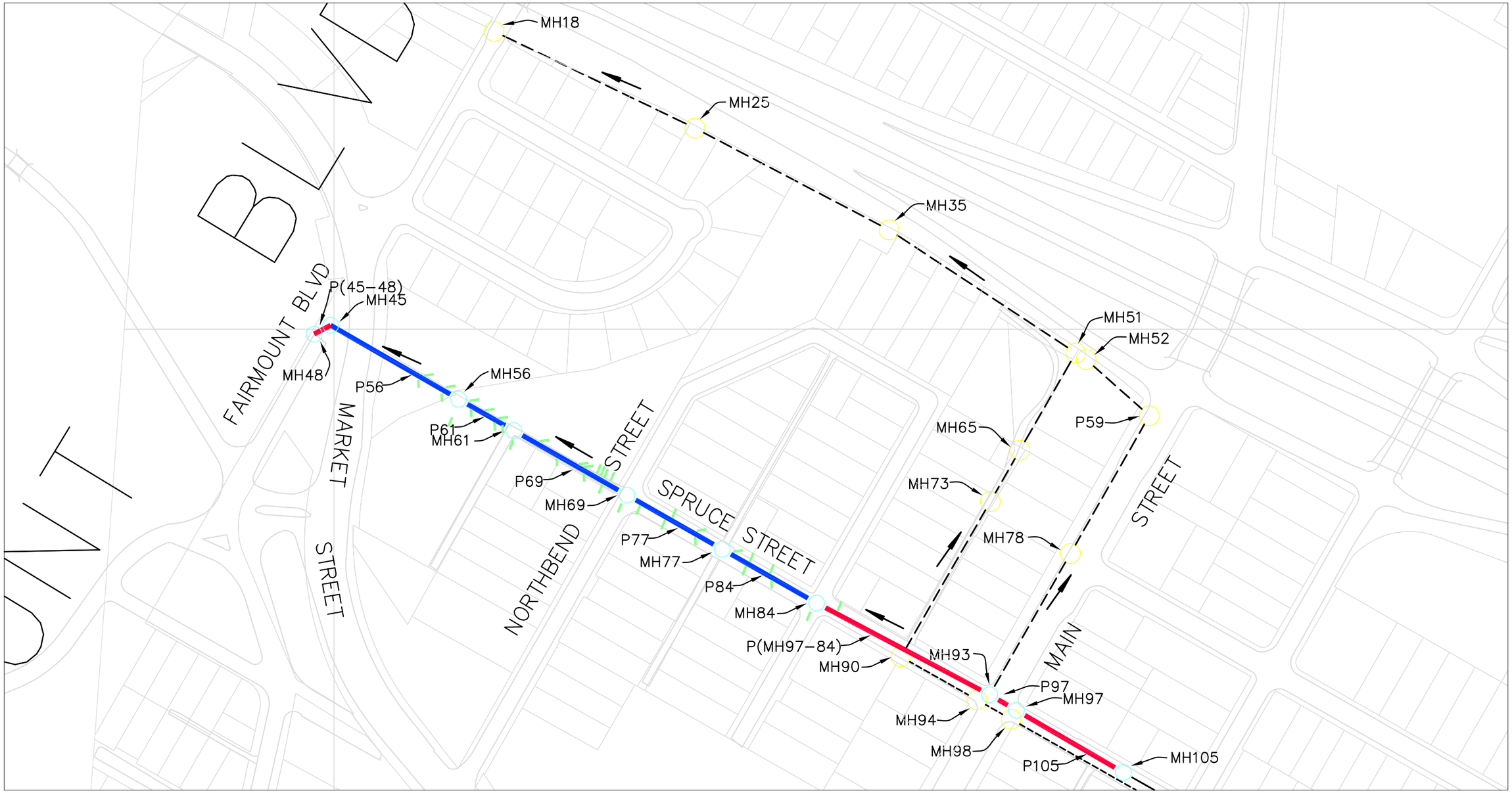
SPRUCE STREET SEWER CAPACITY STUDY

PRIORITY "A" - ALTERNATIVE 1

JUNE 2002

FIGURE 22



LEGEND

- PROPOSED 21" PIPE
- PROPOSED 18" PIPE
- SEWER LATERAL
- MANHOLE TO BE REPLACED

N

GRAPHIC SCALE

200 0 100 200

(IN FEET)

1 inch = 200 ft.

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Riverside, CA 92506
Tel:(909) 341-6380
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SPRUCE STREET SEWER CAPACITY STUDY

PRIORITY "A" – ALTERNATIVE 2

JUNE 2002 | FIGURE 23

Appendix B
TEQUESQUITE TRUNK SEWER STUDY

City of Riverside
Tequesquite Trunk Sewer Study

Prepared By:

3610 Central Avenue, Suite 500
Riverside, CA 92506
(909) 341-6380

December, 2003

TEQUESQUITE TRUNK SEWER STUDY

City of Riverside

Client Representative L.F.(Sandy) Caldwell, P.E.

PBS&J

Project Manager Louis Atwell, P.E.

Technical Advisory Mark Iverson, P.E.

Project Engineer Barmeshwar Rai, P.E.

J.N. 590065

December, 2003

PBS&J 3610 Central Avenue, Suite 500, Riverside, CA 92506

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Executive Summary

ES.1 Introduction

This report presents the results of the Tequesquite Trunk Sewer System Capacity Study prepared by PBS&J for the City of Riverside. The report contains recommendations regarding system deficiencies as identified by hydraulic model XP-SWMM (XP Software, Version 2000).

The City of Riverside is located in the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. The study area encompasses approximately 13,000 acres of mixed land use development and is generally bounded by University of California (UCR) to the North, Tequesquite Avenue to the West, Van Buren Boulevard to the South and Freeway 215 to the East. The study area is essentially a fully developed community, comprising single family residential, multi family residential, commercial and light industrial areas with vacant lands to be developed in the future. The areas not falling under the City's jurisdiction are not part of this study. The vacant area designated as Industrial Business Park (IBP) in Sycamore Canyon Park Neighborhood would be one of the major contributors of future sewage flow to the system.

ES.2 Existing Sewer System

The existing trunk sewer system within the study area is comprised of approximately 21.8 miles of gravity sewer main and 1.6 miles of force main. The gravity sewer main lines range in sizes from 8-inch to 42-inch in diameter and there are 397 manholes. These sewer lines are essentially VCP and the manholes are typically brick lined. The force main line is a 16-inch ductile iron pipe. The City of Riverside owns and operates the sewer system.

ES.3 Methodology

For determination of current wastewater flows, flow monitoring was performed at five (5) strategic locations. These meter locations were chosen to observe actual flow characteristics for various sub areas with a distinct land use pattern within the study area. The flow monitoring was accomplished over a two-week period. The flow results were carefully evaluated for their accuracy and some adjustments were made based on depth of flow at meter locations. The readings at meter no. 2 were discarded for inconsistencies. The flow data received from the City for the Pepsi Plant, Ralph Storage Facility and Edgemont Community were also evaluated and used for flow calculation.

A theoretical estimate of current and future wastewater flow was estimated based on factors from the City of Riverside "Criteria for Sewer Facility Design". Residential wastewater flow was determined by using

current and future projected population, whereas commercial and industrial flow was determined based on acreage and City estimated flow coefficients.

The Computer Model Simulation Analysis involved evaluation of available capacity in the existing collection system under present and future development conditions. Based on the results of model runs, system deficiencies were identified on a priority basis and a phased facility improvement plan was developed to allow for the projected growth within the study area.

ES.4 Project Priorities and Cost

Deficient and marginally deficient pipes were identified from the results of model runs and were prioritized for replacement / re-habilitation purpose. The pipes that are currently flowing more than 90% full under modeled existing maximum flow conditions and needing near term (2004-2007) replacement / re-habilitations are grouped under priority "A". The pipes that would flow more than 90% full in modeled years 2008-2013 under anticipated maximum future flow conditions are classified as priority "B".

The future development of IBP in the Sycamore Canyon Park Community would be a prominent source of wastewater generation. The existing trunk sewer system would require major replacement / re-habilitation to accommodate this anticipated flow. So, an alternative system was studied and recommended to divert flow through a "new" proposed trunkline system.

This system would begin at the Central Avenue and Canyon Crest Drive intersection, move along Canyon Crest Drive, Martin Luther King Boulevard, Pennsylvania Avenue, Victoria Avenue and Cridge Street before joining the existing trunk sewer system west of Hwy 91. The future pipelines within this alternative, and existing pipes flowing more than 75% full under future maximum flow conditions are grouped under priority "C". Some adjustment of priorities and combining of improvements was done for continuity and efficiency of improvements.

The time phased improvements for various priorities are listed in Table 7-2. The approximate cost of recommended improvements is summarized in Tables 7-7-A, 7-7-B and 7-7-C.

Under existing flow conditions, a total of 8,000 linear feet of priority "A" deficiencies were identified, requiring near term (2004-2007) attention. Additional deficiencies predicted under ultimate flow conditions (Priority "B") include an additional 17,000 linear feet of inadequate sewer lines. The estimated capital cost to remedy these identified deficiencies (in year 2003 $'s) is approximately $2,757,000 for Priority "A" and approximately $6,734,000 for Priority "B". The total length of pipelines under Priority "C" would be approximately 24,000 feet and the cost of Priority "C" projects would be approximately $8,400,000. However, it may be that not all of the

Priority "B" and Priority "C" improvements will need to be actually implemented. Only those where surcharging (within manhole) and other problems are deemed imminent should be considered for improvement. Periodic flow monitoring is also recommended to verify anticipated deficiencies and need for improvements. The priorities are summarized in the table Ex-1:

Table Ex-1
Summary of Priorities

Priority	Approximate Pipeline Length (feet)	Location	Replacement Year	Total Project Cost (year 2003$'s)
"A"	8,000	Tequesquite Avenue, Near Hwy 91, Victoria Country Club, Eastridge Avenue, 13th Street, 5th Street	2004-2007	$2,757,000
"B"	17,000	Tequesquite Avenue, Riverside Community College, Victoria Country Club, Trautwein Road, Eastridge Avenue	2008-2013	$6,734,000
"C"	24,000	Canyon Crest Drive, Martin Luther King Boulevard, Pennsylvania Avenue, Victoria Avenue, Cridge Avenue, Wood Road, Brockton Avenue	2014-2018	$8,400,000

1.0 INTRODUCTION

1.1 Background

On May 12, 2003 the City of Riverside (City) retained PBS&J to prepare a Trunk Sewer System Study. The study is necessitated by the fact that the City is experiencing sewer capacity issues along the Tequesquite Avenue Trunk Sewer Line and its other tributary sewers.

1.2 Study Area

The City of Riverside is located in the northwest corner of the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. Founded in 1870, the City is known for its citrus industry, world famous Mission Inn and other historical monuments. Figure-1 is a Vicinity Map depicting the City's location and its accessibility. Figure 2 shows the study area. The study area shown in Figure 2 encompasses approximately 13,000 acres and is generally bounded by University of California (UCR) to the North, Tequesquite Avenue to the West, Van Buren Boulevard to the South and Freeway 215 to the East. The areas not falling within City's jurisdiction are not part of this study. For purpose of this study, the area has been divided into 29 tributary sub-areas, where downstream sub-areas intercept sewage flow from upstream sub-areas. To obtain "real" flow information for this study, sewage flow meters were placed at strategic locations to monitor cumulative flows contributed from the tributary sub-areas.

In general, the study area is considered to be a mature community comprised of single family residential, multi-family residential, commercial and light industrial uses. The vacant area designated as Industrial Business Park in Sycamore Canyon Neighborhood would be one of the major contributors of future sewage flow within the study area. Another area marked as Sycamore Canyon Park is a reserved area.

1.3 Objective

The objective of this Sewer System Capacity Study is to provide a comprehensive evaluation of the capacity of the sewer system within the study area, identify deficiencies in the current system,

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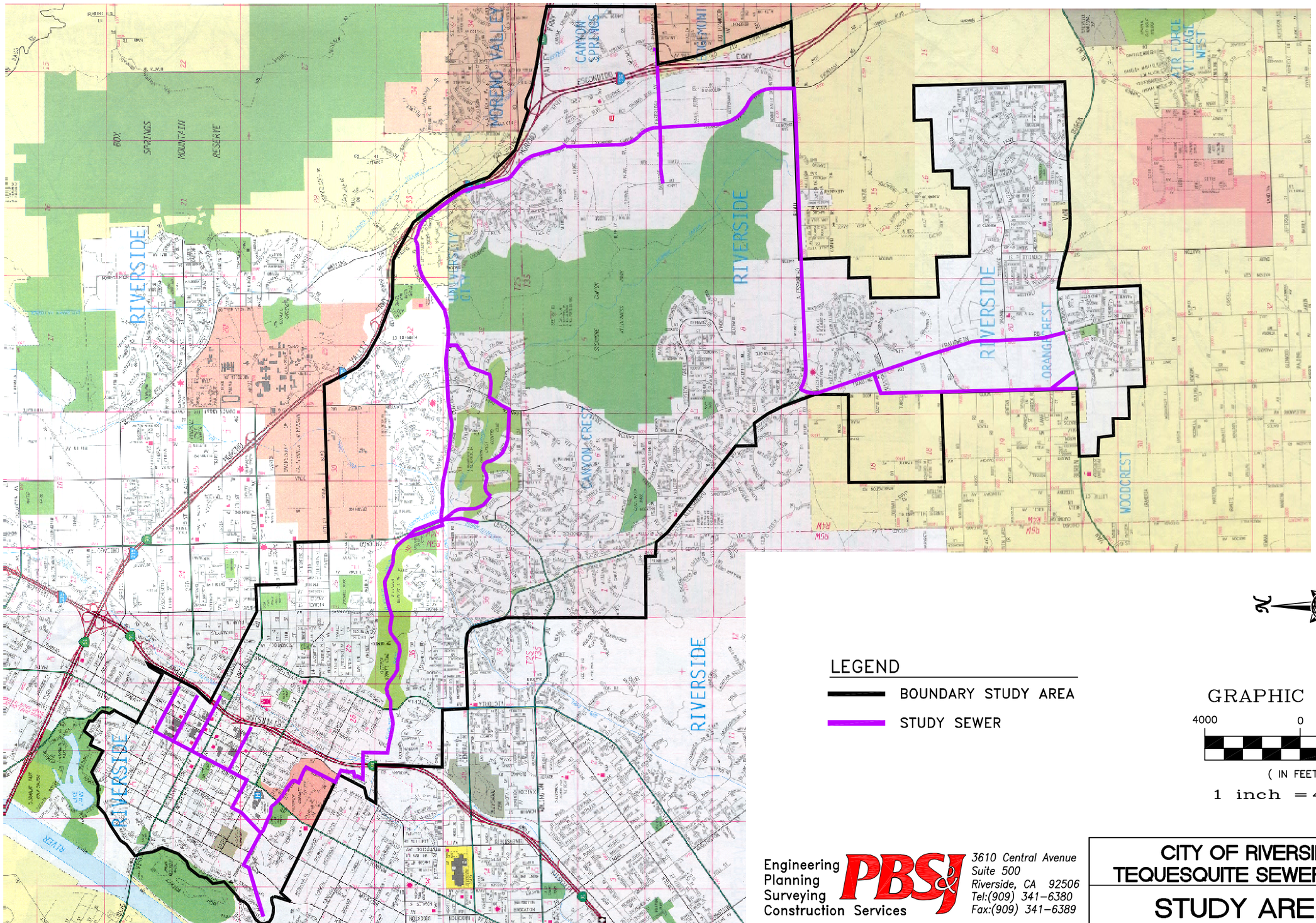
3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
TEQUESQUITE SEWER STUDY

FIGURE 1

VICINITY MAP



LEGEND

- BOUNDARY STUDY AREA
- STUDY SEWER

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE
TEQUESQUITE SEWER STUDY

FIGURE 2

STUDY AREA MAP

and evaluate alternatives to enhance the conveyance capacity to accommodate ultimate wastewater flows anticipated to be generated in the study area.

1.4 Scope and Study Approach

Specific work tasks undertaken for this study are summarized as follows:

- Kickoff Meeting

  An initial meeting was held between PBS&J and the City to discuss project scope, communication protocol, scheduling of flow monitoring dates and explanation of methodology involved, and field data and other digital files to be provided by the City.

- Progress Meetings

  Informal Project Progress Meetings were held to discuss on going issues and progress of study.

- Flow Monitoring and Hydrograph Development

  The sub-consultant, Downstream Services Inc, installed, maintained, and collected flow data from five (5) monitoring stations throughout the study area. They submitted the collected raw data in electronic/hard copy format to PBS&J. PBS&J then processed and reviewed this information and created a hydraulic database. The City provided a copy of City's General Plan for estimation of current and future flows. Other information like as-built plans of wastewater facilities were provided by the City as and when requested by PBS&J.

- Model Development

  Model development included input data collection, conversion of data and calibration. The City's GIS staff made available data pertaining to roads, sewers, land use and other utilities in ArcView format on a CD. As built plans for trunk line sewer were reviewed. Data available from GIS system and as built plans were placed in a database system (MS Excel) as a pre-processor for XP-SWMM model development. Calibration of model was done after construction of the model and additional data input.

- Draft Report

  Based on the calibrated model and City's criteria for Sewer Facility Design, a Draft Report was prepared that summarizes existing and future capacity problems. Alternatives were suggested for additional or alternate sewer improvements along with probable costs. The draft report was reviewed by the City personnel for their comments and suggestions.

- Final Report

  Draft Report review comments from the City were incorporated into the Final Report along with any additional information or research in order to reflect a final level of study completion. The Final Report includes data and information assembled, alternatives evaluated, capital improvement recommendations to remediate anticipated deficiencies, and approximate cost.

A comprehensive evaluation of the sewage collection system to accomplish the above-summarized scope entailed the following multi-step approach:

- Review of as built plans provided by the City to determine system configuration, inverts, pipe sizes and slopes.
- Use of detailed database provided by the City in Arcview format.
- Creation of computer hydraulic model using existing sewer system to study project area.
- Identification of flow monitoring station locations.
- Identification of tributary areas contributing sewage flow to meter locations.
- Installation of flow meters and monitoring of flows at the selected locations on continuous basis for two-week period.
- Review of current land use in study area per GIS information from the City and determination of existing land use, population and vacant land.
- Assessment of ultimate land use and projected population.
- Review and evaluation of metered data from flow monitoring stations.
- Development of flow coefficients and representative diurnal flow patterns based on typical curves for various land uses and observed flows from monitored sub areas which are dominated by a specific land use.
- Modeling of sewer system, deficiency identification, and model simulation of remedial alternatives using above -mentioned information as input data.
- Evaluation of alternatives, optimization, cost comparison.
- Prioritization of recommended improvements, including identification of critical pipelines which need immediate attention.

- Draft Report and recommendations including phased improvements and costs.
- Review by the City, comments and discussion.
- Final Report

2.0 LAND USE

2.1 Existing Land Use

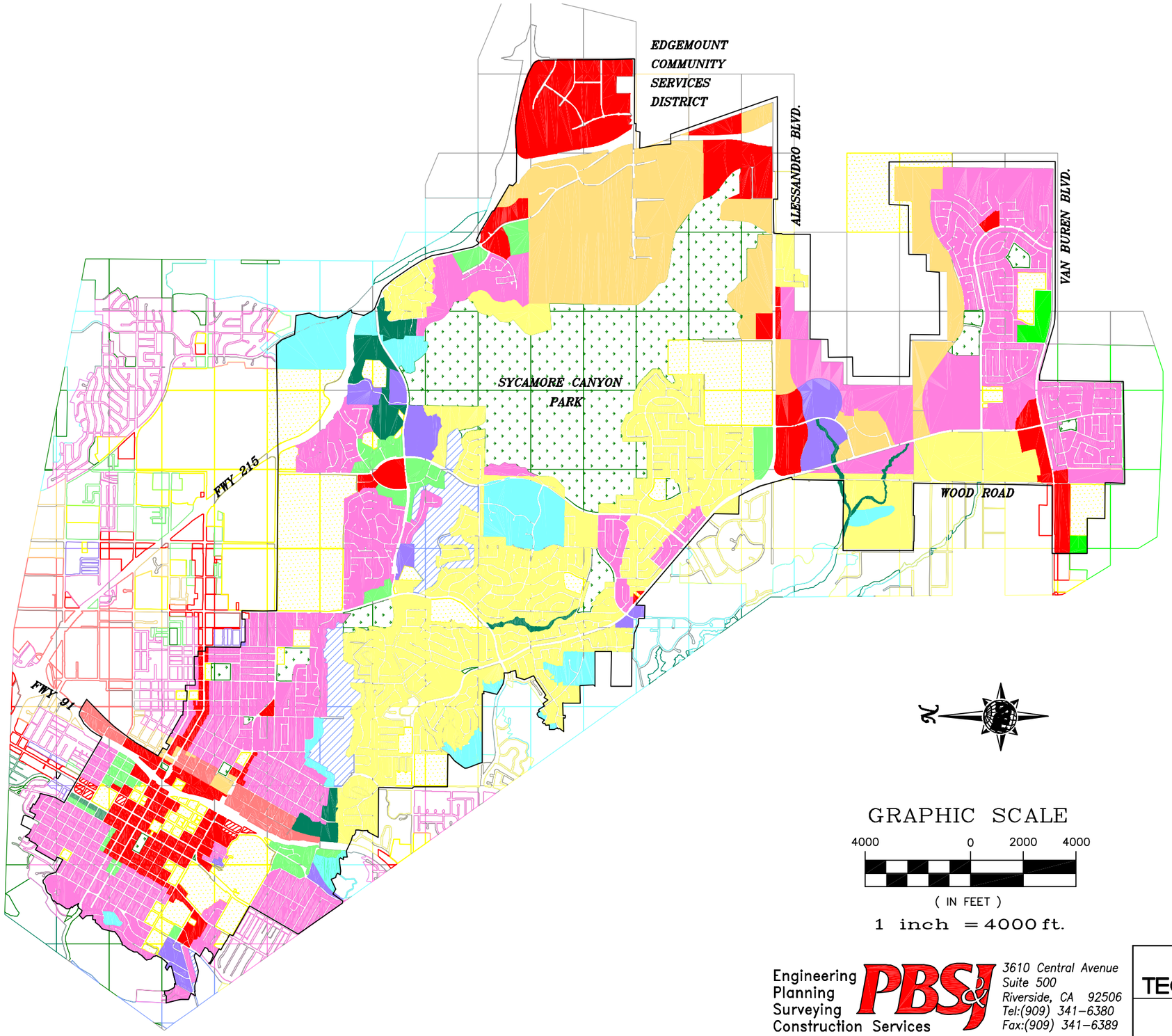
Land use is the basis for estimating sewage flow from the majority of the study area. The land use pattern for this study was developed from the GIS information provided by the City. Figure 3 shows land use for the City portion of the study area based on the City's "Land Use" GIS layer. For the purpose of this study, land uses in the study area have been broadly classified into four categories: Single Family Residential (SFR), Multi Family Residential (MFR), Commercial and Industrial. Sycamore Canyon Park, which is marked as Public Facilities and Open Space is a non -flow generating area. Table 2-1 summarizes the areas within the study area that would generate wastewater flow.

2.2 Industrial Business Park (IBP)

The City has designated approximately 800 Acres of land to be developed as Industrial Business Park in Sycamore Canyon Park Community. This area is north of Alessandro Boulevard and west of Freeway 215. This area was designated to house a large shopping mall in addition to many business developments. When fully developed, it would be a major contributor of sewage flow in the Tequesquite Trunk Sewer System.

2.3 Proposed Land Use

The study area is primarily a mature community. With the exception of the area designated as Industrial Business Park near the 215 Freeway, there is little vacant land remaining for future development. The majority of the remaining growth is planned to take place as part of the Industrial Business Park development north of Alessandro Boulevard, along Sycamore Canyon Boulevard. It is assumed that the majority of vacant lots within the study area would be fully developed by year 2018.



LEGEND

- INDUSTRIAL BUSINESS PARK
- PARKS PUBLIC (RESERVED AREAS)
- RESIDENTIAL HILLSIDE
- INDUSTRIAL GENERAL
- PUBLIC FAC. & OPEN SPACE
- RESIDENTIAL LOW DENSITY – (SFR)
- RESIDENTIAL MEDIUM DENSITY – (SFR)
- RESIDENTIAL HIGH DENSITY – (MFR)
- RESIDENTIAL MEDIUM DENSITY – (MFR)
- AGRICULTURE
- COMMERCIAL BUSINESS OFFICE
- MIXED USE – OFFICE EMPHASIS – (COMM)
- MIXED USE – RESIDENTIAL EMPHASIS – (SFR)
- PKO – PARK OTHER RECREATION

N

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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Riverside, CA 92506
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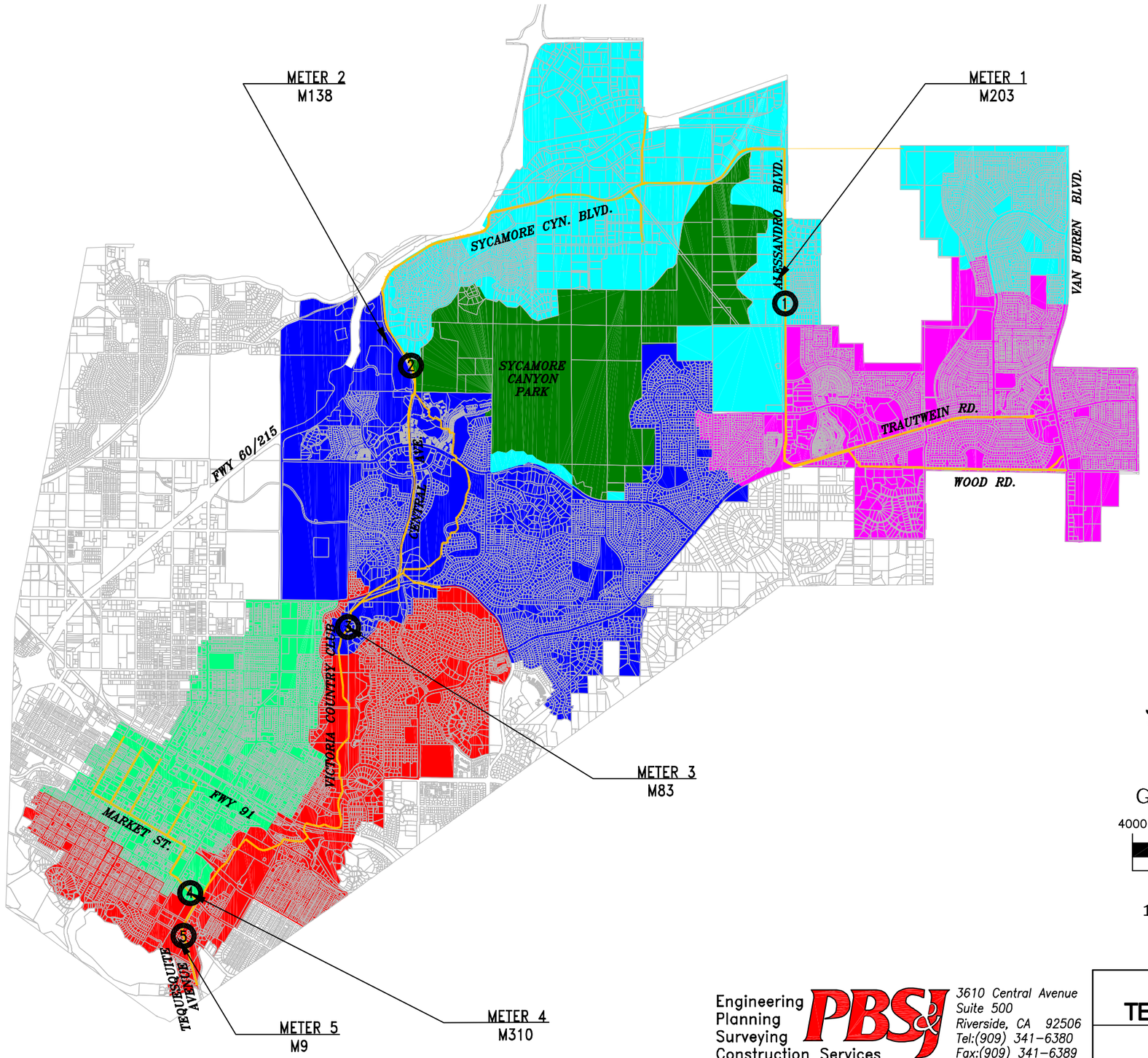
FIGURE 3

GENERAL LAND USE PLAN



LEGEND

- METER 1 FLOW AREA
- METER 2 FLOW AREA (PART)
- METER 3 FLOW AREA (PART)
- METER 4 FLOW AREA
- METER 5 FLOW AREA (PART)
- STUDY SEWER
- SYCAMORE CANYON PARK

N

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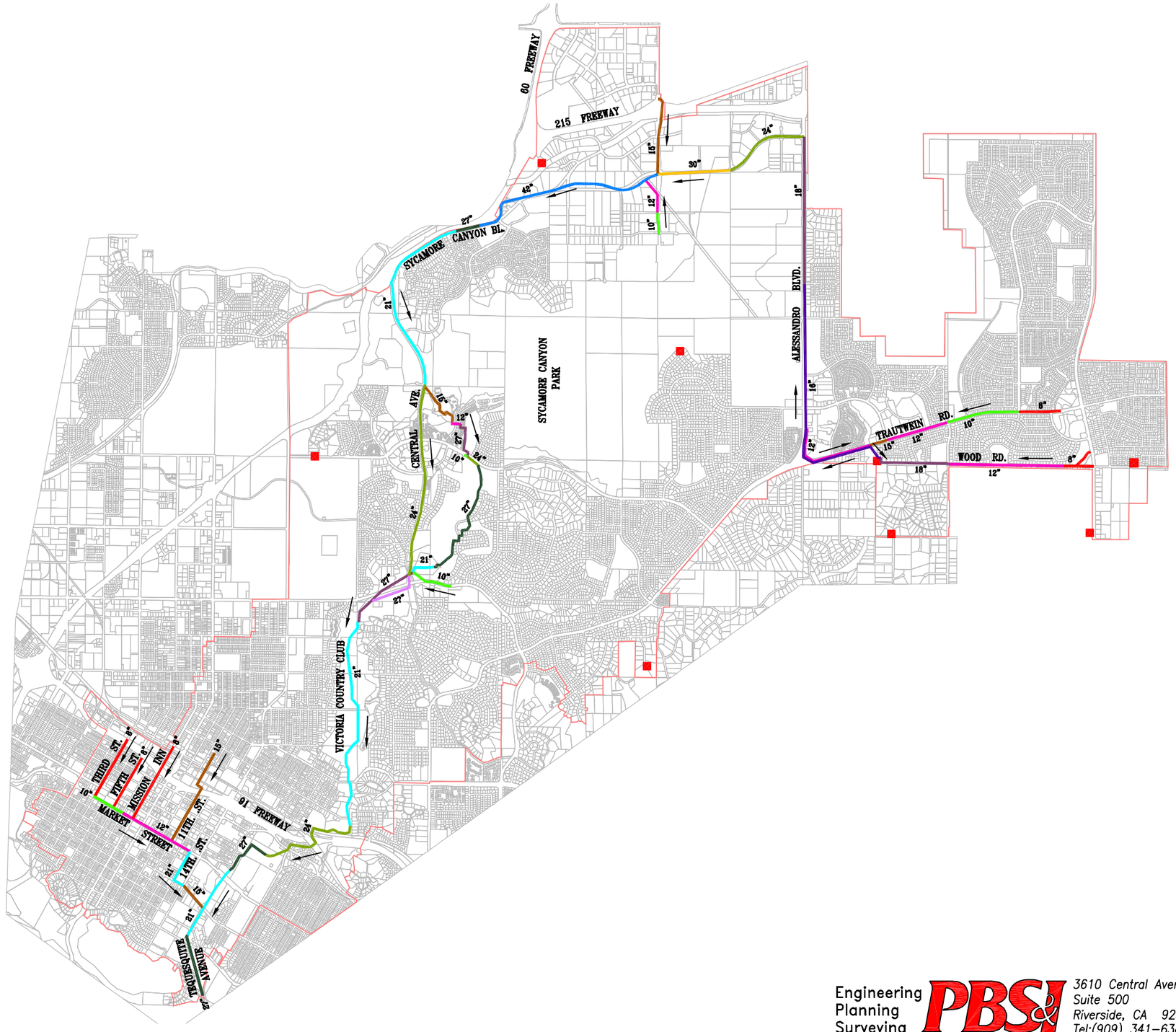
FIGURE 4

FLOW MONITORING STATIONS



N

GRAPHIC SCALE

40 0 20 40

(IN FEET)

1 inch = 40 ft.

MODELED TRUNK LINES

- 8" DIA. PIPE
- 10" DIA. PIPE
- 12" DIA. PIPE
- 15" DIA. PIPE
- 16" DIA. PIPE (FORCE MAIN)
- 18" DIA. PIPE
- 21" DIA. PIPE
- 24" DIA. PIPE
- 27" DIA. PIPE
- 30" DIA. PIPE
- 33" DIA. PIPE
- 42" DIA. PIPE
- LIFT STATIONS
- BOUNDARY STUDY AREA
- DIRECTION OF FLOW

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3610 Central Avenue
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Tel:(909) 341-6380
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CITY OF RIVERSIDE TEQUESQUITE SEWER STUDY

FIGURE 5

SEWER SYSTEM AND PIPE DIAMETERS

Table 2-1
Land Use that would produce Wastewater Flow within the Study Area (Acres)

Category	Existing (Year 2003)	Future (Year 2018)	Change
Single-Family Residential (SFR)	6,744	7,530	786 (11.7%)
Multi-Family Residential (MFR)	241	274	33 (13.9%)
Commercial (Includes IBP)	849	2,191	1,342(158%)
Industrial	54	60	6 (10.4%)

The areas that are marked as reserved areas or open space public facilities in Figure 3 are not included in Table 2-1because of zero wastewater flow generation. Sycamore Canyon Park is a reserved area.

.

3.0 EXISTING SEWER SYSTEM

3.1 System Overview

As previously described the Tequesquite Trunk Sewer System Study covers approximately 13,000 acres, which has been divided into 31 tributary sub-areas (See Figure 8). The wastewater flow generated from a sub-area can be measured at a meter location or can be reasonably assessed based on land use plan of that sub area. The location of meter locations can be seen on Figure-4. The modeled gravity conveyance system is approximately 115,000 linear feet (21.8 miles) of gravity sewer system, with pipe sizes varying from 8 inches to 42 inches in diameter (See Figure 5). The most of the gravity sewer lines within the system are vitrified clay (VCP). The force main sewer system, located in Trautwein Road and Alessandro Boulevard is a 16-inch ductile iron pipe and is approximately 8,200 feet (1.55 miles) in length.

3.2 Collection System

The wastewater generated within the study area flows in a northerly or westerly direction depending on general topography. The major trunk lines are along Wood Road, Trautwein Road, Alessandro Boulevard, Sycamore Canyon Boulevard, Central Avenue, Canyon Crest Country Club, Victoria Country Club, Market Street, Brockton Avenue and Tequesquite Avenue. The trunk line in Wood Road accepts sewage flow from Single Family Residences north of Van Buren Boulevard. The trunk line in

Trautwein Road picks up flow from Orangecrest area north of Van Buren Boulevard. The trunk sewer line in Alessandro Boulevard conveys sewage flow generated by single-family residences north and south of Alessandro Boulevard and some multi family residences and commercial establishments at the intersection of Alessandro Boulevard and Mission Grove Parkway. The trunk sewer line in Sycamore Canyon Boulevard conveys almost all wastewater generated from the area between Alessandro Boulevard and Van Buren Boulevard, and from commercial and business park areas on both sides of Freeway 215. The trunk sewer line in Central Avenue conveys wastewater flow from Sycamore Highlands and Canyon Crest areas. Another trunk sewer line parallel to Central Avenue trunk lines runs through Canyon Crest Country Club and it re-joins the main trunk sewer line near Chicago Avenue. The trunk line in Victoria Country Club runs through a sewer easement inside the Golf Course and it conveys sewage flow coming out of Victoria Neighborhood. The sewer line in Riverside Community College (RCC) conveys sewage generated from RCC and other adjoining commercial and residential areas. The downtown sewer line along Market Street convey sewage flow from Riverside downtown area. Finally, the Tequesquite trunk sewer line accumulates total sewage flow generated from the entire study area and conveys it to the Wastewater Treatment Plant. Pipe sizes, lengths, and number of manholes have been tabulated for major segments of the modeled trunk system (See Table 3-1).

Table 3-1

City of Riverside
Summary of Modeled Sewer Lines within Study Area

Location	Pipe Dia. (Inches)	Length (Feet)	Number of Manholes
Wood Road	8	705	4
	10	806	3
	12	4,716	13
	18	2,656	11
Trautwein Road	8	1,550	7
	10	2,553	8
	12	5,922	20
	15	690	2
	16	3,254	(Force Main)
	18	565	2
Alessandro Bl.	16	4,924	(Force Main)

Location	Pipe Dia. (Inches)	Length (Feet)	Number of Manholes
	18	6,665	16
	24	521	1
Sycamore Canyon Bl.	2-20	200	2
	21	2,445	6
	24	3,266	7
	27	2,221	6
	30	2,621	8
	42	6,660	16
Eastridge Avenue	10	733	3
	12	1,352	4
	15	1,738	6
Central Avenue	21	3,424	9
	24	7,953	14
	33	172	1
Canyon Crest Country Club	12	392	3
	15	2,734	14
	18	3,467	9
	21	677	3
	24	501	2
	27	4,767	23
Chicago Avenue	8	1,000	2
	10	546	2
Victoria Country Club	18	1,251	8
	21	7,221	20
	24	1,205	6
	27	739	3
	33	2,253	6
Riverside Community College	18	372	2
	24	1,478	9
	27	2,858	15
Downtown Area	8	7,296	34
	10	1,615	8
	12	3,275	14
	14	33	
	15	4,453	22
	18	248	3
	21	761	3

Location	Pipe Dia. (Inches)	Length (Feet)	Number of Manholes
Tequesquite Avenue	15	97	2
	21	654	3
	24	314	2
	27	3,717	15
	30	73	1
TOTAL		**1,23,200 (23.3 miles)**	**397**

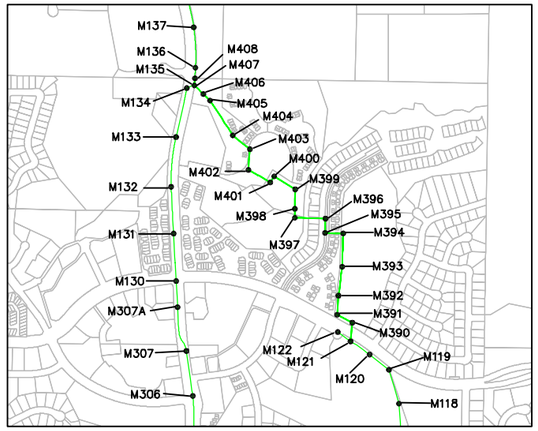
Approximate Gravity System Length: 115,000 feet
Approximate Force Main System Length: 8,200 feet

3.3 System Hydraulics

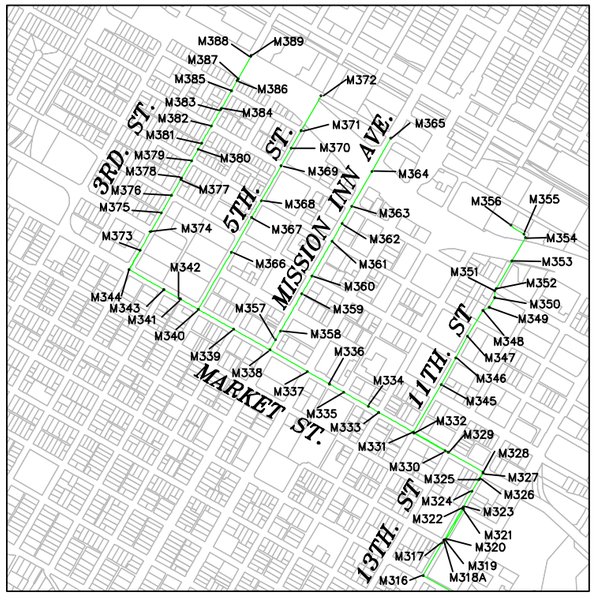
The existing trunk sewer system, which is the subject of this evaluation, is shown on Figure-5. The sewer collection system was constructed over a period of years (possibly 60 plus years) as needed; to accommodate development within the City. The GIS data and as-built plans provided by the City were studied to ascertain characteristics of the system. The existing sewer manholes and sewer lines can be see in Figure-6 and Figure-7 respectively. The sewer system, from upstream to downstream end, is briefly described as follows:

- *Wood Road Study Area Sewer Lines:* The sewer line along Wood Road begins just north of Van Buren Boulevard with an 8-inch diameter line flowing north. At manhole No. 232 (M232) it picks up flow coming from a 10-inch sewer line flowing northwest along reach M238 to M232. Beginning at M232 a 12-inch line picks up flow from these two sewer reaches and continues north of John Kennedy Drive at M218. North of M218 the size of sewer line changes to 18-inch till M207 where it joins another trunk line north of Zomora Way. Sewage flow in Wood Road sewer line is in northerly direction till M206, which is a lift station. From this location, sewage is pumped through a force main line, that is described seperately.

- *Trautwein Road Study Area Sewer Line*: Trautwein Road sewer lines may broadly be divided in two parts, one flowing in northwesterly direction beginning north of Van Buren Boulevard and other flowing in southeasterly direction beginning north of Alessandro Boulevard. An 8-inch sewer line beginning north of Van Buren Boulevard at M277 picks up flow from the Orangecrest neighborhood. The size of this line changes to a 10-inch line north of M271. This line meets another 12-inch line coming in



DETAIL "A"
NOT TO SCALE



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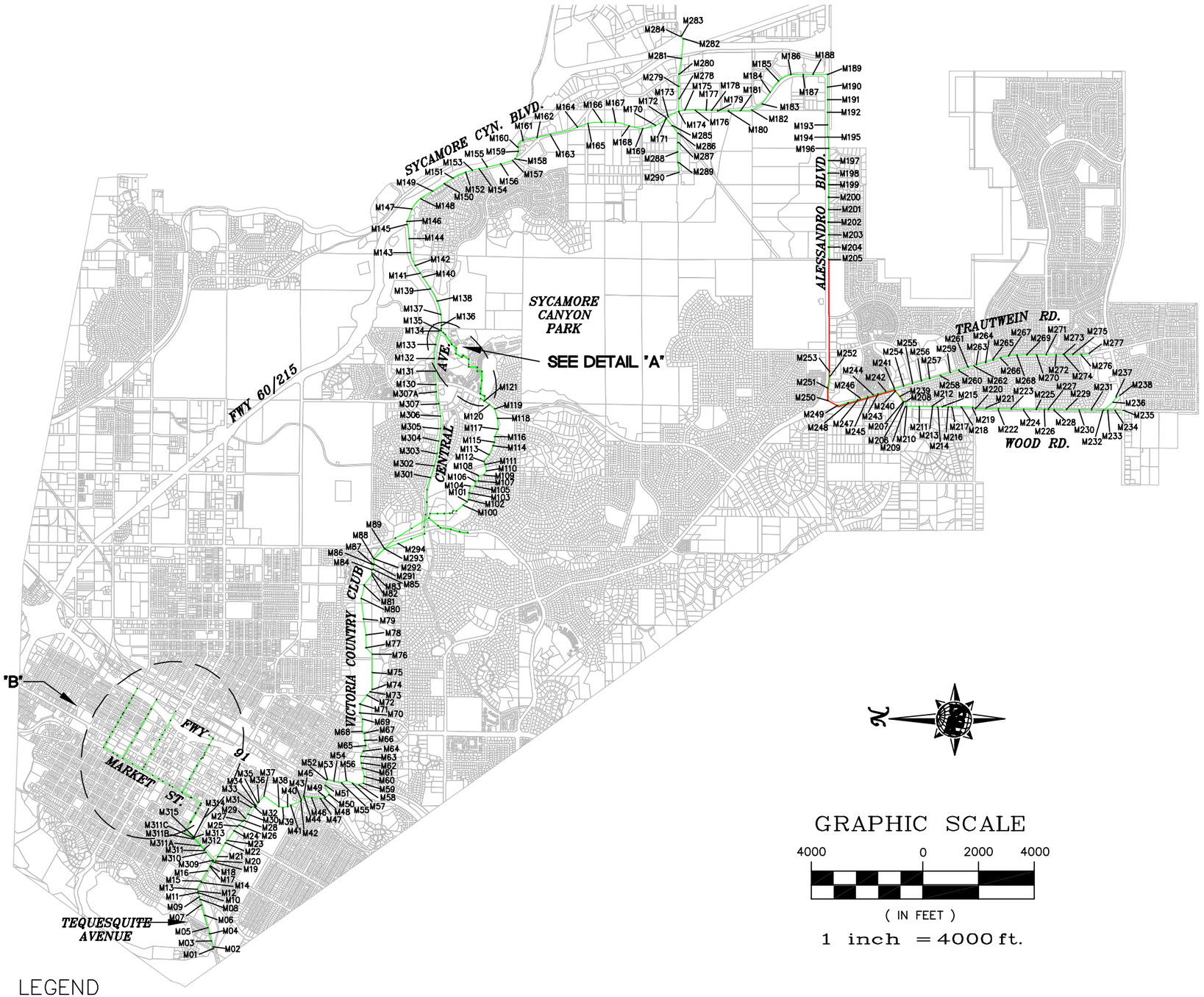

GRAPHIC SCALE
4000 0 2000 4000
(IN FEET)
1 inch = 4000 ft.

LEGEND

	FORCE MAIN
	GRAVITY SEWER
M01	MANHOLE NUMBER

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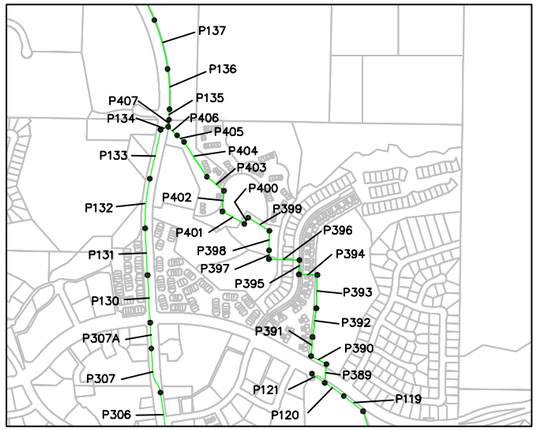
FIGURE 6

EXISTING MANHOLES



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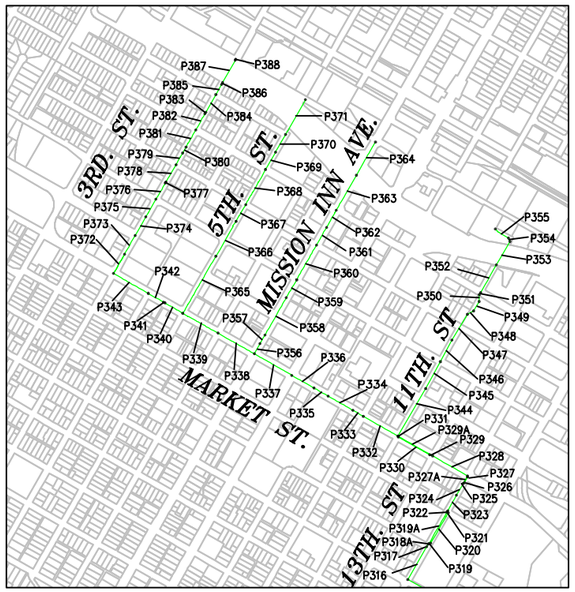

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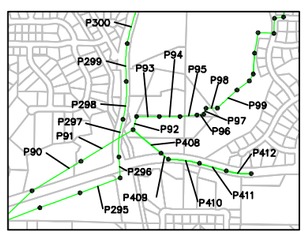
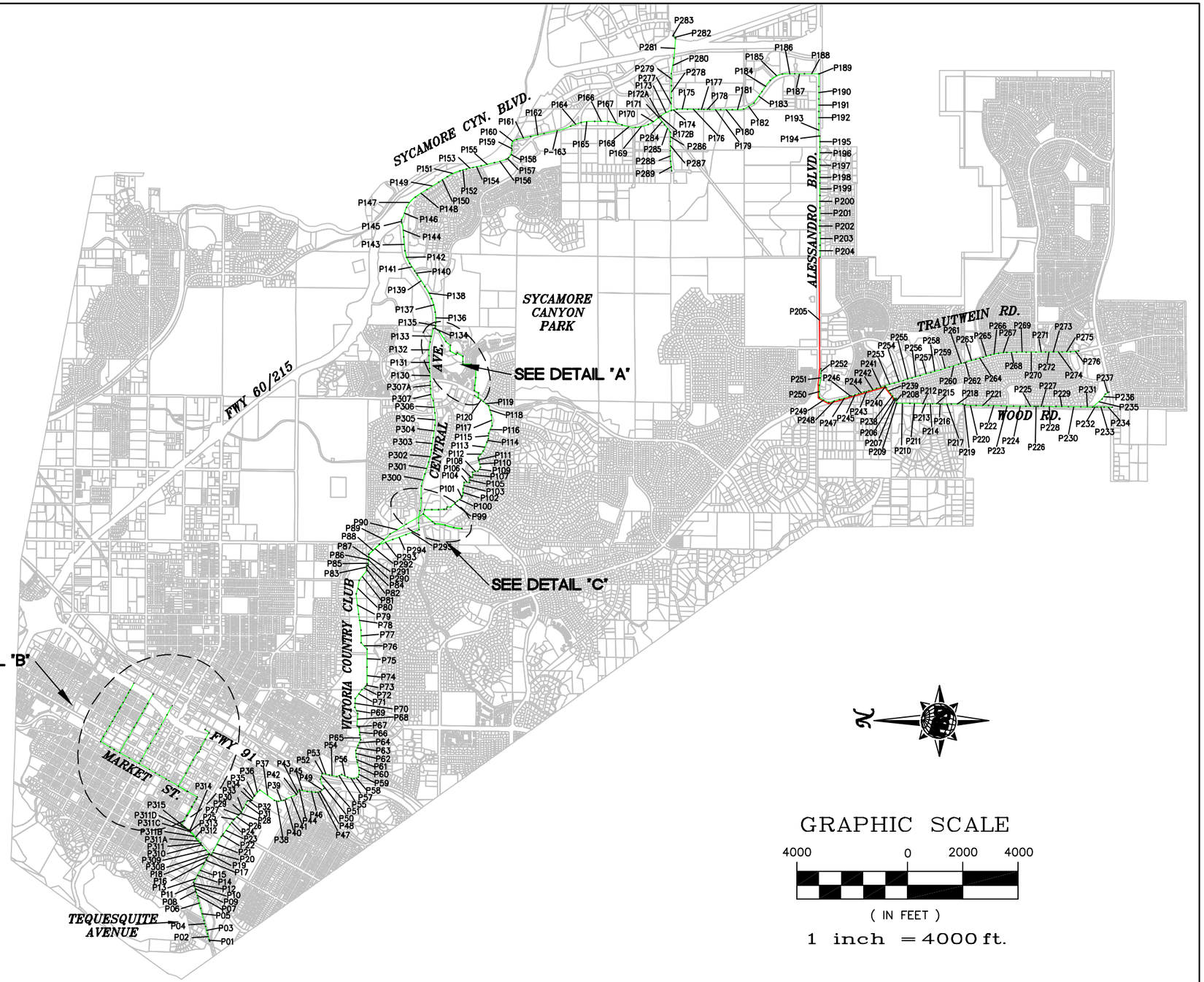


DETAIL "C"

NOT TO SCALE



LEGEND

	FORCE MAIN
	GRAVITY SEWER
P01	PIPE NUMBER

N

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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FIGURE 7

EXISTING PIPES

southeasterly direction at M241. Thereafter, the flow is in westerly direction to the lift station at M206.

The second 12-inch trunk sewer line in Trautwein Road begins at M253 at Alessandro Boulevard and continues west till the intersection of Trautwein Road and Alessandro Boulevard (M250). Then a 12-inch line continues in southeasterly direction till M241, which is the confluence point of these two study sewers in Trautwein Road. From M241, an 18-inch sewer line continues in westerly direction to M206, which is a lift station.

- *Alessandro Boulevard Study Area Sewer Line*: The 18-inch gravity sewer lines along Alessandro Boulevard begins at M205 at Barton Street and continues in easterly direction towards the intersection of Alessandro Boulevard and Sycamore Canyon Boulevard. The sewage flow from 16-inch force main line along Alessandro Boulevard discharges into M205 and thereafter it flows by gravity in easterly direction. The sewer line along Alessandro Boulevard is generally in the southern portion of the street except after M195 where it turns north and continues in northern portion of street. It meets the trunk sewer line at M189.

- *Sycamore Canyon Boulevard Study Area Sewer Line*: This portion of sewer line begins at M189, continues in northerly direction and generally follows the alignment of Sycamore Canyon Boulevard. A 24-inch sewer line begins at M189 and continues till M182 where it turns into a 30-inch sewer line. This 30-inch sewer line continues to M174 at the intersection of Sycamore Canyon Boulevard and Eastridge Avenue. A 42-inch sewer line beginning at M174 continues in northwesterly direction. It splits into two 20-inch CIP sewer lines at M173. In between M173 and M172 reach California Aqueduct crosses over the sewer line. Two 20-inch CIP lines join at M172 and a 42-inch sewer line continues northeast of this manhole location till M157, northwest of Fair Isle Drive and Sycamore Canyon Boulevard intersection. The whole reach of 42-inch sewer line passes through flat terrain, so the pipe slopes in this reach are at a minimum possible value. The pipeline between M162 and M158 is not within the street right of way; it passes through a sewer easement between Sycamore Canyon Boulevard and Freeway 60/215. Beginning M157, a 27-inch sewer line continues along Sycamore Canyon Boulevard down to M151. Beyond M151, a 21-inch sewer line continues up to M146 at the intersection of Sycamore Canyon Boulevard and Central Avenue.

- *Eastridge Avenue Study area Sewer Lines:* There are two segments of contributory sewer lines to the main trunk sewer line along Sycamore Canyon Boulevard; one coming from the east and another from the west. The east segment of the sewer line along Eastridge Avenue begins at M284, east of Freeway 215. A 15-inch line continues westerly, crosses the freeway and joins the trunk sewer line at M174. This sewer line picks up flow from the Edgemont/Canyon Springs area. The west segment of sewer line begins at M290; a 10-inch sewer line continues east till M288 where the line size changes into a 12-inch sewer. Thereafter, a 12-inch sewer line continues in an easterly/northeasterly direction parallel to the California Aqueduct to M171 of the trunk sewer line along Sycamore Canyon Boulevard. The western segment of Eastridge Avenue sewer line picks up wastewater flow from industrial/light commercial area west of Freeway 215, which includes Pepsi Bottling Plant and Ralphs Grocery Company.

- *Central Avenue Study Area Sewer Line:* The trunk sewer line along Central Avenue begins at M145 at the intersection of Central Avenue and Sycamore Canyon Boulevard. The sewer line along Central Avenue is at a relatively steep slope and has been laid at minimum cover following finished surface profile of the street. A 21-inch sewer line begins at M145 and continues westerly to M139 where the size increases 24-inches. After M138 the size changes to 21-inches and continues to M134. The sewer size remains 24-inches in the reach between M139 and M297. The trunk sewer line in Central Avenue picks up wastewater flow from part of Canyon Crest area, multi family residential and commercial areas near Canyon Crest and Central Avenue intersection.

- *Canyon Crest Country Club Study Area Sewer Line:* This sewer line begins at Central Avenue, east of Canyon Crest Drive at M408. A 12-inch line continues through the apartment complex building, crosses Via La Paloma and joins the trunk line at M120. The size of the sewer line changes from 12-inch to 18-inch in the reach M408 to M390. After M120, the sewer line continues along Canyon Crest Drive up to M118 and then it generally traverses through Canyon Crest Country Club. The size of the

sewer line ranges from 24-inch to 27-inch in the reach from M120 to M96. After M96 the sewer line continues in northwesterly direction, crosses Central Avenue and joins Central Avenue trunk sewer line at M86. This trunk sewer line picks up wastewater flow from Canyon Crest area.

- *Chicago Avenue Study Area Sewer Line:* This study trunk sewer line along Chicago Avenue begins at M413 near the intersection of Country Club Drive and Chicago Avenue. These sewer lines are laid at relatively steeper slopes. An 8-inch sewer line begins at M413 and continues in northerly direction to M410 where the size changes to10-inch and continues to M92. This sewer line picks up wastewater flow from single family residential areas on the east and west sides of Alessandro Boulevard and south of Chicago Avenue.

- *Victoria Country Club Study Area Sewer Line:* The trunk sewer line in Victoria Country Club passes through a sewer easement and generally, is parallel to Tequesquite Canyon passing through Victoria Golf Course. An 18-inch sewer line begins at M86 and continues westerly to M81. Beyond M81 a 21-inch line continues in westerly direction to M60. It turns into a northerly direction after M59 and a 24-inch line continues north to M56. North of M56, a 27-inch line continues to M52 where it turns west. A 24-inch sewer line continues to the east side of Hwy 91 at M51. Beyond M51, an 18-inch CIP sewer line continues in westerly direction under Hwy 91 to M50. The sewage flow at this location is under siphon action. This trunk sewer line generally picks up wastewater flow from Victoria area.

- *Riverside Community College (R.C.C.) Study Area Sewer Line:* A 24-inch study sewer line begins at M50 west of Hwy 91 and continues along Brooks Street to the intersection of Olivewood Avenue and City College Drive. Thereafter, it traverses within the boundary of RCC generally parallel to Saunders Street. The size of the sewer line within the RCC campus is 27-inch. The wastewater flow is in northwesterly direction. Pipe P48 (M49 to M48) has a steep slope to avoid excessive earthwork in that reach. This trunk sewer line continues westerly till M26. This trunk sewer line picks up flow from RCC and adjoining residential and commercial areas.

- *Downtown Area Sewer Line:* The study sewer lines in downtown area include trunk and tributary sewer lines along Brockton Avenue, 13th street, Market Street, 11th Street, Mission Inn Avenue, 5th Street and 3rd Street. The sewer sizes range from 8-inch to 21-inch. In general, the wastewater flow is in the southwesterly direction except for the tributary sewer lines in 3rd Street, 5th Street, Mission Inn Avenue and 11th Street, which flow, in northwesterly direction.

    - The study sewer line along 3rd Street begins at M389 just east of Hwy 91. The size of sewer line is 8-inch and the flow is in northwesterly direction. The sewer line joins trunk sewer line along Market Street at M344. This sewer line picks up wastewater flow from commercial and multi-family residential areas along 3rd Street.

    - The Fifth Street sewer line begins at M372 east of Hwy 91. An 8-inch size sewer line continues in northwesterly direction to the M340 at the intersection of 5th Street and Market Street. This contributory sewer line picks up flow from commercial/high density residential areas along 5th Street.

    - The study sewer line along Mission Inn Avenue begins at M365 at Vine Street, east of Hwy 91 and continues northwestwards towards Market Street. The size of sewer line is 8-inch and the direction of flow is in northwesterly direction. This contributory sewer line picks up wastewater flow from generally commercial areas in the vicinity of Mission Inn Avenue.

    - The 11th Street study sewer line begins at M356 east of Hwy 91 near Vine Street. It crosses Hwy 91 and continues in northwesterly direction to M332 at the intersection of 11th Street and Market Street. The size of the sewer line is 15-inch in between M356 and M350, 18-inch in between M350 and M348 and 15-inch in between M348 and M332. This sewer line picks up sewage flow from commercial area along 11th Street in downtown, and residential area east of Hwy 91, up to Chicago Avenue.

    - The trunk sewer line along Market Street begins at M344 at the intersection of 3rd and Market Street. It continues in southwesterly direction till M339. From M339 a 12-inch sewer line continues along Market Street till M330 where a split flow situation occurs. A 15-inch VCP line branches off at M330 to re-join the

trunk sewer line at M329. A 12-inch line continues till M328 at the intersection of Market Street and 13th Street.

- 13th Street trunk line begins at M328 and continues in northwesterly direction. This sewer line has two split flow situations. A 12-inch line begins at M328 and continues to M325. Another 10-inch line, which begins at M328, converts into a 15-inch sewer line after M327 and re-joins 12-inch at M325. From M325, a 12-inch line continues in northwesterly direction till M323. A 10-inch sewer line branches off at M323 to re-join at M319. A 21-inch line continues after M317 to M316 at the intersection of 13th Street and Brockton Avenue.

- Brockton Avenue study sewer lines begin at M316 and continue in southwesterly direction to M315. At M315, there is a split flow situation. A 15-inch line begins at this manhole and continues till M311. Another 10-inch line branches off and joins the main line at M311. Beyond M311 a 15-inch line continues to the trunk sewer line at M19 at the intersection of Tequesquite Avenue and Brockton Avenue.

- *Tequesquite Avenue Study Area Sewer Line:* The Tequesquite Avenue sewer lines begin at M26, west of Magnolia Avenue. A 27-inch sewer line continues southwest of Riverside Community Hospital Campus along a sewer easement to M21. Beyond M21 a 24-inch line continues to M20 where it splits into two 15-inch pipes. The reach between M20 and M19 has siphon action. Two 15-inch sewer lines branch off at M20 and rejoin at MH-19. Thereafter a 24-inch sewer line continues westwards to M18. The sewer lines between M18 and M15 are 21-inches in size and flow in northwesterly direction. In the reach between M12 M10, the flow is in southwesterly direction and the size of pipe is 30-inches. Beyond M10 the size of pipe is 27-inch and the flow is in southwesterly direction to M1. The trunk sewer line in Tequesquite Avenue picks up wastewater flow from the areas southeast of Mount Rubidoux Park and commercial and residential areas around Riverside Community Hospital.

3.4 Tributary Areas

The study area was divided into 31 sub-areas; each area having its distinct land use pattern. These sub-areas are tributary to a particular meter location either individually or collectively. Because of their strategic locations, meters upstream to a cumulative meter can be subtracted out to deduct cumulative effect. See Figure-8 for details of tributary sub-areas. Following is the listing of tributary sub-areas and their contribution to a particular meter location.

1. Sub-areas A-14, A-12, A-11, A-10, A-9, A-8 are tributary to meter No. 1, located in Alessandro Boulevard, east of Barton Street.
2. All the sub-areas mentioned above and sub-areas A-7, A-13, A-6-1, A-6-3, A-6-4, A-6-5, A-5-1 and A-5-2 are tributary to meter No. 2 located in Central Avenue.
3. All the sub-areas as mentioned in (1) and (2) and sub-areas A-4-1, A-4-2, A-4-3 are tributary to meter No. 3 located in Victoria Country Club area.
4. Sub-areas No. A-2-1, A-2-2, A-2-3, A-2-4, A-2-5, A-2-6 and A-2-7 are tributary to meter No. 4, located in Brockton Avenue.
5. All the sub-areas as mentioned in (1) to (4) and sub-areas A-1-1, A-1-2, A-2-8 and A-3 are tributary to meter No. 5, located in Tequesquite Avenue. This meter picks up almost entire flow from the study area.

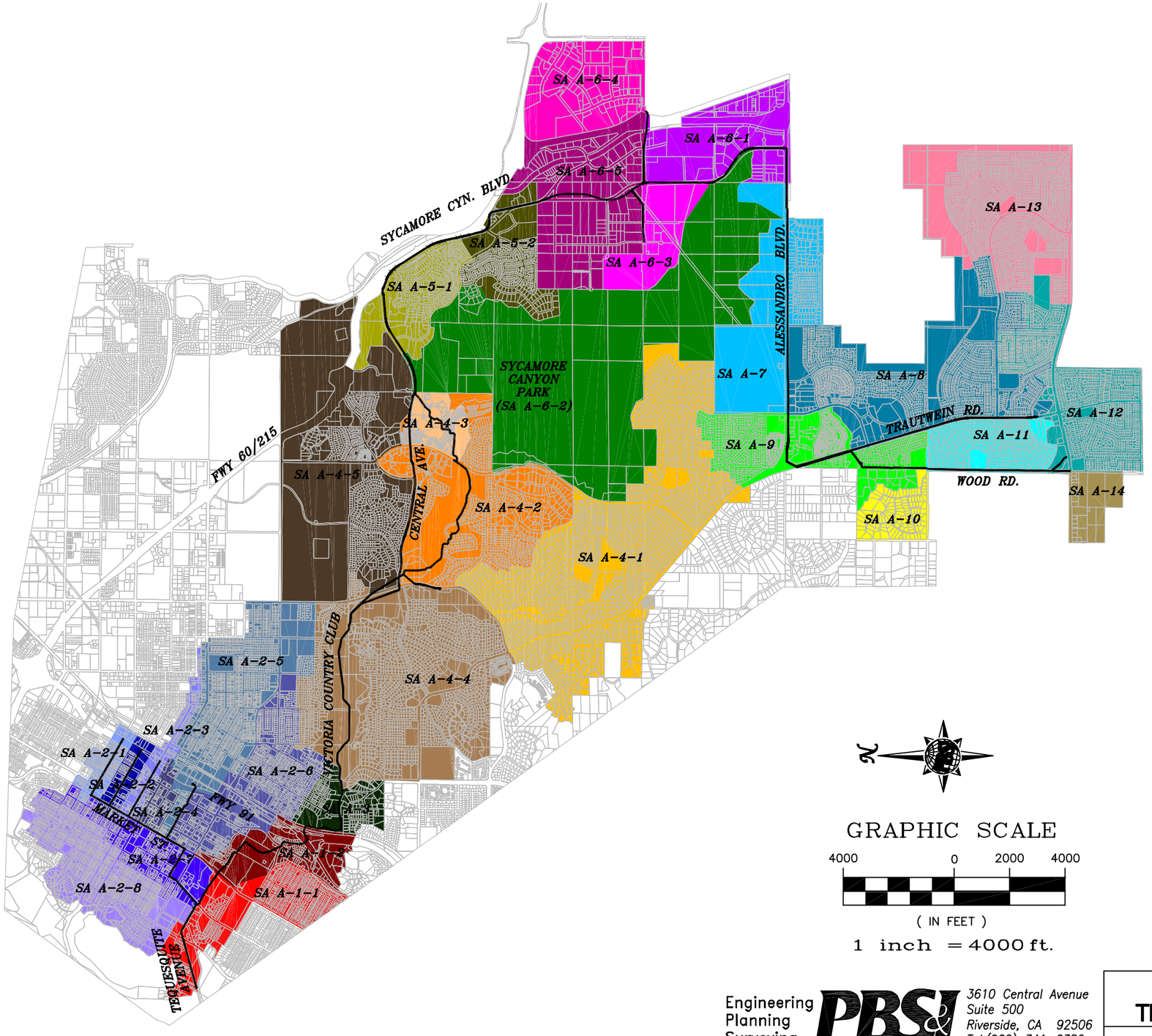
Within each sub-area there is generally a distinct mixture of land uses, which generates a unique quantity and diurnal pattern of wastewater flows. For identification of land use patterns, data provided by the City of Riverside in GIS Arcview format was used. The following table summarizes land uses within a particular sub-area.

Table 3-2

Developed Tributary Areas and Current Wastewater Generating Land Use

Sub Area	SFR (Acres)	MFR (Acres)	Commercial (Acres)	Industrial (Acres)	School (Acres)	Total (Acres)
A-1-1	261	40	-	1	-	302
A-1-2	-	-	31	-	98	129
A-2-1	-	39	10	-	-	49
A-2-2	20	-	37	-	-	57
A-2-3	44	2	33	-	-	79
A-2-4		-	27	-	-	27
A-2-5	418	23	53	-	-	494
A-2-6	248	5	53	43	-	349
A-2-7	145	42	-	-	-	187
A-2-8	319	-	44	-	-	363
A-3	96	-	11	-	-	107
A-4-1	1205	11	-	-	-	1216
A-4-2	225	2	-	-	3	230
A-4-3	61	32	-	-	-	93
A-4-4	845	-	68	-	-	913
A-4-5	221	6	23			250
A-5-1	111	-	-	-	-	111
A-5-2	292	29	14	-	-	335
A-6-1	-	-	44	-	-	44
A-6-3	-	-	110	-	-	110
A-6-4	-	-	70	-	-	70
A-6-5	-	-	94	-	-	94
A-7	146	-	3	1	-	150
A-8	363	-	-	5	-	368
A-9	269	10	36	-	-	315
A-10	119	-	-	-	-	119
A-11	169	-	-	-	-	169
A-12	393	-	2	-	17	412
A-13	490	-	20	-	-	510
A-14	-	-	3	4	-	7

SFR – Single Family Residential
MFR – Multi Family Residential
The areas do not include undeveloped and reserved areas. Sub Area A-6-2 is a Reserved Area (Sycamore Canyon Park).



LEGEND

- SUB AREA A-1-1
- SUB AREA A-1-2
- SUB AREA A-2-1
- SUB AREA A-2-2
- SUB AREA A-2-3
- SUB AREA A-2-4
- SUB AREA A-2-5
- SUB AREA A-2-6
- SUB AREA A-2-7
- SUB AREA A-2-8
- SUB AREA A-3
- SUB AREA A-4-1
- SUB AREA A-4-2
- SUB AREA A-4-3
- SUB AREA A-4-4
- SUB AREA A-4-5
- SUB AREA A-5-1
- SUB AREA A-5-2
- SUB AREA A-6-1
- SUB AREA A-6-3
- SUB AREA A-6-4
- SUB AREA A-6-5
- SUB AREA A-7
- SUB AREA A-8
- SUB AREA A-9
- SUB AREA A-10
- SUB AREA A-11
- SUB AREA A-12
- SUB AREA A-13
- SUB AREA A-14
- SYCAMORE CANYON PARK (SUB AREA A-6-2)
- STUDY SEWER

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

Engineering
Planning
Surveying
Construction Services

PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE TEQUESQUITE SEWER STUDY

FIGURE 8

TRIBUTARY AREAS

4.0 DETERMINATION OF SEWER FLOWS

4.1 Flow Monitoring

Flow Monitoring was conducted at five (5) sites in order to accomplish the following: (See Figures 4 for locations of Flow Monitoring Stations).

- Establish current flow levels.
- Verify or adjust flow coefficients.
- Establish characteristic flow patterns (Diurnal Curves) for the model (See Figures 13-16).
- Confirm peak to average flow relationships.
- Help prioritize recommend improvements.

Meter locations were chosen to observe actual flow characteristics for the various sub-areas and to provide a continuous record of measured flows over a period of time (two weeks for this study). Meter locations were also chosen in such a manner that current flow quantities along the Tequesquite Avenue Trunk Sewer could be quantitatively determined. Following is an amplification of the logic for placement of each flow meter.

- Meter No. 1; location on Alessandro Boulevard east of Barton Street – This location was chosen because it carries all the flow generated from Orangecrest area which is primarily a residential area. Also, the flow being pumped through the force main line from the sewage lift station at Wood Road can be measured at this location.

- Meter No. 2; location on Central Avenue west of Lochmoor Avenue – This location was chosen to observe flow generated from the area north and south of Alessandro Avenue and west of Freeway 215. The City of Riverside has flow data for Pepsi and Ralph commercial units and Edgemont community. This data, along with data from meter No. 1 and 2 can be manipulated to assess flow coming to the system at strategic locations.

- Meter No. 3; location Victoria Country Club west of Chicago Avenue – This location was chosen to measure the flow from the area generally bounded by Chicago Avenue on west, Martin Luther King Boulevard on north, Freeway 60/215 on east and Van Buren Boulevard on south. The land use within this area is mixture of residential and commercial. A typical

diurnal pattern for this mixed-use land pattern would be derived from the flow monitoring data at this meter location.

- Meter No. 4; location Brockton Avenue north of Tequesquite Avenue – This location was chosen to measure the flow generated from the downtown area of the City of Riverside. The area covers a multiple land use patterns comprising residential (medium to high density), commercial, and office buildings. The maintenance and operation staff of the City indicated that some flow-surcharging problem is being experienced in the Market Street sewer line north of 13th Street. The flow data from meter location No. 4 would be evaluated for possible cause of flow problems in the Market Street sewer line.

- Meter No. 5; location Tequesquite Avenue west of Brockton Avenue - This location was chosen because the trunk sewer line at this location carries almost the entire flow generated from the study area.

4.2 Results of Flow Monitoring

Measurement of sewer flows is an imprecise science, as the in-line equipment is placed in a harsh environment and is subject to solids interference, calibration, turbulence and other problems, which can impede the accuracy. Installed equipment must be frequently inspected and maintained, and monitoring results interpreted, evaluated for reasonableness, and sometimes adjusted. In this particular application, metered flow information was generally quite good. However, some flows at specific meter locations did not display consistent values. Graphical results at each site were carefully reviewed for consistency and reasonableness, using the following general guidelines.

- Where the magnitude or daily pattern varies significantly from one non-holiday weekday to the next, the data is likely to be flawed.
- Where the base (low) flows are rising during the flow monitoring period, the data is suspect.
- Where the algebraic sum of flows from meters in series are significantly out of sync, the data from one or more meters may be faulty.
- Where minimum (nighttime) flows are abnormally high or algebraically inconsistent, the data is suspect.
- Where the measured depth data and velocity data are inconsistent the data is suspect.

Metered flows displaying one or more of the above flaws were purged or abandoned adjusted based on reasonable assumptions.

At each meter location the flow-monitoring device measures depth of flow and velocity. Upon reviewing the report submitted by Downstream Services, and from discussions with their staff, it was determined that the depth-of-flow reading was more reliable than the velocity data. By using depth of flow readings and inputting pipe characteristics from record drawings (slope, size and roughness "n" values), sewage flow can be calculated using Manning's equation. These values more closely resemble theoretically sewage flows calculated using land use information and flow coefficients. The flow data for meter No. 2 is inconsistent so it was not used for estimation of wastewater flow. Flow data have been included in the Appendix A.

The flow monitoring hydrographs at each meter site, adjusted based on the depth measurement, are shown in Figures 9A through 12. The following relevant observations were made from evaluation of the measured flows:

- Flows from the Orangecrest / Alessandro study area are atypical because of the major lift station in the system. Meter No. 1 shows an inconsistent flow pattern due to pumping action at the lift station.

- Weekend hydrographs show generally smaller flows and lesser peaks than weekday patterns, for the Downtown area, usually due to closure of offices during the weekends.

- Diurnal flow patterns reveal a consistent high flow during night - time hours due to mixed land use pattern in the study area. This can be explained by the general nocturnal habits of people living in high-density residential areas. The people working in these areas usually work in multiple shifts and use the wastewater facilities in inconsistent ways.

- Observed flows at meter No. 5 show slightly higher values than the land use. This may be attributed to higher occupancy of people than the census data predicts. This happens in the high-density areas where census data is typically flawed.

Figure 9A

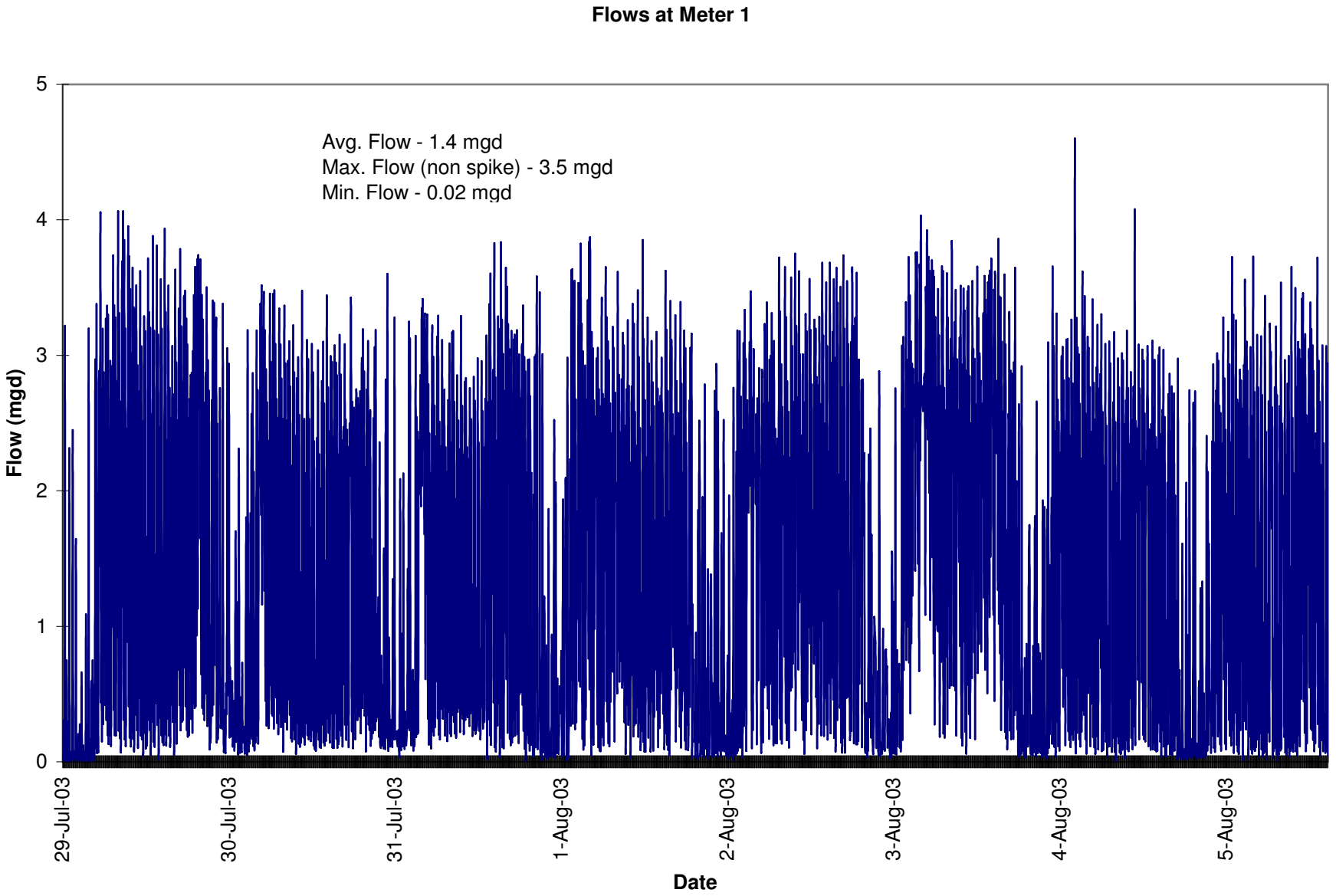

Flows at Meter 1
Avg. Flow - 1.4 mgd
Max. Flow (non spike) - 3.5 mgd
Min. Flow - 0.02 mgd
Flow (mgd)
0
1
2
3
4
5
29-Jul-03
30-Jul-03
31-Jul-03
1-Aug-03
2-Aug-03
3-Aug-03
4-Aug-03
5-Aug-03
Date

Figure 9B

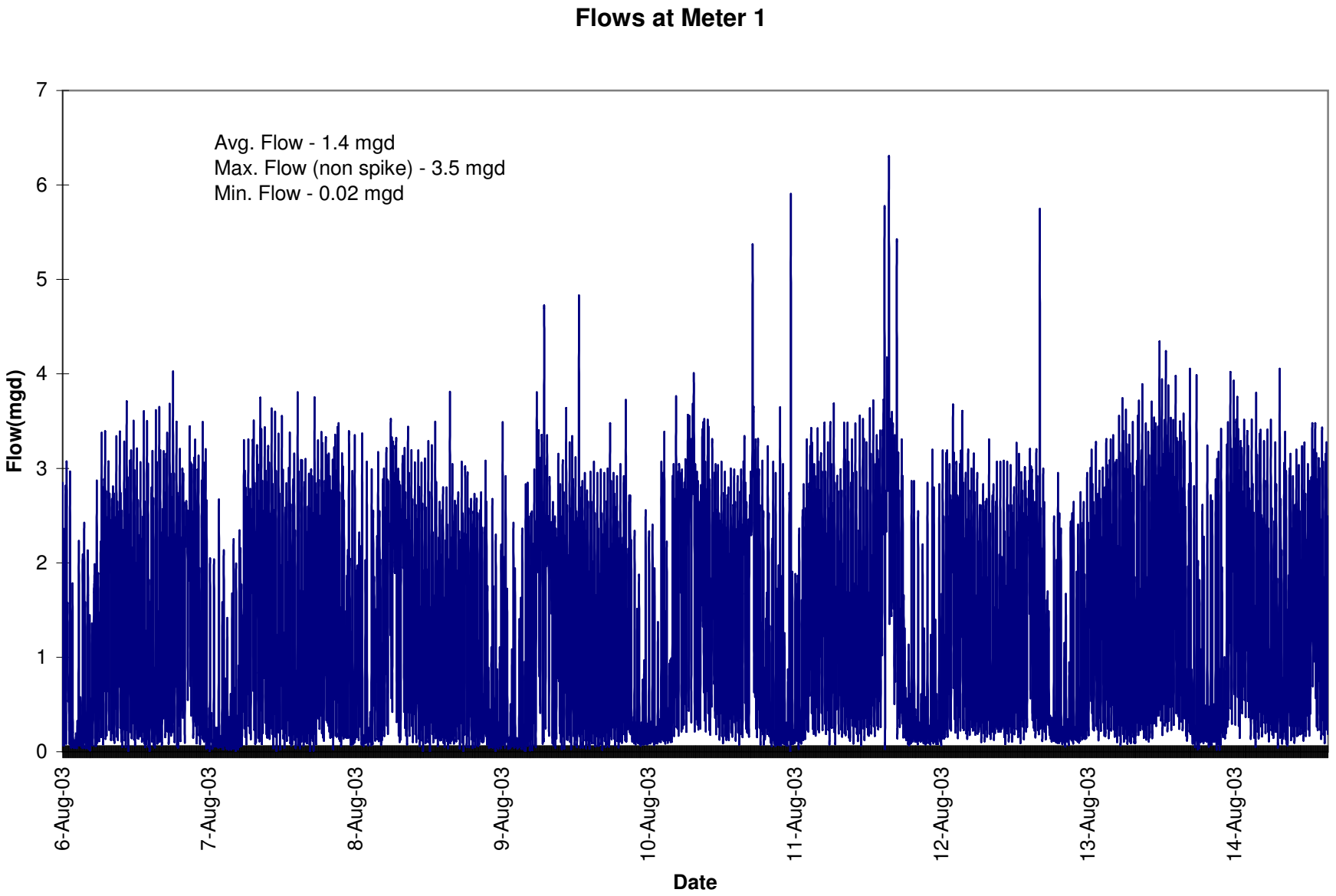

Flows at Meter 1
Avg. Flow - 1.4 mgd
Max. Flow (non spike) - 3.5 mgd
Min. Flow - 0.02 mgd
Flow(mgd)
0
1
2
3
4
5
6
7
6-Aug-03
7-Aug-03
8-Aug-03
9-Aug-03
10-Aug-03
11-Aug-03
12-Aug-03
13-Aug-03
14-Aug-03
Date

Figure 10

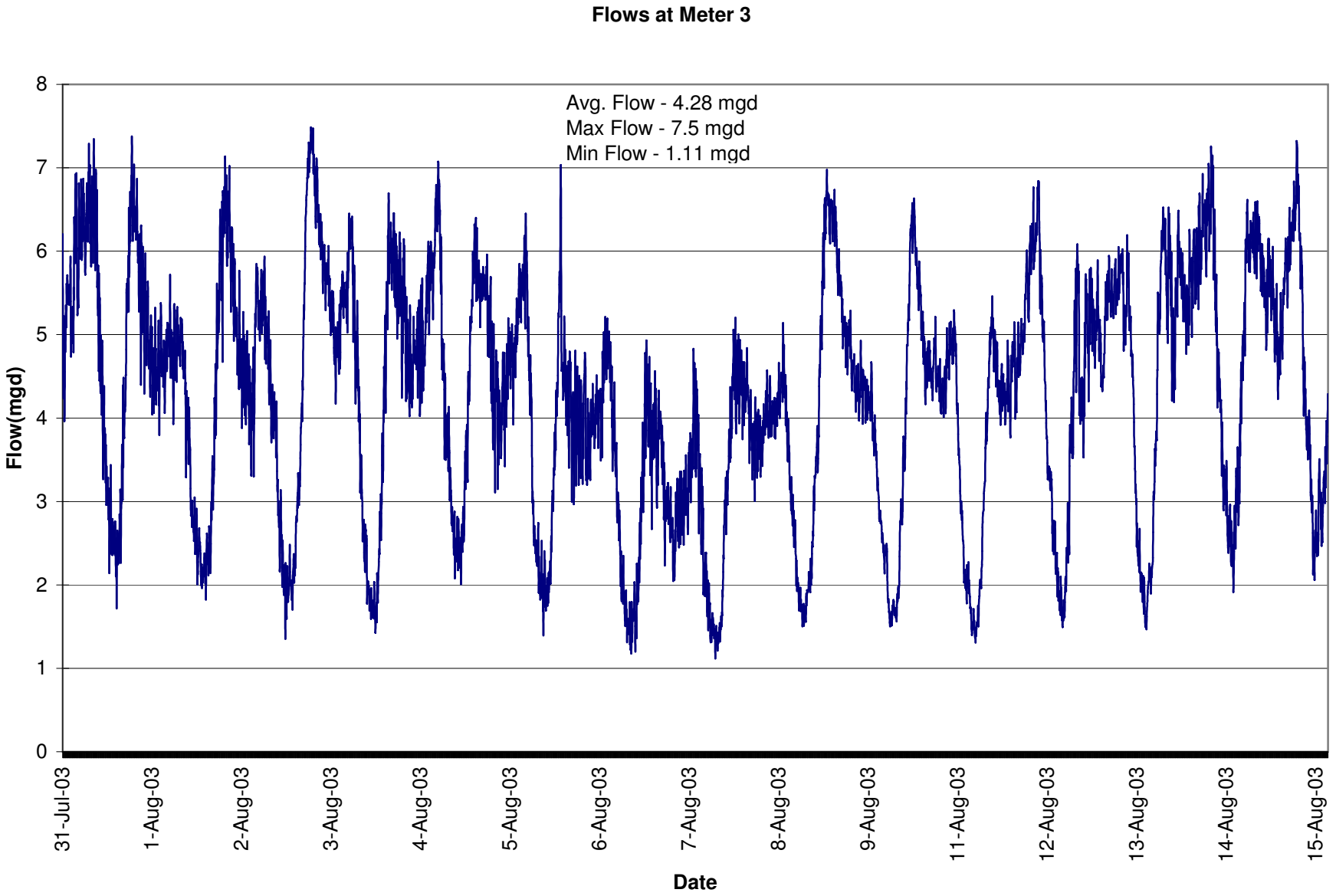

Flows at Meter 3
Avg. Flow - 4.28 mgd
Max Flow - 7.5 mgd
Min Flow - 1.11 mgd
Flow(mgd)
0
1
2
3
4
5
6
7
8
31-Jul-03
1-Aug-03
2-Aug-03
3-Aug-03
4-Aug-03
5-Aug-03
6-Aug-03
7-Aug-03
8-Aug-03
9-Aug-03
11-Aug-03
12-Aug-03
13-Aug-03
14-Aug-03
15-Aug-03
Date

Figure 11

Flows at Meter No. 4

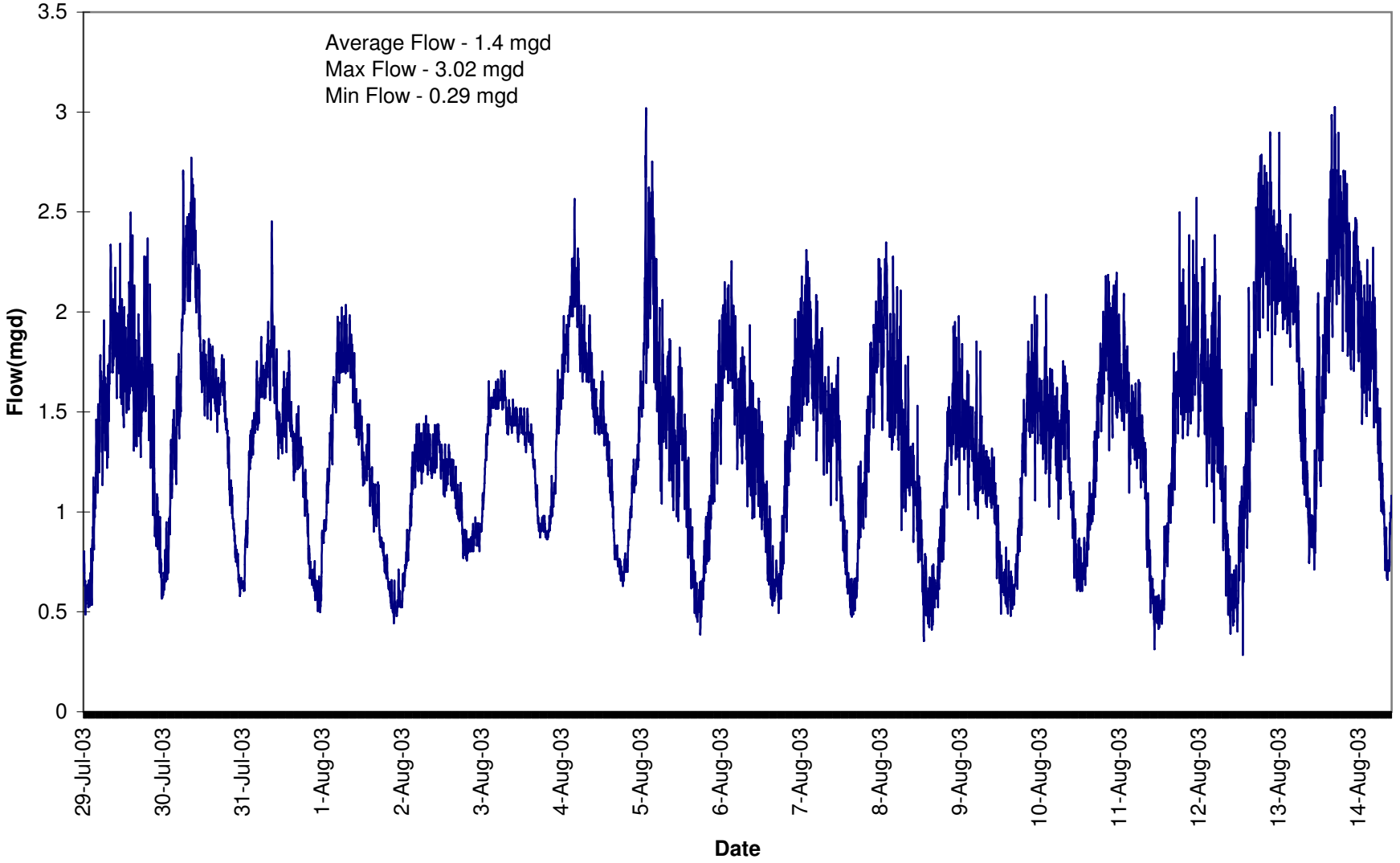
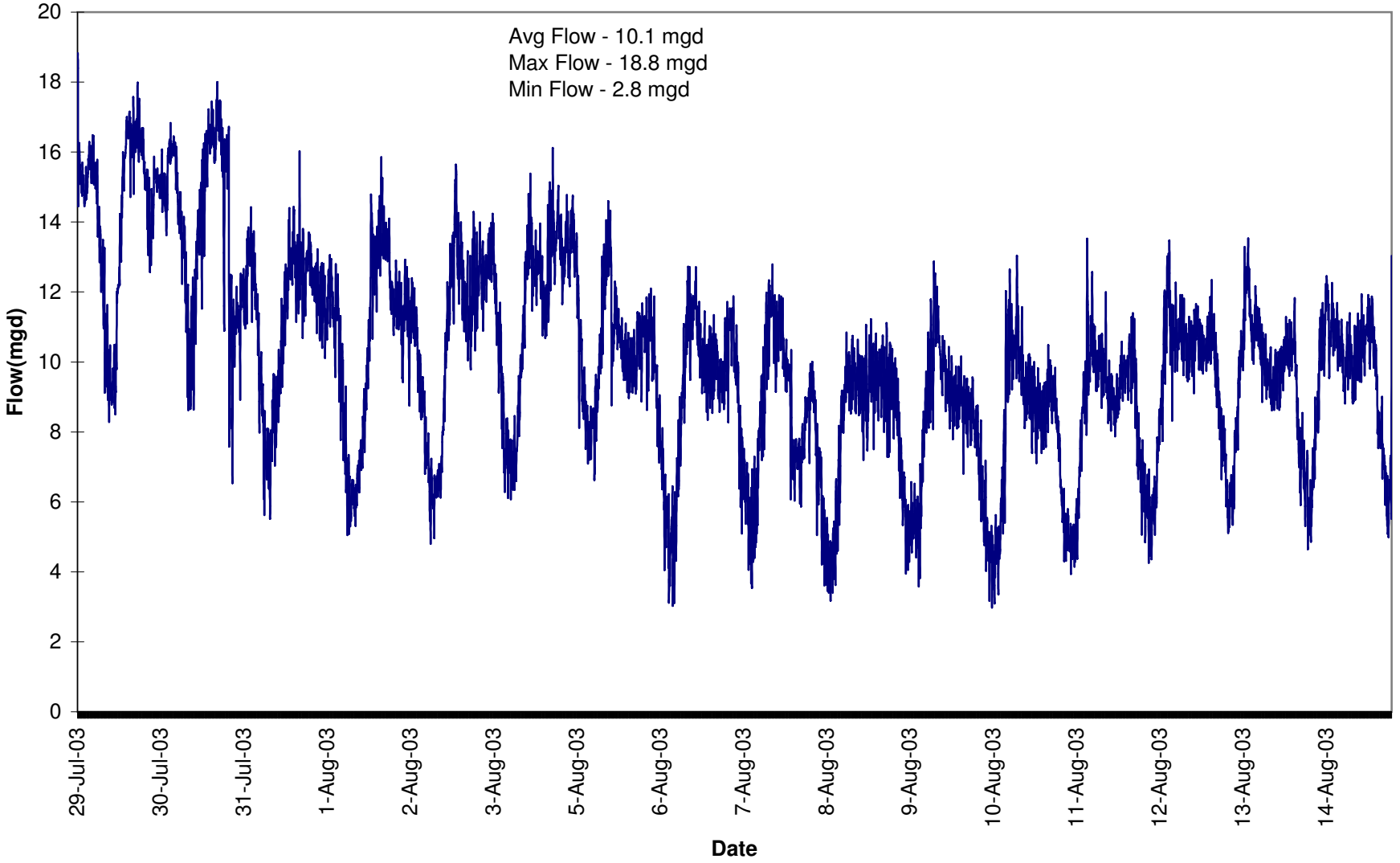


Figure 12

Flows at Meter 5



5.0 ESTIMATED ULTIMATE FLOW

5.1 Methodology

Future wastewater flows in the study area are estimated by applying unit (per acre or per capita) flow factors to the projected "ultimate" land use acreage or population in each sub area. As discussed in Section 2, ultimate land uses within the study area are estimated based on the City's current General Plan (which governs future development/redevelopment). The major contributor of the wastewater flow in the future would be undeveloped industrial business park area in the eastern portion of study areas. For purpose of this study it has been assumed that this area would most likely be developed by the year 2015. Future wastewater flows are estimated using land used base coefficients for the City.

5.2 Flow Coefficients

A review of commonly used flow coefficients (or unit factors) was performed to arrive at preliminary criteria, which would be an appropriate starting point for the study area.

Flow coefficients are commonly expressed in terms of cubic feet per second (cfs) of average dry weather flow (ADWF) per acre of a specific land use type. For population based estimates, flows are expressed in gallons per capita per day (gpcd). Peak flow generation rates estimated by applying peaking factors to the average flow, (with factors often based on observed peak-to-average ratios from previous studies) are of little value in simulating flows within the collection system, since peaks for various uses are not simultaneous, but rather staggered throughout the day. Also, peaks are blended and attenuated by lag times and in-pipe storage as the flows move downstream. Notwithstanding the above, diurnal peaking factors are also estimated for each land use type to estimate peak generation rates.

For preliminary estimation of wastewater flow, the document "Criteria for Sewer Facility Design, Public Works Department, City of Riverside" was used, a copy can be found in Appendix "B". The following is a general guideline for estimation of theoretical wastewater flows within the study area:

Flows from Land Use Categories:

Residential sewage flows are determined by using the following sources of information and criteria:

- Land use shown in the City's General Plan.
- No. of dwelling units per acre within a certain land use.
- Persons per living unit determined from the latest census data for the study area. However, it should not be less than an average of 2.75 persons per living unit.
- Average wastewater flow based on 65 gallons per capita per day.
- Peak to average flows to be determined from the graphs.

Peak flows from non-residential developments shall be determined using the following criteria:

- Industrial Developments – 0.012 cfs/acre
- Commercial Developments – 0.010 cfs/acre
- Offices – 30 gallons per capita (employee on site) per day
- Schools – 30 gallons per capita per day
- Laundromat – 580 gallons per machine per day.
- For Multi Family Residential a flow co-efficient of 0.014 cfs/acre has been assumed (The City of Anaheim uses a coefficient of 0.014 cfs per acre).
- For Industrial Business Parks a coefficient of 0.010 cfs/acre (same as commercial developments) has been used.

The City of Riverside Criteria for Sewer Facility Design is attached as Appendix "B".

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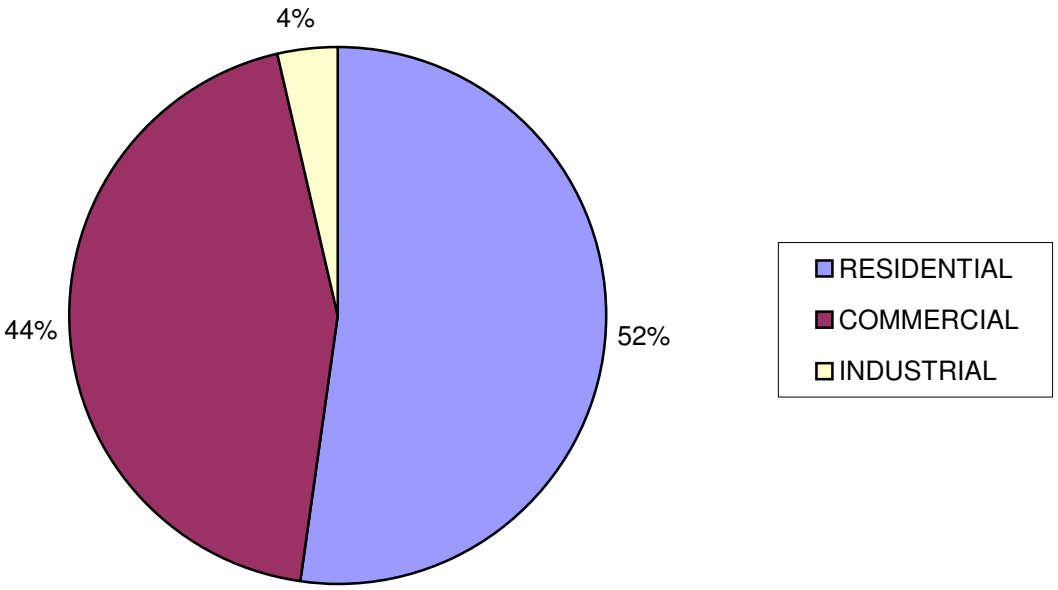
5.3 Representative Diurnal Hydrographs

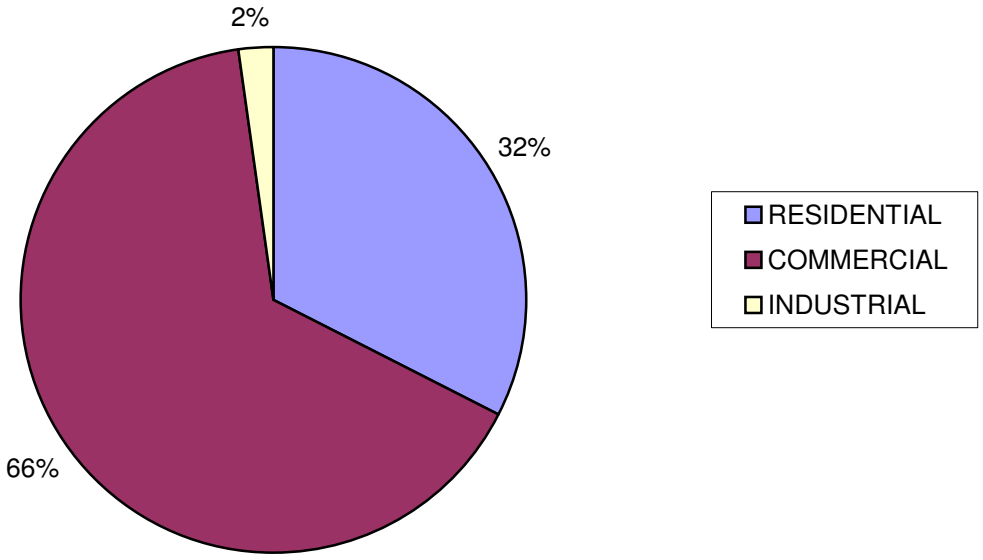
The study area is comprised of a variety of unique land uses. For the purpose of defining characteristic diurnal patterns, flow from each sub-basin was analyzed and percentage of flow contribution from each land use type was estimated. Tables 5-1 summarizes flows from different land use categories contributing to each meter location for current and future conditions, respectively. Table 5-2 and 5-3 summarize theoretical wastewater percentage flow contributions to each meter locations. Figure 13 shows percentage of flow contribution from different land categories at meter location 5. Although none of the tributary sub areas flowing to the meter locations are comprised of a single land use category, several are dominated by one or two categories, and are thus selected as being representative to the diurnal flow patterns for those land uses. In addition Spruce Street Sewer Capacity Study (June 2002) was used to determine flow pattern for Single Family Residential (SFR) units. Based on this table, the following diurnal patterns were used for the modeled peak flow evaluation.

Figure 13
Existing and Future Flow Contributions from Various Land Uses
Meter Location 5

Existing (2003) Contributing Flows at Meter Location 5



Future (2018) Contributing Flows at Meter Location 5



- Flow at meter location 1: Lift station pattern (SFR)
- Flow at meter location 3: Mixed used Commercial/Residential.
- Flow at meter location 4: Downtown.
- Flow at meter location 5: Mixed-use pattern.
- Flow at meter location 8 : SFR (From Spruce Study)

These representative diurnal hydrographs are shown in Figures 14-17. The flow patterns are used in the model to estimate for each land use type; the percentage of Average Dry Weather Flow (ADWF) contributed at specific times throughout the day.

Figure 13 graphically depicts the existing and future conditions and illustrates the increasing influence of proposed industrial business park development near Fwy 215.

Table 5-1
Summary of Theoretical Flow

METER	CONTRIBUTORY AREA	LANDUSE FLOW								Total Peak Flow
		Residential (SFR & MFR)				Commercial		Industrial		
	(ac)	Pop.	Avg. flow	PF	Peak flow	area	Peak flow	area	Peak flow	
CURRENT FLOW:(Year 2003)			(cfs)		(cfs)	(ac)	(cfs)	(ac)	(cfs)	(cfs)
1	2698	13,609	1.368	2.0	2.737	61.00	0.610	10.00	0.120	3.47
2	6584	22,545	2.267	1.6	3.514	359.00	3.590	10.00	0.120	7.22
3	8289	36,941	3.715	1.5	5.572	361.00	3.610	10.00	0.120	9.30
4	1,296	13,341	1.342	2.1	2.817	214.00	2.140	43.00	0.516	5.47
5	12,968	62,432	6.278	1.5	9.417	796.00	7.960	55.00	0.660	18.04
FUTURE FLOW:(Year 2018)										
1	2,698	16,107	1.620	1.9	3.077	207.00	2.070	15.00	0.180	5.33
2	6,584	28,010	2.817	1.5	4.225	1649.00	16.490	15.00	0.180	20.89
3	8,289	42,656	4.289	1.5	6.434	1651.00	16.510	15.00	0.180	23.12
4	1,296	13,419	1.349	1.9	2.564	214.00	2.140	43.00	0.516	5.22
5	12,968	71,434	7.183	1.5	10.775	2168.00	21.680	60.00	0.720	33.17

Notes:

For flow calculation of SFR and MFR population a 2.75 capita per dwelling unit has been used as per City of Riverside guideli
For population growth a 12.65% growth for every ten year has been assumed based on population data for City of Riverside.
Per capita sewage flow- 65 gpcd
Commercial Peak Flow- 0.01 cfs/ac
Industrial Peak Flow- 0.012 cfs/ac
Peaking Factor as per City of Riverside Population vs Peak to Average Ratio Chart.

Abbreviations:

Pop. - Population, Avg. - Average, PF - Peaking Factor, cfs - Cubic feet per second, ac - Acre, SFR - Single Family Residenti
MFR - Multi Family Residential

Table 5-2
Current(2003) Peak Flow and Percentage Contribution from Different Land Use Categories

METER	LOCATION	Total Area	Current Trib. Area	Vacant Area	Current Peak Flow	Land Use Categories Peak Flows					
						Residential		Commercial		Industrial	
		(ac)	(ac)	(ac)	(cfs)	(cfs)	%	(cfs)	%	(cfs)	%
1	MH-203 AT ALESSANDRO BL.	2,698	1,540	1,158	3.467	2.737	79	0.610	18	0.120	3
2	MH-138 AT CENTRAL AVENUE	6,584	2,687	3,897	7.224	3.514	49	3.590	50	0.120	2
3	MH-83 AT VICTORIA COUNTRY	9,600	4,849	4,751	9.302	5.572	60	3.610	39	0.120	1
4	MH-310 AT BROCKTON AVE.	1,296	1,225	71	5.473	2.817	51	2.140	39	0.516	9
5	MH-9 AT TEQUESQUITE AVE.	12,992	7,888	5,104	18.037	9.417	52	7.960	44	0.660	4

Table 5-3
Future(2018) Peak Flow and Percentage Contribution from Different Land Use Categories

METER	LOCATION	Future Total Area	Future Trib. Area	Vacant Area	Future Peak Flow	Land Use Categories Peak Flows					
						Residential		Commercial		Industrial	
		(ac)	(ac)	(ac)	(cfs)	(cfs)	%	(cfs)	%	(cfs)	%
1	MH-203 AT ALESSANDRO BL.	2,698	1,995	703	5.327	3.077	58	2.070	39	0.180	3
2	MH-138 AT CENTRAL AVENUE	6,584	4,592	1,992	20.895	4.225	20	16.490	79	0.180	1
3	MH-83 AT VICTORIA COUNTRY	9,600	6,785	2,815	23.124	6.434	28	16.510	71	0.180	1
4	MH-310 AT BROCKTON AVE.	1,296	1,233	63	5.220	2.564	49	2.140	41	0.180	3
5	MH-9 AT TEQUESQUITE AVE.	12,992	10,055	2,936	33.175	10.775	32	21.680	65	0.720	2

Note:
Residential peak flow was determined by population rather than landuse because of demographics of the area.
Commercial flow includes flow from Industrial Business Park.

Abbreviations:

Trib. Area - Tributary Area
ac - Acre
cfs - Cubic feet per second.
SWR - Sewer
AVE. - Avenue
BL. - Boulevard

Table 5.2
Table 5.3

Figure 14

Representative Diurnal Curve for Lift Station Flow, Meter Location 1

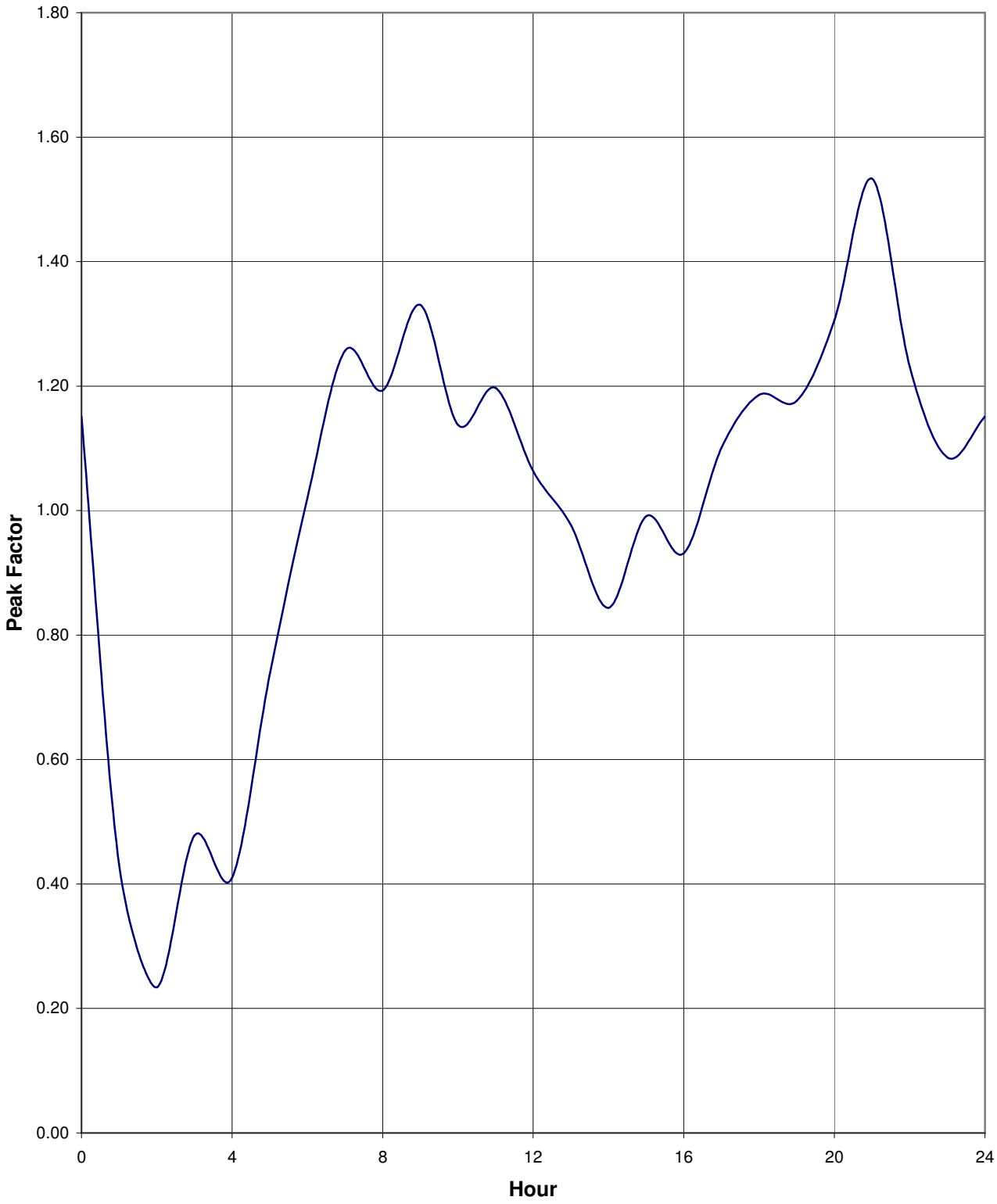


Figure 15

Representative Diurnal Curve for Mixed Land Use (Residential and Commercial), Meter Location 3

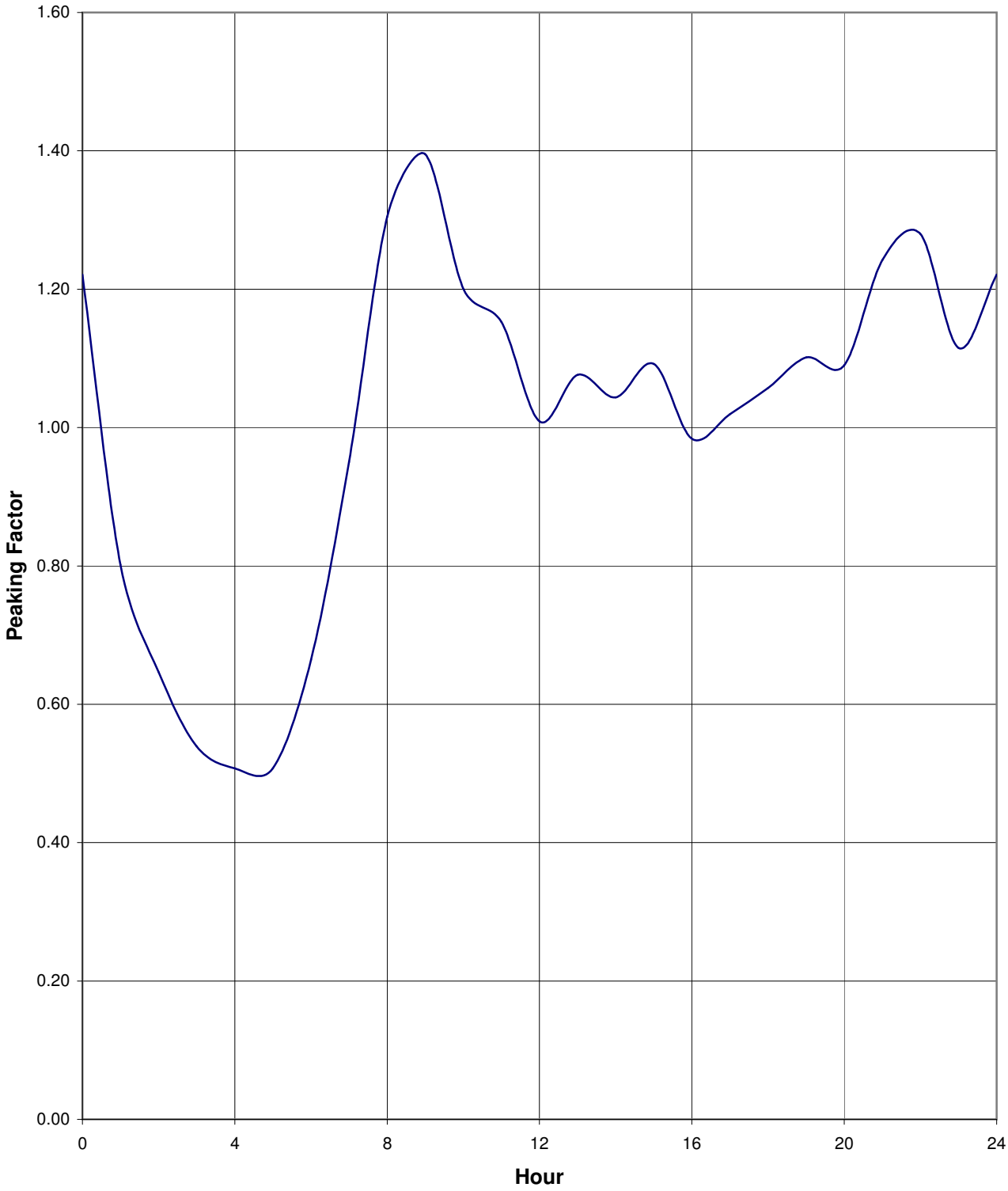


Figure 16

Representative Diurnal Curve for Downtown Area, Meter Location 4

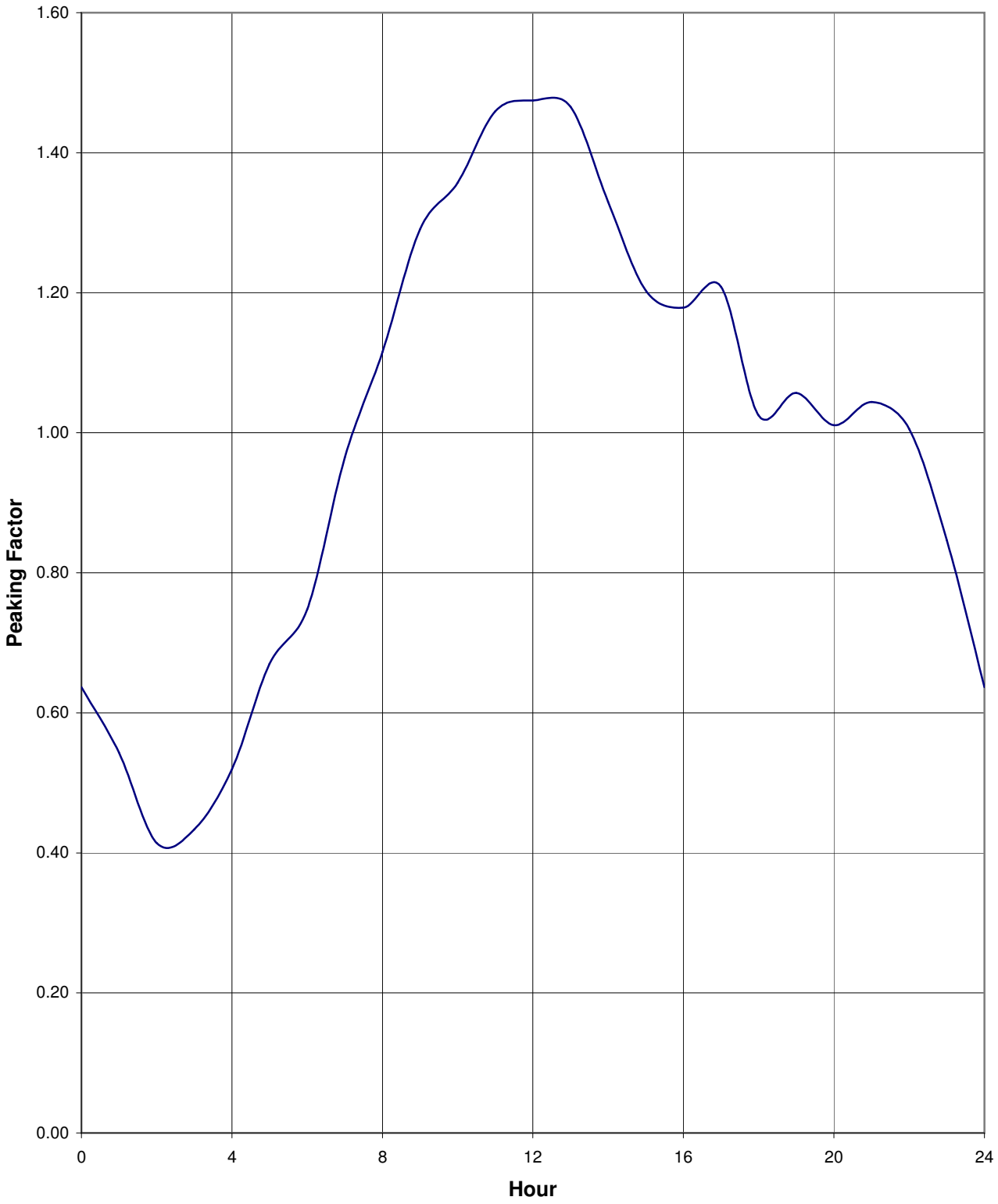
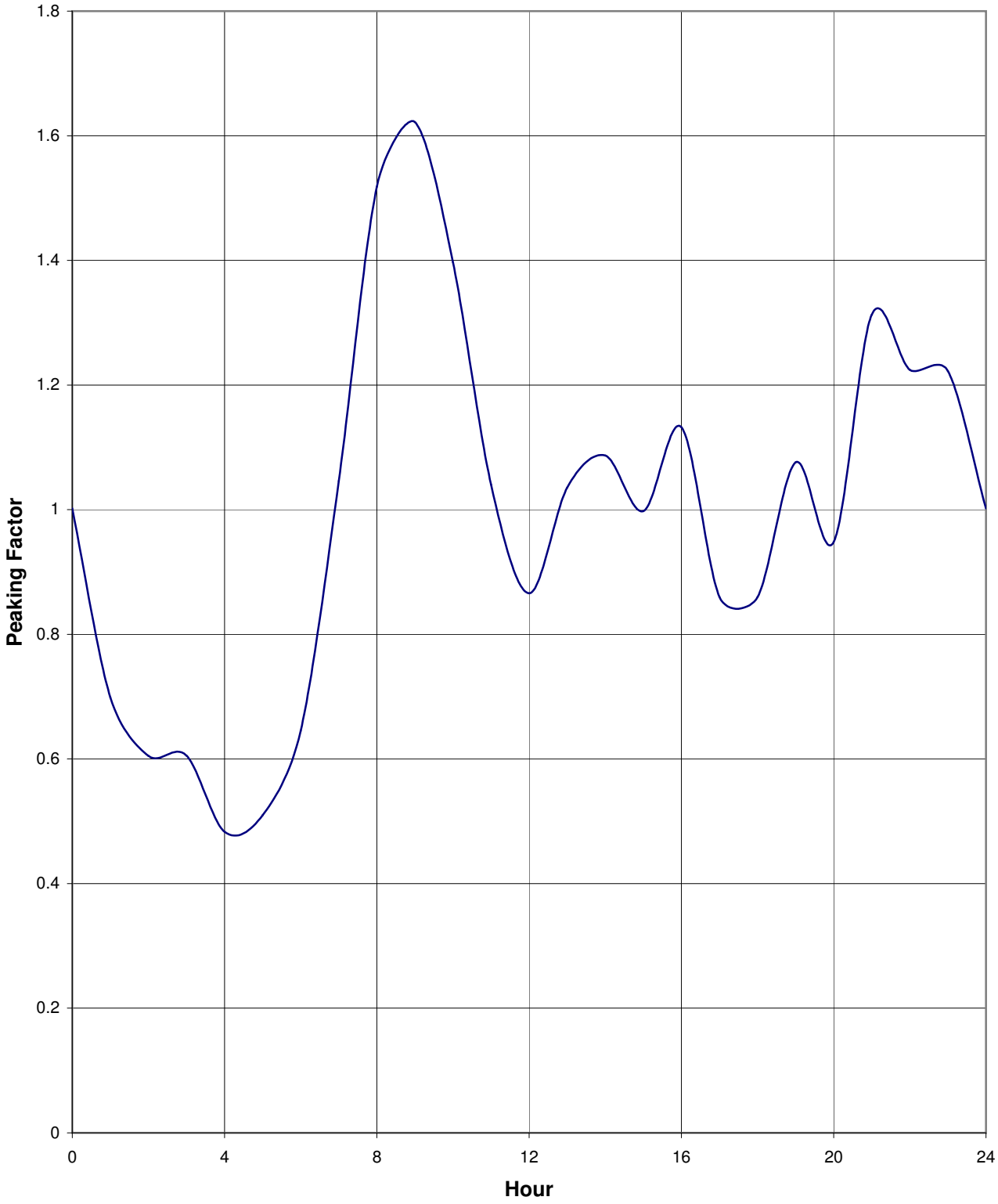


Figure 17

Representative Diurnal Curve for Single Family Residential (SFR)



Note:
This diurnal curve was originally developed from the Spruce Street Sewer Study dated June 2002.

6.0 COMPUTER MODEL SIMULATION ANALYSIS

6.1 Methodology

Capacity analysis involved evaluation of the available capacity in the existing collection system under present and future development conditions. Based on results of the analysis, phased facility improvements were identified to allow for projected growth within the service area.

This Section describes the analytical methodology and hydraulic model development, and summarizes the results of the analyses.

The principal tool utilized in the capacity analysis was a hydraulic model that simulates flow conditions using demand and piping characteristic input data. With this input information, the model is able to output sewage depth of flow, rate of flow, and velocity of flow, within selected pipes and manholes during different times of the day. The model selected for use in this study is XP-SWMM (XP Software, Version 2000); this modeling software belongs to a class of software referred to as “dynamic wave models”. These types of models provide an accurate simulation of hydraulic flow conditions over an extended period of time.

Data required to create the model include information describing the physical wastewater collection system, such as pipe diameters and reach lengths, manhole invert elevations, and estimated pipe roughness coefficients. Additionally, data describing the sewage loading at selected manholes, expressed as a varying flow rate over time (i.e. a diurnal curve), must be provided. Model output consists of a variety of hydraulic parameters, most importantly peak flow velocity and discharge rates.

Calibration of the model consisted of simulating existing sewer flow conditions and comparing the modeled and recorded flows at the meter locations. The assumed diurnal curves that serve as input to the model were iteratively adjusted until the simulated and recorded sewage flow hydrographs achieved reasonable agreement.

Simulations of future sewage flow conditions were performed by developing input data sets that included sewage generation projections for the assumed ultimate conditions. Pipe reaches in which simulated peak flows exceeded a specified trigger criteria were identified as potential improvement reaches. Improvements required to provide adequate capacity for projected flows are then determined through an iterative modeling process. The process consists of simulating flow conditions after increasing the diameter

of downstream portions of the identified reaches. In subsequent iterations, additional lengths of pipe are increased in diameter until the projected peak flow can be conveyed through the reach without exceeding the specified design flow criteria.

6.2 Limitations of Modeling

The hydraulic model, which was utilized as the primary planning tool for the sewer capacity analysis, provides an accurate simulation of actual flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation, however, is directly related to the accuracy of the model input data, including physical parameters and sewage loading projections. For example, in a case where roots had entered the pipeline, thereby causing a restriction of flow, the model would be unable to predict the reduction in flow through this obstruction. Consequently, a general understanding of the data sources is critical in interpreting the modeling results.

The physical parameters of the model, including pipe diameter, slope, and roughness coefficients were based principally on City database information. Where this data appeared to be inaccurate, construction drawings were reviewed and the input data corrected. Network connectivity refers to the flow path followed by sewage within the sewer system. The connectivity is a function of the relative slope of each sewer pipe and the relative invert elevations of the incoming and outgoing sewer pipes at manholes. For example, a manhole may have two or more sewer pipes, which could convey flow away from the manhole. If the invert (bottom) of one of these pipes is lower than the other, the downstream flow path at this manhole would follow the lower pipe.

Sewage loading projections were based on calibrated flow rates. As previously described, flow rates used for calibration were based on actual monitored flows at key points in the trunk system over a 2-week period in July-August 2003. This period included the two weekends.

Since a degree of uncertainty exists in both the physical data and the sewage loading projections used as model inputs, reaches identified by model simulations as near or at capacity should be subject to additional engineering evaluation prior to improvement. Such evaluation may include field inspection, video monitoring and flow metering.

The results of model run for existing and ultimate conditions are summarized in Tables 7-1-A and 7-1-B respectively.

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P01	2.25	0.008	27.98	19.66	70%
P02	2.25	0.008	28.40	19.66	69%
P03	2.25	0.009	29.83	19.66	66%
P04	2.25	0.010	30.82	19.66	64%
P05	2.25	0.009	29.68	19.66	66%
P06	2.25	0.007	25.66	19.66	77%
P07	2.25	0.007	26.50	19.66	74%
P08	2.25	0.007	25.30	19.66	78%
P09	2.25	0.007	26.37	18.66	71%
P10	2.50	0.004	27.35	18.66	68%
P11	2.50	0.004	26.72	18.66	70%
P12	2.25	0.008	28.40	18.66	66%
P13	2.25	0.010	30.77	18.66	61%
P14	2.00	0.013	25.84	18.66	72%
P15	1.75	0.005	11.04	17.56	159%
P16	1.75	0.006	12.38	17.56	142%
P17	1.75	0.006	12.42	17.56	141%
P18	2.00	0.002	11.00	17.56	160%
P19	1.25	0.007	11.01	13.21	120%
P20	2.25	0.003	15.66	13.22	84%
P21	2.25	0.003	17.84	13.22	74%
P22	2.25	0.004	18.41	13.23	72%
P23	2.25	0.003	17.92	13.23	74%
P24	2.00	0.009	21.72	13.23	61%
P25	2.25	0.002	13.16	13.23	101%
P26	2.25	0.003	18.04	13.23	73%
P27	2.25	0.006	23.23	12.17	52%
P28	2.25	0.003	18.06	12.17	67%
P29	2.25	0.003	18.03	12.17	67%
P30	2.25	0.003	17.97	12.17	68%
P31	2.25	0.003	17.63	12.17	69%
P32	2.25	0.003	17.27	12.17	70%
P33	2.25	0.004	19.90	12.17	61%
P34	2.25	0.003	17.80	12.17	68%
P35	2.25	0.003	17.37	12.17	70%
P36	2.25	0.004	20.56	12.16	59%
P37	2.25	0.004	20.57	12.18	59%
P38	2.00	0.008	20.25	12.16	60%
P39	2.25	0.004	20.45	12.16	59%
P40	2.25	0.004	20.23	12.16	60%
P41	2.25	0.006	23.07	12.16	53%
P42	2.25	0.017	40.24	12.16	30%
P43	2.00	0.007	19.19	12.16	63%
P44	2.00	0.008	20.45	12.16	59%
P45	2.00	0.007	19.14	12.16	64%
P46	2.00	0.007	18.88	12.16	64%
P47	2.00	0.028	37.94	12.16	32%
P48	2.00	0.214	104.45	12.16	12%
P49	2.00	0.004	14.74	12.16	83%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P50	1.50	0.002	4.73	12.16	257%
P51	2.00	0.012	24.35	12.16	50%
P52	2.25	0.003	15.91	11.95	75%
P53	2.25	0.002	13.29	11.95	90%
P54	2.25	0.002	13.21	11.95	90%
P55	2.25	0.002	13.28	11.95	90%
P56	2.00	0.004	13.75	11.96	87%
P57	2.00	0.003	12.90	11.98	93%
P58	2.00	0.003	12.77	11.99	94%
P59	2.00	0.003	12.80	12.03	94%
P60	1.75	0.006	12.23	12.06	99%
P61	1.75	0.006	12.35	12.05	98%
P62	1.75	0.006	12.34	12.06	98%
P63	1.75	0.006	12.34	12.06	98%
P64	1.75	0.006	12.38	12.06	97%
P65	1.75	0.006	12.36	12.07	98%
P66	1.75	0.006	12.30	12.07	98%
P67	2.00	0.004	15.06	12.07	80%
P68	1.75	0.009	15.35	10.72	70%
P69	1.75	0.007	13.30	10.72	81%
P70	1.75	0.008	13.85	10.72	77%
P71	1.75	0.007	13.36	10.72	80%
P72	1.75	0.008	13.80	10.72	78%
P73	1.75	0.006	12.71	10.72	84%
P74	1.75	0.006	12.64	10.72	85%
P75	1.75	0.007	13.42	10.72	80%
P76	1.75	0.008	13.78	10.72	78%
P77	1.75	0.010	15.81	10.72	68%
P78	1.75	0.010	15.81	10.72	68%
P79	1.75	0.010	15.81	10.72	68%
P80	1.75	0.010	15.57	10.72	69%
P81	1.50	0.012	11.31	10.72	95%
P82	1.50	0.012	11.34	10.72	95%
P83	1.50	0.012	11.34	10.72	95%
P84	1.50	0.012	11.41	10.72	94%
P85	1.50	0.012	11.34	10.72	95%
P86	1.50	0.012	11.60	10.72	92%
P87	1.50	0.012	11.34	3.35	30%
P88	1.50	0.014	12.22	2.68	22%
P89	1.50	0.013	11.85	2.68	23%
P90	1.50	0.012	11.29	2.68	24%
P91	1.50	0.012	11.28	2.68	24%
P92	1.75	0.011	16.47	0.90	5%
P93	1.75	0.014	18.76	0.90	5%
P94	1.75	0.014	18.67	0.90	5%
P95	1.25	0.301	35.31	0.90	3%
P96	2.25	0.002	13.75	0.90	7%
P97	2.25	0.002	13.83	0.90	6%
P98	2.25	0.002	13.95	0.90	6%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P99	2.25	0.002	13.77	0.90	7%
P100	2.25	0.002	13.91	0.90	6%
P101	2.25	0.002	13.83	0.90	6%
P102	2.25	0.002	13.65	0.90	7%
P103	2.25	0.002	13.89	0.90	6%
P104	2.25	0.002	13.90	0.90	6%
P105	2.25	0.002	14.97	0.44	3%
P106	2.25	0.002	13.66	0.47	3%
P107	2.25	0.002	13.80	0.49	4%
P108	2.25	0.002	13.95	0.49	4%
P109	2.25	0.002	13.83	0.45	3%
P110	2.25	0.002	13.79	0.48	3%
P111	2.25	0.002	13.69	0.44	3%
P112	2.25	0.002	13.92	0.45	3%
P113	2.25	0.002	13.83	0.45	3%
P114	2.25	0.002	13.83	0.44	3%
P115	2.25	0.002	13.87	0.44	3%
P116	2.25	0.002	13.89	0.44	3%
P117	2.25	0.002	13.93	0.44	3%
P118	2.25	0.002	13.79	0.44	3%
P119	2.00	0.002	10.17	0.44	4%
P120	2.00	0.002	10.51	0.44	4%
P121	0.83	0.055	5.13	0.00	0%
P130	2.00	0.028	37.51	8.02	21%
P131	2.00	0.030	39.33	8.02	20%
P132	2.00	0.030	39.37	8.02	20%
P133	2.00	0.030	39.37	8.02	20%
P134	2.00	0.068	58.80	8.02	14%
P135	2.75	0.033	96.62	7.86	8%
P136	1.75	0.069	41.49	7.86	19%
P137	1.75	0.048	34.64	7.86	23%
P138	2.00	0.026	36.73	7.86	21%
P139	1.75	0.059	38.35	7.86	21%
P140	1.75	0.060	38.62	7.86	20%
P141	1.75	0.060	38.61	7.86	20%
P142	1.75	0.034	29.12	7.86	27%
P143	1.75	0.051	35.63	7.86	22%
P144	1.75	0.041	31.88	7.86	25%
P145	1.75	0.036	30.00	7.86	26%
P146	1.75	0.044	32.99	7.86	24%
P147	1.75	0.046	33.95	7.86	23%
P148	1.75	0.051	35.63	7.86	22%
P149	1.75	0.046	33.92	7.87	23%
P150	1.75	0.037	30.31	7.86	26%
P151	2.25	0.009	29.01	7.86	27%
P152	2.25	0.016	39.05	7.87	20%
P153	2.25	0.016	39.09	7.87	20%
P154	2.25	0.009	29.02	7.87	27%
P155	2.25	0.021	44.95	7.87	17%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P156	2.25	0.021	44.71	7.87	18%
P157	3.50	0.001	30.77	7.87	26%
P158	3.50	0.001	27.58	7.12	26%
P159	3.50	0.001	28.61	7.12	25%
P160	3.50	0.001	28.39	7.13	25%
P161	3.50	0.001	28.47	7.13	25%
P162	3.50	0.001	28.47	7.13	25%
P163	3.50	0.001	28.47	7.14	25%
P164	3.50	0.001	28.47	6.63	23%
P165	3.50	0.001	28.47	6.64	23%
P166	3.50	0.001	28.47	6.64	23%
P167	3.50	0.001	28.47	6.65	23%
P168	3.50	0.001	28.47	6.65	23%
P169	3.50	0.001	28.47	6.65	23%
P170	3.50	0.001	28.19	6.66	24%
P171	3.50	0.001	38.23	5.85	15%
P172	1.67	0.012	30.38	5.85	19%
P173	3.50	0.001	28.44	5.85	21%
P174	2.50	0.001	13.50	5.59	41%
P175	2.50	0.001	13.52	5.59	41%
P176	2.50	0.001	13.44	5.59	42%
P177	2.50	0.001	13.18	5.59	42%
P178	2.50	0.001	13.68	5.60	41%
P179	2.50	0.001	13.44	5.60	42%
P180	2.50	0.001	13.48	5.60	42%
P181	2.50	0.001	13.48	5.61	42%
P182	2.00	0.002	10.10	5.29	52%
P183	2.00	0.002	10.11	5.29	52%
P184	2.00	0.002	10.04	5.29	53%
P185	2.00	0.002	10.10	5.30	52%
P186	2.00	0.002	10.10	5.30	52%
P187	2.00	0.054	52.29	5.30	10%
P188	2.00	0.002	9.81	5.30	54%
P189	1.50	0.010	10.43	3.89	37%
P190	1.50	0.010	10.48	3.89	37%
P191	1.50	0.010	10.48	3.89	37%
P192	1.50	0.012	11.37	3.78	33%
P193	1.50	0.014	12.47	3.78	30%
P194	1.50	0.019	14.57	3.78	26%
P195	1.50	0.020	14.91	3.78	25%
P196	1.50	0.020	14.82	4.07	27%
P197	1.50	0.020	14.82	3.78	26%
P198	1.50	0.010	10.49	3.78	36%
P199	1.50	0.020	14.82	3.78	26%
P200	1.50	0.009	10.05	3.78	38%
P201	1.50	0.009	10.05	3.79	38%
P202	1.50	0.010	10.47	3.79	36%
P203	1.50	0.010	10.48	3.79	36%
P204	1.50	0.011	11.21	3.79	34%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P205	1.33	Force Main			
P206	1.75	0.004	10.54	4.54	43%
P207	1.50	0.002	5.20	2.51	48%
P208	1.50	0.002	5.12	2.51	49%
P209	1.50	0.002	5.17	1.94	37%
P210	1.50	0.002	5.12	1.94	38%
P211	1.50	0.002	5.11	1.94	38%
P212	1.50	0.003	5.92	1.94	33%
P213	1.50	0.073	28.27	1.94	7%
P214	1.50	0.002	5.08	1.94	38%
P215	1.50	0.002	5.15	1.94	38%
P216	1.50	0.032	18.74	1.94	10%
P217	1.50	0.032	18.74	1.94	10%
P218	1.50	0.002	5.14	1.84	36%
P219	1.00	0.083	10.20	1.46	14%
P220	1.00	0.013	3.98	1.46	37%
P221	1.00	0.009	3.44	1.46	42%
P222	1.00	0.009	3.44	1.46	42%
P223	1.00	0.009	3.44	1.46	42%
P224	1.00	0.009	3.44	1.46	42%
P225	1.00	0.015	4.34	1.46	34%
P226	1.00	0.015	4.36	1.46	33%
P227	1.00	0.015	4.35	1.46	33%
P228	1.00	0.006	2.74	1.46	53%
P229	1.00	0.006	2.75	1.46	53%
P230	1.00	0.006	2.75	1.46	53%
P231	1.00	0.006	2.75	1.46	53%
P232	0.67	0.018	1.63	0.77	47%
P233	0.67	0.049	2.65	0.08	3%
P234	0.67	0.042	2.44	0.08	3%
P235	0.83	0.010	2.16	0.69	32%
P236	0.83	0.010	2.16	0.69	32%
P237	0.83	0.010	2.16	0.69	32%
P238	1.50	0.017	13.81	2.03	15%
P239	1.50	0.017	13.74	2.03	15%
P240	1.50	0.017	13.72	2.03	15%
P241	1.00	0.004	2.24	0.60	27%
P242	1.00	0.004	2.24	0.60	27%
P243	1.00	0.032	6.39	0.60	9%
P244	1.00	0.032	6.39	0.60	9%
P245	1.00	0.032	6.39	0.60	9%
P246	1.00	0.032	6.40	0.60	9%
P247	1.00	0.026	5.72	0.60	10%
P248	1.00	0.002	1.74	0.60	34%
P249	1.00	0.002	1.74	0.60	34%
P250	1.00	0.002	1.74	0.60	34%
P251	1.00	0.008	3.22	0.60	19%
P252	1.00	0.002	1.73	0.60	35%
P253	1.25	0.026	10.36	1.43	14%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P254	1.25	0.011	6.68	1.43	21%
P255	1.00	0.023	5.41	0.73	13%
P256	1.00	0.009	3.33	0.73	22%
P257	1.00	0.044	7.44	0.73	10%
P258	1.00	0.018	4.76	0.73	15%
P259	1.00	0.012	3.89	0.73	19%
P260	1.00	0.008	3.17	0.73	23%
P261	1.00	0.007	2.89	0.73	25%
P262	1.00	0.007	2.88	0.73	25%
P263	0.83	0.032	3.90	0.73	19%
P264	0.83	0.023	3.33	0.73	22%
P265	0.83	0.034	4.04	0.73	18%
P266	0.83	0.020	3.08	0.73	24%
P267	0.83	0.025	3.46	0.73	21%
P268	0.83	0.027	3.57	0.73	20%
P269	0.83	0.019	3.03	0.73	24%
P270	0.83	0.007	1.88	0.73	39%
P271	0.67	0.013	1.38	0.73	53%
P272	0.67	0.009	1.16	0.73	63%
P273	0.67	0.010	1.17	0.73	62%
P274	0.67	0.010	1.17	0.73	62%
P275	0.67	0.009	1.16	0.73	63%
P276	0.67	0.004	0.76	0.73	96%
P277	1.25	0.014	7.75	0.32	4%
P278	1.25	0.008	5.83	0.32	5%
P279	1.25	0.008	5.91	0.32	5%
P280	1.25	0.004	4.18	0.32	8%
P281	1.25	0.007	5.53	0.32	6%
P282	1.25	0.023	9.83	0.32	3%
P283	1.25	0.005	4.74	0.32	7%
P284	1.00	0.002	1.51	1.00	66%
P285	1.00	0.002	1.50	1.00	67%
P286	1.00	0.002	1.50	1.00	67%
P287	1.00	0.002	1.51	1.01	67%
P288	0.83	0.002	0.97	1.01	104%
P290	2.75	0.008	46.66	8.01	17%
P291	2.75	0.008	47.45	8.01	17%
P292	2.75	0.008	47.06	8.01	17%
P293	2.75	0.016	67.47	8.01	12%
P294	2.75	0.009	51.38	8.01	16%
P295	2.25	0.028	52.07	8.01	15%
P296	2.00	0.025	35.68	8.01	22%
P297	2.00	0.036	42.92	8.01	19%
P298	2.00	0.058	54.35	8.01	15%
P299	2.00	0.058	54.41	8.01	15%
P300	2.00	0.028	37.57	8.01	21%
P301	2.00	0.041	45.46	8.02	18%
P302	2.00	0.046	48.23	8.02	17%
P303	2.00	0.009	21.22	8.02	38%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P304	2.00	0.028	37.49	8.02	21%
P305	2.00	0.012	24.83	8.02	32%
P306	2.00	0.009	21.44	8.02	37%
P307	2.00	0.014	26.82	8.02	30%
P307A	2.00	0.015	27.45	8.02	29%
P308	1.25	0.009	6.01	5.33	100%[1]
P309	1.25	0.009	6.16	5.33	100%[1]
P310	1.25	0.010	6.28	5.33	100%[1]
P311	1.25	0.013	7.45	2.99	100%[1]
P311A	1.25	0.012	7.16	2.51	100%[1]
P311B	1.25	0.012	7.01	2.46	100%[1]
P311C	1.25	0.022	9.52	2.46	26%
P311D	1.25	0.009	6.26	2.46	39%
P312	1.00	0.011	3.71	2.17	100%[1]
P313	1.00	0.026	5.68	2.13	100%[1]
P314	0.83	0.025	3.43	2.13	100%[1]
P315	1.75	0.006	12.63	4.51	36%
P316	1.75	0.006	12.59	4.51	36%
P317	1.75	0.005	11.57	4.51	39%
P318A	1.75	0.005	11.26	4.51	40%
P319	1.00	0.016	4.50	2.93	65%
P319A	1.00	0.022	5.31	1.58	30%
P320	0.83	0.018	2.93	2.93	100%[1]
P321	0.83	0.020	3.09	2.93	100%[1]
P322	1.00	0.037	6.80	1.58	23%
P323	1.00	0.042	7.24	4.51	62%
P324	1.00	0.042	7.30	4.51	62%
P325	1.25	0.024	10.06	1.58	16%
P326	1.25	0.015	7.83	1.58	20%
P327	0.83	0.021	3.15	1.58	50%
P327A	1.00	0.018	4.70	2.93	62%
P328	1.00	0.018	4.81	2.87	60%
P329	1.17	0.004	3.46	2.03	100%[1]
P329A	1.00	0.003	1.98	1.29	100%[1]
P330	1.25	0.003	3.77	2.03	100%[1]
P331	1.25	0.003	3.59	2.03	100%[1]
P332	1.00	0.003	1.88	1.86	100%[1]
P333	1.00	0.003	1.88	1.85	100%[1]
P334	1.00	0.003	1.89	1.85	100%[1]
P335	1.00	0.003	1.92	1.59	100%[1]
P336	1.00	0.003	1.93	1.59	100%[1]
P337	1.00	0.003	1.94	1.59	100%[1]
P338	1.00	0.003	2.03	1.17	100%[1]
P339	0.83	0.003	1.18	1.17	100%[1]
P340	0.83	0.002	1.02	0.64	100%[1]
P341	0.83	0.003	1.15	0.64	100%[1]

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P342	0.83	0.002	1.05	0.64	100%[1]
P343	0.83	0.003	1.25	0.64	100%[1]
P344	1.25	0.003	3.64	1.26	34.51%
P345	1.25	0.003	3.62	1.02	28.24%
P346	1.25	0.003	3.63	1.02	28.20%
P347	1.25	0.003	3.56	1.02	28.75%
P348	1.50	0.002	4.80	1.02	21.33%
P349	1.50	0.003	5.41	1.02	18.94%
P350	1.50	0.002	4.76	1.02	21.49%
P351	1.25	0.002	2.94	0.79	26.93%
P352	1.25	0.011	6.62	0.79	11.96%
P353	1.25	0.012	6.96	0.79	11.38%
P354	1.25	0.008	5.84	0.79	13.57%
P355	1.25	0.010	6.44	0.79	12.31%
P356	0.67	0.011	1.26	0.29	100%[1]
P357	0.67	0.011	1.23	0.29	100%[1]
P358	0.67	0.011	1.23	0.25	20.50%
P359	0.67	0.010	1.23	0.26	21.27%
P360	0.67	0.011	1.23	0.25	20.49%
P361	0.67	0.010	1.20	0.09	7.57%
P362	0.67	0.011	1.27	0.09	7.16%
P363	0.67	0.011	1.27	0.09	7.13%
P364	0.67	0.010	1.17	0.09	7.77%
P365	0.67	0.003	0.65	0.52	100%[1]
P366	0.67	0.006	0.97	0.60	100%[1]
P367	0.67	0.022	1.78	0.52	29.06%
P368	0.67	0.007	1.00	0.26	25.77%
P369	0.67	0.012	1.32	0.26	19.56%
P370	0.67	0.012	1.34	0.26	19.35%
P371	0.67	0.013	1.37	0.26	18.94%
P372	0.67	0.005	0.81	0.52	100%[1]
P373	0.67	0.005	0.82	0.52	62.56%
P374	0.67	0.004	0.74	0.52	70.02%
P375	0.67	0.004	0.80	0.52	64.60%
P376	0.67	0.008	1.08	0.26	23.84%
P377	0.67	0.008	1.04	0.26	24.78%
P378	0.67	0.017	1.57	0.26	16.42%
P379	0.67	0.014	1.44	0.26	17.91%
P380	0.67	0.012	1.29	0.26	20.04%
P381	0.67	0.010	1.20	0.26	21.44%
P382	0.67	0.010	1.21	0.26	21.41%
P383	0.67	0.010	1.22	0.26	21.17%
P384	0.67	0.010	1.20	0.26	21.55%
P385	0.67	0.010	1.22	0.26	21.23%

Table 7-1-A
Sewer Analysis Results (Existing Conditions)

Name	Diameter, ft	Slope (ft/ft)	Theoretical "Full" Flow (cfs)	Existing Modeled Peak Flow (cfs)	Existing % Full
P386	0.67	0.010	1.18	0.26	21.78%
P387	0.67	0.010	1.21	0.26	21.40%
P388	0.67	0.009	1.15	0.26	22.45%
P389	1.50	0.013	12.03	0.44	3.63%
P390	1.25	0.020	9.11	0.44	4.80%
P391	1.25	0.019	8.85	0.44	4.94%
P392	1.25	0.018	8.62	0.44	5.07%
P393	1.50	0.007	8.86	0.44	4.93%
P394	1.50	0.007	8.72	0.44	5.01%
P395	1.50	0.001	2.63	0.44	16.62%
P396	1.00	0.033	6.45	0.44	6.78%
P397	1.00	0.247	17.64	0.22	1.24%
P398	1.25	0.010	6.56	0.22	3.34%
P399	1.25	0.010	6.51	0.22	3.37%
P400	1.25	0.010	6.58	0.22	3.33%
P401	1.25	0.028	10.69	0.22	2.05%
P402	1.25	0.014	7.73	0.22	2.84%
P403	1.25	0.033	11.78	0.22	1.86%
P404	1.25	0.022	9.51	0.22	2.31%
P405	1.25	0.335	37.25	0.22	0.59%
P406	1.25	0.209	29.45	0.22	0.75%
P407	1.25	0.040	12.93	0.22	1.70%
P408	0.83	0.034	4.04	1.80	44.56%
P409	0.83	0.190	9.49	1.80	18.95%
P410	0.67	0.066	3.07	1.80	58.54%
P411	0.67	0.074	3.26	1.80	55.19%
P412	0.67	0.077	3.33	1.80	54.12%

1. Due to back-up in sewer system.

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P01	2.25	0.008	27.98	33.43	119%
P02	2.25	0.008	28.40	33.43	118%
P03	2.25	0.009	29.83	33.43	112%
P04	2.25	0.010	30.82	33.43	108%
P05	2.25	0.009	29.68	33.43	113%
P06	2.25	0.007	25.66	33.43	130%
P07	2.25	0.007	26.50	33.43	126%
P08	2.25	0.007	25.30	33.43	132%
P09	2.25	0.007	26.37	32.42	123%
P10	2.50	0.004	27.35	32.42	119%
P11	2.50	0.004	26.72	32.42	121%
P12	2.25	0.008	28.40	32.42	114%
P13	2.25	0.010	30.77	32.42	105%
P14	2.00	0.013	25.84	32.42	125%
P15	1.75	0.005	11.04	31.36	284%
P16	1.75	0.006	12.38	31.37	253%
P17	1.75	0.006	12.42	31.37	253%
P18	2.00	0.002	11.00	31.37	285%
P19	1.25	0.007	11.01	25.82	235%
P20	2.25	0.003	15.66	25.82	165%
P21	2.25	0.003	17.84	25.83	145%
P22	2.25	0.004	18.41	25.83	140%
P23	2.25	0.003	17.92	25.83	144%
P24	2.00	0.009	21.72	25.83	119%
P25	2.25	0.002	13.16	25.83	196%
P26	2.25	0.003	18.04	25.83	143%
P27	2.25	0.006	23.23	24.72	106%
P28	2.25	0.003	18.06	24.72	137%
P29	2.25	0.003	18.03	24.72	137%
P30	2.25	0.003	17.97	24.71	138%
P31	2.25	0.003	17.63	24.72	140%
P32	2.25	0.003	17.27	24.72	143%
P33	2.25	0.004	19.90	24.72	124%
P34	2.25	0.003	17.80	24.72	139%
P35	2.25	0.003	17.37	24.71	142%
P36	2.25	0.004	20.56	24.71	120%
P37	2.25	0.004	20.57	24.71	120%
P38	2.00	0.008	20.25	24.72	122%
P39	2.25	0.004	20.45	24.71	121%
P40	2.25	0.004	20.23	24.72	122%
P41	2.25	0.006	23.07	24.72	107%
P42	2.25	0.017	40.24	24.72	61%
P43	2.00	0.007	19.19	24.72	129%
P44	2.00	0.008	20.45	24.71	121%
P45	2.00	0.007	19.14	24.72	129%
P46	2.00	0.007	18.88	24.72	131%
P47	2.00	0.028	37.94	24.72	65%
P48	2.00	0.214	104.45	24.72	24%
P49	2.00	0.004	14.74	24.72	168%
P50	1.50	0.002	4.73	24.71	522%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P51	2.00	0.012	24.35	24.72	101%
P52	2.25	0.003	15.91	24.50	154%
P53	2.25	0.002	13.29	24.51	184%
P54	2.25	0.002	13.21	24.55	186%
P55	2.25	0.002	13.28	24.57	185%
P56	2.00	0.004	13.75	24.58	179%
P57	2.00	0.003	12.90	24.58	191%
P58	2.00	0.003	12.77	24.58	192%
P59	2.00	0.003	12.80	24.58	192%
P60	1.75	0.006	12.23	24.58	201%
P61	1.75	0.006	12.35	24.58	199%
P62	1.75	0.006	12.34	24.58	199%
P63	1.75	0.006	12.34	24.58	199%
P64	1.75	0.006	12.38	24.58	199%
P65	1.75	0.006	12.36	24.58	199%
P66	1.75	0.006	12.30	24.58	200%
P67	2.00	0.004	15.06	24.58	163%
P68	1.75	0.009	15.35	22.22	145%
P69	1.75	0.007	13.30	22.22	167%
P70	1.75	0.008	13.85	22.22	160%
P71	1.75	0.007	13.36	22.22	166%
P72	1.75	0.008	13.80	22.22	161%
P73	1.75	0.006	12.71	22.22	175%
P74	1.75	0.006	12.64	22.22	176%
P75	1.75	0.007	13.42	22.22	166%
P76	1.75	0.008	13.78	22.22	161%
P77	1.75	0.010	15.81	22.22	141%
P78	1.75	0.010	15.81	22.22	141%
P79	1.75	0.010	15.81	22.22	141%
P80	1.75	0.010	15.57	22.22	143%
P81	1.50	0.012	11.31	22.22	197%
P82	1.50	0.012	11.34	22.22	196%
P83	1.50	0.012	11.34	22.22	196%
P84	1.50	0.012	11.41	22.22	195%
P85	1.50	0.012	11.34	22.22	196%
P86	1.50	0.012	11.60	22.22	192%
P87	1.50	0.012	11.34	3.41	30%
P88	1.50	0.014	12.22	2.74	22%
P89	1.50	0.013	11.85	2.74	23%
P90	1.50	0.012	11.29	2.74	24%
P91	1.50	0.012	11.28	2.74	24%
P92	1.75	0.011	16.47	0.90	5%
P93	1.75	0.014	18.76	0.90	5%
P94	1.75	0.014	18.67	0.90	5%
P95	1.25	0.301	35.31	0.90	3%
P96	2.25	0.002	13.75	0.90	7%
P97	2.25	0.002	13.83	0.90	6%
P98	2.25	0.002	13.95	0.90	6%
P99	2.25	0.002	13.77	0.90	7%
P100	2.25	0.002	13.91	0.90	6%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P101	2.25	0.002	13.83	0.90	6%
P102	2.25	0.002	13.65	0.90	7%
P103	2.25	0.002	13.89	0.90	6%
P104	2.25	0.002	13.90	0.90	6%
P105	2.25	0.002	14.97	0.44	3%
P106	2.25	0.002	13.66	0.47	3%
P107	2.25	0.002	13.80	0.49	4%
P108	2.25	0.002	13.95	0.49	4%
P109	2.25	0.002	13.83	0.45	3%
P110	2.25	0.002	13.79	0.48	3%
P111	2.25	0.002	13.69	0.44	3%
P112	2.25	0.002	13.92	0.45	3%
P113	2.25	0.002	13.83	0.46	3%
P114	2.25	0.002	13.83	0.44	3%
P115	2.25	0.002	13.87	0.44	3%
P116	2.25	0.002	13.89	0.44	3%
P117	2.25	0.002	13.93	0.44	3%
P118	2.25	0.002	13.79	0.44	3%
P119	2.00	0.002	10.17	0.44	4%
P120	2.00	0.002	10.51	0.44	4%
P121	0.83	0.055	5.13	0.00	0%
P130	2.00	0.028	37.51	19.01	51%
P131	2.00	0.030	39.33	19.01	48%
P132	2.00	0.030	39.37	19.01	48%
P133	2.00	0.030	39.37	19.01	48%
P134	2.00	0.068	58.80	19.01	32%
P135	2.75	0.033	96.62	18.48	19%
P136	1.75	0.069	41.49	18.48	45%
P137	1.75	0.048	34.64	18.49	53%
P138	2.00	0.026	36.73	18.49	50%
P139	1.75	0.059	38.35	18.49	48%
P140	1.75	0.060	38.62	18.48	48%
P141	1.75	0.060	38.61	18.49	48%
P142	1.75	0.034	29.12	18.49	63%
P143	1.75	0.051	35.63	18.49	52%
P144	1.75	0.041	31.88	18.49	58%
P145	1.75	0.036	30.00	18.49	62%
P146	1.75	0.044	32.99	18.49	56%
P147	1.75	0.046	33.95	18.49	54%
P148	1.75	0.051	35.63	18.49	52%
P149	1.75	0.046	33.92	18.51	55%
P150	1.75	0.037	30.31	18.98	63%
P151	2.25	0.009	29.01	18.57	64%
P152	2.25	0.016	39.05	18.57	48%
P153	2.25	0.016	39.09	18.57	48%
P154	2.25	0.009	29.02	18.57	64%
P155	2.25	0.021	44.95	18.57	41%
P156	2.25	0.021	44.71	18.57	42%
P157	3.50	0.001	30.77	18.57	60%
P158	3.50	0.001	27.58	17.61	64%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P159	3.50	0.001	28.61	17.61	62%
P160	3.50	0.001	28.39	17.61	62%
P161	3.50	0.001	28.47	17.61	62%
P162	3.50	0.001	28.47	13.75	48%
P163	3.50	0.001	28.47	13.74	48%
P164	3.50	0.001	28.47	13.75	48%
P165	3.50	0.001	28.47	13.76	48%
P166	3.50	0.001	28.47	13.77	48%
P167	3.50	0.001	28.47	13.78	48%
P168	3.50	0.001	28.47	13.79	48%
P169	3.50	0.001	28.47	13.79	48%
P170	3.50	0.001	28.19	13.80	49%
P171	3.50	0.001	38.23	12.27	32%
P172	1.67	0.012	30.38	12.28	40%
P173	3.50	0.001	28.44	12.28	43%
P174	2.50	0.001	13.50	9.87	73%
P175	2.50	0.001	13.52	9.87	73%
P176	2.50	0.001	13.44	9.88	73%
P177	2.50	0.001	13.18	9.88	75%
P178	2.50	0.001	13.68	9.88	72%
P179	2.50	0.001	13.44	9.89	74%
P180	2.50	0.001	13.48	9.89	73%
P181	2.50	0.001	13.48	9.90	73%
P182	2.00	0.002	10.10	7.47	74%
P183	2.00	0.002	10.11	7.48	74%
P184	2.00	0.002	10.04	7.48	74%
P185	2.00	0.002	10.10	7.48	74%
P186	2.00	0.002	10.10	7.49	74%
P187	2.00	0.054	52.29	7.49	14%
P188	2.00	0.002	9.81	7.49	76%
P189	1.50	0.010	10.43	5.76	55%
P190	1.50	0.010	10.48	5.76	55%
P191	1.50	0.010	10.48	5.76	55%
P192	1.50	0.012	11.37	5.29	47%
P193	1.50	0.014	12.47	5.29	42%
P194	1.50	0.019	14.57	5.64	39%
P195	1.50	0.020	14.91	5.29	36%
P196	1.50	0.020	14.82	5.29	36%
P197	1.50	0.020	14.82	5.30	36%
P198	1.50	0.010	10.49	5.29	50%
P199	1.50	0.020	14.82	5.30	36%
P200	1.50	0.009	10.05	5.30	53%
P201	1.50	0.009	10.05	5.30	53%
P202	1.50	0.010	10.47	5.31	51%
P203	1.50	0.010	10.48	5.31	51%
P204	1.50	0.011	11.21	5.31	47%
P205	1.33	Force Main			
P206	1.75	0.004	10.54	6.34	60%
P207	1.50	0.002	5.20	3.32	64%
P208	1.50	0.002	5.12	3.32	65%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P209	1.50	0.002	5.17	2.66	51%
P210	1.50	0.002	5.12	2.66	52%
P211	1.50	0.002	5.11	2.66	52%
P212	1.50	0.003	5.92	2.66	45%
P213	1.50	0.073	28.27	2.66	9%
P214	1.50	0.002	5.08	2.66	52%
P215	1.50	0.002	5.15	2.66	52%
P216	1.50	0.032	18.74	2.66	14%
P217	1.50	0.032	18.74	2.66	14%
P218	1.50	0.002	5.14	2.57	50%
P219	1.00	0.083	10.20	2.18	21%
P220	1.00	0.013	3.98	2.18	55%
P221	1.00	0.009	3.44	2.29	67%
P222	1.00	0.009	3.44	2.29	67%
P223	1.00	0.009	3.44	2.25	65%
P224	1.00	0.009	3.44	2.21	64%
P225	1.00	0.015	4.34	2.19	50%
P226	1.00	0.015	4.36	2.19	50%
P227	1.00	0.015	4.35	2.19	50%
P228	1.00	0.006	2.74	2.19	80%
P229	1.00	0.006	2.75	2.19	80%
P230	1.00	0.006	2.75	2.19	80%
P231	1.00	0.006	2.75	2.19	80%
P232	0.67	0.018	1.63	1.47	91%
P233	0.67	0.049	2.65	0.75	28%
P234	0.67	0.042	2.44	0.75	31%
P235	0.83	0.010	2.16	0.72	33%
P236	0.83	0.010	2.16	0.72	33%
P237	0.83	0.010	2.16	0.72	33%
P238	1.50	0.017	13.81	3.02	22%
P239	1.50	0.017	13.74	3.02	22%
P240	1.50	0.017	13.72	3.02	22%
P241	1.00	0.004	2.24	0.68	30%
P242	1.00	0.004	2.24	0.68	30%
P243	1.00	0.032	6.39	0.68	11%
P244	1.00	0.032	6.39	0.68	11%
P245	1.00	0.032	6.39	0.68	11%
P246	1.00	0.032	6.40	0.68	11%
P247	1.00	0.026	5.72	0.68	12%
P248	1.00	0.002	1.74	0.68	39%
P249	1.00	0.002	1.74	0.69	39%
P250	1.00	0.002	1.74	0.69	39%
P251	1.00	0.008	3.22	0.69	21%
P252	1.00	0.002	1.73	0.69	40%
P253	1.25	0.026	10.36	2.35	23%
P254	1.25	0.011	6.68	2.35	35%
P255	1.00	0.023	5.41	1.18	22%
P256	1.00	0.009	3.33	1.18	36%
P257	1.00	0.044	7.44	1.18	16%
P258	1.00	0.018	4.76	1.18	25%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P259	1.00	0.012	3.89	1.18	30%
P260	1.00	0.008	3.17	1.18	37%
P261	1.00	0.007	2.89	1.18	41%
P262	1.00	0.007	2.88	1.18	41%
P263	0.83	0.032	3.90	1.18	30%
P264	0.83	0.023	3.33	1.18	36%
P265	0.83	0.034	4.04	1.18	29%
P266	0.83	0.020	3.08	1.18	38%
P267	0.83	0.025	3.46	1.18	34%
P268	0.83	0.027	3.57	1.18	33%
P269	0.83	0.019	3.03	1.19	39%
P270	0.83	0.007	1.88	1.19	63%
P271	0.67	0.013	1.38	1.19	86%
P272	0.67	0.009	1.16	1.19	102%
P273	0.67	0.010	1.17	1.19	101%
P274	0.67	0.010	1.17	1.19	101%
P275	0.67	0.009	1.16	1.20	103%
P276	0.67	0.004	0.76	1.20	159%
P277	1.25	0.014	7.75	2.64	34%
P278	1.25	0.008	5.83	2.64	45%
P279	1.25	0.008	5.91	2.64	45%
P280	1.25	0.004	4.18	2.64	63%
P281	1.25	0.007	5.53	2.64	48%
P282	1.25	0.023	9.83	2.65	27%
P283	1.25	0.005	4.74	2.65	56%
P284	1.00	0.002	1.51	1.68	111%
P285	1.00	0.002	1.50	1.68	112%
P286	1.00	0.002	1.50	1.68	112%
P287	1.00	0.002	1.51	1.68	112%
P288	0.83	0.002	0.97	1.68	173%
P290	2.75	0.008	46.66	19.01	41%
P291	2.75	0.008	47.45	19.01	40%
P292	2.75	0.008	47.06	19.01	40%
P293	2.75	0.016	67.47	19.01	28%
P294	2.75	0.009	51.38	19.01	37%
P295	2.25	0.028	52.07	19.01	37%
P296	2.00	0.025	35.68	19.01	53%
P297	2.00	0.036	42.92	19.01	44%
P298	2.00	0.058	54.35	19.01	35%
P299	2.00	0.058	54.41	19.01	35%
P300	2.00	0.028	37.57	19.01	51%
P301	2.00	0.041	45.46	19.01	42%
P302	2.00	0.046	48.23	19.01	39%
P303	2.00	0.009	21.22	19.01	90%
P304	2.00	0.028	37.49	19.01	51%
P305	2.00	0.012	24.83	19.01	77%
P306	2.00	0.009	21.44	19.01	89%
P307	2.00	0.014	26.82	19.01	71%
P307A	2.00	0.015	27.45	19.01	69%
P308	1.25	0.009	6.01	5.70	100%[1]

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P309	1.25	0.009	6.16	5.70	100%[1]
P310	1.25	0.010	6.28	5.70	100%[1]
P311	1.25	0.013	7.45	3.09	100%[1]
P311A	1.25	0.012	7.16	2.61	100%[1]
P311B	1.25	0.012	7.01	2.61	100%[1]
P311C	1.25	0.022	9.52	2.61	27%
P311D	1.25	0.009	6.26	2.61	42%
P312	1.00	0.011	3.71	2.26	100%[1]
P313	1.00	0.026	5.68	2.26	100%[1]
P314	0.83	0.025	3.43	2.26	100%[1]
P315	1.75	0.006	12.63	4.86	39%
P316	1.75	0.006	12.59	4.86	39%
P317	1.75	0.005	11.57	4.86	42%
P318A	1.75	0.005	11.26	4.86	43%
P319	1.00	0.016	4.50	4.74	105%
P319A	1.00	0.022	5.31	0.12	2%
P320	0.83	0.018	2.93	4.74	162%
P321	0.83	0.020	3.09	4.74	153%
P322	1.00	0.037	6.80	0.12	2%
P323	1.00	0.042	7.24	4.87	67%
P324	1.00	0.042	7.30	4.86	67%
P325	1.25	0.024	10.06	1.71	17%
P326	1.25	0.015	7.83	1.71	22%
P327	0.83	0.021	3.15	1.71	54%
P327A	1.00	0.018	4.70	3.15	67%
P328	1.00	0.018	4.81	3.23	67%
P329	1.17	0.004	3.46	2.31	100%[1]
P329A	1.00	0.003	1.98	1.28	100%[1]
P330	1.25	0.003	3.77	2.31	100%[1]
P331	1.25	0.003	3.59	2.30	100%[1]
P332	1.00	0.003	1.88	1.89	101%
P333	1.00	0.003	1.88	1.89	100%
P334	1.00	0.003	1.89	1.89	100%
P335	1.00	0.003	1.92	1.62	100%[1]
P336	1.00	0.003	1.93	1.61	100%[1]
P337	1.00	0.003	1.94	1.59	100%[1]
P338	1.00	0.003	2.03	1.17	100%[1]
P339	0.83	0.003	1.23	1.17	100%[1]
P340	0.83	0.002	1.02	0.64	100%[1]
P341	0.83	0.003	1.15	0.64	100%[1]
P342	0.83	0.002	1.05	0.64	100%[1]
P343	0.83	0.003	1.25	0.64	100%[1]
P344	1.25	0.003	3.64	1.66	46%
P345	1.25	0.003	3.62	1.36	38%
P346	1.25	0.003	3.63	1.37	38%
P347	1.25	0.003	3.56	1.37	38%
P348	1.50	0.002	4.80	1.37	28%
P349	1.50	0.003	5.41	1.37	25%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P350	1.50	0.002	4.76	1.37	29%
P351	1.25	0.002	2.94	1.06	36%
P352	1.25	0.011	6.62	1.06	16%
P353	1.25	0.012	6.96	1.06	15%
P354	1.25	0.008	5.84	1.06	18%
P355	1.25	0.010	6.44	1.06	16%
P356	0.67	0.011	1.26	0.25	100%[1]
P357	0.67	0.011	1.23	0.25	100%[1]
P358	0.67	0.011	1.23	0.25	20%
P359	0.67	0.010	1.23	0.25	21%
P360	0.67	0.011	1.23	0.25	20%
P361	0.67	0.010	1.20	0.09	8%
P362	0.67	0.011	1.27	0.09	7%
P363	0.67	0.011	1.27	0.09	7%
P364	0.67	0.010	1.17	0.09	8%
P365	0.67	0.003	0.65	0.58	100%[1]
P366	0.67	0.006	0.97	0.52	100%[1]
P367	0.67	0.022	1.78	0.52	29%
P368	0.67	0.007	1.00	0.26	26%
P369	0.67	0.012	1.32	0.26	20%
P370	0.67	0.012	1.34	0.26	19%
P371	0.67	0.013	1.37	0.26	19%
P372	0.67	0.005	0.81	0.51	100%[1]
P373	0.67	0.005	0.82	0.51	62%
P374	0.67	0.004	0.74	0.51	70%
P375	0.67	0.004	0.80	0.51	64%
P376	0.67	0.008	1.08	0.26	24%
P377	0.67	0.008	1.04	0.26	25%
P378	0.67	0.017	1.57	0.26	16%
P379	0.67	0.014	1.44	0.26	18%
P380	0.67	0.012	1.29	0.26	20%
P381	0.67	0.010	1.20	0.26	21%
P382	0.67	0.010	1.21	0.26	21%
P383	0.67	0.010	1.22	0.26	21%
P384	0.67	0.010	1.20	0.26	21%
P385	0.67	0.010	1.22	0.26	21%
P386	0.67	0.010	1.18	0.26	22%
P387	0.67	0.010	1.21	0.26	21%
P388	0.67	0.009	1.15	0.26	22%
P389	1.50	0.013	12.03	0.44	4%
P390	1.25	0.020	9.11	0.44	5%
P391	1.25	0.019	8.85	0.44	5%
P392	1.25	0.018	8.62	0.44	5%
P393	1.50	0.007	8.86	0.44	5%
P394	1.50	0.007	8.72	0.44	5%
P395	1.50	0.001	2.63	0.44	17%
P396	1.00	0.033	6.45	0.44	7%
P397	1.00	0.247	17.64	0.22	1%
P398	1.25	0.010	6.56	0.22	3%
P399	1.25	0.010	6.51	0.22	3%

Table 7-1-B
Sewer Analysis Results (Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Future Modeled Peak Flow (cfs)	Future % Full
P400	1.25	0.010	6.58	0.22	3%
P401	1.25	0.028	10.69	0.22	2%
P402	1.25	0.014	7.73	0.22	3%
P403	1.25	0.033	11.78	0.22	2%
P404	1.25	0.022	9.51	0.22	2%
P405	1.25	0.335	37.25	0.22	1%
P406	1.25	0.209	29.45	0.22	1%
P407	1.25	0.040	12.93	0.22	2%
P408	0.83	0.034	4.04	1.86	46%
P409	0.83	0.190	9.49	1.86	20%
P410	0.67	0.066	3.07	1.86	60%
P411	0.67	0.074	3.26	1.86	57%
P412	0.67	0.077	3.33	1.86	56%

1. Due to back-up in sewer system.

7.0 DEFICIENCIES AND SOLUTIONS

7.1 Deficient and Marginally Deficient Pipes

The City's design criteria for sewer lines allows pipes to flow at a ratio of 75% of "full" hydraulic capacity. Assuming that "full" capacity is the maximum hydraulic capacity of a pipe flowing under gravity (non-pressure) conditions, Mannings equation shows that maximum flow occurs when a pipe reaches a flow depth ratio of about 95% d/D.

Pipe reaches which fail the "75% full" criteria for both existing and future flow conditions are shown in Table 7-2 and Figures 18 and 20. It is seen that portions of the modeled trunk system are already flowing at greater than "75% full", and several reaches are computed to be over 100% full (surcharge conditions). At ultimate conditions, numerous additional reaches are shown to surcharge or exceed the "75% full" criteria.

The pipes that are currently deficient are shown in Figure 18 whereas the pipes that are currently deficient in velocity are shown in Figure 19. The pipes that would be deficient in flow in the future are shown in Figure 20.

7.2 Project Prioritization Methodology

The 75% full criteria is useful for analyzing deficient pipes and as a basis for sizing new facilities. However, the criteria is not necessarily the trigger point for replacement or augmentation of an existing sewer line.

In most cases, a sewer entity would not implement a relief project until capacity problems are actually observed or known to be imminent.

A recommended system of project prioritization is the categorization of deficient sewer lines in different priorities, where the "A" priority projects are imminently needed and the "B" and "C" projects require further considerations for replacement. Priority classifications are described as follows:

Priority "A" – The pipes listed within this priority are currently deficient and are flowing more than 90% full under maximum flow condition. These pipes need replacement / re-habilitation in near future (year 2004-2007).

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P01	62	27	72%	120%	36	56%	B	2008-2013
P02	219	27	71%	119%	36	55%	B	2008-2013
P03	296	27	68%	113%	36	52%	B	2008-2013
P04	225	27	65%	109%	36	50%	B	2008-2013
P05	457	27	68%	113%	36	52%	B	2008-2013
P06	387	27	79%	131%	36	61%	B	2008-2013
P07	207	27	76%	127%	36	59%	B	2008-2013
P08	94	27	80%	133%	36	61%	B	2008-2013
P09	138	27	73%	124%	36	57%	B	2008-2013
P10	38	30	70%	119%	36	73%	B	2008-2013
P11	40	30	72%	122%	42	50%	B	2008-2013
P12	85	27	68%	115%	42	35%	B	2008-2013
P13	257	27	62%	106%	42	32%	B	2008-2013
P14	16	24	74%	126%	42	28%	B	2008-2013
P15	450	21	157%	276%	42	43%	A	2004-2007
P16	180	21	140%	246%	42	39%	A	2004-2007
P17	24	21	139%	246%	42	38%	A	2004-2007
P18	198	24	157%	277%	42	62%	A	2004-2007
P19(Siphon)	97	2-15	120%	236%	2-18	144%	C	2014-2018
P20	144	27	84%	165%	42	51%	A	2004-2007
P21	571	27	74%	145%	42	44%	B	2008-2013
P22	133	27	72%	141%	42	43%	B	2008-2013
P23	414	27	74%	145%	42	44%	B	2008-2013
P24	200	24	61%	119%	42	27%	B	2008-2013
P25	50	27	100%	197%	42	60%	A	2004-2007
P26	200	27	73%	144%	42	44%	B	2008-2013
P27	39	27	52%	107%	42	33%	B	2008-2013
P28	111	27	67%	137%	42	42%	B	2008-2013
P29	177	27	67%	138%	42	42%	B	2008-2013
P30	281	27	67%	138%	42	42%	B	2008-2013
P31	105	27	69%	141%	42	43%	B	2008-2013
P32	39	27	70%	144%	42	44%	B	2008-2013
P33	15	27	61%	125%	42	38%	B	2008-2013
P34	163	27	68%	139%	42	43%	B	2008-2013
P35	44	27	70%	143%	42	44%	B	2008-2013
P36	265	27	59%	121%	42	37%	B	2008-2013
P37	638	27	59%	121%	42	37%	B	2008-2013
P38	151	24	60%	123%	42	27%	B	2008-2013
P39	190	27	59%	121%	42	37%	B	2008-2013
P40	145	27	60%	123%	42	38%	B	2008-2013
P41	370	27	53%	107%	42	33%	B	2008-2013
P42	27	27	30%	62%				
P43	184	24	63%	129%	42	29%	B	2008-2013
P44	7	24	59%	121%	42	27%	B	2008-2013
P45	290	24	64%	130%	42	29%	B	2008-2013
P46	309	24	64%	131%	42	29%	B	2008-2013
P47	152	24	32%	65%				
P48	28	24	12%	24%				
P49	157	24	83%	168%	42	38%	B	2008-2013
P50(Siphon)	358	1-18	257%	524%	2-18	261%	A	2008-2013[2]
P51	227	24	50%	102%	42	23%	B	2008-2013
P52	15	27	75%	155%	42	47%	B	2008-2013
P53	249	27	90%	185%	42	57%	A	2004-2007
P54	280	27	90%	186%	42	57%	A	2004-2007
P55	195	27	90%	185%	42	57%	A	2004-2007
P56	246	24	87%	179%	36	61%	B	2004-2007[1]
P57	236	24	93%	191%	36	65%	A	2004-2007
P58	166	24	94%	192%	36	65%	A	2004-2007
P59	259	24	94%	192%	36	65%	A	2004-2007
P60	312	21	99%	201%	36	48%	A	2004-2007
P61	190	21	98%	199%	36	47%	A	2004-2007
P62	225	21	98%	199%	36	47%	A	2004-2007
P63	217	21	98%	199%	36	47%	A	2004-2007
P64	211	21	97%	199%	36	47%	A	2004-2007
P65	174	21	98%	199%	36	47%	A	2004-2007
P66	274	21	98%	200%	36	47%	A	2004-2007
P67	106	24	80%	163%	36	55%	B	2008-2013
P68	458	21	70%	145%	36	34%	B	2008-2013
P69	260	21	81%	167%	33	50%	B	2008-2013
P70	304	21	77%	160%	33	48%	B	2008-2013
P71	380	21	80%	166%	33	50%	B	2008-2013
P72	179	21	78%	161%	33	48%	B	2008-2013
P73	144	21	84%	175%	33	52%	B	2008-2013
P74	610	21	85%	176%	33	53%	B	2008-2013
P75	650	21	80%	166%	33	50%	B	2008-2013

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P76	344	21	78%	161%	33	48%	B	2008-2013
P77	578	21	68%	141%	33	42%	B	2008-2013
P78	628	21	68%	141%	33	42%	B	2008-2013
P79	600	21	68%	141%	33	42%	B	2008-2013
P80	500	21	69%	143%	33	43%	B	2008-2013
P81	453	18	95%	197%	33	39%	A	2004-2007
P82	73	18	95%	196%	33	39%	A	2004-2007
P83	118	18	95%	196%	33	39%	A	2004-2007
P84	48	18	94%	195%	33	39%	A	2004-2007
P85	177	18	95%	196%	33	39%	A	2004-2007
P86	9	18	92%	192%	33	38%	A	2004-2007
P87	203	18	30%	30%				
P88	525	18	22%	22%				
P89	525	18	23%	23%				
P90	675	18	24%	24%				
P91	720	18	24%	24%				
P92	177	21	5%	5%				
P93	287	21	5%	5%				
P94	246	21	5%	5%				
P95	201	15	3%	3%				
P96	81	27	7%	7%				
P97	75	27	6%	6%				
P98	133	27	6%	6%				
P99	313	27	7%	7%				
P100	178	27	6%	6%				
P101	90	27	6%	6%				
P102	252	27	7%	7%				
P103	243	27	6%	6%				
P104	193	27	6%	6%				
P105	209	27	3%	3%				
P106	97	27	3%	3%				
P107	181	27	4%	4%				
P108	197	27	4%	4%				
P109	175	27	3%	3%				
P110	247	27	3%	3%				
P111	97	27	3%	3%				
P112	281	27	3%	3%				
P113	350	27	3%	3%				
P114	150	27	3%	3%				
P115	204	27	3%	3%				
P116	303	27	3%	3%				
P117	389	27	3%	3%				
P118	342	27	3%	3%				
P119	257	24	4%	4%				
P120	245	24	4%	4%				
P121	134	10	0%	0%				
P130	471	24	21%	51%				
P131	465	24	20%	48%				
P132	495	24	20%	48%				
P133	496	24	20%	48%				
P134	63	24	14%	32%				
P135	172	33	8%	19%				
P136	400	21	19%	45%				
P137	500	21	23%	53%				
P138	500	24	21%	50%				
P139	500	21	21%	48%				
P140	173	21	20%	48%				
P141	327	21	20%	48%				
P142	500	21	27%	63%				
P143	500	21	22%	52%				
P144	525	21	25%	58%				
P145	95	21	26%	62%				
P146	480	21	24%	56%				
P147	500	21	23%	54%				
P148	500	21	22%	52%				
P149	500	21	23%	55%				
P150	370	21	26%	63%				
P151	505	27	27%	64%				
P152	244	27	20%	48%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P153	248	27	20%	48%				
P154	283	27	27%	64%				
P155	492	27	17%	41%				
P156	450	27	18%	42%				
P157	107	42	26%	60%				
P158	293	42	26%	64%				
P159	173	42	25%	62%				
P160	327	42	25%	62%				
P161	500	42	25%	62%				
P162	500	42	25%	48%				
P163	1000	42	25%	48%				
P164	400	42	23%	48%				
P165	500	42	23%	48%				
P166	500	42	23%	48%				
P167	500	42	23%	48%				
P168	500	42	23%	48%				
P169	475	42	23%	48%				
P170	446	42	24%	49%				
P-171	14	42	15%	32%				
P172	100	20	19%	40%				
P173	426	42	21%	43%				
P174	212	30	41%	73%				
P175	377	30	41%	73%				
P176	400	30	42%	73%				
P177	193	30	42%	75%	36	46%	C	2014-2018[7]
P178	207	30	41%	72%				
P179	400	30	42%	74%				
P180	425	30	42%	73%				
P181	407	30	42%	73%				
P182	430	24	52%	74%				
P183	504	24	52%	74%				
P184	506	24	53%	74%				
P185	500	24	52%	74%				
P186	450	24	52%	74%				
P187	350	24	10%	14%				
P188	520	24	54%	76%	30	42%	C	2014-2018[7]
P189	454	18	37%	55%				
P190	450	18	37%	55%				
P191	450	18	37%	55%				
P192	450	18	33%	47%				
P193	441	18	30%	42%				
P194	30	18	26%	39%				
P195	400	18	25%	36%				
P196	450	18	27%	36%				
P197	450	18	26%	36%				
P198	411	18	36%	50%				
P199	439	18	26%	36%				
P200	450	18	38%	53%				
P201	450	18	38%	53%				
P202	450	18	36%	51%				
P203	450	18	36%	51%				
P204	435	18	34%	47%				
P205	8178	16						Force Main
P206	56	21	43%	61%				
P207	65	18	48%	64%				
P208	176	18	49%	65%				
P209	25	18	37%	51%				
P210	465	18	38%	52%				
P211	462	18	38%	52%				
P212	13	18	33%	45%				
P213	174	18	7%	9%				
P214	174	18	38%	52%				
P215	228	18	38%	52%				
P216	106	18	10%	14%				
P217	344	18	10%	14%				
P218	424	18	36%	50%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P219	86	12	14%	21%				
P220	401	12	37%	55%				
P221	450	12	42%	67%				
P222	450	12	42%	67%				
P223	450	12	42%	65%				
P224	450	12	42%	64%				
P225	316	12	34%	50%				
P226	131	12	33%	50%				
P227	203	12	33%	50%				
P228	450	12	53%	80%	15	44%	C	2014-2018
P229	450	12	53%	80%	15	44%	C	2014-2018
P230	450	12	53%	80%	15	44%	C	2014-2018
P231	429	12	53%	80%	15	44%	C	2014-2018
P232	149	8	47%	91%	15	17%	B	2014-2018[4]
P233	260	8	3%	28%				
P234	294	8	3%	31%				
P235	450	10	32%	33%				
P236	210	10	32%	33%				
P237	146	10	32%	33%				
P238	225	18	15%	22%				
P239	270	18	15%	22%				
P240	70	18	15%	22%				
P241	310	12	27%	30%				
P242	300	12	27%	30%				
P243	172	12	9%	11%				
P244	203	12	9%	11%				
P245	285	12	9%	11%				
P246	90	12	9%	11%				
P247	350	12	10%	12%				
P248	400	12	34%	39%				
P249	391	12	34%	39%				
P250	442	12	34%	39%				
P251	437	12	19%	21%				
P252	156	12	35%	40%				
P253	352	15	14%	23%				
P254	338	15	21%	36%				
P255	337	12	13%	22%				
P256	300	12	22%	36%				
P257	400	12	10%	16%				
P258	380	12	15%	25%				
P259	320	12	19%	31%				
P260	350	12	23%	38%				
P261	201	12	25%	42%				
P262	99	12	25%	42%				
P263	350	10	19%	31%				
P264	274	10	22%	36%				
P265	277	10	18%	30%				
P266	301	10	24%	39%				
P267	302	10	21%	35%				
P268	351	10	20%	34%				
P269	350	10	24%	40%				
P270	348	10	39%	64%				
P271	352	8	53%	88%	10	48%	C	2008-2013[6]
P272	277	8	63%	104%	10	57%	B	2008-2013
P273	23	8	62%	103%	10	56%	B	2008-2013
P274	300	8	62%	103%	10	56%	B	2008-2013
P275	299	8	63%	104%	10	57%	B	2008-2013
P276	299	8	96%	161%	12	60%	A	2008-2013[2]
P277	435	15	4%	34%				
P278	440	15	5%	45%				
P279	428	15	5%	45%				
P280	574	15	8%	63%				
P281	710	15	6%	48%				
P282	123	15	3%	27%				
P283	24	15	7%	56%				
P284	339	12	66%	111%	18	46%	B	2008-2013
P285	343	12	67%	112%	18	47%	B	2008-2013
P286	337	12	67%	112%	18	47%	B	2008-2013
P287	338	12	67%	112%	18	46%	B	2008-2013
P288	380	10	104%	173%	18	44%	A	2004-2007
P290	12	33	17%	41%				
P291	190	33	17%	40%				
P292	521	33	17%	40%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P293	507	33	12%	28%				
P294	507	33	16%	37%				
P295	507	27	15%	37%				
P296	246	24	22%	53%				
P297	450	24	19%	44%				
P298	450	24	15%	35%				
P299	450	24	15%	35%				
P300	450	24	21%	51%				
P301	450	24	18%	42%				
P302	450	24	17%	39%				
P303	450	24	38%	90%	30	49.38%	B	2014-2018[5]
P304	450	24	21%	51%				
P305	450	24	32%	77%	30	42.18%	C	2014-2018[5]
P306	446	24	37%	89%	30	48.85%	C	2014-2018[5]
P307	454	24	30%	71%				
P307A	254	24	29%	69%				
P308	46	15	100%[8]	77%	18	58.43%	C	2014-2018
P309	400	15	100%[8]	75%	18	56.95%	C	2014-2018
P310	100	15	100%[8]	73%				See Appendix "C"
P311	23	15	100%[8]	35%				See Appendix "C"
P311A	227	15	100%[8]	28%				See Appendix "C"
P311B	324	15	100%[8]	29%				See Appendix "C"
P311C	54	15	26%	21%				
P311D	32	15	39%	32%				
P312	569	12	100%[8]	48%				See Appendix "C"
P313	27	12	100%[8]	32%				See Appendix "C"
P314	34	10	100%[8]	52%				See Appendix "C"
P315	348	21	36%	30%				
P316	377	21	36%	30%				
P317	28	21	39%	33%				
P318A	8	21	40%	34%				
P319	21	12	65%	84%	15	52.05%	C	2004-2007[3]
P319A	361	12	30%	30%				
P320	396	10	100%[8]	130%	15	49.11%	A	2004-2007
P321	20	10	100%[8]	123%	15	46.48%	A	2004-2007
P322	15	12	23%	23%				
P323	178	12	62%	52%				
P324	132	12	62%	52%				
P325	13	15	16%	13%				
P326	68	15	20%	17%				
P327	10	10	50%	42%				
P327A	87	12	62%	53%				
P328	397	12	60%	48%				
P329	33	14	100%[8]	34%				See Appendix "C"
P329A	397	12	100%[8]	58%				See Appendix "C"
P330	355	15	100%[8]	31%				See Appendix "C"
P331	10	15	100%[8]	32%				See Appendix "C"
P332	395	12	100%[8]	37%				See Appendix "C"
P333	118	12	100%[8]	37%				See Appendix "C"
P334	282	12	100%[8]	37%				See Appendix "C"
P335	164	12	100%[8]	22%				See Appendix "C"
P336	250	12	100%[8]	22%				See Appendix "C"
P337	429	12	100%[8]	22%				See Appendix "C"
P338	412	12	100%[8]	3%				See Appendix "C"
P339	399	10	100%[8]	52%				Abandon in place
P340	206	10	100%[8]	63%				See Appendix "C"
P341	18	10	100%[8]	56%				See Appendix "C"
P342	172	10	100%[8]	61%				See Appendix "C"
P343	395	10	100%[8]	134%				See Appendix "C"
P344	545	15	35%	37%				
P345	303	15	28%	38%				
P346	242	15	28%	38%				
P347	294	15	29%	38%				
P348	72	18	21%	28%				
P349	109	18	19%	25%				
P350	68	18	21%	22%				

Table 7-2
Proposed Construction Prioritization and Schedule

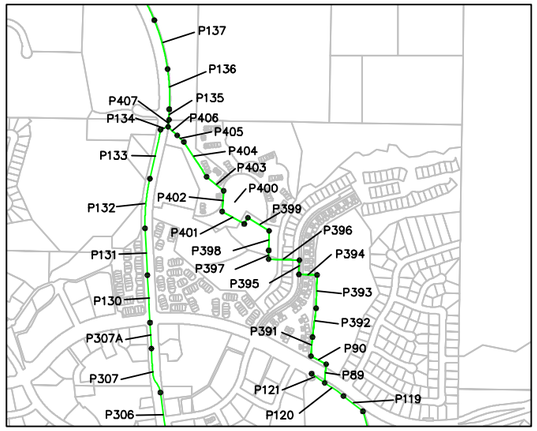
Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
P351	24	15	27%	36%				
P352	315	15	12%	16%				
P353	267	15	11%	15%				
P354	38	15	14%	18%				
P355	157	15	12%	4%				
P356	115	8	100%[8]	20%				See Appendix "C"
P357	100	8	100%[8]	20%				See Appendix "C"
P358	423	8	20%	20%				
P359	205	8	21%	21%				
P360	395	8	20%	7%				
P361	201	8	8%	8%				
P362	197	8	7%	7%				
P363	398	8	7%	7%				
P364	378	8	8%	44%				
P365	651	8	100%[8]	80%	10	44%	A	2004-2007[3]
P366	401	8	100%[8]	54%				See Appendix "C"
P367	195	8	29%	15%				
P368	399	8	26%	26%				
P369	197	8	20%	20%				
P370	201	8	19%	19%				
P371	400	8	19%	38%				
P372	219	8	100%[8]	64%				See Appendix "C"
P373	211	8	63%	62%				
P374	212	8	70%	70%				
P375	203	8	65%	32%				
P376	184	8	24%	24%				
P377	13	8	25%	25%				
P378	198	8	16%	16%				
P379	132	8	18%	18%				
P380	69	8	20%	20%				
P381	199	8	21%	21%				
P382	181	8	21%	21%				
P383	16	8	21%	21%				
P384	201	8	22%	21%				
P385	117	8	21%	21%				
P386	21	8	22%	22%				
P387	255	8	21%	21%				
P388	11	8	22%	22%				
P389	166	18	4%	4%				
P390	170	15	5%	5%				
P391	189	15	5%	5%				
P392	288	15	5%	5%				
P393	330	18	5%	5%				
P394	181	18	5%	5%				
P395	143	18	17%	17%				
P396	304	12	7%	7%				
P397	81	12	1%	1%				
P398	194	15	3%	3%				
P399	246	15	3%	3%				
P400	72	15	3%	3%				
P401	250	15	2%	2%				
P402	206	15	3%	3%				
P403	217	15	2%	2%				
P404	413	15	2%	2%				
P405	93	15	1%	1%				
P406	130	15	1%	1%				
P407	71	15	2%	2%				
P408	433	10	45%	46%				
P409	113	10	19%	20%				
P410	379	8	59%	60%				
P411	311	8	55%	57%				
P412	311	8	56%	56%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Length (ft)	Existing Pipe Size (inch)	Existing % Full	Future % Full	Proposed Pipe Size (inch)	New % Full for Future Flow	Priority	Approximate Replacement Period
New Pipelines:								
L440	414				12		A	2004-2007
L441	393				12		A	2004-2007
L442	396				12		A	2004-2007
L443	398				12		A	2004-2007
P1000	730				27		C	2014-2018
P1001	735				27		C	2014-2018
P1002	1160				27		C	2014-2018
P1003	560				27		C	2014-2018
P1004	1900				27		C	2014-2018
P1005	5260				27		C	2014-2018
P1005A	2650				27		C	2014-2018
P1006	650				27		C	2014-2018
P1013	2070				30		C	2014-2018
P1013A	250				30		C	2014-2018
P1014	1470				30		C	2014-2018
P1015	2060				30		C	2014-2018
P1016	360				30		C	2014-2018
P1017	195				30		C	2014-2018
P1018	195				30		C	2014-2018
P1019	350				30		C	2014-2018
P1020	570				30		C	2014-2018

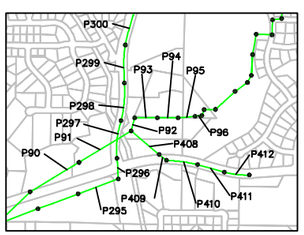
Notes:

1. Although this pipeline is under priority "B" it is proposed to be replaced in the period 2004-2007 to maintain continuity.
2. This segment of pipeline is a Siphon and would require replacement / re-habilitation in the period 2008-2013.
3. This segment is part of proposed improvement of Market Street so it is proposed to be replaced in the period 2004-2007.
4. Although this pipeline is under priority "B" it is proposed to be replaced in the period 2014-2018 to maintain continuity.
5. Although this pipeline is under priority "C" this segment would not be replaced due to proposed diversion of flow along Cyn Crest.
6. Although this pipeline is under priority "C" it is proposed to be replaced in the period 2008-2013 to maintain continuity.
7. Although this pipeline is under priority "C" (approx. 75% full), it may not have capacity problem in future due to larger diameter.
8. Surcharging conditions due to back-up in sewer system.

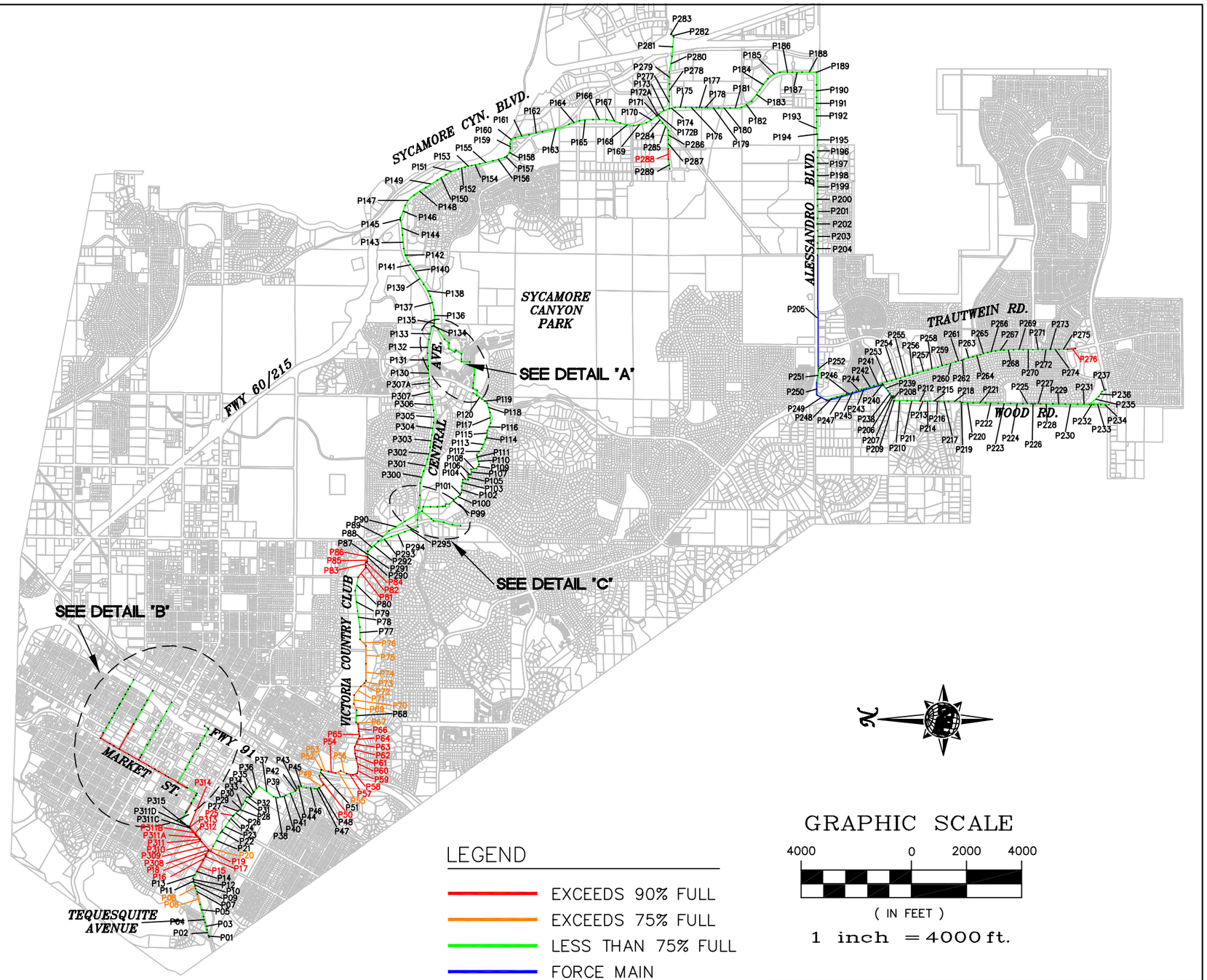


DETAIL "A"
NOT TO SCALE

DETAIL "B"
NOT TO SCALE



DETAIL "C"
NOT TO SCALE



LEGEND

- EXCEEDS 90% FULL
- EXCEEDS 75% FULL
- LESS THAN 75% FULL
- FORCE MAIN

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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Planning
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Construction Services

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3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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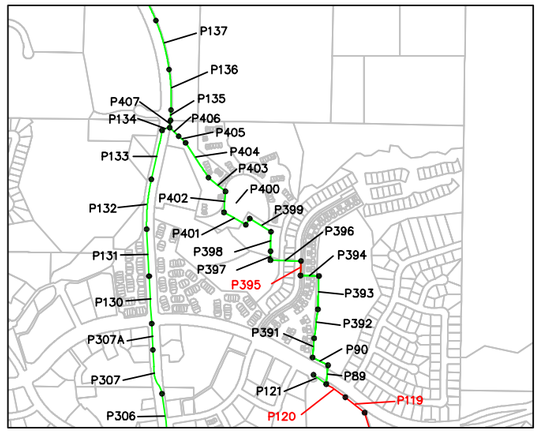
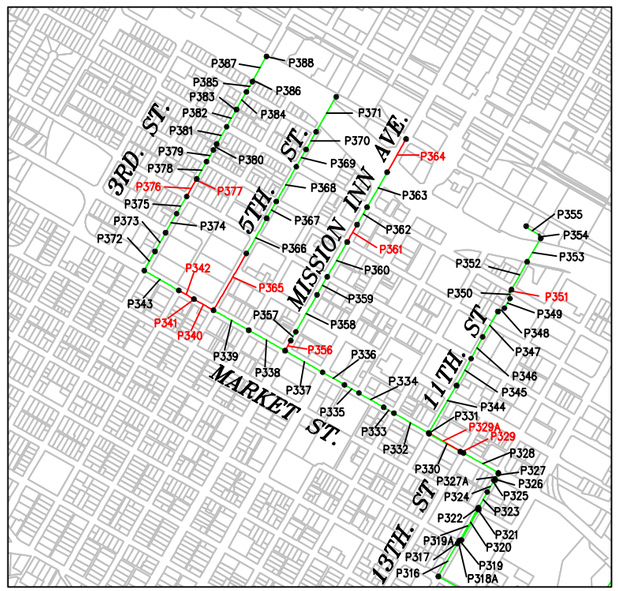
FIGURE 18

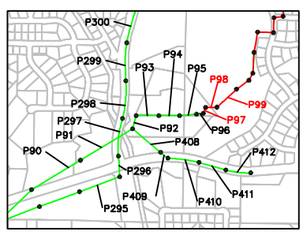
EXISTING FLOW CONDITIONS



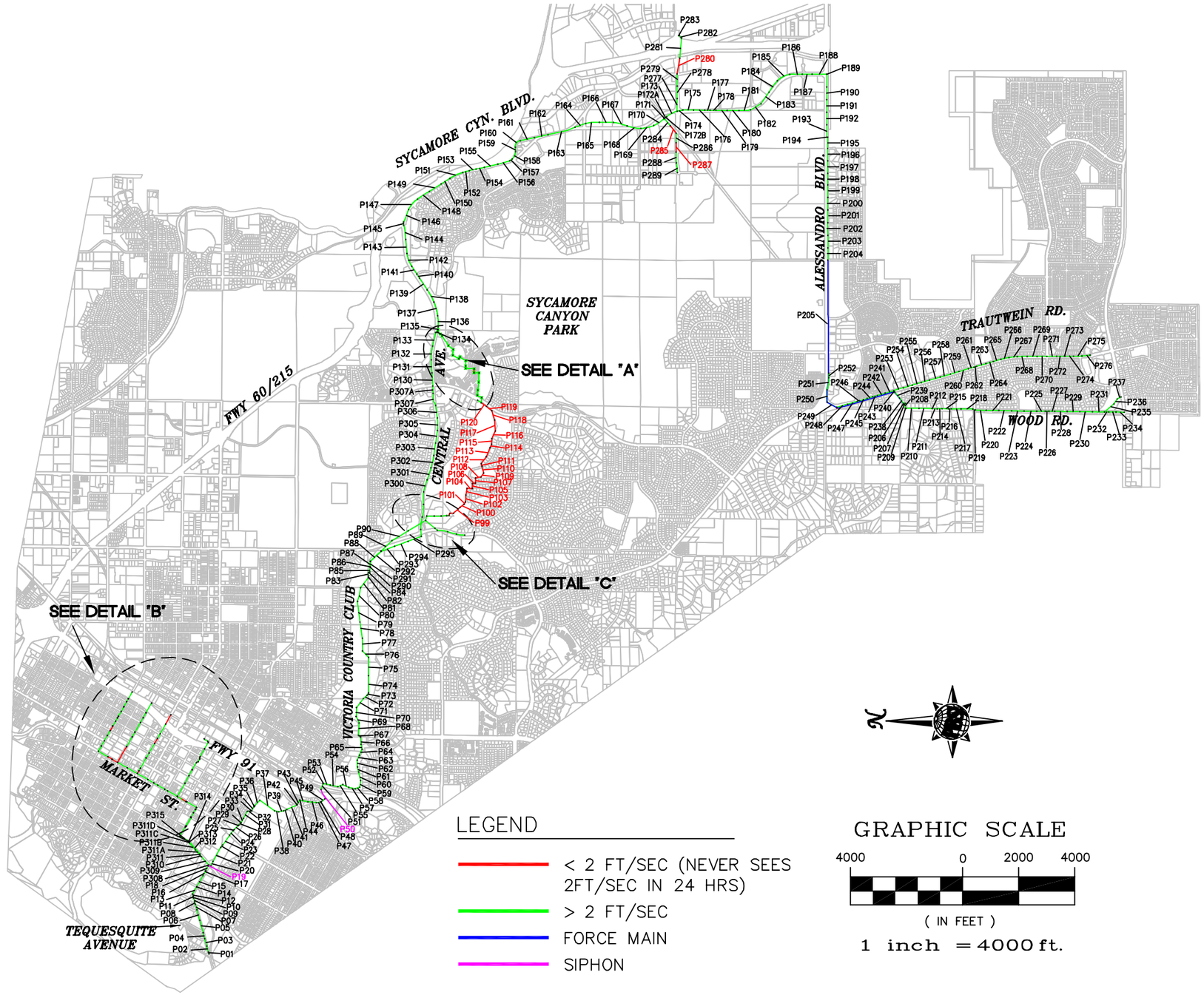
DETAIL "A"
NOT TO SCALE



DETAIL "B"
NOT TO SCALE



DETAIL "C"
NOT TO SCALE



LEGEND

- < 2 FT/SEC (NEVER SEES 2FT/SEC IN 24 HRS)
- > 2 FT/SEC
- FORCE MAIN
- SIPHON

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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Construction Services

PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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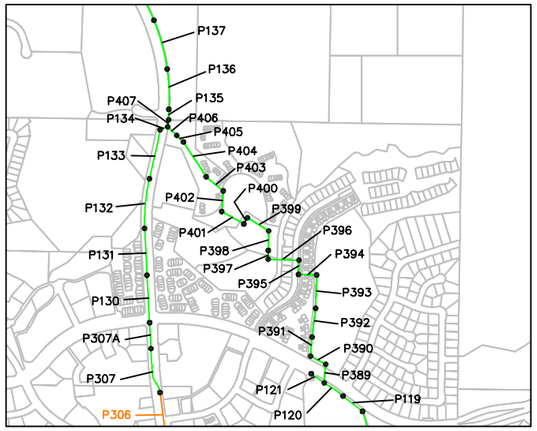
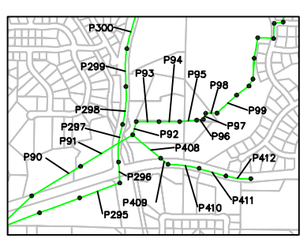
FIGURE 19

EXISTING SYSTEM DEFICIENCIES (VELOCITY)

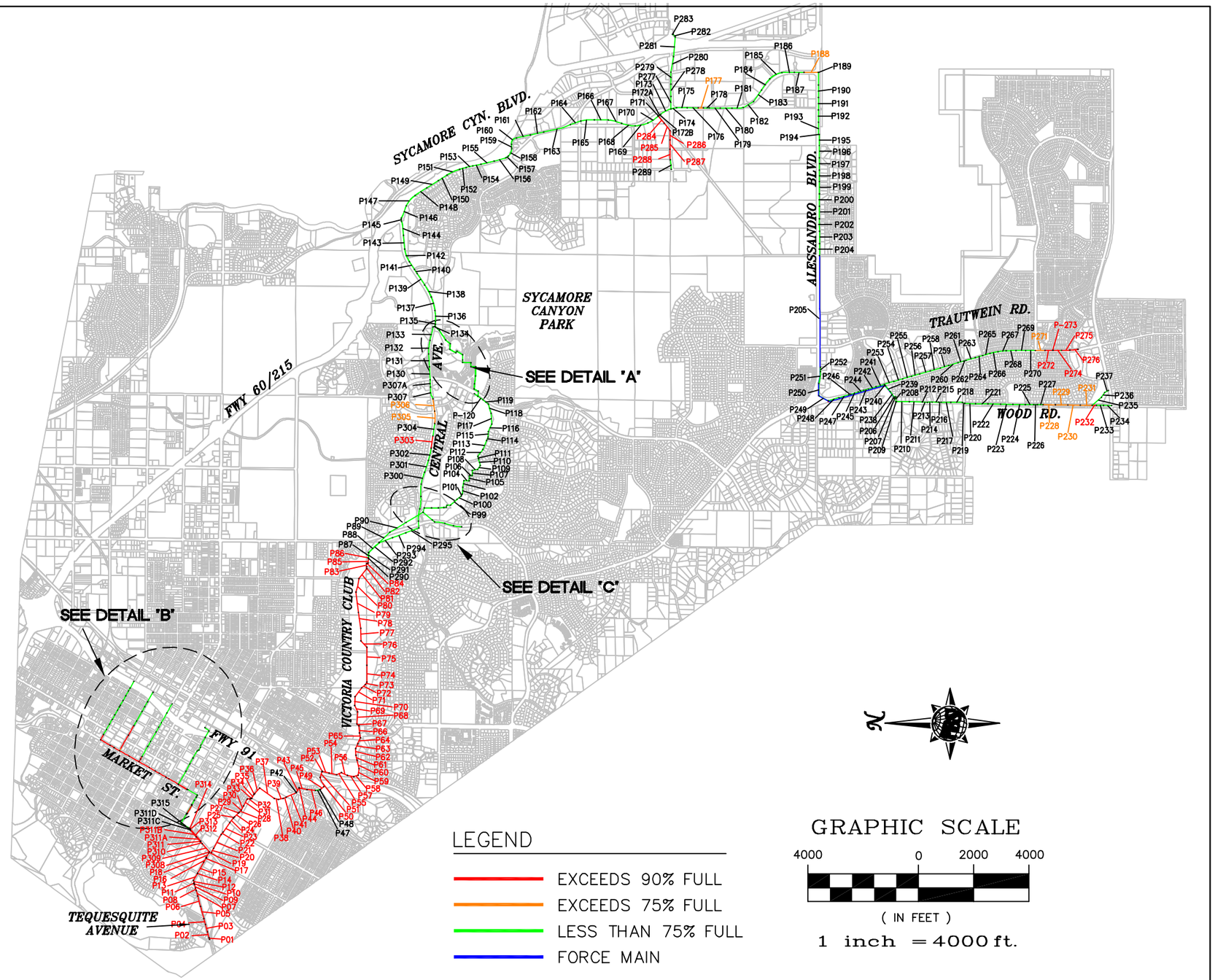


DETAIL "A"
NOT TO SCALE

DETAIL "B"
NOT TO SCALE



DETAIL "C"
NOT TO SCALE



N

LEGEND

- EXCEEDS 90% FULL
- EXCEEDS 75% FULL
- LESS THAN 75% FULL
- FORCE MAIN

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

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PBS&J

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Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

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FIGURE 20

ULTIMATE FLOW CONDITIONS

Priority “B” – The pipes listed in this priority would be flowing more than 90% full in the future under maximum flow condition. A linear interpolation was done for anticipation of mid term flow in pipes between current year (2003) and ultimate year (2018). These pipes need evaluation as new development takes place in the tributary area. The flow monitoring within the study area should be considered for actual flow measurements. The pipes under this priority are grouped for replacement / re-habilitation in the period (2008-2013).

Priority “C” – The existing trunk sewer system would not be capable to handle anticipated ultimate flow without excess construction activities for replacement or re-habilitation of sewer system in the Victoria Country Club area. Also, an alternative sewer system would be required for the proposed expansion of UCR in Chicago Ave. - MLK Blvd. area. An alternative relief trunk sewer system (described separately) would intercept sewage flow from the existing sewer system at the intersection of Canyon Crest Dr. and Central Avenue to relieve the existing sewer system. This proposed new sewer system and pipelines in the existing sewer system that would flow more than 75% full under future flow conditions be listed under priority “C”. An evaluation of the existing system would be required before undertaking this priority.

7.3 Recommended Improvements

Table 7.3 lists project priority, project location, problem, solution and approximate cost for problem reaches. This table identifies immediate and future problems in the sewer lines and suggested solutions for that. The project cost is based on year 2003 prices.

7.4 Grouping of Projects

Proposed improvements under different priorities have been combined or grouped into projects to improve deficient and marginally deficient pipes based on following criteria:

- Pipes identified as either deficient (Priority “A”) or marginally deficient (Priority “B”), located geographically close to one another and requiring improvements in future (2004-2013) are grouped to reduce improvement costs.
- Some pipe reaches identified as marginally deficient (Priority “B”) and marginally deficient in future (Priority “C”) are grouped together for the same reason as mentioned above. However, improvements of these reaches would not be required until year 2014.
- Pipes identified in Priority “A” and Priority “C” in Market Street area are grouped together because the City is proposing improvements of Market Street in near future.

Table 7-3
Summary of Improvement Plans for Problem Areas

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2003 $'s)
"A" (See Figure 21 and Table 7-7-A for details of pipes)	Tequesquite Avenue	Pipes P15 to P18, Pipe P20 and Pipe P25	Immediate Capacity Problem in the reach M25 to M14 due to flat slopes. Surcharging conditions.	Replace pipes with larger size pipes maintaining the same slope	$568,000
	Hwy 91 / Victoria Country Club	Pipes P53 to P66 and P81 to P86	Immediate Capacity Problem in the reach M67 to M53 and reach M87 to M81 due to flat slopes. Surcharging conditions.	Replace pipes with larger size pipes maintaining the same slope	$1,512,000
	Eastridge Avenue	Pipe P288	Immediate Capacity Problem in the reach M289 to M288 due to flat slope and smaller pipe size. Surcharging conditions.	Replace pipe with larger size pipe maintaining the same slope	$102,000
	13th Street	Pipes P319, P320 and P321	Immediate Capacity Problem in the reach M320 to M318 due to flat slopes, old pipes and smaller pipe sizes. Surcharging conditions.	Replace pipes with larger size pipes maintaining the same slope	$112,000
	5th Street[1]	Pipe365	Immediate Capacity Problem in the reach M366 to M340 due to flat slopes, old pipes and smaller pipe sizes. Surcharging conditions.	Replace pipe with larger size pipe maintaining the same slope	$123,000
	5th Street (New Pipeline)[1]	Pipes L440, L441, L442 and L443	Immediate Capacity Problems in the reach M340 to M328 due to flat slopes and smaller pipe sizes. Surcharging conditions.	Divert part of flow along Market Street at Manhole M340 along a proposed pipeline along 5th Street east of M340.	$340,000
				Total Cost for Priority "A" Projects (2004-2007 Replacement / Rehabilitation)	**$2,757,000**

Table 7-3
Summary of Improvement Plans for Problem Areas

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2003 $'s)
"B" (See Figure 22 and Table 7-7-B for details of pipes)	Tequesquite Avenue	Pipes P01 to P14 and pipes Pipe P21 to P24	Future Capacity Problem due to increased flow in the system. The main contributor will be proposed Industrial Business Park (IBP) near Fwy 215 and Sycamore Canyon Boulevard.	Replace pipes with larger size pipes maintaining the same slope	$1,868,000
	Riverside Community College (R.C.C.)	Pipes P26 to P46, Pipe P50(Siphon)	Future Capacity Problem due to increased flow in the system. The main contributor will be proposed Industrial Business Park (IBP) near Fwy 215 and Sycamore Canyon Boulevard.	Replace pipes with larger size pipes maintaining the same slope	$2,675,000
	Hwy 91 / Victoria Country Club	Pipes P51, P52 and pipes P67 to P80	Future Capacity Problem due to increased flow in the system. The main contributor will be proposed Industrial Business Park (IBP) near Fwy 215 and Sycamore Canyon Boulevard.	Replace pipes with larger size pipes maintaining the same slope	$1,534,000
	Eastridge Avenue	Pipe P284 to P287	Future Capacity Problem in the reach M284 to M288 due to the proposed IBP development and smaller pipe sizes.	Replace pipe with larger size pipe maintaining the same slope	$347,000
	Trautwein Road	Pipes P271 to P276	Future Capacity Problems in the reach M277 to M270 due to proposed development in the area, smaller pipe sizes.	Replace pipes with larger size pipes maintaining the same slope	$310,000
				Total Cost for Priority "B" Projects (2008-2013 Replacement / Rehabilitation)	**$6,734,000**

Table 7-3
Summary of Improvement Plans for Problem Areas

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2003 $'s)
"C" (See Figure 23 and Table 7-7-C for details of pipes)	Tequesquite Avenue	Pipe P19(Siphon)	Future Capacity Problem due to increased flow in the system. The main contributor will be proposed Industrial Business Park (IBP) near Fwy 215 and Sycamore Canyon Boulevard.	Replace siphon pipes with larger size pipes maintaining the same slope	$147,000
	Wood Road	Pipe P228 to P232	Future Capacity problem due to proposed new developments and smaller pipe sizes.	Replace pipes with larger size pipes maintaining the same slope	$407,000
	Brockton Avenue	Pipes P308, P309	Future Capacity Problem in the reach due to smaller pipe sizes.	Replace pipes with larger size pipes maintaining the same slope	$123,000
	NEW PIPELINES:				
	Cridge Avenue	New pipes Pipe P1015 to P1020	Future capacity problem.The existing sewer system would not be capable to handle anticipated future flow coming into the system primarily from the proposed IBP development without excessive construction activities in the Victoria Country Club area. This would necessitate exploring other alternatives for diversion of flow.	New pipeline for diversion of flow. Pipe size based on anticipated flow.	$1,915,000
	Victoria Avenue	New pipes Pipe P1014 and P1013A	Same as above	Same as above	$594,000
	Pennsylvania Avenue	New Pipe P1013	Same as above	Same as above	$718,000
	Martin Luther King Boulevard	New Pipe P1005, P1005A and P1006	Same as above	Same as above	$2,847,000
	Canyon Crest Drive	New Pipe P1000 to P1004	Same as above	Same as above	$1,649,000
				Total Cost for Priority "C" Projects (2014-2018 Replacement / Rehabilitation)	**$8,400,000**

1. See Appendix "C"

7.5 Construction Schedule

A summary of proposed construction prioritization and recommended scheduling is shown in Table 7-2. This table lists construction priorities and the year in which these activities are proposed. The pipes falling under priority “A” need near term replacement (2004-2007) whereas priority “B” and “C” pipes would need re-evaluation before their replacement.

7.6 Alternative

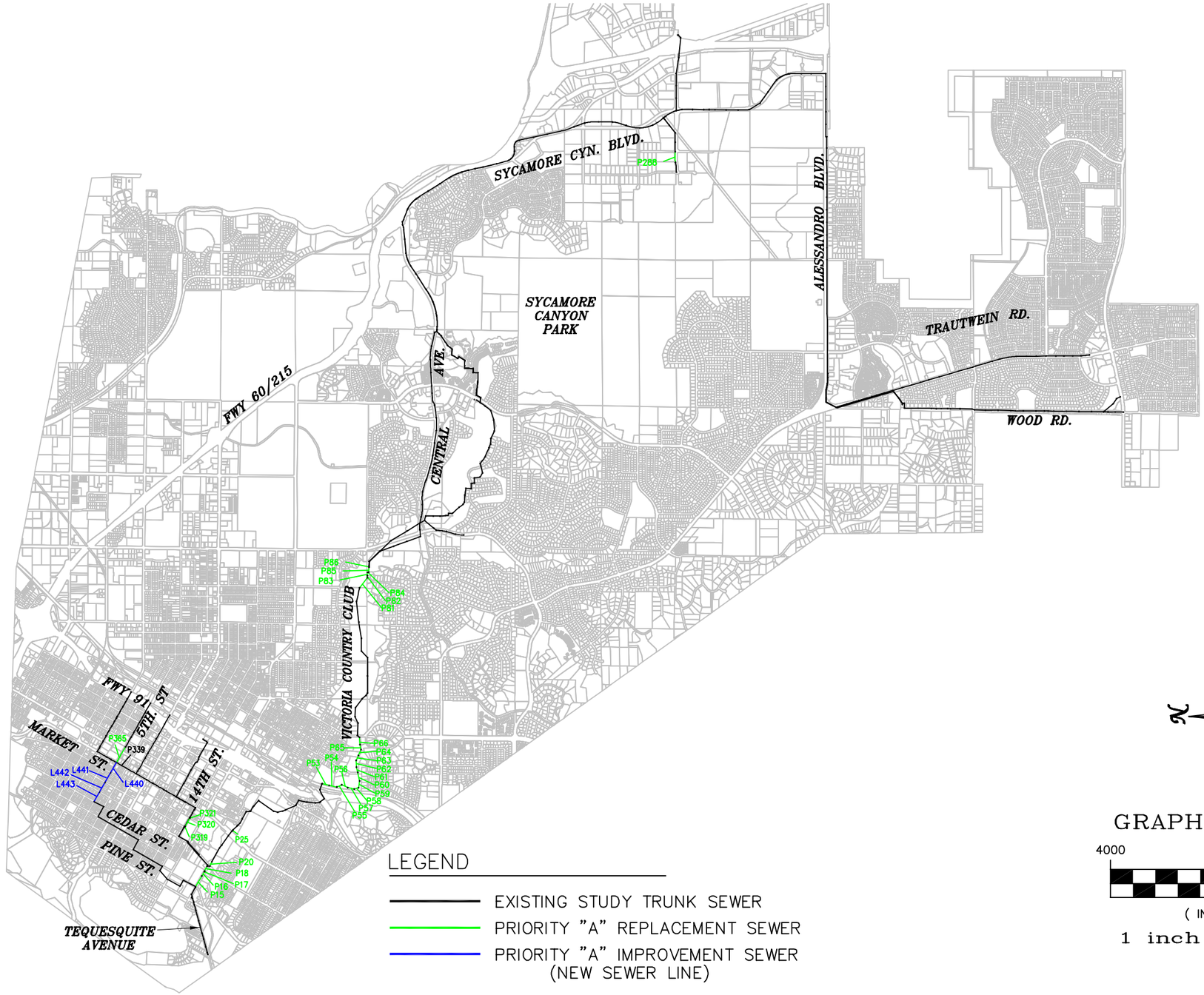
The study area involves a wide range of flow conditions contributing to the system; thus atypical flow patterns. A future addition of approximately 10 cfs maximum flow coming out of proposed IBP development near Fwy 215 and Sycamore Canyon Boulevard necessitates exploring of other alternative alignments of trunk sewer system to relieve the existing sewer system. The improvement of the existing sewer system for an additional 10 cfs maximum flow would require major construction activities in the Victoria Country Club Area. So, an alternative that would relieve the existing sewer system from additional flow and collect sewage flow from the proposed residential expansion of UCR was considered the best. This alternative trunk sewer line would begin at the Central Avenue – Canyon Crest Drive intersection and move westwards on Canyon Crest Drive to Martin Luther King Blvd. Beyond this intersection it would move southwards to Pennsylvania Avenue. Beyond this intersection the sewer line would continue along Pennsylvania Avenue till Victoria Avenue, then along Victoria Avenue till Cridge Street. From Cridge Street and Vine Street intersection it would move southwards towards Date Street and cross Hwy 91 near College Drive and Olivewood intersection. At this location it would join the existing study sewer system. The details of alternatives can be seen on Figure 23. The alternative for diversion of Market Street Wastewater Flow has been separately discussed in Appendix “C”.

7.7 Cost Estimate

Unit costs of pipes are based on rates obtained from the contractors over telephone, bid prices for similar projects and from web site www.get-a-quote.net. The cost of construction includes labor, materials, excavation, backfill and all other items associated with pipe laying. To estimate total cost, cost of mobilization /

demobilization (7%), traffic control (7%), bond (1%), contractor's profit (15%) and construction contingency (20%) is added to the cost of construction. For priorities "B" and "C", the cost estimate is based on current year prices and no escalation has been added to estimate future cost. Following is the summary of cost for the various priorities:

- Priority "A" - $2,757,000 (See Figure 21 and Table 7-7-A for details)
- Priority "B" - $6,734,000 (See Figure 22 and Table 7-7-B for details)
- Priority "C" - $ 8,400,000 (See Figure 23 and Table 7-7-C for details)



LEGEND

- EXISTING STUDY TRUNK SEWER
- PRIORITY "A" REPLACEMENT SEWER
- PRIORITY "A" IMPROVEMENT SEWER (NEW SEWER LINE)

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

Engineering
Planning
Surveying
Construction Services

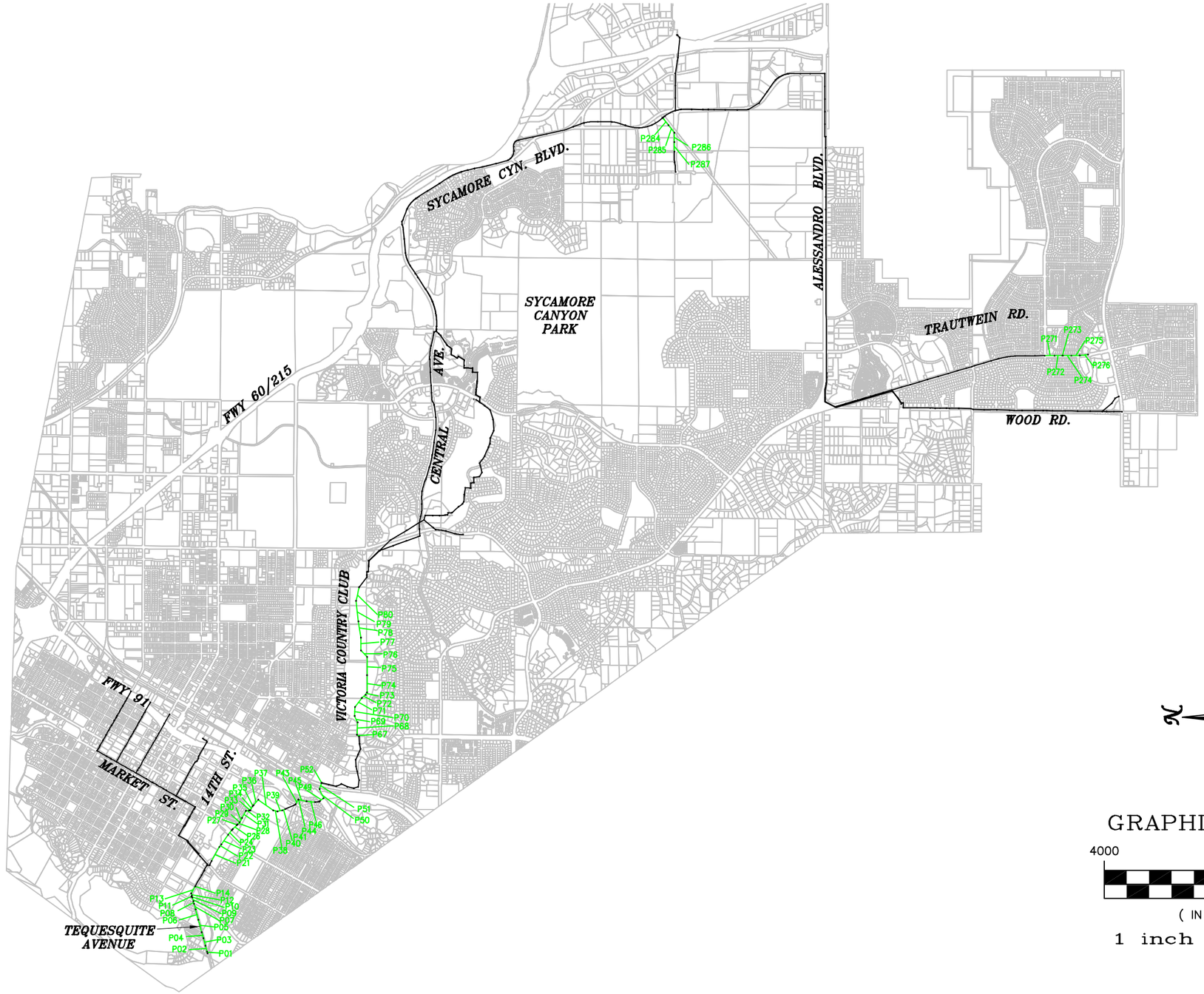
PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE TEQUESQUITE SEWER STUDY

FIGURE 21

PRIORITY "A"



N

GRAPHIC SCALE

4000 0 2000 4000

(IN FEET)

1 inch = 4000 ft.

LEGEND

EXISTING STUDY TRUNK SEWER

PRIORITY "B" REPLACEMENT SEWER

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Planning
Surveying
Construction Services

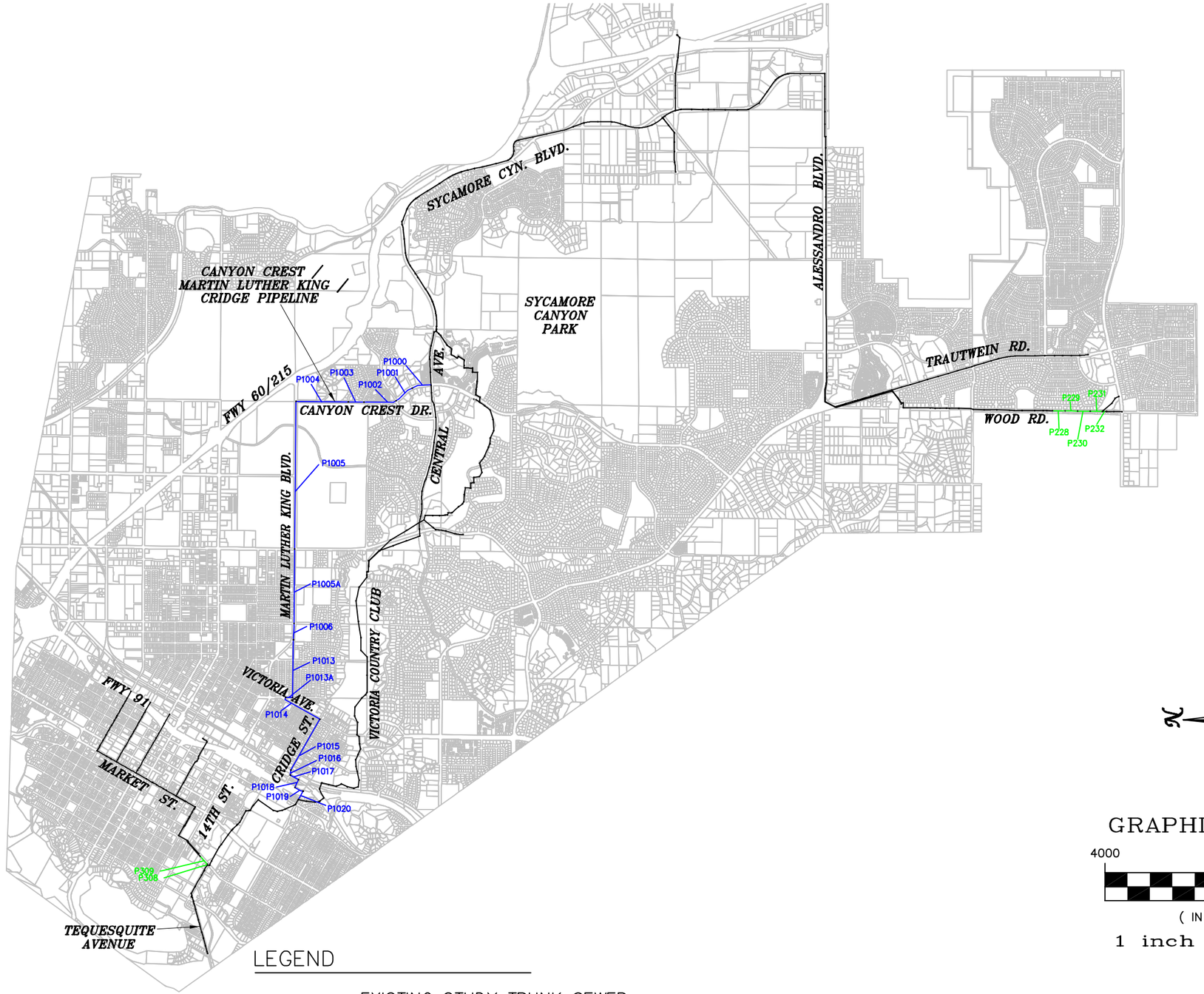
PBS&J

3610 Central Avenue
Suite 500
Riverside, CA 92506
Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE TEQUESQUITE SEWER STUDY

FIGURE 22

PRIORITY "B"



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Suite 500
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Tel:(909) 341-6380
Fax:(909) 341-6389

CITY OF RIVERSIDE TEQUESQUITE SEWER STUDY

FIGURE 23

PRIORITY "C"

Table 7-7-A
Cost Estimate For Priority "A" Projects, (2004-2007 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
Tequesquiite Avenue	Replace Pipe P15	21	42	LF	450	$300	$135,000
	Replace Pipe P16	21	42	LF	180	$300	$54,000
	Replace Pipe P17	21	42	LF	24	$300	$7,200
	Replace Pipe P18	21	42	LF	198	$300	$59,400
	Replace Pipe P20	27	42	LF	144	$300	$43,200
	Replace Pipe P25	27	42	LF	50	$300	$15,000
	Rehab / Replace Manhole			EA	7	$5,000	$35,000
	Reconnect Sewer Laterals			EA	10	$1,500	$15,000
						Total:	$363,800
Mobilization / Demobilization (7%)							$25,466
Traffic Control (7%)							$25,466
Bond (1%)							$3,638
Contractor's Profit(15%)							$54,570
Subtotal:							$472,940
Construction Contingency(20%)							$94,588
Total Cost (Tequesquite Avenue Sewer)							**$568,000**
Hwy 91/Victoria Country Club	Replace Pipe P53	27	36	LF	249	$250	$62,335
	Replace Pipe P54	27	36	LF	280	$250	$69,888
	Replace Pipe P55	27	36	LF	195	$250	$48,825
	Replace Pipe P56	24	36	LF	246	$250	$61,425
	Replace Pipe P57	24	36	LF	236	$250	$59,018
	Replace Pipe P58	24	36	LF	166	$250	$41,453
	Replace Pipe P59	24	36	LF	259	$195	$50,427
	Replace Pipe P60	21	36	LF	312	$195	$60,916
	Replace Pipe P61	21	36	LF	190	$195	$37,089
	Replace Pipe P62	21	36	LF	225	$195	$43,904
	Replace Pipe P63	21	36	LF	217	$195	$42,237
	Replace Pipe P64	21	36	LF	211	$195	$41,048
	Replace Pipe P65	21	36	LF	174	$195	$33,833
	Replace Pipe P66	21	36	LF	274	$195	$53,469
	Replace Pipe P81	18	24	LF	453	$110	$49,864

Table 7-7-A
Cost Estimate For Priority "A" Projects, (2004-2007 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
	Replace Pipe P82	18	24	LF	73	$110	$8,078
	Replace Pipe P83	18	24	LF	118	$110	$12,965
	Replace Pipe P84	18	24	LF	48	$110	$5,292
	Replace Pipe P85	18	24	LF	177	$110	$19,444
	Replace Pipe P86	18	24	LF	9	$110	$988
	Rehab / Replace Manhole			EA	21	$5,000	$105,000
	Reconnect Sewer Laterals			EA	41	$1,500	$61,500
						Total:	$968,995
Mobilization / Demobilization (7%)							$67,830
Traffic Control (7%)							$67,830
Bond (1%)							$9,690
Contractor's Profit(15%)							$145,349
Subtotal:							$1,259,694
Construction Contingency(20%)							$251,939
Total Cost (Hwy 91 / Victoria Country Club Sewer)							**$1,512,000**
Eastridge Avenue	Replace Pipe P288	10	18	LF	381	$130	$49,530
	Rehab / Replace Manhole			EA	2	$5,000	$10,000
	Reconnect Sewer Laterals			EA	4	$1,500	$6,000
						Total:	$65,530
Mobilization / Demobilization (7%)							$4,587
Traffic Control (7%)							$4,587
Bond (1%)							$655
Contractor's Profit(15%)							$9,830
Subtotal:							$85,189
Construction Contingency(20%)							$17,038
Total Cost (Eastridge Avenue Sewer)							**$102,000**

Table 7-7-A
Cost Estimate For Priority "A" Projects, (2004-2007 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
13th Street	Replace Pipe P319	12	15	LF	21	$105	$2,205
	Replace Pipe P320	10	15	LF	396	$105	$41,580
	Replace Pipe P321	10	15	LF	20	$105	$2,100
	Rehab / Replace Manhole			EA	4	$5,000	$20,000
	Reconnect Sewer Laterals			EA	4	$1,500	$6,000
						Total:	$71,885
Mobilization / Demobilization (7%)							$5,032
Traffic Control (7%)							$5,032
Bond (1%)							$719
Contractor's Profit(15%)							$10,783
Subtotal:							$93,451
Construction Contingency(20%)							$18,690
Total Cost (13th Street Sewer)							**$112,000**
5th Street	Replace Pipe P365	8	10	LF	651	$90	$58,590
	Rehab / Replace Manhole			EA	2	$5,000	$10,000
	Reconnect Sewer Laterals			EA	7	$1,500	$10,500
						Total:	$79,090
Mobilization / Demobilization (7%)							$5,536
Traffic Control (7%)							$5,536
Bond (1%)							$791
Contractor's Profit(15%)							$11,864
Subtotal:							$102,817
Construction Contingency(20%)							$20,563
Total Cost (5th Street Sewer)							**$123,000**

Table 7-7-A
Cost Estimate For Priority "A" Projects, (2004-2007 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
NEW PIPELINE:							
5th Street	New Pipe L440		12	LF	414	$100	$41,400
	New Pipe L441		12	LF	393	$100	$39,300
	New Pipe L442		12	LF	396	$100	$39,600
	New Pipe L443		12	LF	398	$100	$39,800
	Rehab / Replace Manhole			EA	5	$5,000	$25,000
	Reconnect Sewer Laterals			EA	20	$1,500	$30,000
	Abandon in place Pipe P339			LS	1	$3,000	$3,000
						Total =	$218,100
Mobilization / Demobilization (7%)							$15,267
Traffic Control (7%)							$15,267
Bond (1%)							$2,181
Contractor's Profit(15%)							$32,715
Subtotal:							$283,530
Construction Contingency(20%)							$56,706
Total Cost (5th Street New Sewer)							**$340,000**
TOTAL COST FOR PRIORITY "A" PROJECTS							**$2,757,000**

Table 7-7-B
Cost Estimate For Priority "B" Projects, (2008- 2013 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
Tequesquiite Avenue	Replace Pipe P01	27	36	LF	62	$250	$15,585
	Replace Pipe P02	27	36	LF	219	$250	$54,868
	Replace Pipe P03	27	36	LF	296	$250	$73,950
	Replace Pipe P04	27	36	LF	225	$250	$56,178
	Replace Pipe P05	27	36	LF	457	$250	$114,335
	Replace Pipe P06	27	36	LF	387	$250	$96,663
	Replace Pipe P07	27	36	LF	207	$250	$51,770
	Replace Pipe P08	27	36	LF	94	$250	$23,545
	Replace Pipe P09	27	36	LF	138	$250	$34,393
	Replace Pipe P10	30	36	LF	38	$250	$9,540
	Replace Pipe P11	30	42	LF	40	$300	$12,000
	Replace Pipe P12	27	42	LF	85	$300	$25,620
	Replace Pipe P13	27	42	LF	257	$300	$77,010
	Replace Pipe P14	24	42	LF	16	$300	$4,812
	Replace Pipe P21	27	42	LF	571	$300	$171,348
	Replace Pipe P22	27	42	LF	133	$300	$39,789
	Replace Pipe P23	27	42	LF	414	$300	$124,200
	Replace Pipe P24	24	42	LF	200	$300	$60,000
	Rehab / Replace Manhole			EA	19	$5,000	$95,000
	Reconnect Sewer Laterals			EA	38	$1,500	$57,000
						Total:	$1,197,604
Mobilization / Demobilization (7%)							$83,832
Traffic Control (7%)							$83,832
Bond (1%)							$11,976
Contractor's Profit(15%)							$179,641
Subtotal:							$1,556,885
Construction Contingency(20%)							$311,377
Total Cost (Tequesquite Avenue Sewer)							**$1,868,000**
R.C.C	Replace Pipe P26	27	42	LF	200	$300	$59,964
	Replace Pipe P27	27	42	LF	39	$300	$11,700
	Replace Pipe P28	27	42	LF	111	$300	$33,432
	Replace Pipe P29	27	42	LF	177	$300	$52,974

Table 7-7-B
Cost Estimate For Priority "B" Projects, (2008- 2013 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
	Replace Pipe P30	27	42	LF	281	$300	$84,420
	Replace Pipe P31	27	42	LF	105	$300	$31,416
	Replace Pipe P32	27	42	LF	39	$300	$11,550
	Replace Pipe P33	27	42	LF	15	$300	$4,350
	Replace Pipe P34	27	42	LF	163	$300	$48,954
	Replace Pipe P35	27	42	LF	44	$300	$13,326
	Replace Pipe P36	27	42	LF	265	$300	$79,422
	Replace Pipe P37	27	42	LF	638	$300	$191,325
	Replace Pipe P38	24	42	LF	151	$300	$45,183
	Replace Pipe P39	27	42	LF	190	$300	$57,000
	Replace Pipe P40	27	42	LF	145	$300	$43,500
	Replace Pipe P41	27	42	LF	370	$300	$111,102
	Replace Pipe P43	24	30	LF	184	$195	$35,933
	Replace Pipe P44	24	30	LF	7	$195	$1,427
	Replace Pipe P45	24	30	LF	290	$195	$56,458
	Replace Pipe P46	24	30	LF	309	$105	$32,461
	Replace Pipe P49	24	30	LF	157	$195	$30,615
	Replace Pipe P50 (Siphon)-DIP	18	2-18	LF	358	$280	$100,240
	Rehab / Replace Manhole			EA	23	$5,000	$115,000
	Reconnect Sewer Laterals			EA	42	$1,500	$63,000
	Jack and Bore Under Freeway and Railroad			LF	800	$500	$400,000
						Total:	$1,714,752
Mobilization / Demobilization (7%)							$120,033
Traffic Control (7%)							$120,033
Bond (1%)							$17,148
Contractor's Profit(15%)							$257,213
Subtotal:							$2,229,178
Construction Contingency(20%)							$445,836
Total Cost (R.C.C. Sewer)							**$2,675,000**

Table 7-7-B
Cost Estimate For Priority "B" Projects, (2008- 2013 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
Victoria Country Club	Replace Pipe P51	24	36	LF	227	$250	$56,750
	Replace Pipe P52	24	36	LF	15	$250	$3,750
	Replace Pipe P67	24	30	LF	106	$145	$15,370
	Replace Pipe P68	21	27	LF	458	$130	$59,540
	Replace Pipe P69	21	27	LF	260	$130	$33,800
	Replace Pipe P70	21	27	LF	304	$130	$39,520
	Replace Pipe P71	21	27	LF	380	$130	$49,400
	Replace Pipe P72	21	27	LF	179	$130	$23,270
	Replace Pipe P73	21	27	LF	144	$130	$18,720
	Replace Pipe P74	21	27	LF	610	$130	$79,300
	Replace Pipe P75	21	27	LF	650	$130	$84,500
	Replace Pipe P76	21	27	LF	344	$130	$44,720
	Replace Pipe P77	21	27	LF	578	$130	$75,140
	Replace Pipe P78	21	27	LF	628	$130	$81,640
	Replace Pipe P79	21	27	LF	600	$130	$78,000
	Replace Pipe P80	21	27	LF	500	$130	$65,000
	Rehab / Replace Manhole			EA	17	$5,000	$85,000
	Reconnect Sewer Laterals			EA	60	$1,500	$90,000
						Total:	$983,420
Mobilization / Demobilization (7%)							$68,839
Traffic Control (7%)							$68,839
Bond (1%)							$9,834
Contractor's Profit(15%)							$147,513
Subtotal:							$1,278,446
Construction Contingency(20%)							$255,689
Total Cost (Victoria Country Club Sewer)							**$1,534,000**
Trautwein Road	Replace Pipe P271	8	10	LF	352	$90	$31,680
	Replace Pipe P272	8	10	LF	277	$90	$24,930
	Replace Pipe P273	8	10	LF	23	$90	$2,070
	Replace Pipe P274	8	10	LF	300	$90	$27,000
	Replace Pipe P275	8	10	LF	299	$90	$26,910
	Replace Pipe P276	8	10	LF	299	$90	$26,910
	Rehab / Replace Manhole			EA	7	$5,000	$35,000

Table 7-7-B
Cost Estimate For Priority "B" Projects, (2008- 2013 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
	Reconnect Sewer Laterals			EA	16	$1,500	$24,000
						Total:	$198,500
Mobilization / Demobilization (7%)							$13,895
Traffic Control (7%)							$13,895
Bond (1%)							$1,985
Contractor's Profit(15%)							$29,775
Subtotal:							$258,050
Construction Contingency(20%)							$51,610
Total Cost (Trautwein Road Sewer)							**$310,000**
Eastridge Avenue	Replace Pipe P284	12	18	LF	339	$130	$44,044
	Replace Pipe P285	12	18	LF	343	$130	$44,647
	Replace Pipe P286	12	18	LF	337	$130	$43,759
	Replace Pipe P287	12	18	LF	338	$130	$43,953
	Rehab / Replace Manhole			EA	5	$5,000	$25,000
	Reconnect Sewer Laterals			EA	14	$1,500	$21,000
						Total:	$222,404
Mobilization / Demobilization (7%)							$15,568
Traffic Control (7%)							$15,568
Bond (1%)							$2,224
Contractor's Profit(15%)							$33,361
Subtotal:							$289,125
Construction Contingency(20%)							$57,825
Total Cost (Eastridge Avenue Sewer)							**$347,000**
TOTAL COST FOR PRIORITY "B" PROJECTS							**$6,734,000**

Table 7-7-C
Cost Estimate For Priority "C" Projects, (2014-2018 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
Tequesquiite Avenue	Replace Pipe P19 (Siphon)-DIP	2-15	2-18	LF	194	$280	$54,320
	Rehab / Replace Manhole			EA	2	$5,000	$10,000
	Extra for Siphon Replacement			LS			$30,000
						Total:	$94,320
Mobilization / Demobilization (7%)							$6,602
Traffic Control (7%)							$6,602
Bond (1%)							$943
Contractor's Profit(15%)							$14,148
Subtotal:							$122,616
Construction Contingency(20%)							$24,523
Total Cost (Tequesquite Avenue Sewer)							**$147,000**
Wood Road	Replace Pipe P228	12	15	LF	450	$105	$47,250
	Replace Pipe P229	12	15	LF	450	$105	$47,250
	Replace Pipe P230	12	15	LF	450	$105	$47,250
	Replace Pipe P231	12	15	LF	429	$105	$45,090
	Replace Pipe P232	8	15	LF	149	$105	$15,649
	Rehab / Replace Manhole			EA	6	$5,000	$30,000
	Reconnect Sewer Laterals			EA	19	$1,500	$28,500
						Total:	$260,989
Mobilization / Demobilization (7%)							$18,269
Traffic Control (7%)							$18,269
Bond (1%)							$2,610
Contractor's Profit(15%)							$39,148
Subtotal:							$339,286
Construction Contingency(20%)							$67,857
Total Cost (Wood Road Sewer)							**$407,000**
Brockton Ave.	Replace Pipe P308	15	18	LF	46	$130	$5,980
	Replace Pipe P309	15	18	LF	400	$130	$52,000
	Rehab / Replace Manhole			EA	3	$5,000	$15,000
	Reconnect Sewer Laterals			EA	4	$1,500	$6,000

Table 7-7-C
Cost Estimate For Priority "C" Projects, (2014-2018 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
						Total:	$78,980
Mobilization / Demobilization (7%)							$5,529
Traffic Control (7%)							$5,529
Bond (1%)							$790
Contractor's Profit(15%)							$11,847
Subtotal:							$102,674
Construction Contingency(20%)							$20,535
Total Cost (Brockton AvenueSewer)							**$123,000**
NEW PIPELINE:							
Cridge Avenue	New Pipe P1020		30	LF	570	$195	$111,150
	New Pipe P1019		30	LF	350	$195	$68,250
	New Pipe P1018		30	LF	195	$195	$38,025
	New Pipe P1017		30	LF	195	$195	$38,025
	New Pipe P1016		30	LF	360	$195	$70,200
	New Pipe P1015		30	LF	2060	$195	$401,700
	Rehab / Replace Manhole			EA	9	$5,000	$45,000
	Reconnect Sewer Laterals			EA	37	$1,500	$55,500
	Jack and Bore Under Freeway and Railroad			LF	800	$500	$400,000
						Total:	$1,227,850
Mobilization / Demobilization (7%)							$85,950
Traffic Control (7%)							$85,950
Bond (1%)							$12,279
Contractor's Profit(15%)							$184,178
Subtotal:							$1,596,205
Construction Contingency(20%)							$319,241
Total Cost (Cridge AvenueSewer)							**$1,915,000**
Victoria Avenue	New Pipe P1014		30	LF	1470	$195	$286,650
	New Pipe P1013A		30	LF	250	$195	$48,750
	Rehab / Replace Manhole			EA	4	$5,000	$20,000
	Reconnect Sewer Laterals			EA	17	$1,500	$25,500

Table 7-7-C
Cost Estimate For Priority "C" Projects, (2014-2018 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
						Total:	$380,900
Mobilization / Demobilization (7%)							$26,663
Traffic Control (7%)							$26,663
Bond (1%)							$3,809
Contractor's Profit(15%)							$57,135
Subtotal:							$495,170
Construction Contingency(20%)							$99,034
Total Cost (Victoria Avenue Sewer)							**$594,000**
Pennsylvania Avenue	New Pipe P1013		30	LF	2070	$195	$403,650
	Rehab / Replace Manhole			EA	5	$5,000	$25,000
	Reconnect Sewer Laterals			EA	21	$1,500	$31,500
						Total:	$460,150
Mobilization / Demobilization (7%)							$32,211
Traffic Control (7%)							$32,211
Bond (1%)							$4,602
Contractor's Profit(15%)							$69,023
Subtotal:							$598,195
Construction Contingency(20%)							$119,639
Total Cost (Pennsylvania Avenue Sewer)							**$718,000**

Table 7-7-C
Cost Estimate For Priority "C" Projects, (2014-2018 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2003 $'s)
MLK Blvd.	New Pipe P1006		27	LF	650	$180	$117,000
	New Pipe P1005A		27	LF	2650	$180	$477,000
	New Pipe P1005		27	LF	5260	$180	$946,800
	Rehab / Replace Manhole			EA	21	$5,000	$105,000
	Reconnect Sewer Laterals			EA	86	$1,500	$129,000
	Jack and Bore under Gage Canal			LF	100	$500	$50,000
						Total:	$1,824,800
Mobilization / Demobilization (7%)							$127,736
Traffic Control (7%)							$127,736
Bond (1%)							$18,248
Contractor's Profit(15%)							$273,720
Subtotal:							$2,372,240
Construction Contingency(20%)							$474,448
Total Cost (MLK Blvd. Sewer)							**$2,847,000**
Canyon Crest Dr.	New Pipe P1004		27	LF	1900	$180	$342,000
	New Pipe P1003		27	LF	560	$180	$100,800
	New Pipe P1002		27	LF	1160	$180	$208,800
	New Pipe P1001		27	LF	735	$180	$132,300
	New Pipe P1000		27	LF	730	$180	$131,400
	Rehab / Replace Manhole			EA	13	$5,000	$65,000
	Reconnect Sewer Laterals			EA	51	$1,500	$76,500
						Total =	$1,056,800
Mobilization / Demobilization (7%)							$73,976
Traffic Control (7%)							$73,976
Bond (1%)							$10,568
Contractor's Profit(15%)							$158,520
Subtotal:							$1,373,840
Construction Contingency(20%)							$274,768
Total Cost (Canyon Crest Drive Sewer)							**$1,649,000**
TOTAL COST FOR PRIORITY "C" PROJECTS							**$8,400,000**

Appendix C
ARLANZA TRUNK SEWER STUDY

City of Riverside
Arlanza Trunk Sewer Study

590110.10

Prepared By:

10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

August, 2006

ARLANZA TRUNK SEWER STUDY

City of Riverside

Client Representative	L.F.(Sandy) Caldwell, P.E.

PBS&J

Project Director	Gary H. Eikermann
Project Engineer	Barmeshwar Rai, P.E.
Technical Support	Charlene Drake Cristina Chavez

J.N. 590110.10

August, 2006

10370 Hemet Street, Suite 200, Riverside, CA 92503 Ph: (951)-358-1433

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Executive Summary

ES.1 Introduction

This report presents the results of the Arlanza Trunk Sewer System Capacity Study prepared by PBS&J for the City of Riverside. The report contains recommendations regarding system deficiencies as identified by hydraulic model XP-SWMM (XP Software, Version 9.1).

The City of Riverside is located in the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. The study area encompasses approximately 20,650 acres of mixed land use development and is generally bounded by Santa Ana River to the North, the City of Norco to the West, Home Gardens neighborhood of the County of Riverside to the South and Jefferson Street to the East. The study area is essentially a fully developed community, comprised of single family residential, multi family residential, commercial and light industrial areas with some vacant lands to be developed in the future. The portion of study area southeast of Victoria Avenue and designated as "residential semi-rural" would be one of the major contributors of sewage flow to the system. The study area can be divided into two distinct study basins: the area west of Tyler Street served by a lift station at Pierce Street and the area on east served by a gravity system.

ES.2 Existing Sewer System

The existing trunk sewer system within the study area is comprised of approximately 38 miles of gravity sewer mains, ranging in size from 8-inch to 51-inch in diameter, and 691 manholes. These sewer lines are essentially VCP and the manholes are typically brick lined. The sewer system also includes a lift station and 5.6 miles of force mains. The City of Riverside owns, maintains and operates the sewer system.

ES.3 Methodology

For determination of current wastewater flows, flow monitoring was performed at eight (8) strategic locations. These meter locations were chosen to observe actual flow characteristics for various sub areas with a distinct land use pattern within the study area. The flow monitoring was accomplished over a three-week period. The flow results were carefully evaluated for accuracy and some adjustments were made based on depth of flow at meter locations.

A theoretical estimate of wastewater flow from vacant areas was done based on factors from the City of Riverside "Criteria for Sewer Facility Design". Residential wastewater flow was estimated by using future projected population, whereas commercial and industrial flow was estimated based on acreage and City assumed unit flow coefficients.

The Computer Model Simulation Analysis involved evaluation of available capacity in the existing collection system under present and future development conditions. System deficiencies were identified from the results of model runs and a prioritized capital improvement plan was developed to allow for the projected growth within the study area.

ES.4 Project Priorities and Cost

Deficient and marginally deficient pipes were identified from the results of model runs and were prioritized for replacement/re-habilitation purpose. The pipes that are currently flowing more than 90% full under modeled existing maximum flow conditions and needing near term (2005-2010) replacement/re-habilitation are grouped under priority "A". The pipes that would flow more than 90% full in year 2015 under anticipated maximum future flow condition are classified as priority "B". The pipelines that are not included in priorities "A" and "B" and, are anticipated to flow more than 75% full under future flow conditions are categorized as priority "C". Some adjustment of priorities and combining of improvements was done for continuity and efficiency of effecting improvements.

The time phased improvements for various priorities are listed in Table 7-2. The approximate cost of recommended improvements is summarized in Tables 7-6-A, 7-6-B and 7-6-C.

Under existing flow conditions, a total of approximately 2,000 linear feet of priority "A" deficiencies were identified, requiring near term (2005-2010) attention. Additional deficiencies predicted under ultimate flow conditions (Priority "B") include an additional 9,000 linear feet of inadequate sewer lines. The estimated capital cost to remedy these identified deficiencies (in year 2005 $ s) is approximately $748,000 for Priority "A" and approximately $3,324,000 for Priority "B". The total length of pipelines under Priority "C" would be approximately 28,000 feet and the cost of Priority "C" projects would be approximately $10,000,000. However, it may be that not all of the Priority "B", and a fraction of Priority "C" improvements will need to be actually implemented. Only those projects where surcharging (within manholes) and other problems are deemed imminent should be considered for improvement. Periodic flow monitoring is recommended to verify anticipated deficiencies and the actual need for improvements. It is recommended that field observations of all pipes should be done where modeled results indicate surcharging conditions. The priorities are summarized in the Table Ex-1.

Table Ex-1
Summary of Prioritized Improvement Projects

Priority	Approximate Pipeline Length (feet)	Location	Replacement Year	Total Project Cost (year 2005 $ s)
"A"	2,000	Collett Avenue, Fillmore Street, Golden Avenue, RWQCP	2005-2010	$748,000
"B"	9,000	Monticello Avenue, Van Buren Boulevard	2011-2015	$3,324,000
"C"	28,000	Acorn Street, Arizona Avenue, Collett Avenue, Fillmore Street, Golden Avenue, Harrison Street, Hole Avenue, Jackson Street, Jones Avenue, La Sierra Channel, Magnolia Avenue, Monroe Street, RWQCP, Van Buren Boulevard	2016-2020	$10,000,000

1.0 INTRODUCTION

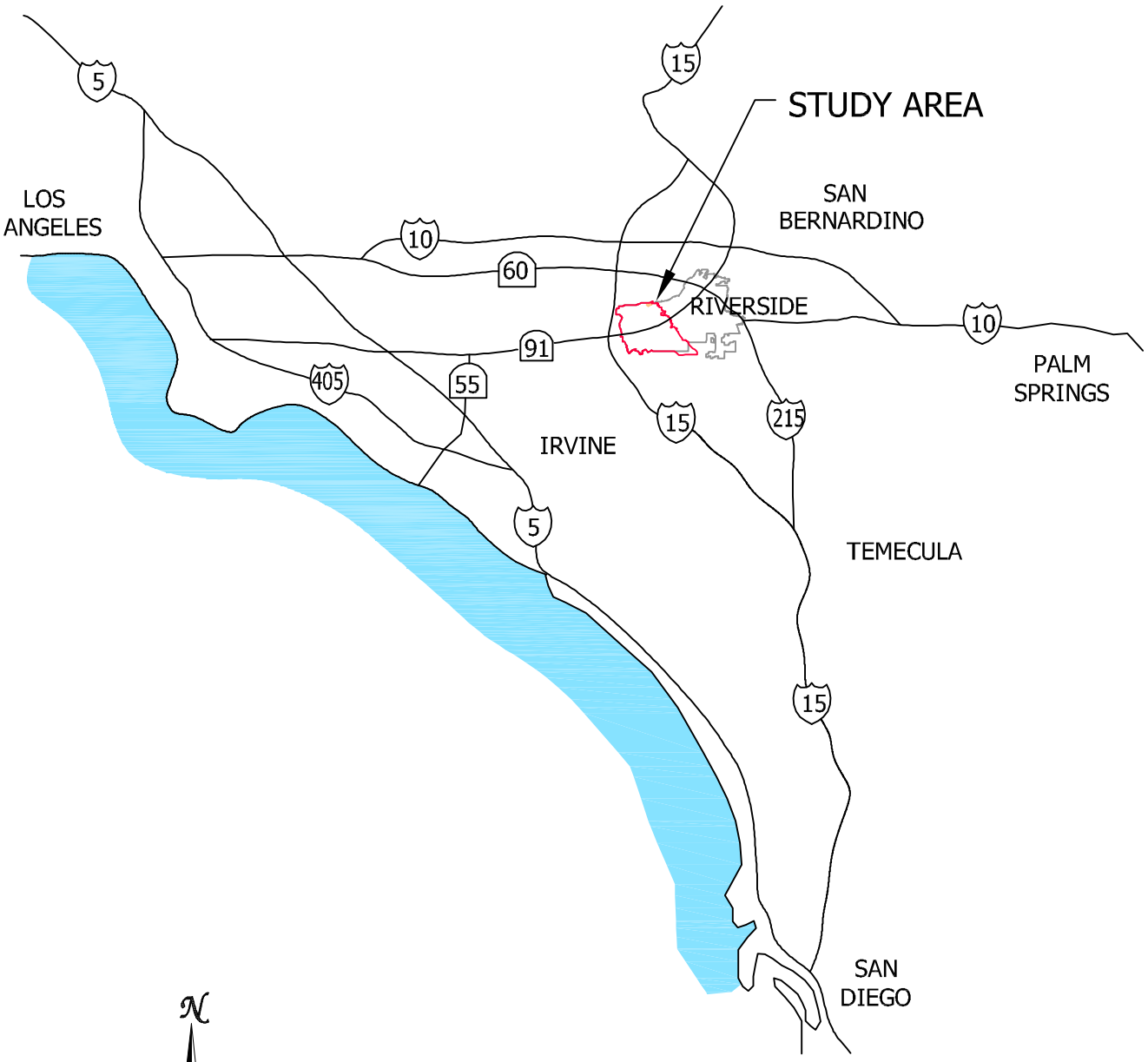
1.1 Background

The City of Riverside (City) retained PBS&J to prepare a Trunk Sewer System Study for the westerly portion of the City. The Sewer System has been designated as Arlanza Trunk Sewer System. The study is necessitated by the fact that the City desires to evaluate the capacity of the existing trunk sewer system.

1.2 Study Area

The City of Riverside is located in the northwest corner of the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. Founded in 1870, the City is known for its citrus industry, world famous Mission Inn and other historical monuments. Figure 1 is a Vicinity Map depicting the City's location and its accessibility. Figure 2 shows the study area. The study area shown in Figure 2 encompasses approximately 20,650 acres and is generally bounded by Santa Ana River to the North, the City of Norco to the West, Home Gardens neighborhood of the County of Riverside to the South and Jefferson Street to the East. For purposes of this study, the study area has been divided into 34 tributary sub-areas, where downstream sub-areas intercept sewage flow from upstream sub-areas. To obtain actual observed flow information for this study, sewage flow meters were placed at eight (8) strategic locations to monitor cumulative flows contributed from the tributary sub-areas.

The Arlanza Study Area can be divided into two distinct study basins: the area west of Tyler Street is served by a gravity – force main system with a lift station at Pierce Street and the area east of Tyler Street is served by the gravity system. The study area is considered to be a mature community comprised of single family residential, multi-family residential, commercial and light industrial uses. The portion of study area along both sides of Hwy 91 is primarily commercial development. Future development would take place in the eastern and south eastern portion of the study area which has been designated rural and light residential land use categories.



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CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 1
VICINITY MAP	

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PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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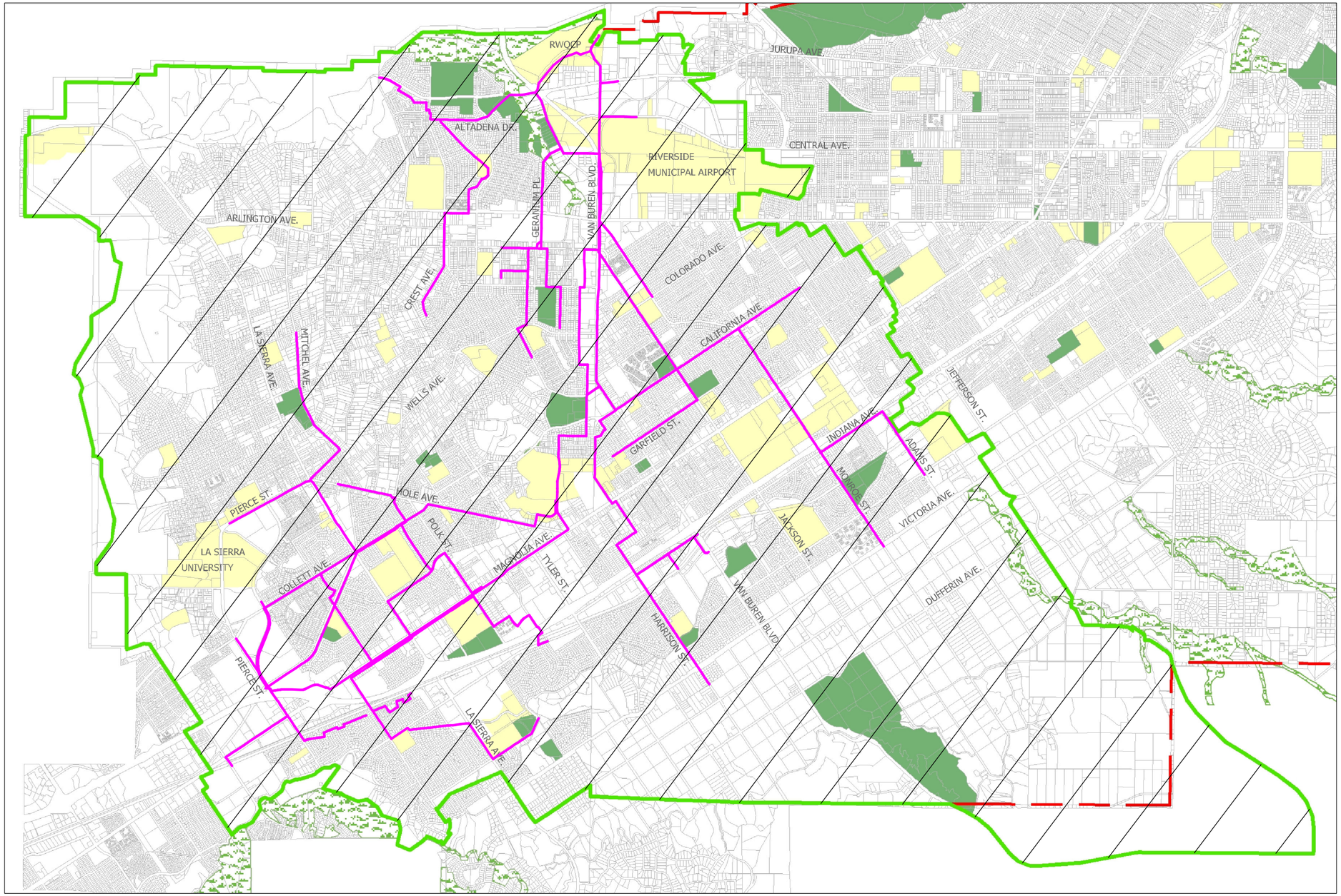

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SCALE:
1" = 4000'

LEGEND

- STUDY AREA BOUNDARY
- STUDY SEWER
- CITY LIMITS

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CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 2
STUDY AREA	

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10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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1.3 Objective

The objective of this Sewer System Capacity Study is to provide a comprehensive evaluation of the capacity of the sewer system within the study area, identify deficiencies in the current system, and evaluate alternatives to enhance the conveyance capacity to accommodate ultimate wastewater flows anticipated to be generated in the study area.

1.4 Scope and Study Approach

Specific work tasks undertaken for this study are summarized as follows:

- Kickoff Meeting

  An initial meeting was held between PBS&J and the City to discuss the project scope, communication protocol, explanation of methodology and scheduling of flow monitoring. Field data and other digital files to be provided by the City were also discussed.

- Progress Meetings

  Informal Project Progress Meetings were held to discuss on-going issues and the progress of the study.

- Flow Monitoring and Hydrograph Development

  Downstream Services Inc, installed, maintained, and collected flow data from eight (8) monitoring stations within the study area. They submitted the collected raw data in an electronic/hard copy format to PBS&J. PBS&J then processed and reviewed this information and created a hydraulic database. The City provided a copy of City's General Plan for estimation of current and future flows. Other information such as as-built plans of wastewater facilities were provided by the City when requested by PBS&J.

- Model Development

  Model development included input data collection, conversion of data and calibration. The City's GIS staff made available data pertaining to roads, sewers, land use, buildings and other utilities in ArcView format on a CD. As-built plans for study sewer lines were reviewed. Data available from GIS system and as-built plans were placed in a database system (MS Excel) as a pre-processor for XP-SWMM model development.

Calibration of model was done after construction of the model and additional data input.

- Draft Report

  Based on the calibrated model and City's criteria for Sewer Facility Design, a Draft Report was prepared that summarized the existing and future capacity situations. Where deficiencies were identified, alternatives were developed for needed sewer improvements, along with probable costs. The draft report was prepared for submittal/review by the City.

- Final Report

  Draft Report review comments from the City were incorporated into the Final Report along with any additional information or research in order to reflect a final level of study completion. The Final Report will include data and information assembled, system deficiencies identified, alternatives evaluated, capital improvement recommendations to remediate anticipated deficiencies, prioritization of improvements, and approximate costs.

The comprehensive evaluation of the sewage collection system to accomplish the above-summarized scope entailed the following multi-step approach:

- Review of as built plans provided by the City to determine system configuration, inverts, pipe sizes and slopes
- Use of detailed database provided by the City in Arcview format
- Creation of computer hydraulic model using existing sewer system to study project area
- Identification of flow monitoring station locations
- Identification of tributary areas contributing sewage flow to meter locations or combinations
- Installation of flow meters and monitoring of flows at the selected locations on continuous basis for two-week period
- Review of current land use in study area per GIS information from the City and determination of existing land use, population and vacant land
- Assessment of ultimate land use and projected population
- Review and evaluation of metered data from flow monitoring stations
- Development of flow coefficients and representative diurnal flow patterns based on typical curves for various land uses and observed flows from monitored sub areas which are dominated by a specific land use

- Modeling of sewer system, deficiency identification, and model simulation of remedial alternatives using above-mentioned information as input data
- Evaluation of alternatives, optimization, cost comparison
- Prioritization of recommended improvements, including identification of critical pipelines which need immediate attention
- Draft Report and recommendations including phased improvements and costs
- Review of Draft Report by the City, comments and discussion
- Final Report

2.0 LAND USE

2.1 Existing Land Use

Land use is the basis for estimating sewage flow from the majority of the study area. The land use pattern for this study was developed from the GIS information provided by the City. Figure 3A shows land use within the study area based on the City's "Land Use" GIS layer. The vacant areas within various land use categories are shown in Figure 3B. For the purpose of this study, land uses in the study area have been broadly classified into four categories: Single Family Residential (SFR), Multi Family Residential (MFR), Commercial and Industrial. Table 2-1 summarizes the land use areas within the study area that would generate wastewater flow.

2.2 Proposed Land Use

The portion of study area northwest of Victoria Avenue is primarily a mature community. The portion of study area on southeast side of Victoria Avenue has vacant parcels that are designated as "residential - semi rural" and is expected to be developed in the future. This area is primarily designated to be developed as low density Single Family Residential (SFR). Another portion of the study area located at Riverside–Norco boundary may experience development in the future. It is assumed that the majority of vacant lots within the study area would be fully developed by year 2020.

Table 2-1
Land Use That Would Produce Wastewater Flow
(Acres)

Category	Existing (Year 2005)	Future (Year 2020)	Change
Single-Family Residential (SFR)	7,220	12,240	5,020 (70 %)
Multi-Family Residential (MFR)	880	960	80 (9 %)
Commercial / School	2,735	3,190	455 (17 %)
Industrial	190	215	25 (13 %)

The areas that are marked as open space or public facilities are not included in Table 2-1 because of zero sewage flow generation.

N

SCALE:
1" = 4000'

RIVERSIDE WATER QUALITY
CONTROL PLANT (RWQCP)

JURUPA AVE.

ARLINGTON AVE.

VAN BUREN BLVD.

CALIFORNIA AVE.

TYLER ST.

ADAMS ST.

LA SIERRA AVE.

MAGNOLIA AVE.

HWY 91

VICTORIA AVE.

VAN BUREN BLVD.

DUFFRIN AVE.

PIERCE ST.

LA SIERRA
UNIVERSITY

COUNTY AREA MAY BE SERVED BY CITY
(LOW DENSITY RESIDENTIAL)

LEGEND

- Commercial – Business and Office
- Commercial – Center
- Commercial – Service
- Industrial – Business Park
- Industrial – General
- Industrial – Light
- Mixed Use – Office Emphasis
- Natural Open Space
- Office – Low Rise
- Office – Mid Rise
- Parks – Other Recreation
- Parks – Public
- Public Facilities and Open Space*
- Residential – Estate
- Residential – High Density
- Residential – Hillside
- Residential – Low Density
- Residential – Medium Density
- Residential – Medium–High Density
- Residential – Rural and Residential
- Residential – Semi–Rural
- County Area – May be Served by City**
- Sewer Basin Boundary

*Includes schools and other public use facilities
**Assumed to be Low Density Residential

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PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358–1433
Fax:(951) 358–1434

CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 3A

ZONED LAND USE

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SCALE:
1" = 4000'

RIVERSIDE WATER QUALITY
CONTROL PLANT (RWQCP)

JURUPA AVE.

ARLINGTON AVE.

VAN BUREN BLVD.

CALIFORNIA AVE.

TYLER ST.

ADAMS ST.

LA SIERRA AVE.

MAGNOLIA AVE.

HWY 91

VICTORIA AVE.

VAN BUREN BLVD.

DUFFRIN AVE.

PIERCE ST.

LA SIERRA
UNIVERSITY

COUNTY AREA MAY BE SERVED BY CITY
(LOW DENSITY RESIDENTIAL)

LEGEND

- Commercial – Automotive Park
- Commercial – Business and Office
- Commercial – Center
- Commercial – Service
- Industrial – Business Park
- Industrial – General
- Industrial – Light
- Mixed Use – Office Emphasis
- Natural Open Space
- Office – Low Rise
- Office – Mid Rise
- Parks – Other Recreation
- Parks – Public
- Public Facilities and Open Space*
- Residential – Estate
- Residential – High Density
- Residential – Hillside
- Residential – Low Density
- Residential – Medium Density
- Residential – Medium–High Density
- Residential – Rural and Residential
- Residential – Semi–Rural
- Occupied Parcels
- County Area – May be Served by City**
- Sewer Basin Boundary

*Includes schools and other public use facilities
**Assumed to be Low Density Residential

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 3B

ZONED LAND USE (VACANT PARCELS)

Engineering
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Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358–1433
Fax:(951) 358–1434

3.0 EXISTING SEWER SYSTEM

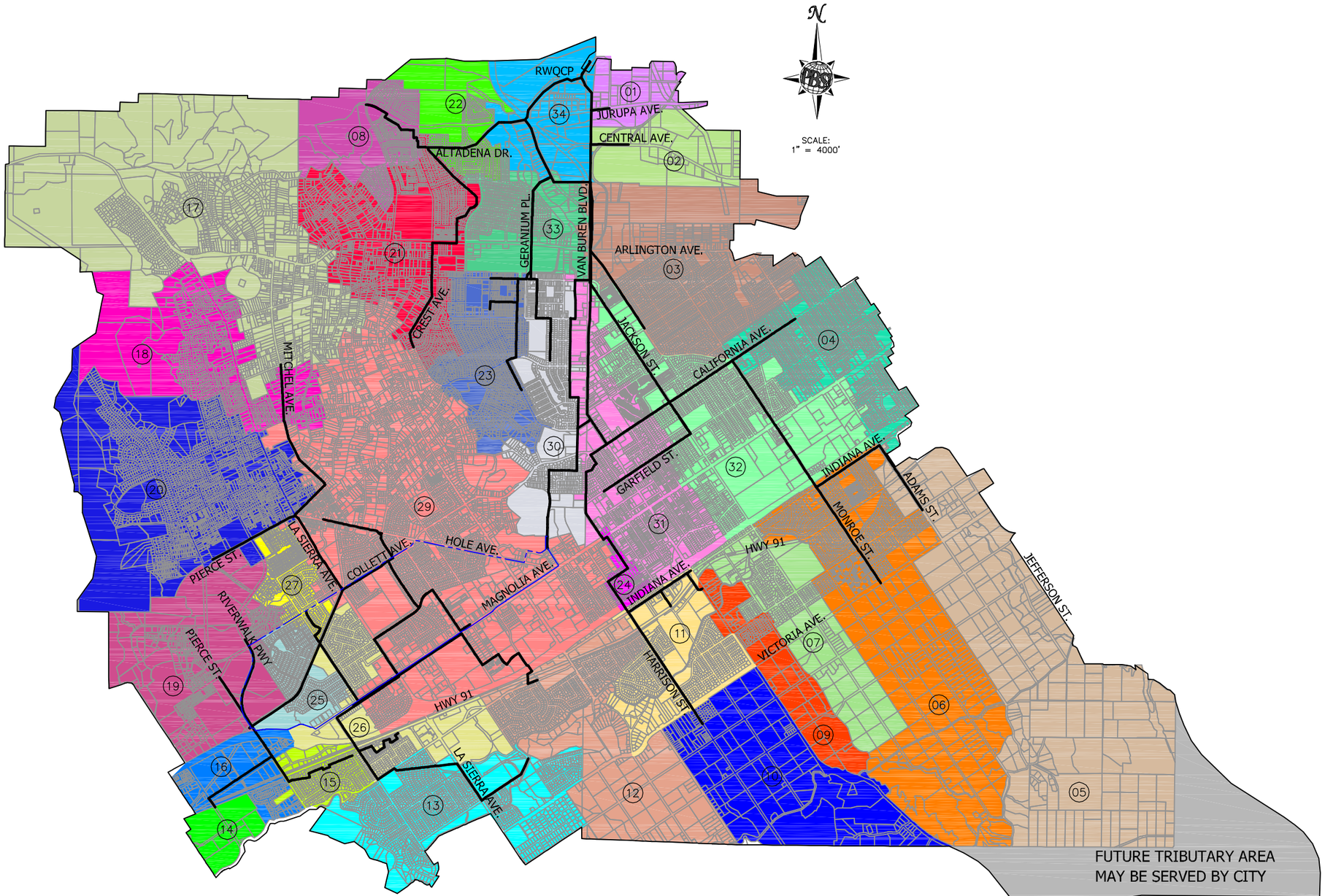
3.1 System Overview

As previously described, the Arlanza Trunk Sewer study area covers approximately 20,650 acres including the County of Riverside area that might be served by the City sewer system and have been divided into 34 tributary sub-areas (See Figure 4). The wastewater flow from a sub-area can be measured at a meter location or can be reasonably assessed based on land use plan of that sub-area. The location of meters can be seen on Figure 5. The modeled gravity conveyance system is approximately 202,000 linear feet (38 miles) of gravity sewer system, with pipe sizes varying from 8 inches to 51 inches in diameter (See Figures 6A and 6B). Most of the gravity sewer lines within the system are vitrified clay pipe (VCP). The sewer system also includes 29,400 linear feet (5.6 miles) of force main lines.

3.2 Collection System

The Arlanza Study Area can be divided into two distinct sub-areas. The western portion is served by a lift station at Pierce Street west of Hwy. 91 and the eastern portion is served by the gravity system. Generally, the wastewater flow generated from the area east of Tyler Street flows to the Lift Station in either southerly or easterly direction. The wastewater generated from the area west of Tyler Street generally flows in a northeasterly direction to the Regional Water Quality Control Plant (RWQCP).

The major trunk lines contributing to Pierce Street Lift Station are along La Sierra Avenue, Pierce Street, Hole Avenue, La Sierra Channel and Magnolia Avenue. The trunk lines contributing to the RWQCP are along Jurupa Avenue, California Avenue, Monroe Street, Jackson Street, Adams Street, Indiana Avenue and Van Buren Boulevard. The details of sewer system are explained in section 3.3 System Description. Pipe sizes, lengths, and number of manholes have been tabulated for major segments of the modeled trunk system (See Appendix “C”).



N

SCALE:
1" = 4000'

TRIBUTARY AREA LEGEND

- SUB AREA 01
- SUB AREA 02
- SUB AREA 03
- SUB AREA 04
- SUB AREA 05
- SUB AREA 06
- SUB AREA 07
- SUB AREA 08
- SUB AREA 09
- SUB AREA 10
- SUB AREA 11
- SUB AREA 12
- SUB AREA 13
- SUB AREA 14
- SUB AREA 15
- SUB AREA 16
- SUB AREA 17
- SUB AREA 18
- SUB AREA 19
- SUB AREA 20
- SUB AREA 21
- SUB AREA 22
- SUB AREA 23
- SUB AREA 24
- SUB AREA 25
- SUB AREA 26
- SUB AREA 27
- SUB AREA 29
- SUB AREA 30
- SUB AREA 31
- SUB AREA 32
- SUB AREA 34
- FUTURE TRIBUTARY AREA MAY BE SERVED BY CITY

STUDY MAIN LEGEND

- GRAVITY MAIN
- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 12/21/05 | DWN BY: CD

CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 4

TRIBUTARY AREAS

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-TributaryAreas.dwg, 9/28/2006 10:33:42 AM

N

SCALE:
1" = 3000'

FLOW METER 7

I&I FLOW METER INSTALLED FROM
JAN 7, 2005 TO FEB 28, 2005
(FLOW METER 10)

FLOW METER 8

I&I FLOW METER INSTALLED FROM
JAN 7, 2005 TO FEB 28, 2005
(FLOW METER 9)

FLOW METER 5

FLOW METER 6

FLOW METER 4

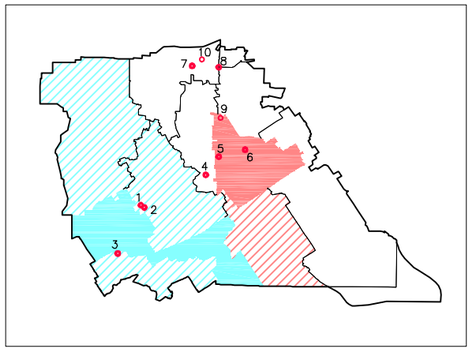
FLOW METER 1

FLOW METER 2

PIERCE STREET
LIFT STATION

FLOW METER 3

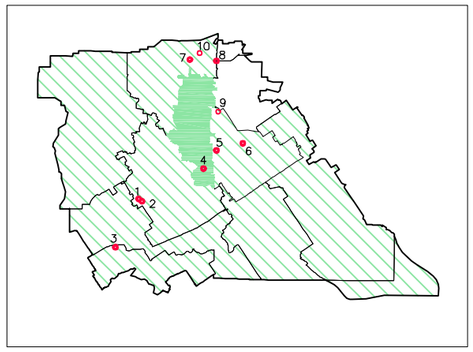
RWQCP
JURUPA AVE.
VAN BUREN BLVD.
RIVERSIDE
MUNICIPAL AIRPORT
ARLINGTON AVE.
CREST AVE.
MITCHEL AVE.
JACKSON ST.
CALIFORNIA AVE.
CALIFORNIA
BAPTIST
UNIVERSITY
INDIANA AVE.
ADAMS ST.
RIVERSIDE FWY (HWY91)
MONROE ST.
JEFFERSON ST.
VICTORIA AVE.
HARRISON ST.
HOLE AVE.
COLLETT AVE.
LA SIERRA
UNIVERSITY
LA SIERRA AVE.
MAGNOLIA AVE.
LA SIERRA CHANNEL
PIERCE ST.
ARLINGTON CHANNEL



FLOW METER AREAS THAT
MERGE WITH FLOW METER 4 (BLUE)
AND FLOW METER 9 (RED)

LEGEND

- STUDY MAIN AND MANHOLES
- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- SUB AREA 01
- FLOW METER 1
- FLOW METER 2
- FLOW METER 3
- FLOW METER 4
- FLOW METER 5
- FLOW METER 6
- FLOW METER 7
- FLOW METER 8
- FLOW METER 9
- FLOW METER 10
- COUNTY AREA
  MAY BE SERVED BY CITY
  (FLOWS TO METER 6)
- FLOW METER LOCATION
- INFLOW AND INFILTRATION
  STUDY FLOW METER LOCATION



FLOW METER AREAS THAT
MERGE WITH FLOW METER 10 AREA

DATE: 12/21/05	DWN BY: CD / ED
CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 5
FLOW MONITORING LOCATIONS	

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-FlowMonitoring.dwg, 9/28/2006 9:49:32 AM

3.3 System Description

The existing trunk sewer system, which is the subject of this evaluation, is shown on Figures 6A and 6B. The sewer collection system was constructed over a period of time (possibly 50 plus years) to accommodate increasing sewage flow during the development within the City. As previously discussed in sections 1.2 and 3.2, the sewer system can be broadly divided into two distinct parts: the eastern part that consists of gravity sewers only and the western part that drains by gravity to a lift station at Pierce Street and then is pumped through force main sewer to the eastern gravity system. The GIS data and as-built plans provided by the City were studied to ascertain characteristics of the system. The existing sewer manholes and their numerical designations can be seen in Figures 7A, 7B and 7C. The existing pipelines and their numerical designations can be seen in Figures 8A, 8B and 8C. The pipelines in the system are prefixed with letter "P" (for pipe) and the manholes are prefixed with letter "M" (for manhole) to match with the Hydraulic Model. The description of sewer segments begins at the most upstream manhole and ends at the most downstream manhole. The sewer system is briefly described as follows:

- *Adams Street Sewer Line:* The trunk sewer line along Adams Street begins at manhole number M393 at the intersection of Adams Street and Lincoln Avenue with a 12-inch diameter line flowing northwest. At this location it picks up flow from residential developments on both sides of Adams Street. The size of the sewer line between manholes M393 and M390 is 12-inch. The size of sewer line between manhole M390 and M384 is 15-inch. The sewer line crosses Riverside Canal and Metrolink / BNSF Railroad near Auto Drive. At the manhole location M384 the sewer line joins the trunk sewer line along Indiana Avenue.

- *Indiana Avenue (1) Sewer Line*: The trunk sewer line in Indiana Avenue begins at manhole M384 located at Adams Street and Indiana Avenue intersection. The flow is in the southwesterly direction. The sewer line between manholes M384 and M349 is 15-inch. The sewer line collects wastewater flow from the commercial areas and office complexes located on both sides of Indiana Avenue. It joins the trunk sewer line along Monroe Street at M349.

- *Monroe Street Sewer Line*: The 12-inch trunk sewer line along Monroe Street begins at manhole M364 located at

the intersection of Monroe Street and Victoria Avenue. The flow is in the northwesterly direction. The sewer is 12-inch between manholes M364 and M344 and 15-inch between manholes M344 and M331. The sewer line crosses Riverside Canal near Lincoln Avenue and Metrolink Railroad near Don Derr Park. It also crosses Metropolitan Water District Aqueduct near Magnolia Avenue. It picks up wastewater flow from the residential development east of Hwy 91 and from California Baptist University on the western side of freeway. The sewer line joins California Avenue trunk sewer line at the manhole M331.

- *Garfield Street Sewer Line*: The trunk sewer line along Garfield Street begins at manhole M306 east of Van Buren Boulevard. A 12-inch sewer line collects wastewater flows from the residential development and flows in northeasterly direction to the trunk sewer line along Jackson Street. The sewer line between manholes M306 and M303 is 12-inch and, 14-inch between manholes M303 and M294. The sewer line joins the trunk line in Jackson Street at manhole M294 near Parkview Community Hospital Medical Center.

- *California Avenue (1) Sewer Lines:* The trunk sewer line along California Avenue (1) begins at manhole M375 located at the intersection of California Avenue and Adams Street. This trunk line picks up flow from Monroe Street sewer line at the manhole M331. The sewer line between manhole M375 and M331 is 15-inch and in the reach between manholes M331 and M290 is 21-inch. The sewer line crosses Metropolitan Water District Aqueduct between Adams Street and Monroe Street. The sewer line joins the trunk sewer line along Jackson Street at manhole M290.

- *California Avenue (2) Sewer Line:* The trunk sewer line along California Avenue (2) begins at manhole M127 located at the intersection of California Avenue and Van Buren Boulevard. At this location it picks up wastewater flow from Harrison Street sewer line. An 18-inch sewer line continues along California Avenue in the easterly direction up to manhole M290 located at the intersection of California Avenue and Jackson Street. This sewer line picks up part of flow from Harrison Street sewer line and residential development along this pipe segment.

- *Indiana Avenue (2) Sewer Line:* The trunk sewer line begins at manhole M431 located at the intersection of Indiana Avenue and Van Buren Boulevard. A 12-inch sewer line continues in the westerly direction to manhole M405. At this location it joins the trunk sewer line along

Harrison Street. The sewer line along Indiana Avenue (2) picks up wastewater flow generated from residential areas along Van Buren Boulevard and Meyers Street.

- *Harrison Street Sewer Line:* The sewer line along Harrison Street begins at manhole M422 located at Harrison Street south of Victoria Avenue. This sewer line consists of various pipe segments; sizes ranging from 12-inch to 24-inch. From manhole M422, a 12-inch sewer line continues in the northerly direction to manhole M410. At manhole M410, the pipe size changes to 15-inch to manhole M407. From there, a 12-inch line continues to manhole M405. The reach between manholes M405 and M137 is an 18-inch line. At this location the pipe size changes to 15-inch and continues to manhole M131. The size of pipeline between manhole M131 and M127 is 24-inch. The sewer line joins Van Buren Boulevard trunk sewer line at manhole M127. The sewer line crosses Riverside Canal near Victoria Avenue and Metrolink Railroad near Hwy. 91. This sewer line picks up wastewater flow from residential development between Victoria Avenue and Hwy. 91.

- *Jurupa Avenue Sewer Line:* The trunk sewer line in Jurupa Avenue comprises of a 12-inch sewer line beginning at node M253 at the intersection of Jurupa Avenue and Payton Avenue. This pipeline continues in a westerly direction and joins Acorn Street trunk sewer line at manhole M045. The sewer line collects wastewater flow generated from the commercial / light industrial development on north and south side of Jurupa Avenue.

- *Central Avenue Sewer Line:* This trunk sewer line comprises of a 12-inch sewer line that begins at manhole M257 at Central Avenue west of Wilderness Avenue. The pipeline joins Acorn Street trunk sewer line at manhole M047. The sewer line collects wastewater flow from the commercial area north of Riverside Municipal Airport.

- *Monticello Avenue Sewer Line:* The sewer line along Monticello Avenue begins at manhole M271 at the intersection of Monticello Avenue and Colorado Avenue. A 12-inch sewer line begins from this location and continues in a northwesterly direction and joins manhole M056 located at the intersection of Arlington Avenue and Van Buren Boulevard. The flow from this sewer line is discharged into the western trunk line along Van Buren Boulevard. This sewer line picks up wastewater flow from the residential area east of Monticello Avenue and commercial area south of Arlington Avenue.

- *Jackson Street Sewer Line:* The trunk sewer line along Jackson Street comprises of many sewer segments varying in size from 8-inch to 24-inch. The sewer begins at manhole M294 at the intersection of Jackson Street and Garfield Street. A 15-inch sewer line begins from this location and continues in northwesterly direction to manhole M290. Then a 24-inch line continues to manhole M059A. At this location it joins Van Buren trunk sewer line. A 20-inch sub-segment of sewer line runs parallel to the main sewer line between manholes M308 and M307. This sewer line picks up wastewater flow from California Avenue trunk sewer, the residential areas north of California Avenue and commercial areas at Van Buren Boulevard and Jackson Street intersection.

- *Van Buren Plaza Sewer Line:* This trunk sewer line, which runs parallel to Van Buren Boulevard trunk sewer line, begins at Megginson Lane north of Magnolia Avenue. It consists of many sewer segments varying in size from 24-inch to 36-inch. A 24-inch sewer begins at manhole M093 and continues in northerly direction to manhole M091. From manhole M091 to manhole M076 the size of sewer line is 33-inch. At this location the size changes to 36-inch up to manhole M059. This sewer picks up wastewater flow from 24-inch force main line at manhole M093. The sewer line joins Van Buren Boulevard trunk sewer at manhole M110 located at the intersection of Van Buren Boulevard and Cypress Avenue. Besides picking wastewater flow from force mains, this sewer line picks up flow from commercial areas west of Van Buren Boulevard.

- *Van Buren Boulevard Sewer Line:* This sewer line begins at manhole M127 at the intersection of Van Buren Boulevard and California Avenue. An 18-inch sewer line continues in northwesterly direction to manhole M124. Then a 24-inch line continues in northerly direction to manhole M110. The sewer line has two parallel segments between Cypress Avenue and Morris Street. The eastern line is 33-inch and the western line is 24-inch. From manhole M110, the 33-inch sewer line continues northwards to manhole M104. Then it turns westward to manhole M100. The sewer line between manhole M100 and M012 is 42-inch. The western portion of the sewer line (24-inch) begins at manhole M059A and continues northward to manhole M056. The sewer line between manhole M056 and M049 is 27-inch. The sewer line joins Riverside Water Quality Control Plant (RWQCP) trunk sewer line at manhole M012. This study sewer line picks up majority of flows generated from Arlanza study area. It picks up Harrison Street flow at manhole M127, Jackson Street flow at manhole M059A, Van Buren Plaza flow at

manhole M110 and Monticello Avenue flow at manhole M056.

- *Crest Avenue Sewer Line:* The trunk sewer line along Crest Avenue begins at manhole M250 at the intersection of Crest Avenue and Overton Avenue. A 12-inch sewer line begins from this location and continues in a northerly direction to manhole M247. Then a 15-inch line continues to manhole M246. The size changes to 12-inch between manholes M246 and M244, 15-inch between manholes M244 and M241B and 12-inch between manholes M241B and M241A. The sewer line between manhole M241A and M240 is 15-inch. From manhole M240, a 15-inch sewer line continues in northerly direction to manhole M237 where the size changes to 18-inch and continues to manhole M237. The sewer line between manhole M237 and M224 is 15-inch. From this location the sewer continues in a northwesterly direction. The sewer line between manhole M224 and manhole M027 is 27-inch. At manhole M027 the sewer line joins RWQCP trunk sewer line. This sewer line picks up wastewater flow generated from the residential and neighborhood commercial development between Van Buren Boulevard and Tyler Street south of Jurupa Avenue.

- *Trey Avenue Sewer Line:* The trunk sewer line along Trey Avenue begins at manhole M498 at Challen Avenue north of Philbin Avenue. At this location it picks up flow from residential developments south of Cypress Avenue. The sewer line between manholes M498 and M481 is 12-inch. At the manhole location M481 the sewer line joins the trunk sewer line along Picker Street.

- *Picker Street Sewer Line:* Picker Street trunk sewer line begins at manhole number M494 at the intersection of Challen Avenue and Orlando Drive. A 12-inch sewer line continues in a northerly direction to manhole M481. The sewer line is 15-inch from manhole M481 to manhole M476. The sewer line picks up flow from Trey Avenue sewer at manhole M481. It joins Cypress Avenue trunk sewer at manhole M476.

- *Cypress Avenue Sewer Line:* The trunk sewer line along Cypress Avenue begins at manhole M478 at the intersection of Cypress Avenue and Challen Avenue. A 12-inch sewer line continues in an easterly direction to manhole M476. The sewer line is 18-inch from manhole M476 to manhole M458. The sewer line picks up flow from Picker Street sewer at manhole M476. It joins Warren Street trunk sewer north of the siphon at manhole M476.

- *Warren Street Sewer Line:* The sewer line along Warren Street begins at manhole M472 at Crowin Lane north of Wells Avenue. A 12-inch sewer line begins from this location and continues in a northerly direction to manhole M464, where a 21-inch line continues to manhole M459. There is a 2-barrel siphon (size 12-inch) between manhole M459 and M458. The sewer line between manhole M458 and M453 is 21-inch. The size changes to 18-inch between manholes M453 and M100. The sewer line joins Van Buren trunk sewer line at manhole M100. A parallel 24-inch sewer continues from manhole M443 and joins Van Buren trunk sewer at M099. The sewer line picks up wastewater flow from Cypress Avenue sewer line at manhole M458. In addition, it picks up flow from residential areas between Picker Street and Van Buren Boulevard.

- *Acorn Street Sewer Line:* The trunk sewer line begins at manhole M049 north of Van Buren Boulevard and continues northward toward RWQCP sewer line. The sewer line between manhole M049 and M043 is 27-inch. From manhole M043 a 36-inch sewer line continues to manhole M002. This sewer line picks up wastewater flow from western trunk sewer line in Van Buren Boulevard. In addition, it picks up wastewater flow from the commercial development east of Van Buren Boulevard and north of Arlington Avenue.

- *RWQCP Sewer Line:* RWQCP trunk sewer line begins at manhole M042 at Jurupa Avenue west of Cobb Street. A 15-inch sewer line begins at this location and continues in an easterly direction to manhole M027. Then a 27-inch line continues to manhole M013. Beyond this manhole a 42-inch sewer line continues eastward to manhole M012. The size of sewer line between manhole M012 and M004 is 51-inch. This manhole is the entry point of to RWQCP.

- *Mitchell Avenue Sewer Line:* The study sewer line along Mitchell Avenue begins at manhole M749 at the intersection of Mitchell Avenue and Campbell Avenue. A 12-inch sewer line begins at this location and continues in a southerly direction to manhole M742. From there, a 15-inch line continues to manhole M738. The pipe segment between M738 and M737 is 8-inch. At manhole M737 the size changes to 12-inch and continues to manhole M735. The last segment of the pipeline is 15-inch. It joins Bushnell Avenue trunk sewer line at manhole M734. The sewer line picks up flow from the residential development in the northern portion of La Sierra Hills neighborhood.

- *Bushnell Avenue Sewer Line:* The trunk sewer line begins at manhole M734 located at the intersection of Bushnell Avenue and Mitchell Avenue and continues in a southwesterly direction. The sewer line between manhole M734 and M731 is 18-inch. At manhole M731 the size changes to 15-inch. The sewer line joins La Sierra Avenue (1) trunk sewer line at manhole M205. The sewer line crosses La Sierra Channel near Mitchell Avenue. This sewer line picks up wastewater flow from Mitchell Avenue sewer line and residential development along Bushnell Avenue.

- *Pierce Street (3) Sewer Line:* The trunk sewer line begins at manhole M214 located at Pierce Street east of Sierra Vista Avenue. A 15-inch sewer line continues from this location in an easterly direction to manhole M207. A 12-inch line continues to Manhole M205 at the intersection of Bushnell Avenue and La Sierra Avenue where it joins La Sierra Avenue (1) trunk sewer line. This sewer line picks up wastewater flow from residential development north of La Sierra University.

- *La Sierra Avenue (1) Sewer Line:* The trunk sewer line begins at manhole M205 located at La Sierra Avenue and Pierce Street intersection. A 21-inch sewer line continues from this location in a southeasterly direction to manhole M196. At this location, it joins the trunk sewer line along La Sierra Channel. The sewer line also crosses La Sierra Channel at this location. It picks up wastewater flow from Pierce Street sewer line and Bushnell Avenue sewer line at M205 in addition to flow from commercial development along La Sierra Avenue.

- *Hole Avenue Sewer Line:* Hole Avenue trunk sewer line is comprised of many sewer segments of varying sizes and begins at manhole M725 at the intersection of Hole Avenue and Doane Avenue. A 15-inch sewer line begins from this location and continues in a southeasterly direction to manhole M723. An 18-inch line continues to manhole M718. Beyond this manhole, a 12-inch sewer line continues southward to manhole M717. The sewer line joins Collett Avenue trunk sewer line at M188. The sewer line crosses La Sierra Channel north of Mitchell Avenue. This sewer line picks up wastewater flow from the residential development along Hole Avenue west of Collett Avenue. In addition, it picks up flow from commercial development near the Hole Avenue and California Avenue intersection.

- *Collett Avenue Sewer Line:* The trunk sewer line begins at manhole M188 located at the intersection of Collett Avenue and Jones Avenue. An 18-inch sewer line continues from this location in a southwesterly direction to manhole M196. This sewer line picks up wastewater flow from Hole Avenue and Jones Avenue sewer lines and also from residential and commercial development along Collett Avenue. It joins La Sierra Channel Trunk Sewer at manhole M196.

- *Arizona Avenue Sewer Line:* The trunk sewer line begins at manhole M622 located at the intersection of Arizona Avenue and Cross Street. An 18-inch sewer line continues from this location in a southwesterly direction to manhole M614. Then an 8-inch line continues to manhole M597. The size changes to 10-inch at this location and continues to manhole M594 where it joins Filmore Street trunk sewer. This sewer line picks up wastewater flow from residential development along La Sierra Avenue between Indiana Avenue and Victoria Avenue.

- *Polk Street (2) Sewer Line:* Polk Street (2) trunk sewer line begins at manhole M577 at the intersection of Indiana Avenue and Racine Drive and crisscrosses through many streets before joining Magnolia Avenue (1) sewer line at manhole M553. A 12-inch sewer line continues from manhole M577 in a southwesterly direction to manhole M573. From there, an 8-inch line continues to manhole M572. Beyond this manhole a 12-inch sewer line continues southwards to manhole M553. The sewer line joins Magnolia Avenue (1) trunk sewer line at M553. The sewer line crosses Metrolink Railroad and Hwy 91. It picks up wastewater flow from the residential development east of Hwy 91 and commercial developments between Hwy 91 and Magnolia Avenue.

- *Polk Street (1) Sewer Line:* The trunk sewer line begins at manhole M167B at the intersection of Magnolia Avenue and Polk Street. A 15-inch sewer line continues from this manhole in a northwesterly direction to manhole M177 and then continues southwesterly direction to manhole M180 at Jones Avenue. It picks up wastewater flow from commercial development along Polk Street west of Hwy 91.

- *Magnolia Avenue (1) Sewer Line:* Magnolia Avenue (1) trunk sewer line begins at manhole M553 at the intersection of Magnolia Avenue and Polk Street. An 8-inch sewer line continues from manhole M553 in

southwesterly direction to manhole M551. From there, a 21-inch line continues to manhole M548. Beyond this manhole a 24-inch sewer line continues to manhole M42. A parallel sewer line also continues from manhole M553 to M551. The sewer line joins La Sierra Avenue (2) trunk sewer line at M536. It picks up wastewater flow from Polk Street sewer line and commercial development between Hwy 91 and Magnolia Avenue.

- *Magnolia Avenue (2) Sewer Line:* The trunk sewer line has two parallel segments between La Sierra Avenue and Golden Avenue. A 12-inch segment begins at manhole M545 located at the intersection of Magnolia Avenue and Golden Avenue and continues in a northeasterly direction to manhole M538. At this location, the line changes to 15-inch and continues to manhole M536 located at the intersection of Magnolia Avenue and La Sierra Avenue. Another 24-inch segment of pipeline continues from manhole M536 in a southwesterly direction to manhole M582 located at the Magnolia Avenue and Golden Avenue intersection. Besides collecting flow from Polk Street (2) sewer, this sewer line picks up wastewater flow from the commercial development in the vicinity.

- *Magnolia Avenue (3) Sewer Line:* Magnolia Avenue (3) trunk sewer line begins at manhole M702 at Buchanan Avenue south of Magnolia Avenue. A 12-inch sewer line continues from manhole M702 in a westerly direction to manhole M701. Then an 8-inch line continues to manhole M700. Beyond this manhole a 15-inch sewer line continues to Pierce Street trunk sewer line at manhole M676. The sewer line crosses Arlington Channel and Metrolink Railroad east of Magnolia Avenue.

- *Queensborough Street Sewer Line:* The trunk sewer line begins at manhole M712 located at the intersection of Queensborough Street and Price Street. A 12-inch sewer line continues from manhole M712 in a southwesterly direction to manhole M591 at the intersection of Queensborough Street and Fillmore Street. It picks up wastewater flow from residential development south of La Sierra Avenue and east of Hwy.91.

- *Fillmore Street Sewer Line:* Fillmore Street trunk sewer line begins at manhole M594 at the intersection of Fillmore Street and Indiana Avenue. A 10-inch sewer line continues from manhole M594 in a northwesterly direction to manhole M587. Then, a 12-inch line continues to manhole M582. The sewer line joins Golden Avenue trunk sewer line at manhole M582. It crosses Arlington Channel,

Metrolink Railroad and Hwy 91 east of Magnolia Avenue. The sewer line picks up Arizona Avenue wastewater flow at M594, Queensborough Street flow at M591 and flow from residential development along Fillmore Street.

- *Riverwalk Parkway Sewer Line:* The trunk sewer line begins at manhole M668 located at the intersection of Riverwalk Parkway and Collett Avenue. A 12-inch sewer line continues from manhole M668 in a southeasterly direction to manhole M658 at the intersection of Riverwalk Parkway and Pierce Street. It picks up wastewater flow from La Sierra University (LSU) and residential development on eastern edge of LSU.

- *Pierce Street (1) Sewer Line:* Pierce Street (1) trunk sewer line begins at manhole M672 located at the intersection of Pierce Street and Collett Avenue. A 15-inch sewer line continues from this location in a southeasterly direction to manhole M671 where the size changes to 12-inch. The 12-inch line continues to manhole M657. The sewer line joins La Sierra Channel trunk sewer line at manhole M642. The sewer line picks up wastewater flow from Riverwalk Parkway sewer line and also from residential development west of Pierce Street.

- *Taylor Street Sewer Line:* The trunk sewer line begins at manhole M692 located at the intersection of Queensborough Street and Paines Street. A 15-inch sewer line continues from manhole M692 in a southwesterly direction to manhole M680 at the intersection of Taylor Street and Pierce Street. It picks up wastewater flow from residential development north of Pierce Street and west of Indiana Avenue.

- *Pierce Street (2) Sewer Line:* Pierce Street (2) trunk sewer line begins at manhole M680 located at the intersection of Pierce Street and Taylor Street. A 15-inch sewer line continues from this location in northwesterly direction to manhole M676, where the size changes to 21-inch. The 21-inch line continues to manhole M642 where it joins the La Sierra Channel trunk sewer line. The sewer line picks up wastewater flow from Magnolia Avenue (3) sewer at M676 and from Taylor Street sewer at M681.

- *Stonewall Drive Sewer Line:* The trunk sewer line begins at Collett Avenue north of Golden Avenue at manhole M656. A 12-inch sewer line continues from this location to manhole M651 where the size changes to 15-inch. The

sewer line joins La Sierra Channel trunk sewer line at manhole M650. It picks up wastewater flow from residential development west of La Sierra Channel and Collett Avenue.

- *Golden Avenue Sewer Line:* The sewer line begins at manhole M582 located at the intersection of Golden Avenue and Magnolia Avenue. A 12-inch sewer line continues from this location to manhole M631 where it joins La Sierra Channel trunk sewer line. It picks up wastewater flows from Fillmore Street and Magnolia Avenue (2) sewer lines. Also, it picks up wastewater flow from residential development along Golden Avenue between Magnolia Avenue and La Sierra Channel.

- *La Sierra Avenue (2) Sewer Line:* La Sierra Avenue (2) trunk sewer line begins at manhole M536 located at the intersection of La Sierra Avenue and Magnolia Avenue. It joins Cochran Avenue sewer line at manhole M531. The sewer line picks up wastewater flow from Magnolia Avenue (1) and Magnolia Avenue (2) sewer lines at manhole M536. Also, it picks up wastewater flow from commercial developments near La Sierra Avenue and Magnolia Avenue intersection.

- *Cochran Avenue Sewer Line:* The trunk sewer line begins at manhole M531 located at the intersection of Cochran Avenue and Jones Avenue. A 15-inch sewer line continues from this location to manhole M180 where it joins Jones Avenue trunk sewer line. It picks up wastewater flows from La Sierra Avenue (2) sewer line. Also, it picks up wastewater flow from residential development between La Sierra Avenue and Jones Avenue.

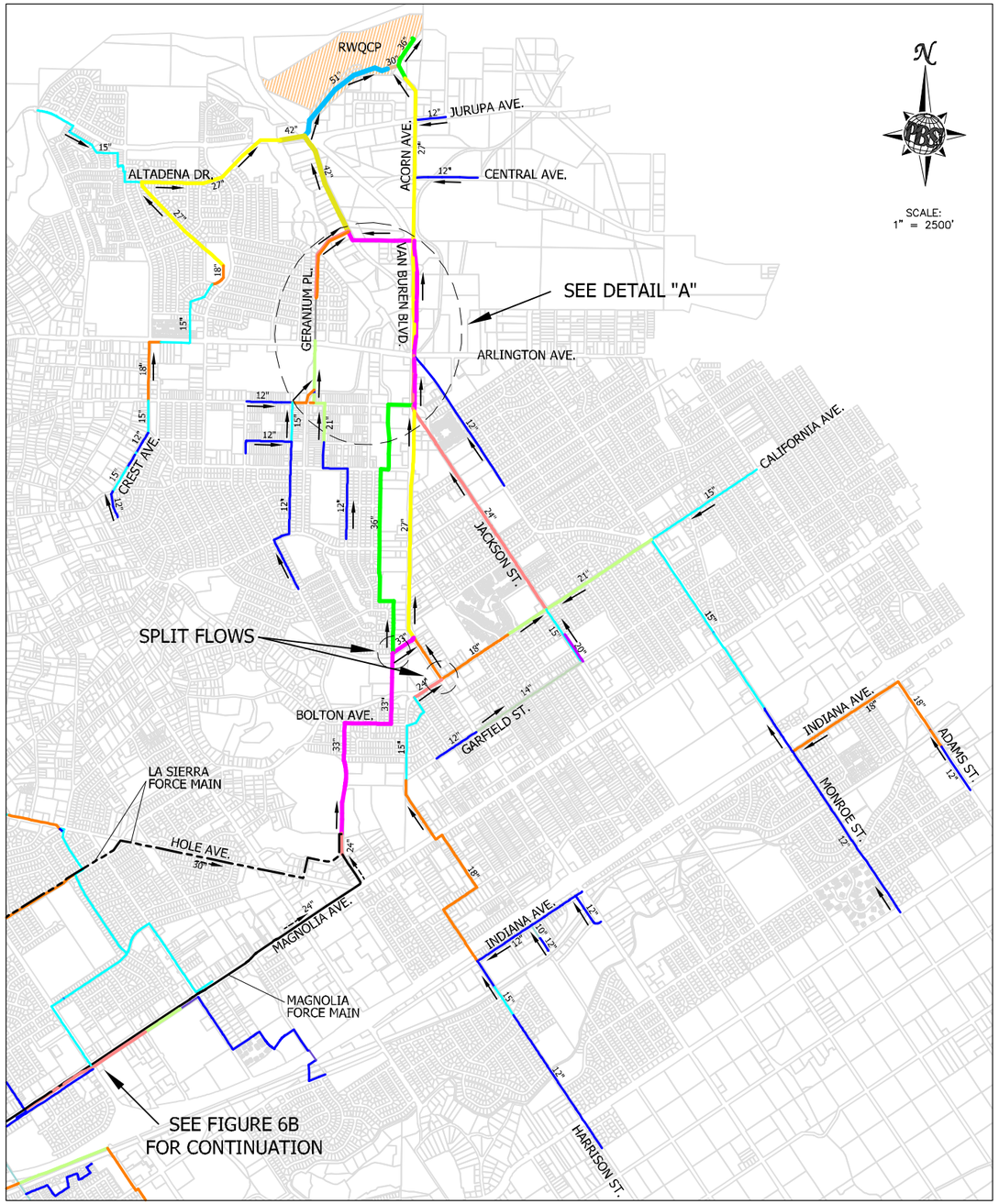
- *Jones Avenue Sewer Line:* The trunk sewer line begins at manhole M180 located at the intersection of Cochran Avenue and Jones Avenue. A 15-inch sewer line continues from this location to manhole M188, where it joins Collett Avenue trunk sewer line. It picks up wastewater flows from Polk Street (1) and Cochran Avenue sewer lines at manhole M180.

- *La Sierra Channel Sewer Line:* La Sierra Channel trunk sewer line picks up all wastewater flow from the western portion of the Arlanza Trunk Sewer Study Area that drains to Pierce Pump Station. The sewer line begins at manhole M196 located at the intersection of La Sierra Avenue and La Sierra Channel. A 27-inch sewer line continues from this location in a southeasterly direction to manhole M642.

From this location, a 30-inch sewer line continues to manhole M645, which is the location of the pump station.

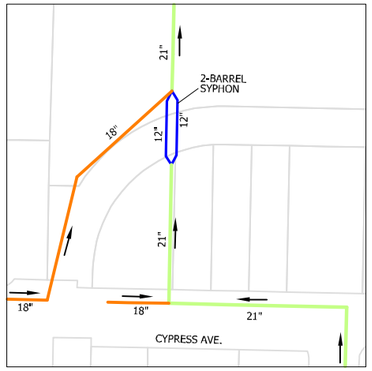
- *Magnolia Avenue Force Main:* Magnolia Avenue Force Main begins at Pierce Pump Station located near Pierce Street and Hwy.91. From this location, the line follows the alignment of Magnolia Avenue in northeasterly direction to manhole M093 where it joins the gravity sewer system at Megginson Lane north of Magnolia Avenue. It is a 24-inch Mortar Lined and Coated (ML&C) steel pipe in its entire reach.

- *La Sierra Area Force Main:* The force main begins at Pierce Pump Station located near Pierce Street and Hwy 91. From this location, the force main initially follows the alignment of Pierce Street in a northwesterly direction to Riverwalk Parkway and then along Riverwalk Parkway to Collett Avenue. From there, it follows Collett Avenue in a northeasterly direction to the intersection of Hole Avenue and Collett Avenue. It follows Hole Avenue to the intersection of Hole Avenue and Tyler Street. Thereafter, it continues through an easement to the gravity sewer line at manhole M092. The force main is a 30-inch ML&C steel pipeline.



N

SCALE:
1" = 2500'



DETAIL "B"
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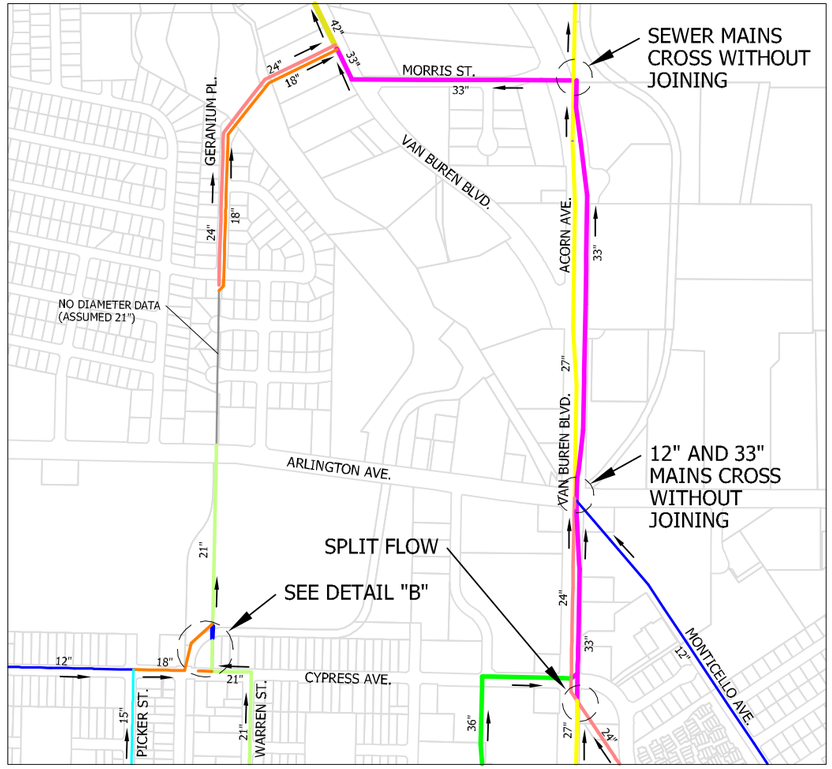

DETAIL "A"
NTS

LEGEND

- 8" DIAMETER PIPE
- 10" DIAMETER PIPE
- 12" DIAMETER PIPE
- 14" DIAMETER PIPE
- 15" DIAMETER PIPE
- 18" DIAMETER PIPE
- 20" DIAMETER PIPE
- 21" DIAMETER PIPE
- 24" DIAMETER PIPE
- 27" DIAMETER PIPE
- 30" DIAMETER PIPE
- 33" DIAMETER PIPE
- 36" DIAMETER PIPE
- 42" DIAMETER PIPE
- 51" DIAMETER PIPE
- NO DIAMETER DATA (ASSUMED 21")
- 24" MAGNOLIA FORCE MAIN
- 30" LA SIERRA FORCE MAIN
- GRAVITY MAIN FLOW DIRECTION
- FORCE MAIN FLOW DIRECTION

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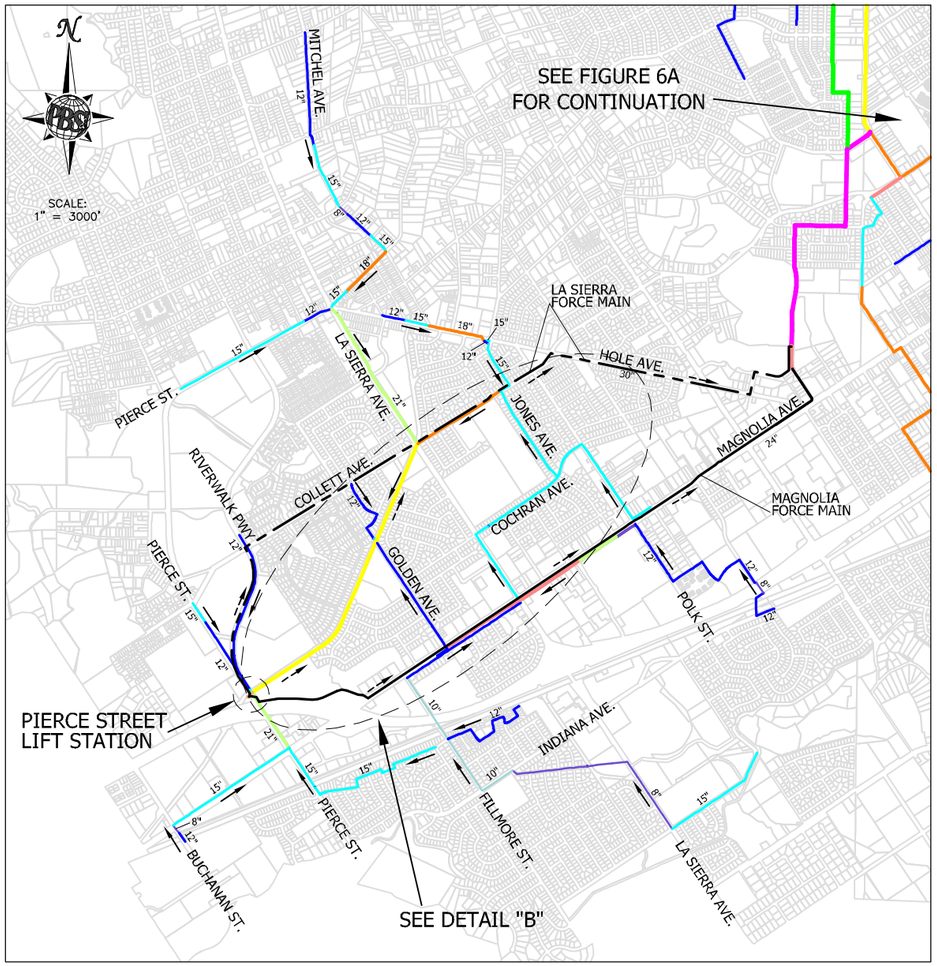
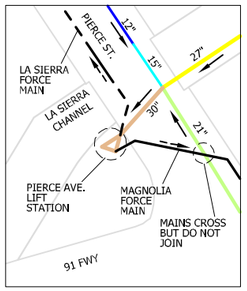
CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 6A

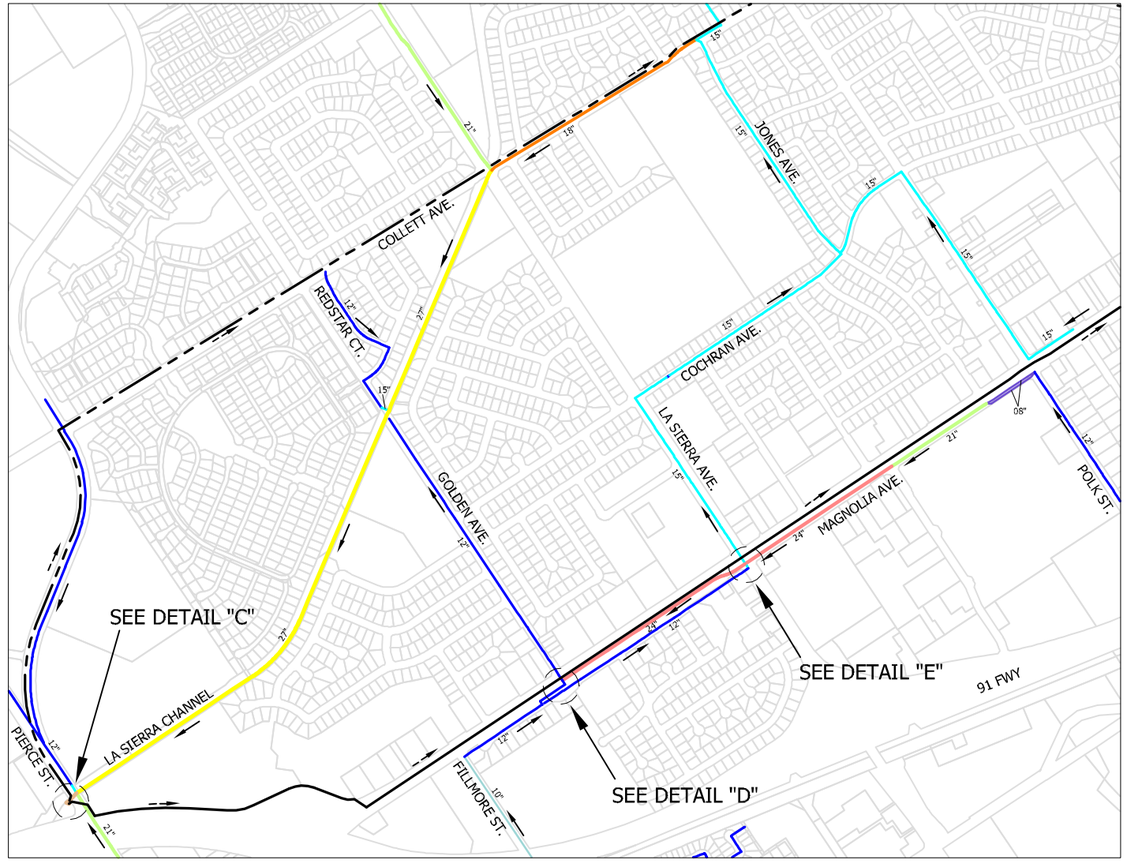
SYSTEM PIPE DIAMETERS - PART 1

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-SewerSysAndDia.dwg, 9/28/2006 10:30:10 AM





DETAIL "C"
NTS



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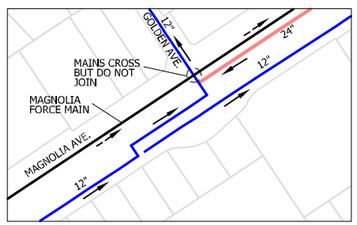

DETAIL "D"
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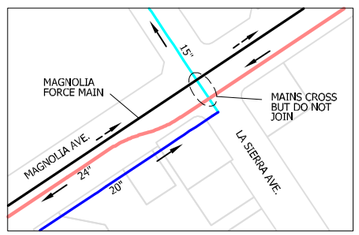

DETAIL "E"
NTS

LEGEND

- 8" DIAMETER PIPE
- 10" DIAMETER PIPE
- 12" DIAMETER PIPE
- 14" DIAMETER PIPE
- 15" DIAMETER PIPE
- 18" DIAMETER PIPE
- 20" DIAMETER PIPE
- 21" DIAMETER PIPE
- 24" DIAMETER PIPE
- 27" DIAMETER PIPE
- 30" DIAMETER PIPE
- 33" DIAMETER PIPE
- 36" DIAMETER PIPE
- 42" DIAMETER PIPE
- 51" DIAMETER PIPE
- 24" MAGNOLIA FORCE MAIN
- 30" LA SIERRA FORCE MAIN
- FORCE MAIN FLOW DIRECTION
- GRAVITY MAIN FLOW DIRECTION

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CITY OF RIVERSIDE
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FIGURE 6B

SYSTEM PIPE DIAMETERS - PART 2

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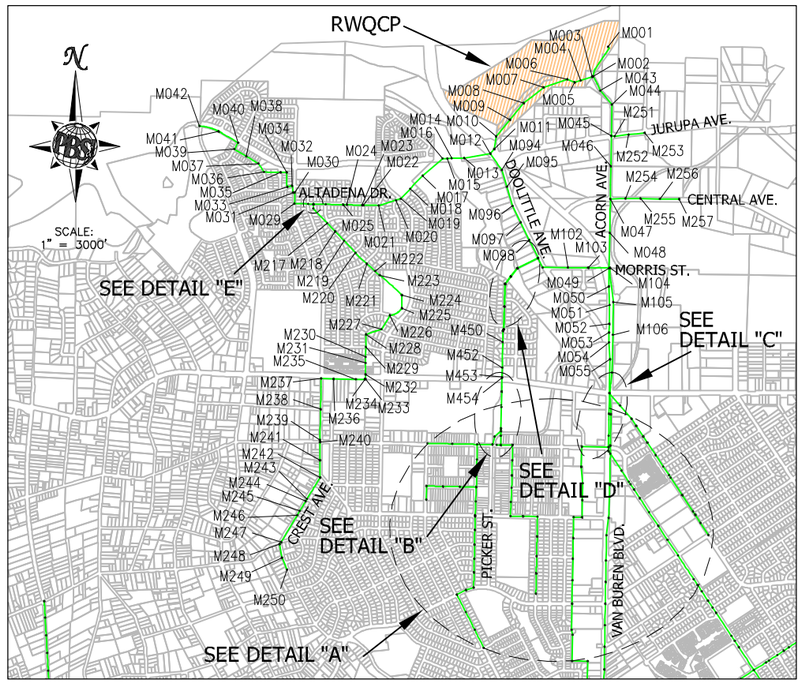

DETAIL "A"
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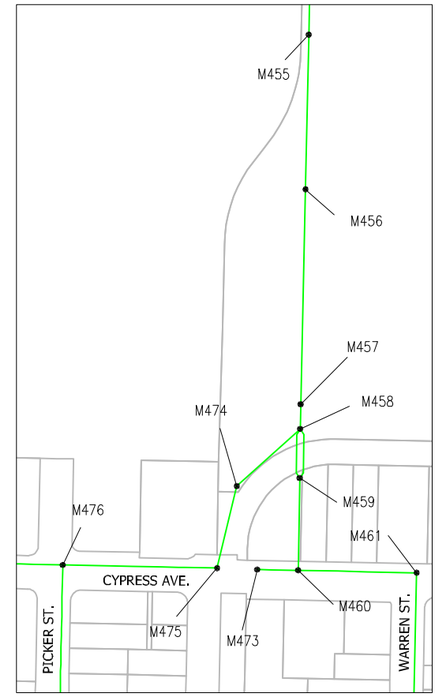

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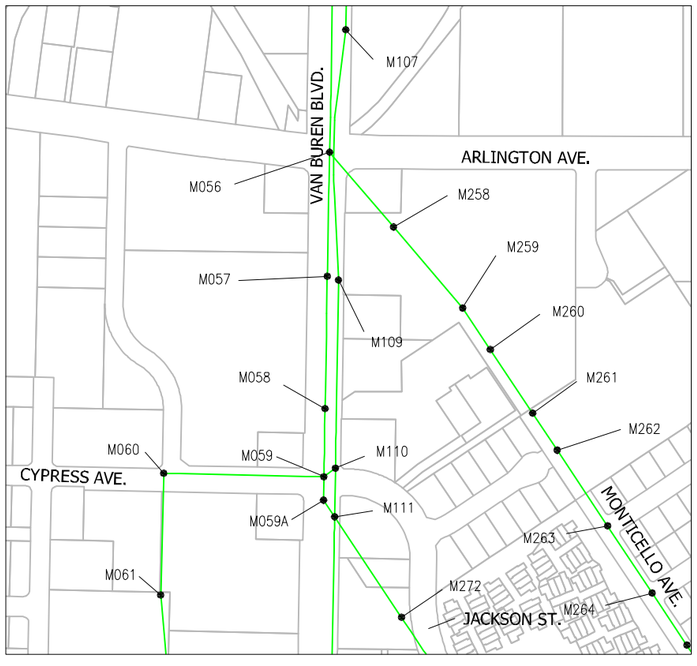

DETAIL "C"
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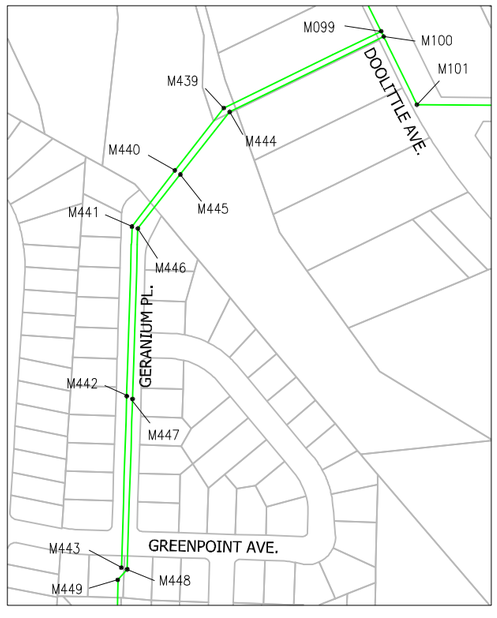

DETAIL "D"
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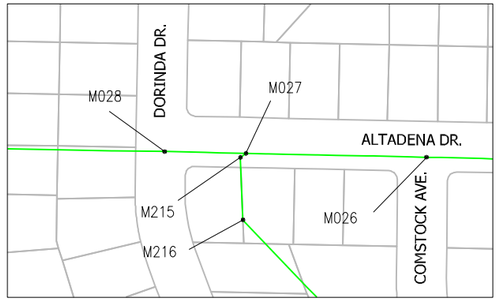

DETAIL "E"
NTS

LEGEND

GRAVITY SEWER

M001 MANHOLE NUMBER

SEE FIGURES 7B AND 7C FOR CONTINUATION OF SEWER BASIN SYSTEM

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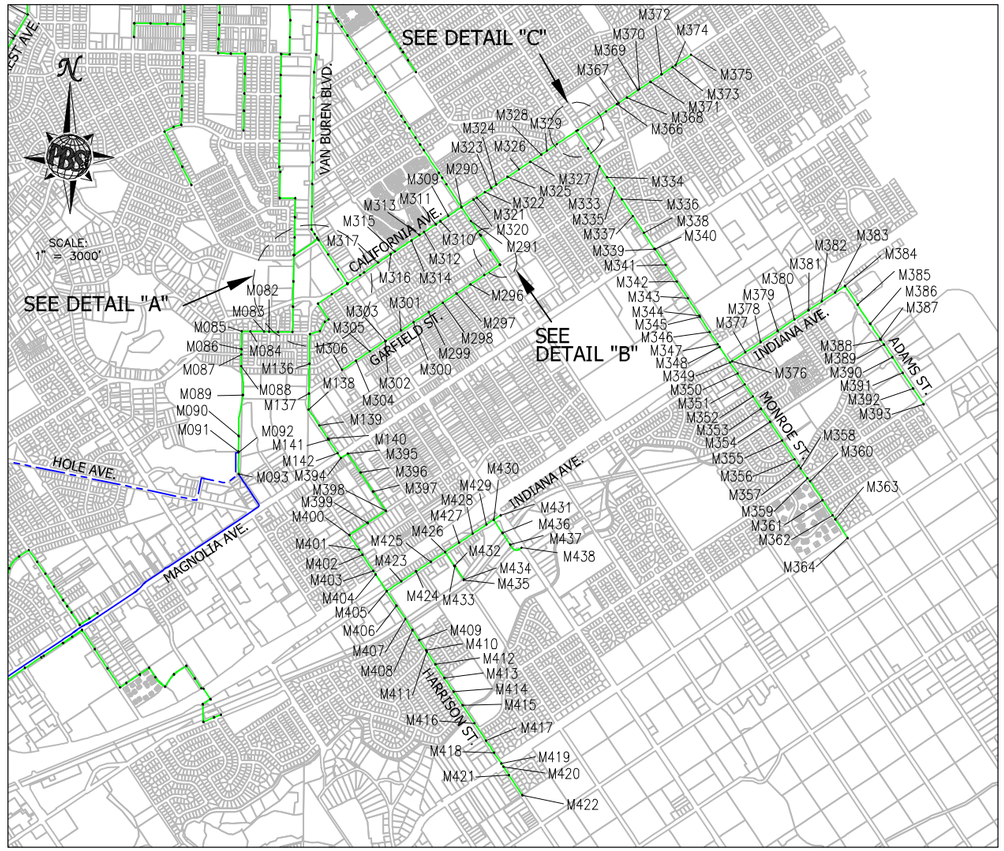
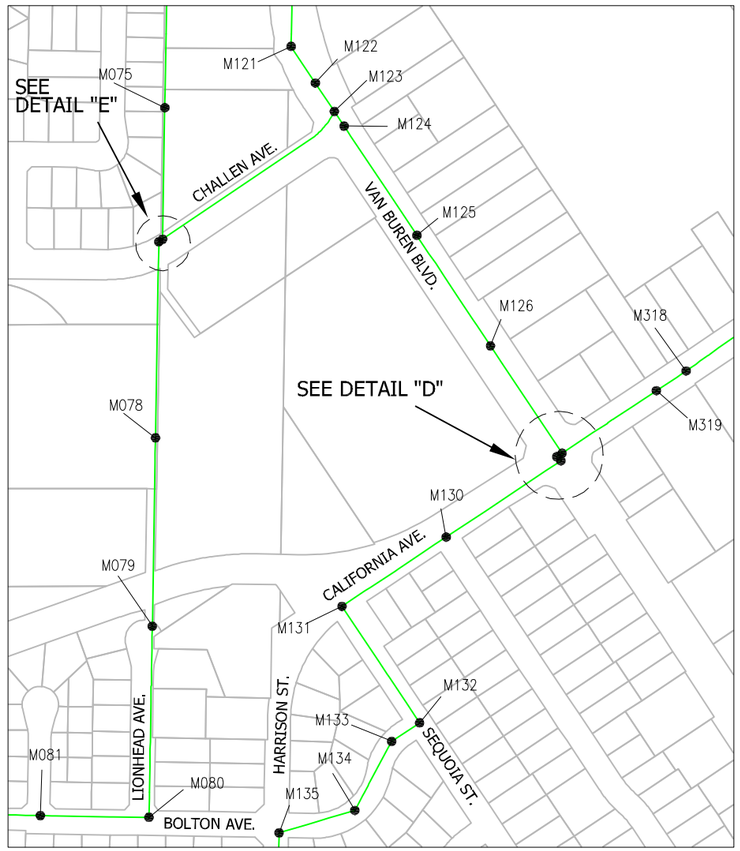
CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 7A

EXISTING MANHOLES - PART 1

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-ManholestIDs.dwg, 9/28/2006 9:54:48 AM





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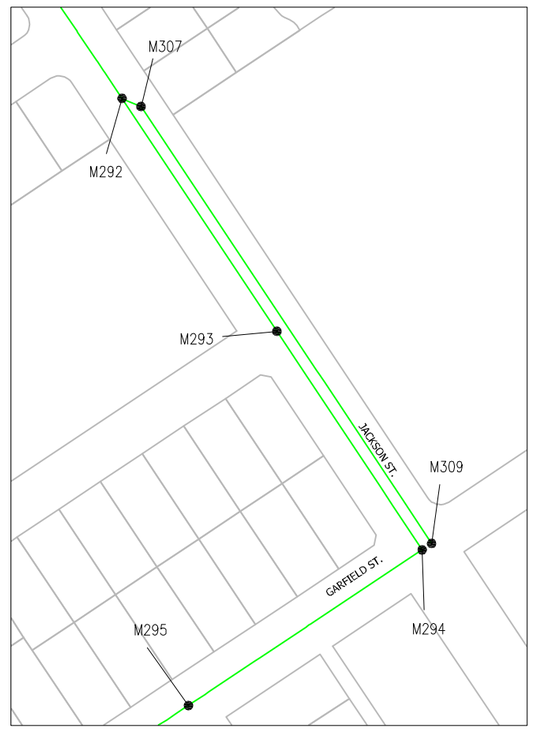
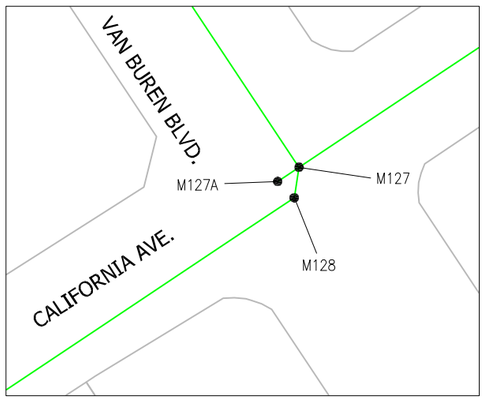


DETAIL "B"
NTS

DETAIL "C"
NTS



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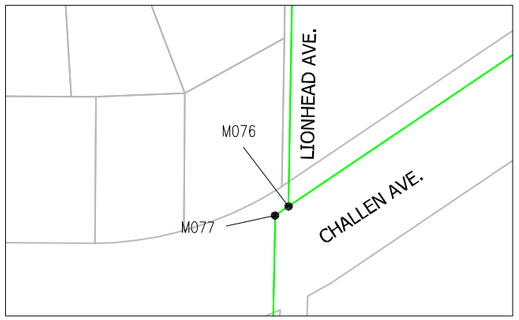

DETAIL "E"
NTS

LEGEND

———	MAGNOLIA FORCE MAIN
— - —	LA SIERRA FORCE MAIN
———	GRAVITY SEWER
M001	MANHOLE NUMBER

SEE FIGURES 7A AND 7C FOR CONTINUATION OF SEWER BASIN SYSTEM

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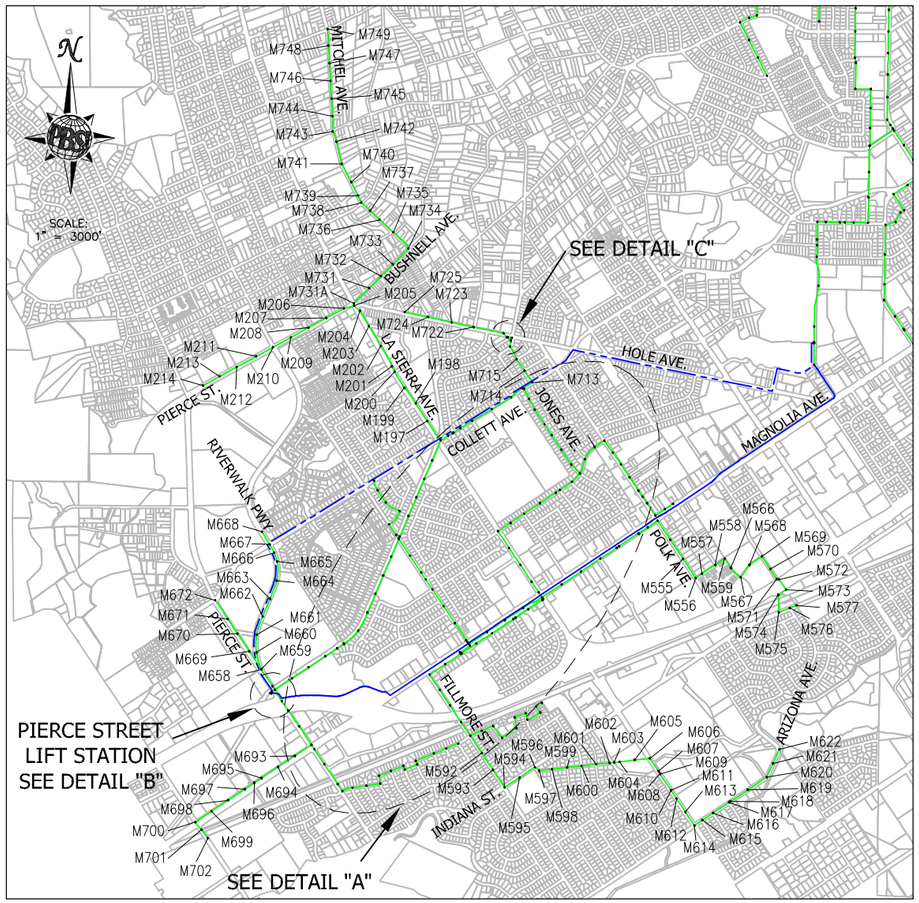
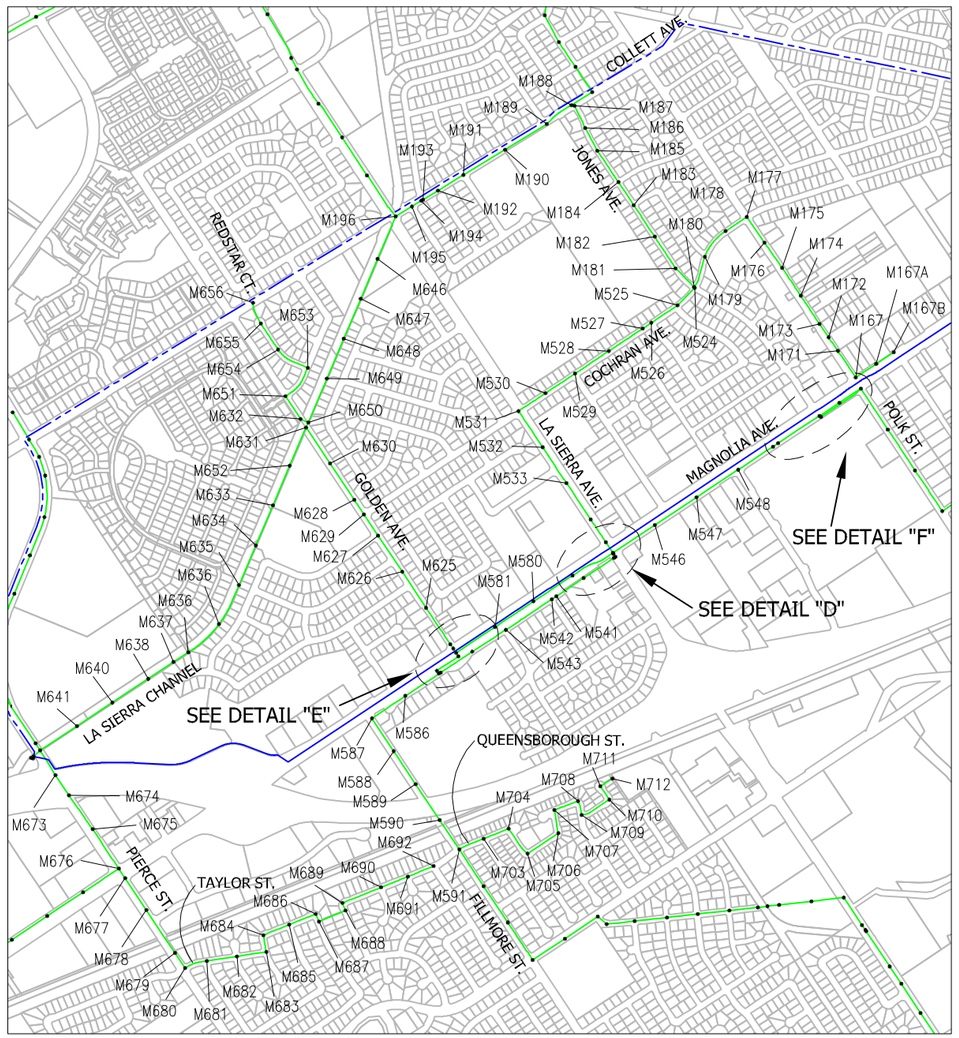
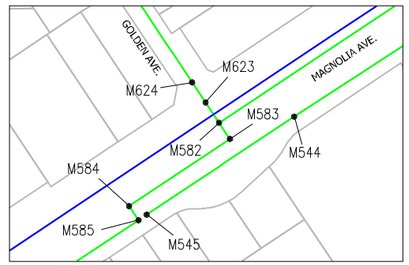
FIGURE 7B

EXISTING MANHOLES - PART 2

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-ManholesIDsB.dwg, 9/28/2006 9:58:33 AM







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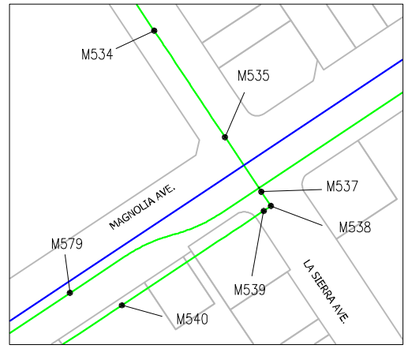
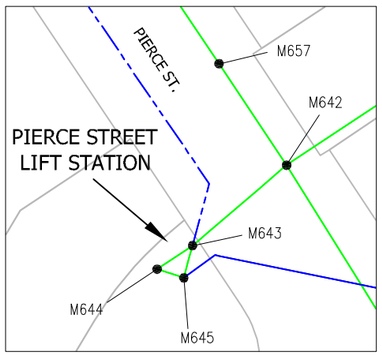


DETAIL "D"
NTS

DETAIL "F"
NTS



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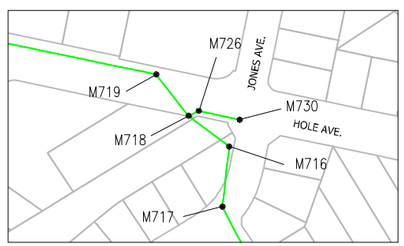

DETAIL "C"
NTS

DETAIL "A"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- M001 MANHOLE NUMBER

SEE FIGURES 7A AND 7B FOR CONTINUATION OF SEWER BASIN SYSTEM

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FIGURE 7C

EXISTING MANHOLES - PART 3

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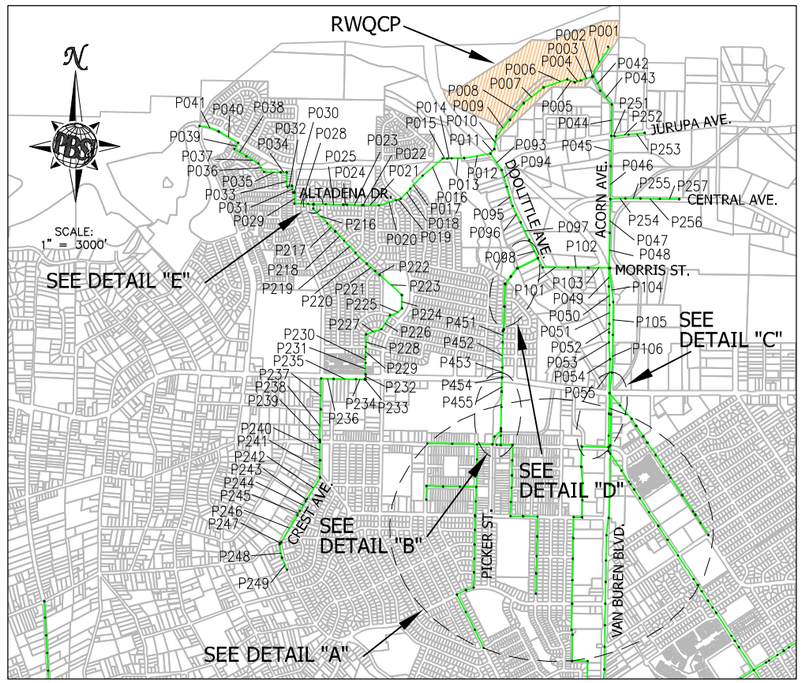
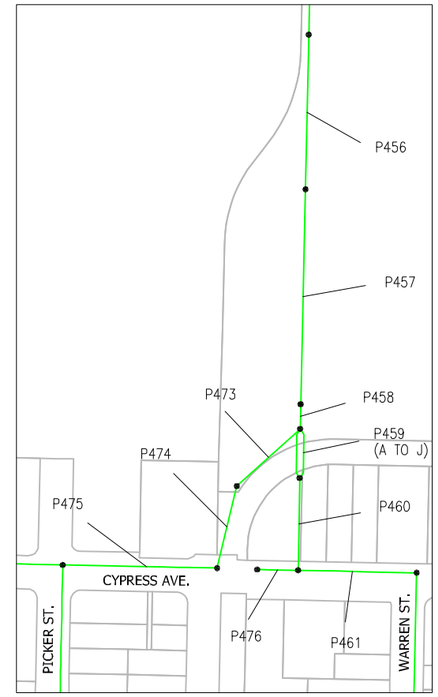


DETAIL "A"
NTS



DETAIL "B"
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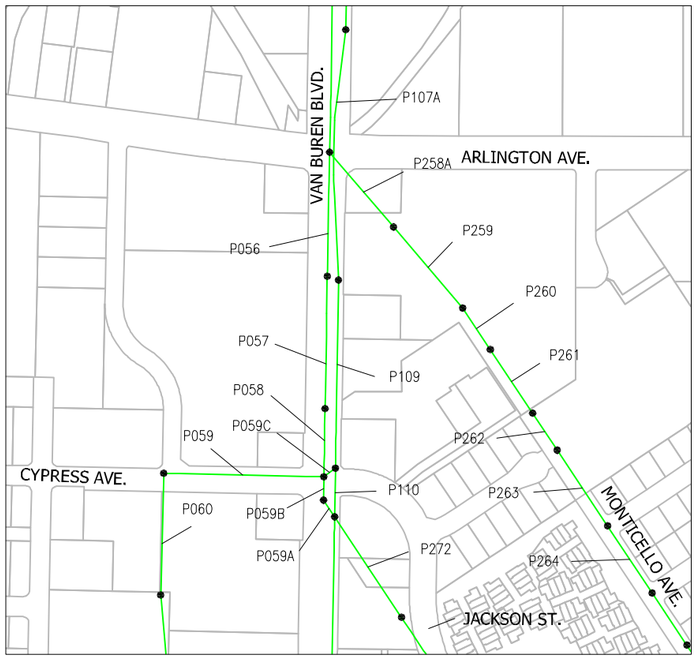

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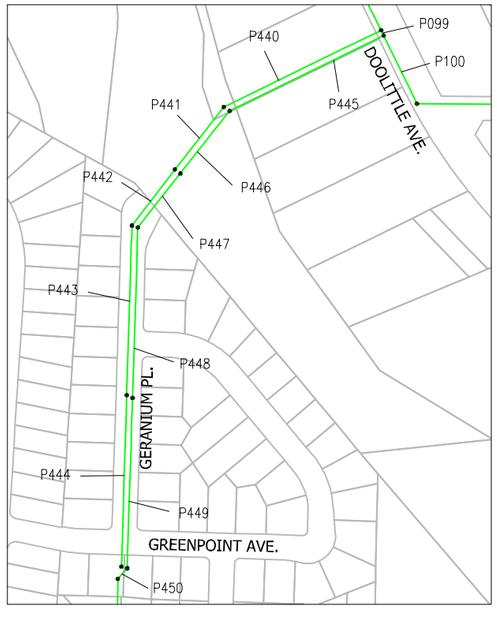

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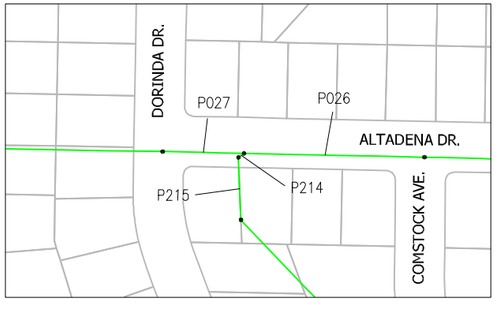

DETAIL "E"
NTS

LEGEND

GRAVITY SEWER

P001 PIPE SEGMENT NUMBER

SEE FIGURES 8B AND 8C FOR CONTINUATION OF SEWER BASIN SYSTEM

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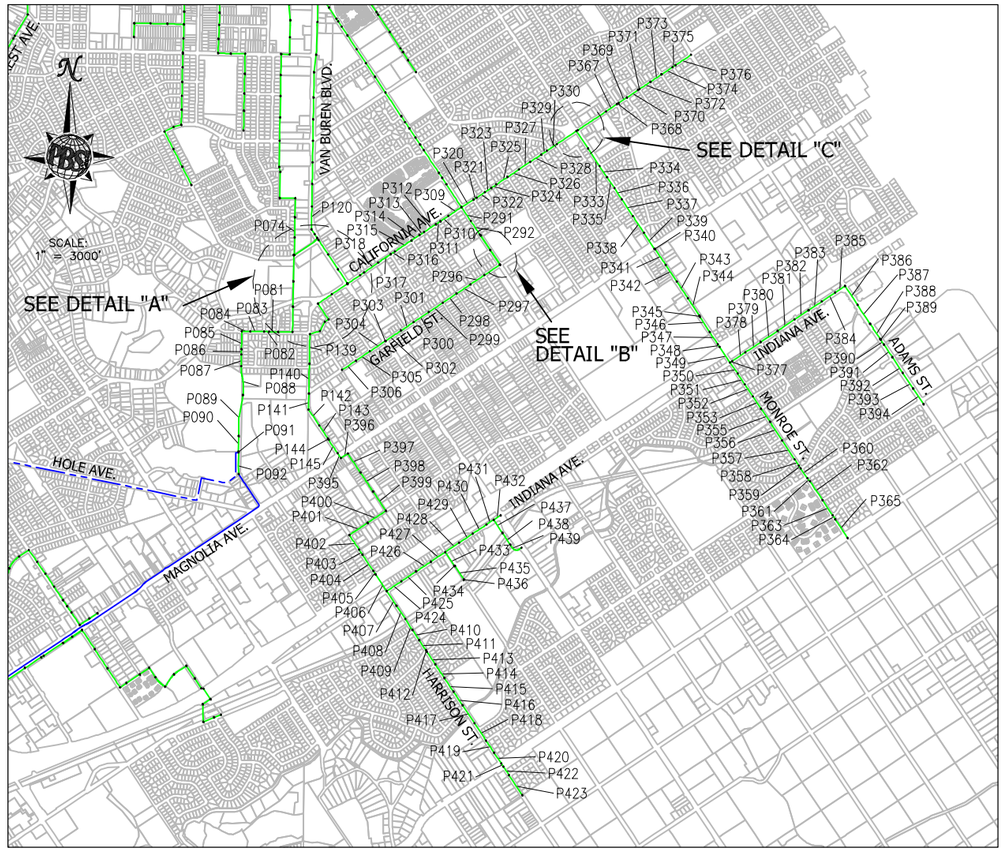
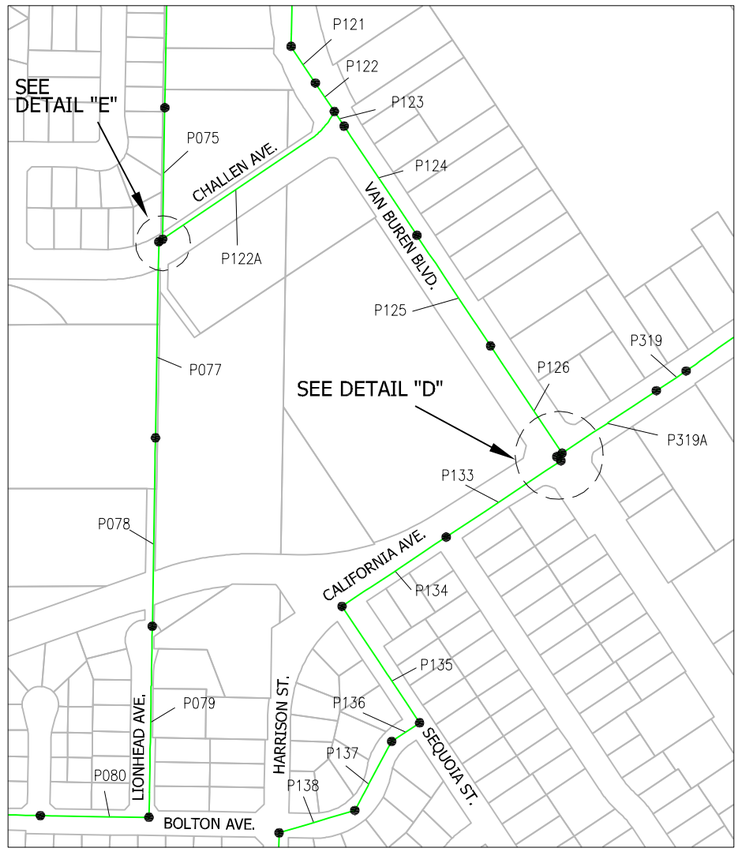
CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 8A

EXISTING PIPES - PART 1

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-PipeIDs.dwg, 9/28/2006 10:01:41 AM





DETAIL "A"
NTS

DETAIL "B"
NTS

DETAIL "C"
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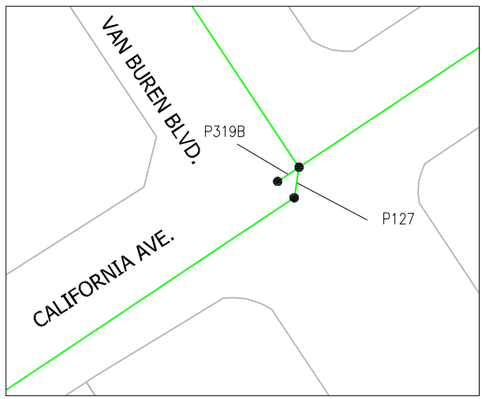

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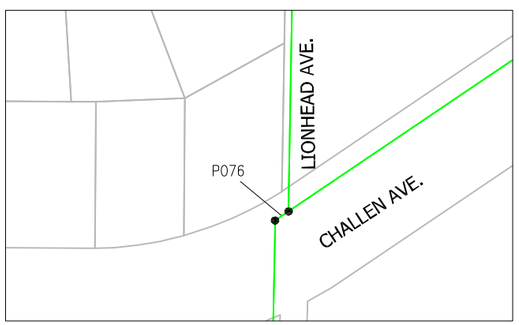

DETAIL "E"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 8A AND 8C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 8B

EXISTING PIPES - PART 2

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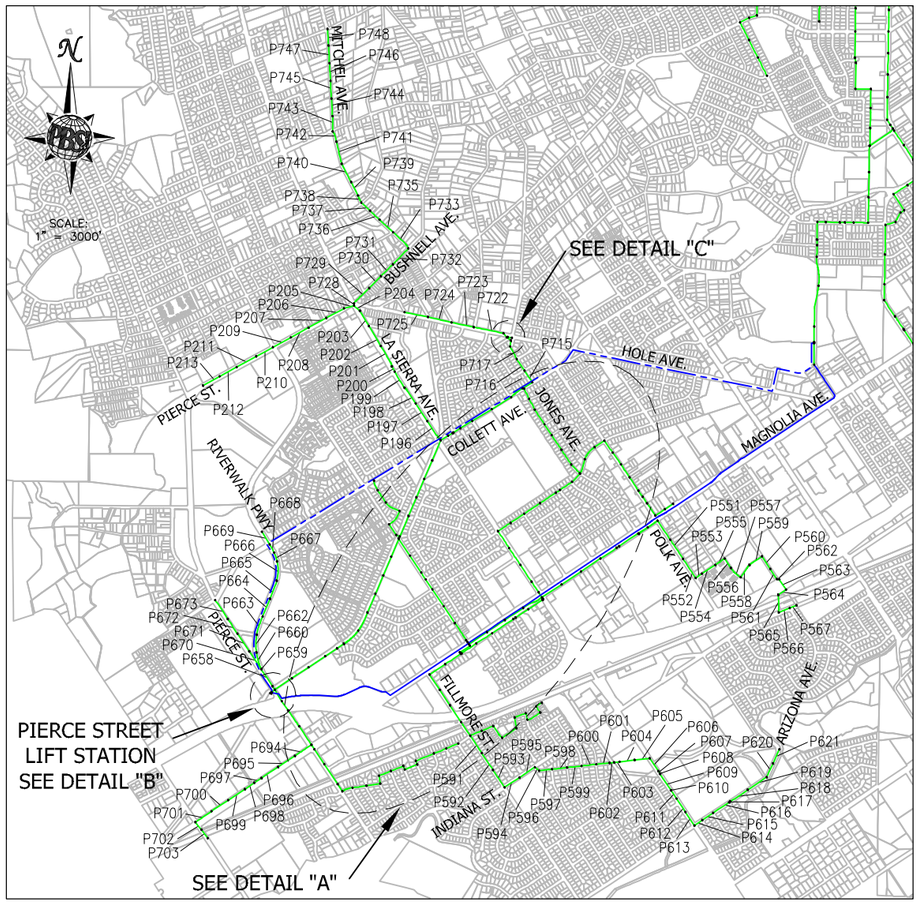

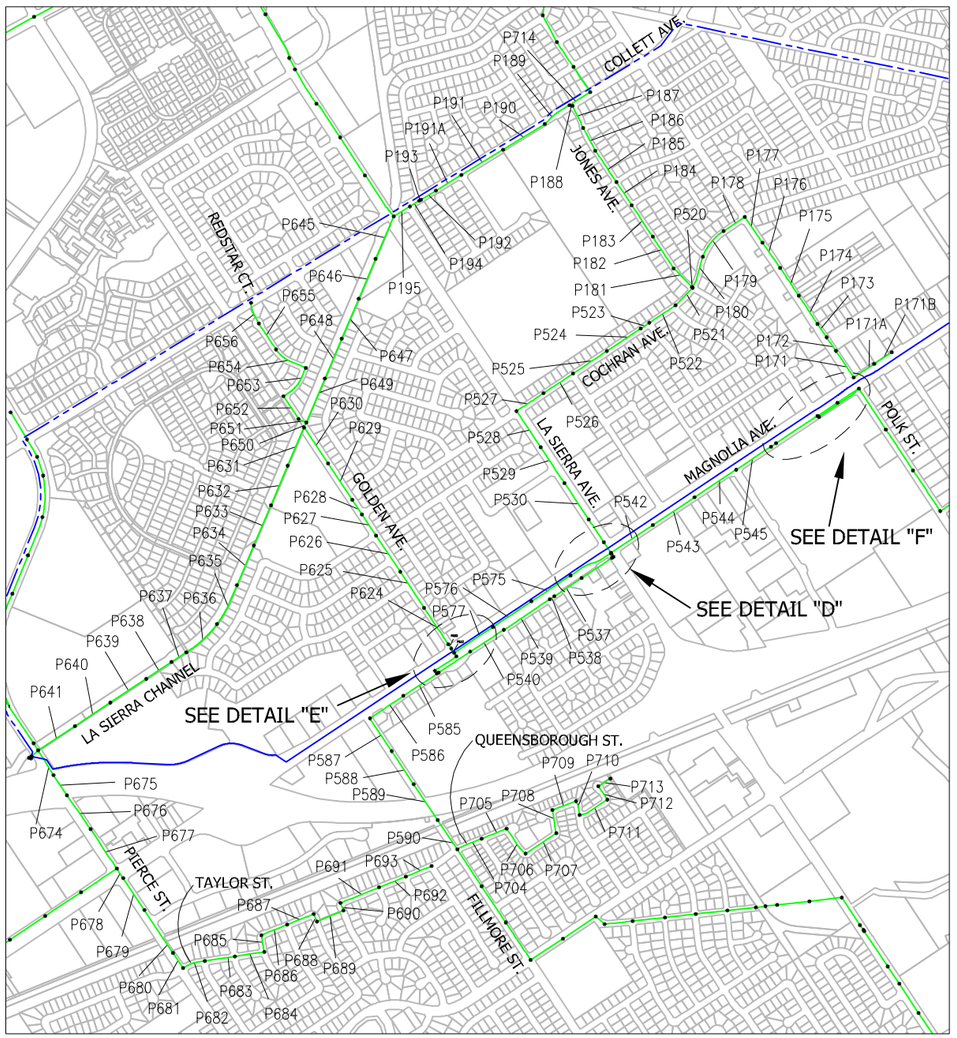

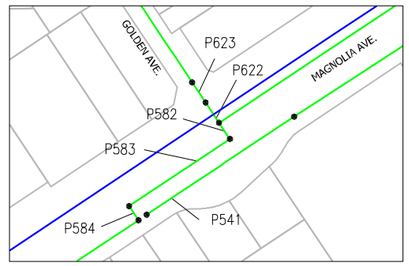

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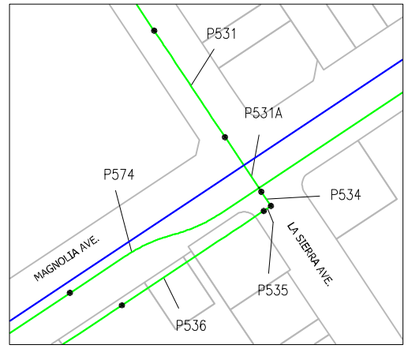

DETAIL "D"
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DETAIL "F"
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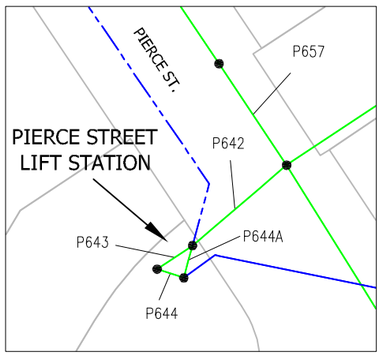

DETAIL "B"
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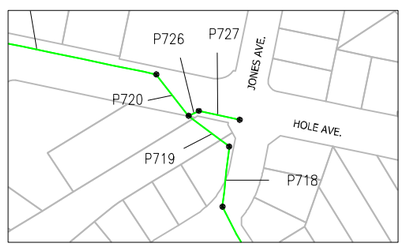

DETAIL "C"
NTS

DETAIL "A"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 8A AND 8B FOR CONTINUATION OF SEWER BASIN SYSTEM

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ARLANZA SEWER STUDY

FIGURE 8C

EXISTING PIPES - PART 3

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-PipeIDs3.dwg, 9/28/2006 10:04:01 AM

3.4 Tributary Areas

The study area is divided into 34 sub-areas, each having a land use or flow pattern distinctive from other. These sub-areas are tributary to a particular meter location either individually or collectively (See section 4.1 Flow Monitoring). Because of their strategic locations, meters upstream from a cumulative meter can be subtracted out to deduce the cumulative effect. See Figure 5 for meter locations and tributary areas, and Figure 4 for details of tributary sub-areas. Following is the listing of tributary sub-areas and their contribution to a particular meter location.

Meter No. 1: Sub-areas 17, 18 and 20 are tributary to meter No. 1, located on La Sierra Avenue, northwest of the La Sierra Avenue and Collett Avenue intersection.

Meter No. 2: Sub-areas 12 and 29 are tributary to meter No. 2 located on the Collett Avenue near Collett Avenue and Sunrose intersection.

Meter No. 3: Sub-areas 14, 15 and 16 are tributary to meter no. 3 located at Pierce Street near Pierce Street Lift Station.

Meter No. 4: Flow from Pierce Lift Station that includes sub-areas 12,13,14,15,16,18,19,20,25,16,27 and 29 are tributary to meter 4, located on Selma Avenue between the Tomilinson Avenue and Selma Avenue intersection.

Meter No. 5: Sub-areas 7, 9, 10, 11 and 24 are tributary to meter 5, located on Van Buren Boulevard at the Van Buren Boulevard and Challen Avenue intersection.

Meter No.6: Sub-areas 4, 5, 6 and 35 are tributary to meter 6, located on California Avenue between Nessel Street and Wheeler Street.

Meter No.7: Sub-areas 8, 21, 22 and 34 are tributary to meter 7, located on Jurupa Avenue west of the Van Buren Boulevard and Jurupa Avenue intersection.

Meter No. 8: Sub-areas 2 and 3 are tributary to meter 8, located on Acorn Street between Jurupa Avenue and Central Avenue. Also, flows from other upstream meters are intercepted at this location.

Within each sub-area there is generally a distinct mixture of land use, that generates a unique quantity and diurnal pattern of wastewater flows. For identification of land use patterns, data provided by the City of Riverside in GIS Arcview format was used. Table 3-2 summarizes the sub-areas and land uses within the

sub-areas that are currently contributing to the existing sewer system.

Table 3-1

Developed Tributary Areas and Current Wastewater Land Use

Sub Area	SFR (Acres)	MFR (Acres)	Commercial (Acres)	Industrial (Acres)	School (Acres)	Total (Acres)
1	0	0	82	0	0	82
2	0	0	151	0	0	151
3	265	14	305	12	9	605
4	299	40	19	0	7	365
5	401	8	94	0	0	503
6	526	21	22	0	0	569
7	113	5	27	0	50	195
8	95	0	0	0	0	95
9	42	0	26	0	0	68
10	212	0	0	0	0	212
11	190	0	83	0	11	284
12	314	16	55	0	0	385
13	354	0	7	0	38	399
14	9	93	0	0	0	102
15	60	0	31	0	4	95
16	42	27	77	0	0	146
17	727	0	0	0	27	754
18	317	0	0	0	0	317
19	176	81	155	33	103	548
20	479	23	18	10	82	612
21	382	38	86	24	10	540
22	63	0	0	0	0	63
23	241	0	4	17	31	293
24	25	9	3	0	0	37
25	83	38	0	0	0	121
26	118	36	20	0	10	184
27	67	3	5	0	0	75
29	903	200	397	0	80	1,580
30	177	12	31	11	31	262
31	207	80	127	2	24	440
32	260	80	67	5	216	628
33	73	58	42	79	10	262
34	0	0	52	0	0	52

SFR – Single Family Residential
MFR – Multi Family Residential

4.0 DETERMINATION OF SEWER FLOWS

4.1 Flow Monitoring

Flow Monitoring was conducted at eight (8) sites to measure flows at strategic locations. In addition, flow readings from the Inflow and Infiltration (I&I) Study meters that were installed between 01/07/05 and 02/28/05 were also used. (See Figure 5 for locations of Flow Monitoring Stations). The flow monitoring was designed to accomplish the following:

- Establish current flow levels (See Figures 9-16).
- Verify or adjust flow coefficients.
- Establish characteristic flow patterns (Diurnal Curves) for the model (See Figures 17-24).
- Confirm peak to average flow relationships.
- Help prioritize recommend improvements.

Meter locations were chosen to observe actual flow characteristics for the various sub-areas and to provide a continuous record of measured flows over a period of time (two weeks for this study). Meter locations were also chosen in such a manner that current flow quantities at the RWQCP could be quantitatively determined. The City measures inflow from Arlanza study area at RWQCP at one minute intervals. The flow records received from the City were used for flow comparison and determination of diurnal patterns. Following is an amplification of the logic for placement of each flow meter.

- Meter No. 1; location on La Sierra Avenue northwest of Collett Avenue – This location was chosen because it carries all the flow generated from the residential area north of Pierce Street. The flow pattern at this location would reflect a diurnal pattern for single family residential developments.

- Meter No. 2; location on Collett Avenue near Sunrose Drive – This location was chosen to observe flow generated from the mixed use land area west of Hwy 91. This meter will measure flow generated from a matured residential - commercial area. The flow pattern at this location reflects a diurnal pattern for mixed land use.

- Meter No. 3; location on Pierce Street northwest of Magnolia Avenue – This location was chosen to measure the flow from residential and commercial areas on both sides of Hwy 91. The flow pattern at this location reflects a mixed diurnal pattern for residential – commercial land use.

- Meter No. 4; location on Selma Avenue north of Tomlinson Avenue – This location was chosen to measure the flow from Pierce Street Lift Station. The meter measures approximately all wastewater flow from the study area west of Tyler Street. The flow pattern at this location also reflects a pattern for a lift station.

- Meter No. 5; location on Van Buren Boulevard south of Challen Avenue – This location was chosen to measure the flow from residential areas along Van Buren Boulevard. This portion of study area is typically low density residential.

- Meter No. 6; location on California Avenue between Nessel Street and Wheeler Street – This location was chosen to measure the flow from residential areas in the northeastern portion of study area. The residential land use in this portion of study area is typically low density. The diurnal flow pattern can be used to estimate and calibrate residential flow patterns.

- Meter No. 7; location on Jurupa Avenue (extended) west of Van Buren Boulevard – This location was chosen to measure the flow from residential areas near City's northern boundary. The residential land use is typically medium density.

- Meter No. 8; location on Acorn Street north of Central Avenue – This location was chosen to measure flow from the commercial areas east of Acorn Street. It also intercepts flows from upstream contributing areas.

In conjunction with flow measured at the above meters and the I&I meters, flow data from the City was also used.

4.2 Results of Flow Monitoring

Measurement of sewer flows is an imprecise science, as the in-line equipment is placed in a harsh environment and is subject to solids interference, turbulence and other problems, which can impede the accuracy. Installed equipment must be frequently inspected and maintained, and monitoring results interpreted, evaluated for reasonableness, and sometimes adjusted. In this particular application, metered flow information was generally good. However, some flows at specific meter locations did not display consistent values. Graphical results at each site were carefully reviewed for consistency and reasonableness, using the following general guidelines:

- Where the magnitude or daily pattern varies significantly from one non-holiday weekday to the next, the data is likely to be flawed.
- Where the base (low) flows are rising during the flow monitoring period, the data is suspect.
- Where the algebraic sum of flows from meters in series are significantly out of sync, the data from one or more meters may be faulty.
- Where the minimum (nighttime) flows are abnormally high or algebraically inconsistent, the data is suspect.
- Where the measured depth data and velocity data are inconsistent the data is suspect.

Metered flows displaying one or more of the above flaws were purged or adjusted based on reasonable assumptions.

At each meter location the flow-monitoring device measures depth of flow and velocity. Upon reviewing the report submitted by Downstream Services, and from discussions with their staff, it was determined the data (depth or velocity) that is more consistent should be used for determination of flow. By using depth of flow readings and inputting pipe characteristics from record drawings (slope, size and roughness "n" values), sewage flow can be calculated using Manning's equation. The raw flow data have been included in the Appendix "A".

The flow monitoring hydrographs at each meter site, adjusted based on the depth measurements, are shown in Figures 9 through 16. The following relevant observations were made from evaluation of the measured flows:

- At meter location 1 the velocity and depth of flow readings are consistent for the entire period. The flow during this monitoring period has been used for estimation of the maximum flow and calibration of the model for sub-areas 17, 18 and 20.

- Flow measured at meter location 2 are generally consistent for week days. Some inconsistency has been observed during weekends that can be explained by the mixed land use flow contribution. The flow measured at this meter location has been used for calibration of flow from sub-areas 12 and 29.

- At meter location 3 the velocity and depth of flow readings are generally consistent for the monitoring period. During the weekdays, small spikes have been observed. The flow during this monitoring period has been used for estimation

of the maximum flow and calibration of the model for sub-areas 14, 15 and 16.

- The flow from the Pierce Street Lift Station is measured at meter location 4. Data for depth, velocity and flow are consistent at this location. The maximum flow value observed at this location has been used for calibration of the model for sub-areas 13, 19, 25, 26 and 27.

- At meter location 5, the velocity and depth of flow readings are generally consistent for the monitoring period. It also shows some spikes in the flow during the rain event. The flow at this monitoring station has been used for calibration of the model for sub-areas 7, 9, 10, 11 and 24.

- At meter location 6 the flow readings are generally consistent for the monitoring period. At this location, primarily flow from residential land use is measured. It shows a typical residential diurnal pattern. The flow at this monitoring station has been used for calibration of the model for sub-areas 4, 5 and 6.

- Flow measured at meter location 7 is not consistent for the entire flow measurement period. Flow measured between Oct 11 and Oct 16 has been used for the calibration of the model. The flow and diurnal pattern of this meter location is used for flow calibration of sub-areas 8, 21 and 22.

- Flow measured at meter location 8 shows a minimum flow value during early hours and a high peaking factor. This phenomenon can be explained by the split flow situation upstream of this meter location. The flow and diurnal pattern at this meter location is used for flow calibration of sub-areas 2 and 3.

5.0 ESTIMATED ULTIMATE FLOW

5.1 Methodology

Future wastewater flows in the study area are estimated by applying unit (per acre or per capita) flow factors to the projected "ultimate" land use acreage or population in each sub area. As discussed in Section 2, ultimate land uses within the study area are estimated based on the City's current General Plan (which governs future development/redevelopment). The major contributor to the increased wastewater flow in the future would be undeveloped low density residential areas southeast of Victoria Avenue and areas at Riverside-Norco boundary. For purpose of this study it has been assumed that these areas would most likely be developed by the year 2020.

5.2 Flow Coefficients

A review of commonly used flow coefficients (or unit factors) was performed to arrive at preliminary criteria, which are considered to be an appropriate starting point for the study.

Flow coefficients are commonly expressed in terms of cubic feet per second (cfs) of average dry weather flow (ADWF) per acre of a specific land use type. For population based estimates, flows are expressed in gallons per capita per day (gpcd). Peak flow generation rates are estimated by applying peaking factors to the average flow, with factors often based on observed peak-to-average ratios from previous studies. However, peaking factors and diurnal flow patterns vary greatly from one setting to another. Peaks for various land uses differ not only in magnitude, but also in time of day. The diurnal patterns are a composite picture of inflows that are not simultaneous, but rather staggered throughout the day. Also, peaks are attenuated by lag times and in pipe storage as the flows move downstream. Notwithstanding the above, diurnal peaking factors are also estimated for each land use to estimate peak generation rates.

For preliminary estimation of wastewater flow, the document "Criteria for Sewer Facility Design, Public Works Department, City of Riverside" was used (See Appendix "B"). The document states the following general guideline for estimation of wastewater flows.

Flows from Residential Developments:

- Land use shown in the City's General Plan.
- No. of dwelling units per acre within a certain land use.

- Persons per living unit determined from the latest census data for the study area. However, it should not be less than an average of 2.75 persons per living unit.
- Average wastewater flow based on 65 gallons per capita per day.
- Peak to average flows to be determined from the graphs.

Flows from Non-residential Developments:

- Industrial Developments – Peak flow; 0.012 cfs per acre.
- Commercial Developments – Peak flow 0.01 cfs per acre.
- Offices – 30 gallons per capita (employee on site) per day peak flow.
- Schools – 0.01 cfs/acre peak flow.
- Laundromat – 580 gallons per machine per day peak flow.

5.3 Representative Diurnal Hydrographs

The study area is comprised of a variety of unique land uses. For the purpose of defining characteristic diurnal patterns, flow from each sub-basin was analyzed and percentage of flow contribution from each land use type was estimated. Although none of the tributary sub areas flowing to the meter locations are comprised of a single land use category, several are dominated by one or two categories, and are thus selected as being representative of the diurnal flow patterns for those land uses. The diurnal patterns were established for each meter location, and the model was calibrated for mixed land use patterns. The following diurnal patterns were used for the modeled peak flow evaluation.

- Flow at meter location 1: Mixed Land Use with SFR predominance.
- Flow at meter location 2: Mixed Land Use
- Flow at meter location 3: Mixed (Commercial and Residential)
- Flow at meter location 5: Mixed Land Use with residential predominance.
- Flow at meter location 6: Low density residential
- Flow at meter location 7: Medium density residential
- Flow at meter location 8: Commercial use

These representative diurnal hydrographs are shown in Figures 17-24. The flow patterns are used in the model to estimate the

percentage of Average Dry Weather Flow (ADWF) contributed at specific times throughout the day.

Figure 9

Flow at Meter 1
Location: La Sierra Ave. near Collett Ave.

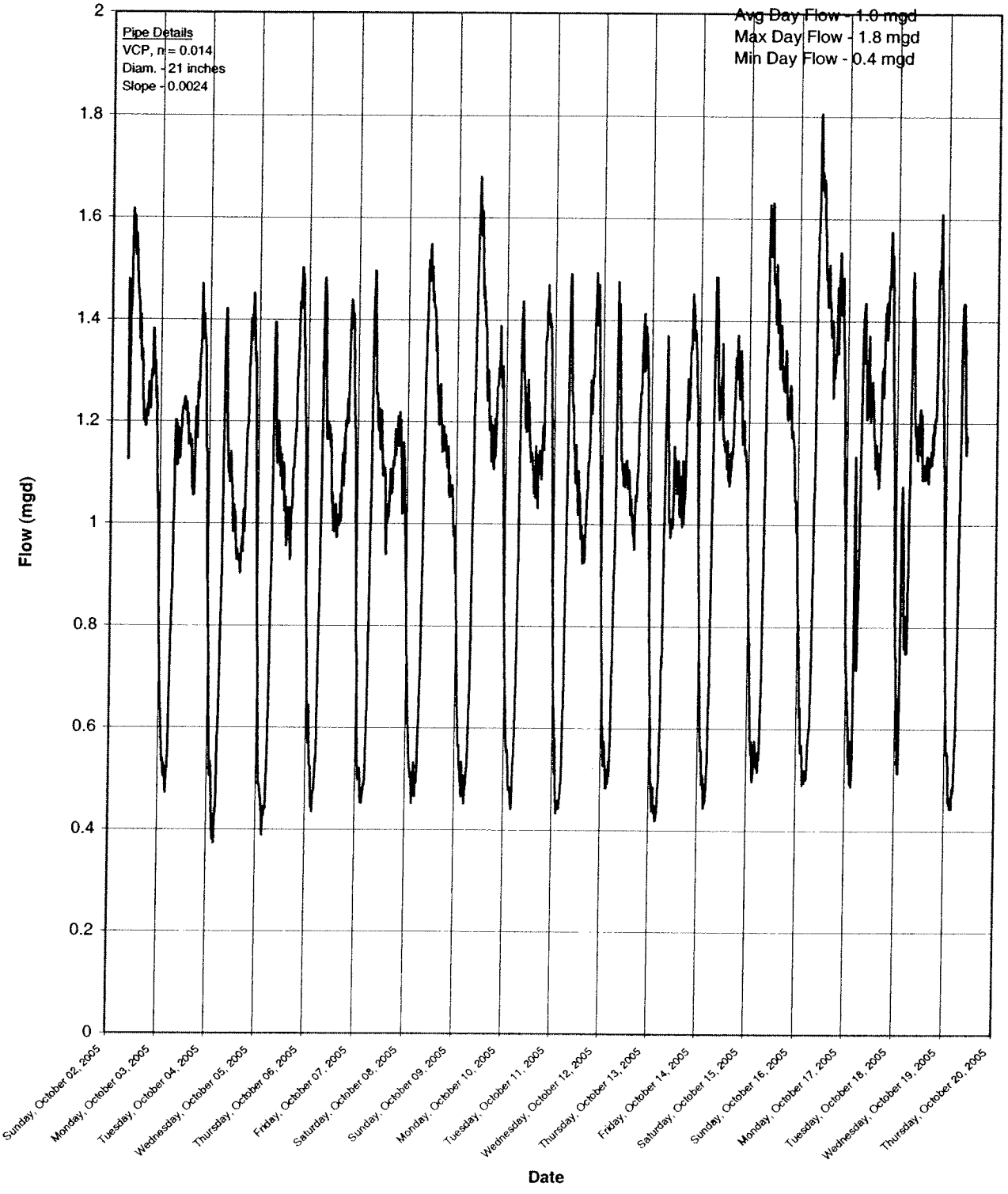


Figure 10

Flow at Meter 2
Location: Collett Ave. near La Sierra Ave.

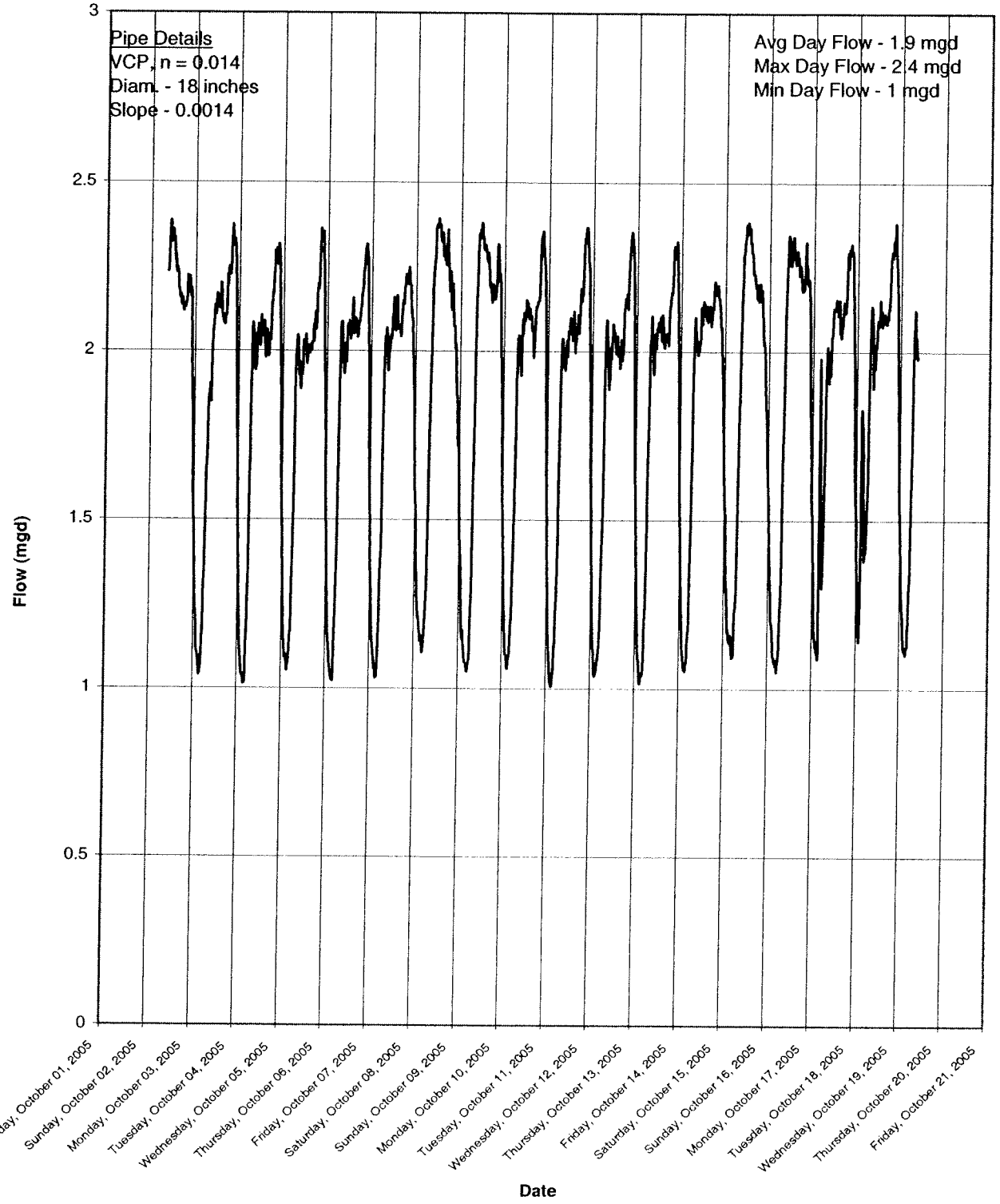


Figure 11

Flow at Meter 3
Location: Pierce St. near Pierce St. Pump Station

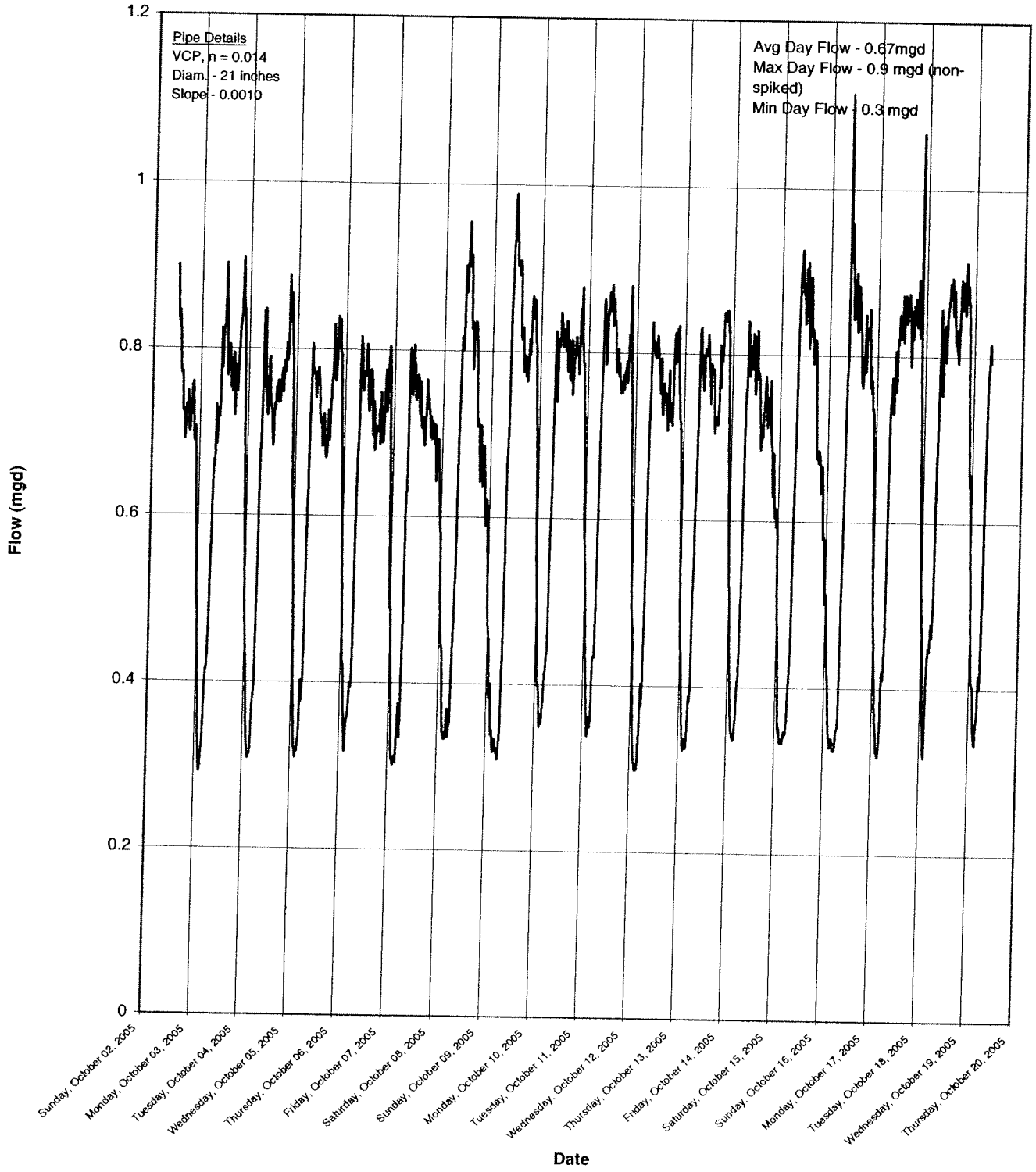


Figure 12

Flow at Meter 4
Location: Selma Ave. near Tomlinson Ave.

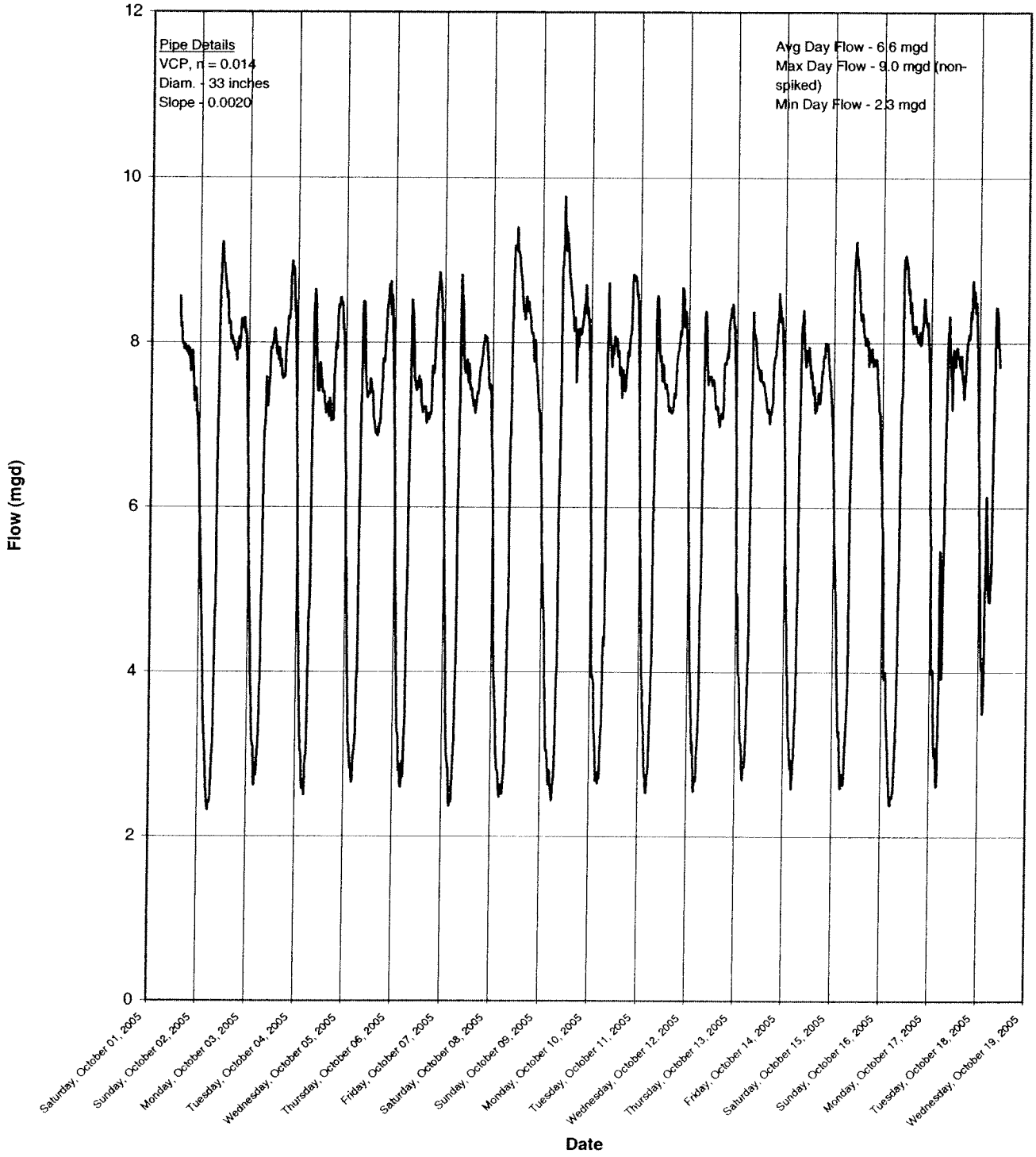


Figure 13

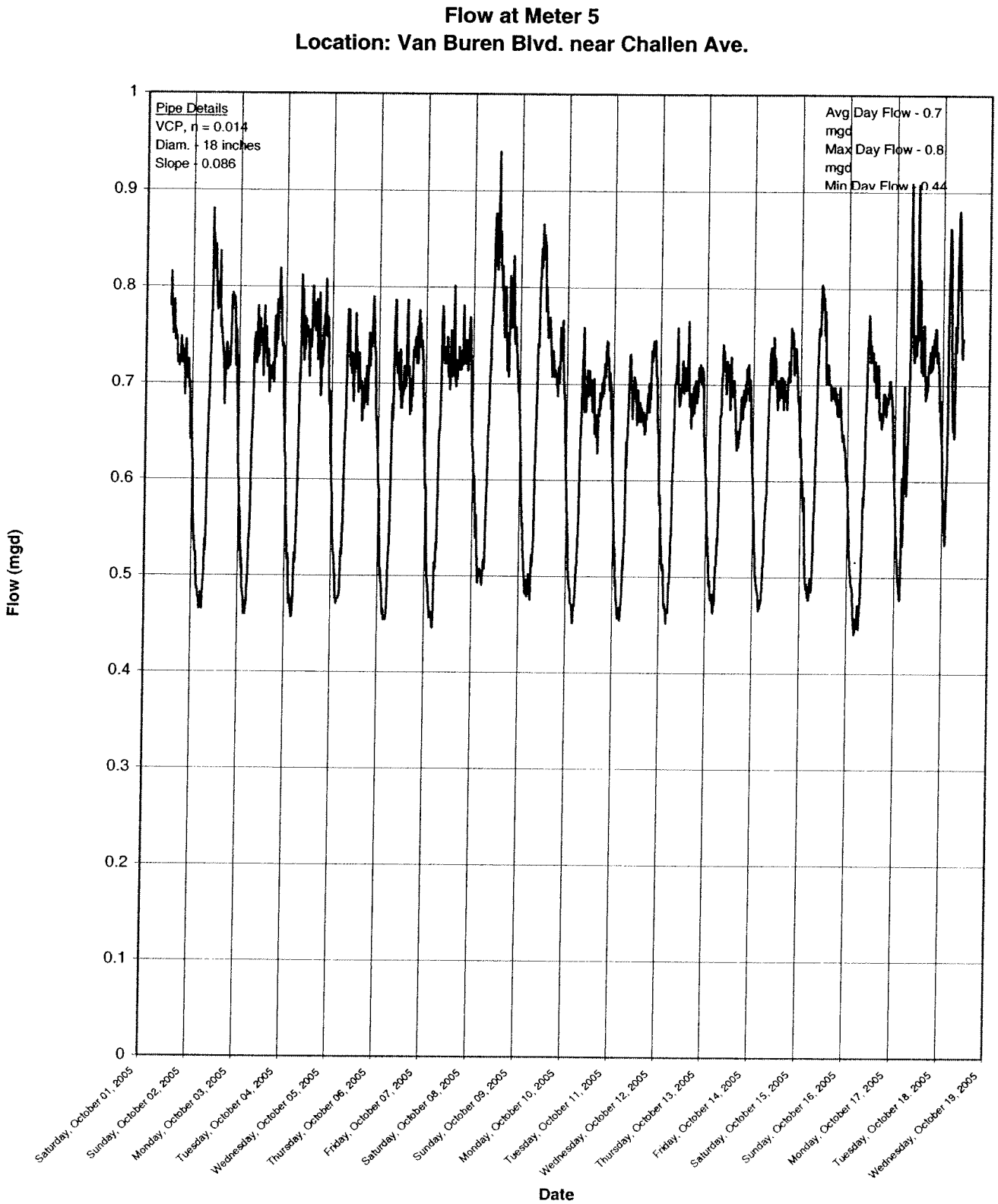

Flow at Meter 5
Location: Van Buren Blvd. near Challen Ave.
Pipe Details
VCP, n = 0.014
Diam. = 18 inches
Slope = 0.086
Avg Day Flow - 0.7 mgd
Max Day Flow - 0.8 mgd
Min Day Flow - 0.44
Flow (mgd)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Saturday, October 01, 2005
Sunday, October 02, 2005
Monday, October 03, 2005
Tuesday, October 04, 2005
Wednesday, October 05, 2005
Thursday, October 06, 2005
Friday, October 07, 2005
Saturday, October 08, 2005
Sunday, October 09, 2005
Monday, October 10, 2005
Tuesday, October 11, 2005
Wednesday, October 12, 2005
Thursday, October 13, 2005
Friday, October 14, 2005
Saturday, October 15, 2005
Sunday, October 16, 2005
Monday, October 17, 2005
Tuesday, October 18, 2005
Wednesday, October 19, 2005
Date

Figure 14

Flow at Meter 6
Location: California Ave. near Nessel St.

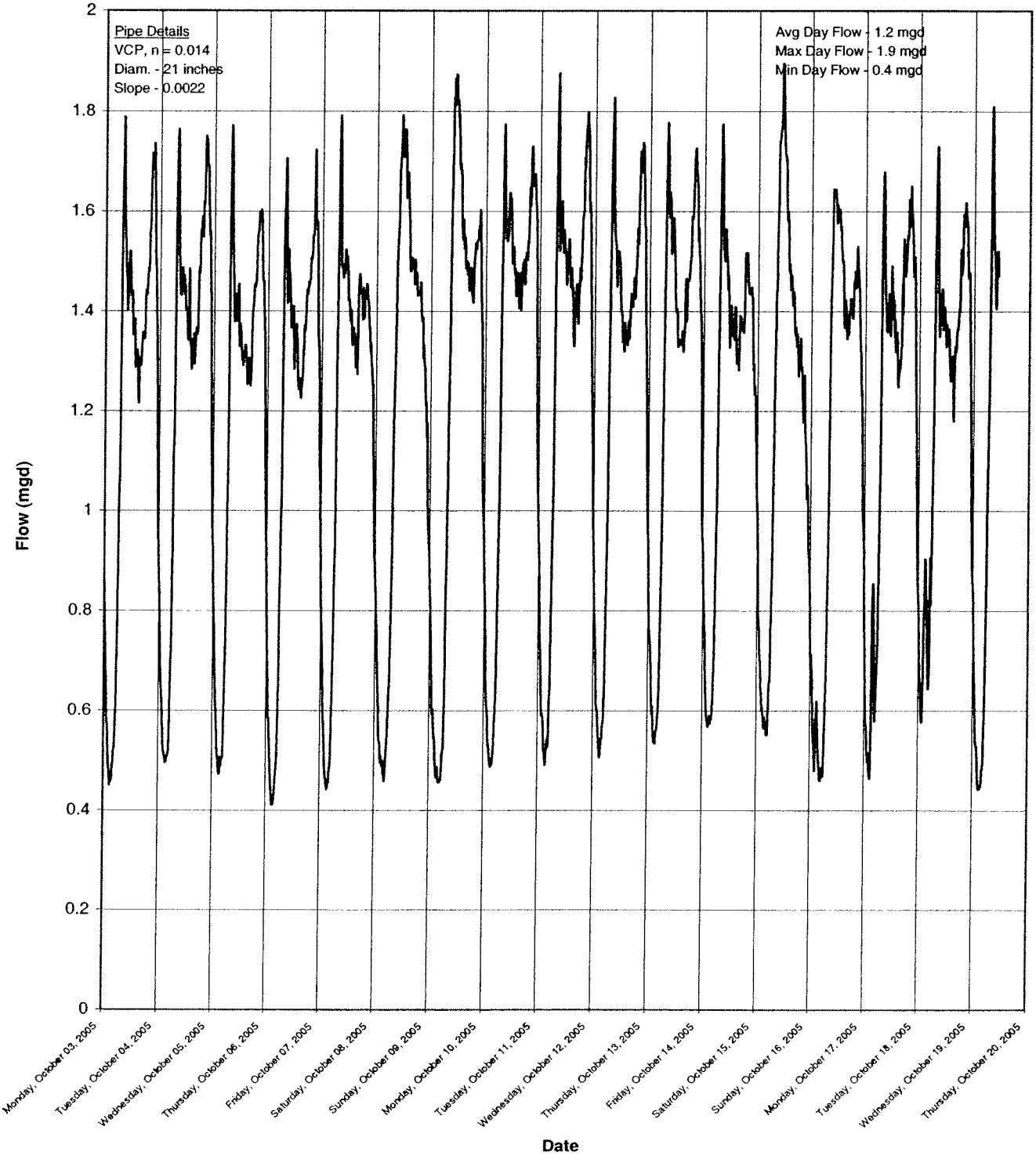


Figure 15

Flow at Meter 7
Location: Jurupa Ave. near Van Buren Blvd.

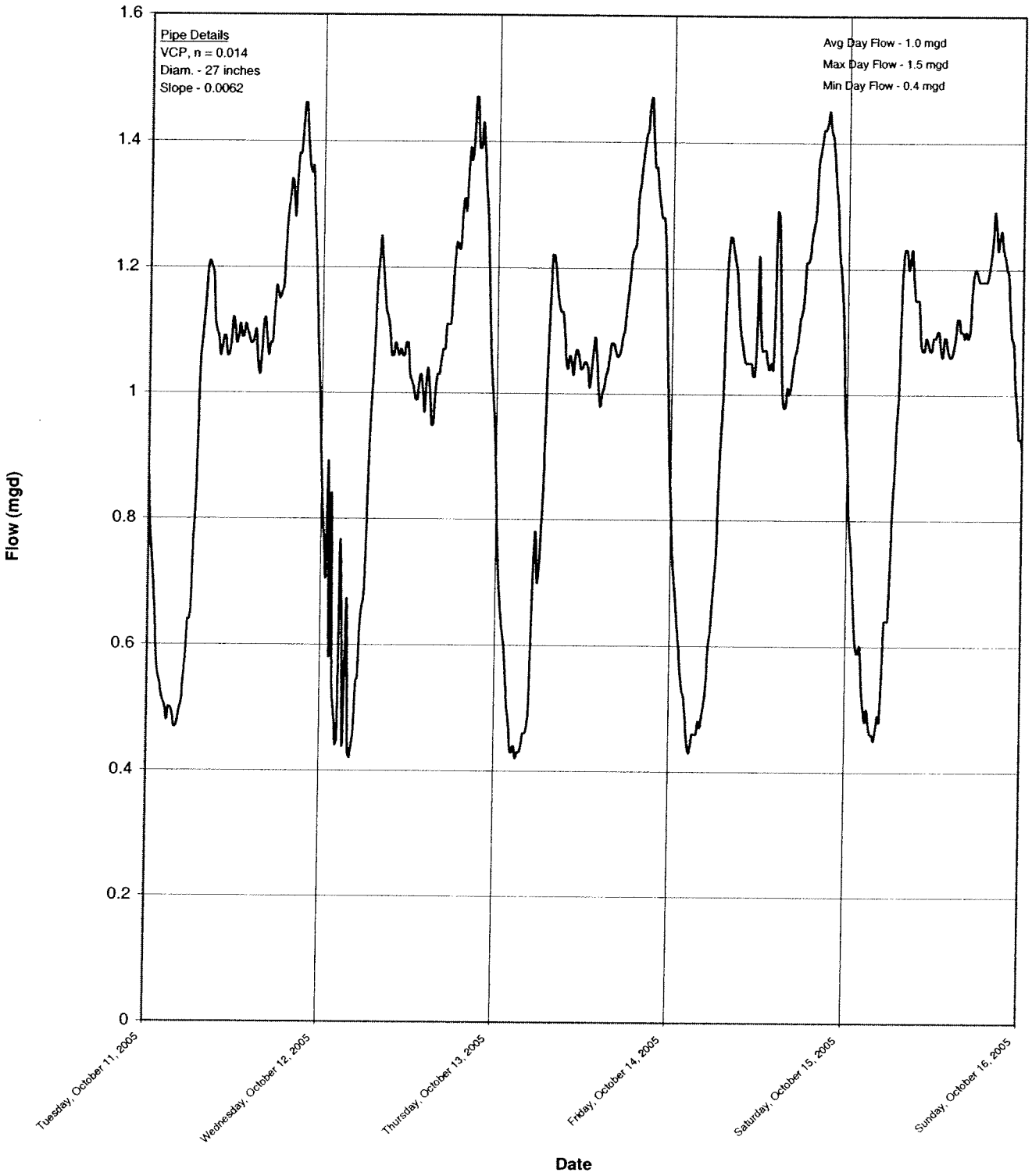


Figure 16

Flow at Meter 8
Location: Van Buren Blvd. near Central Ave.

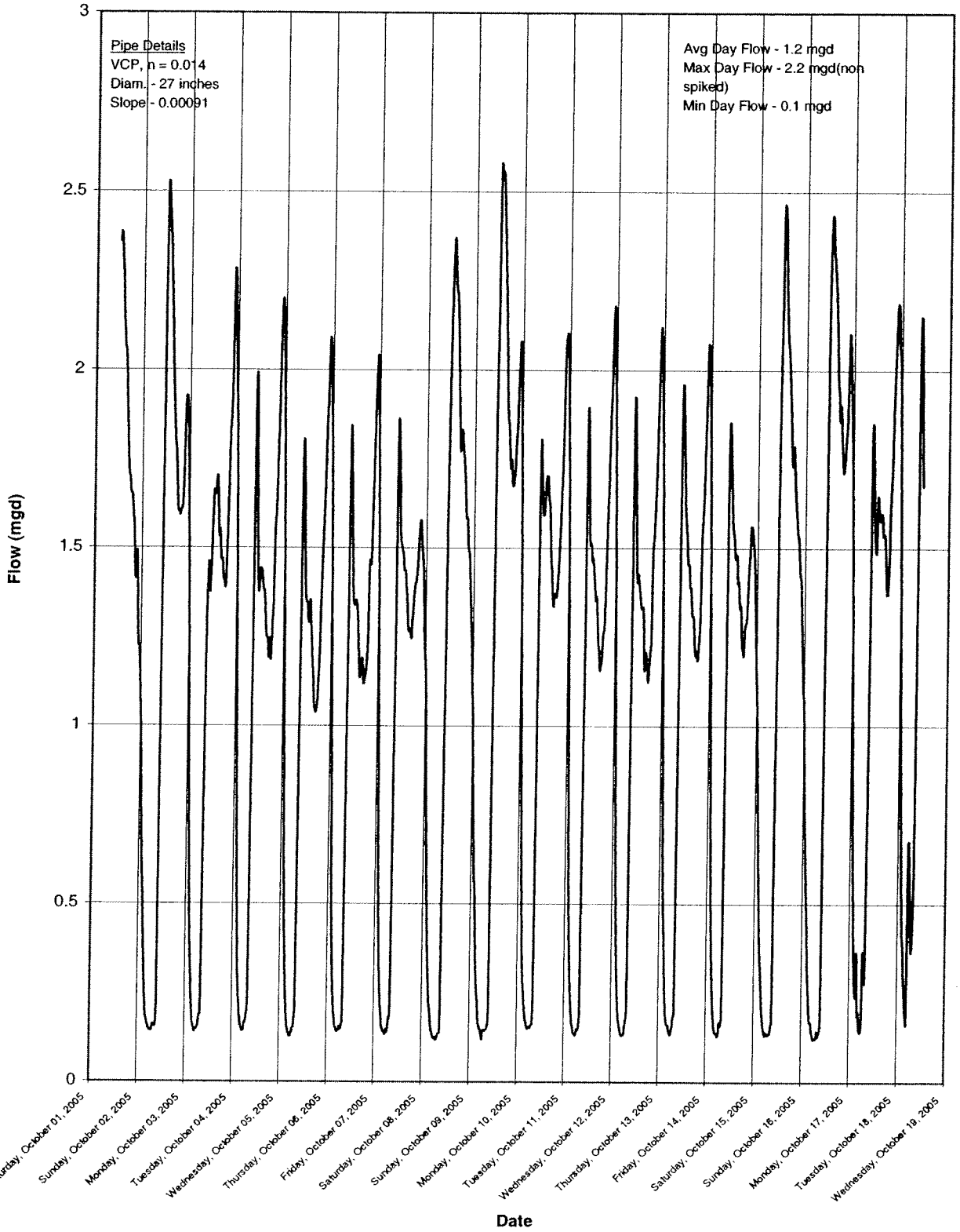


Figure 17

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 1

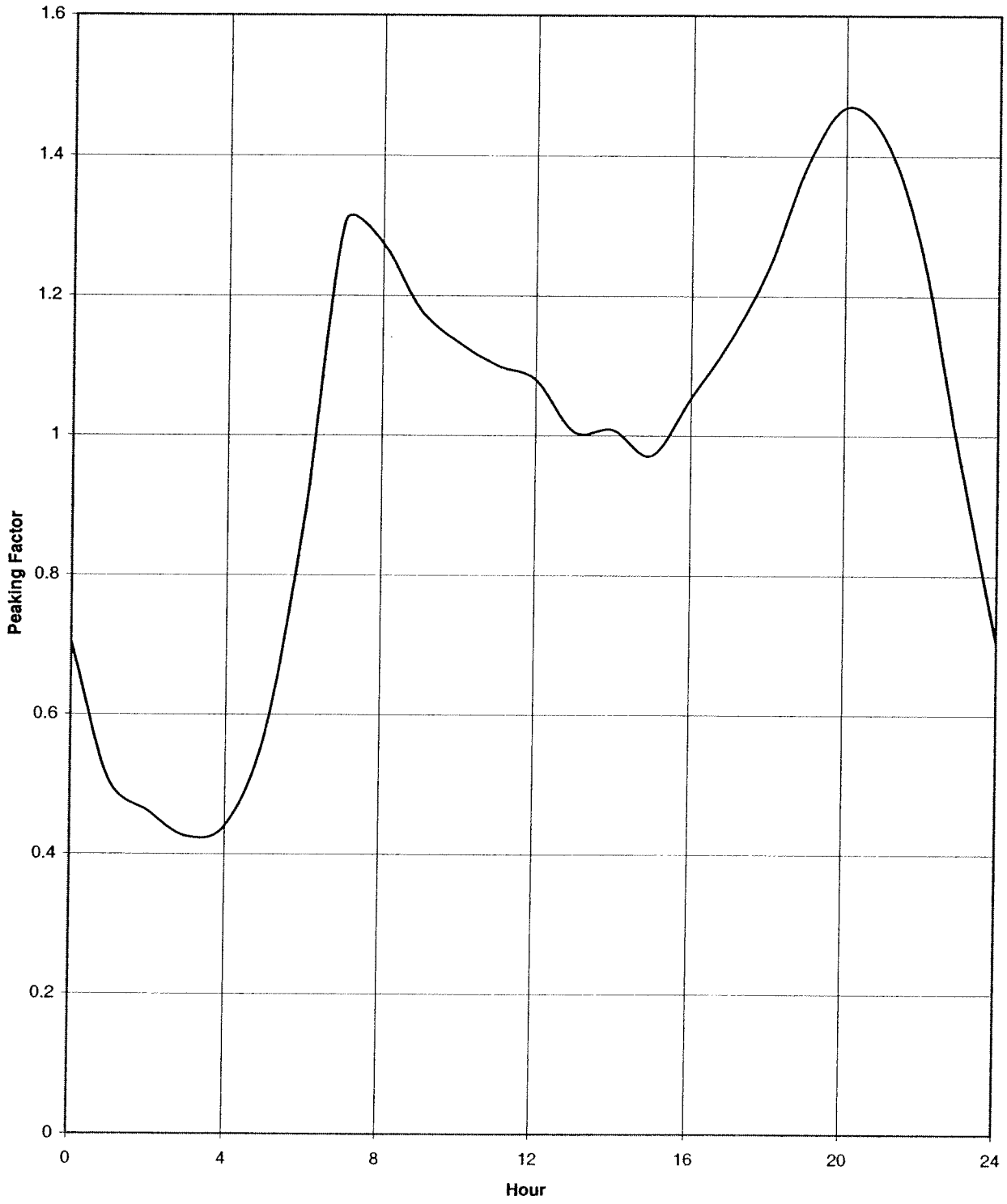


Figure 18

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 2

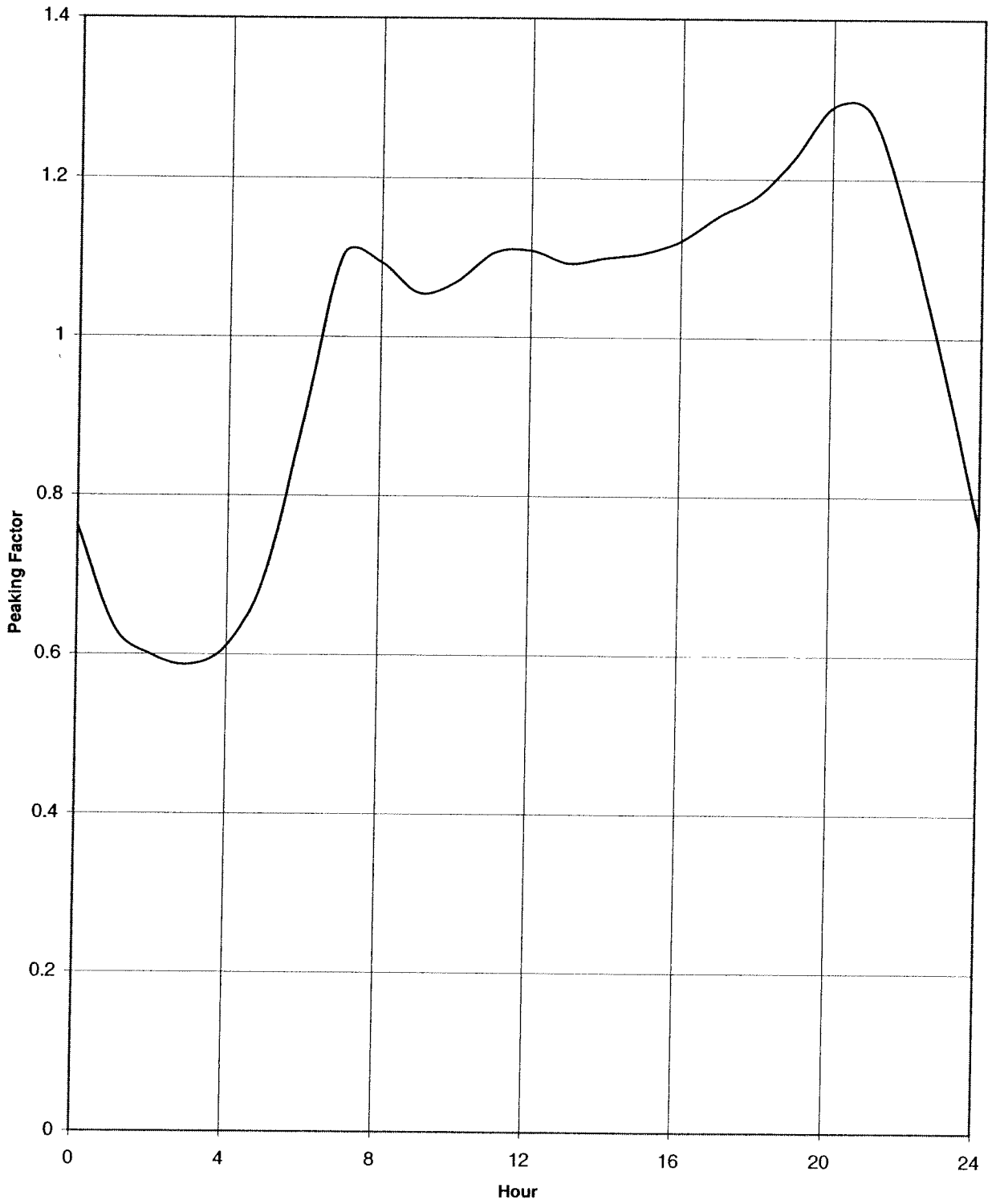


Figure 19

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 3

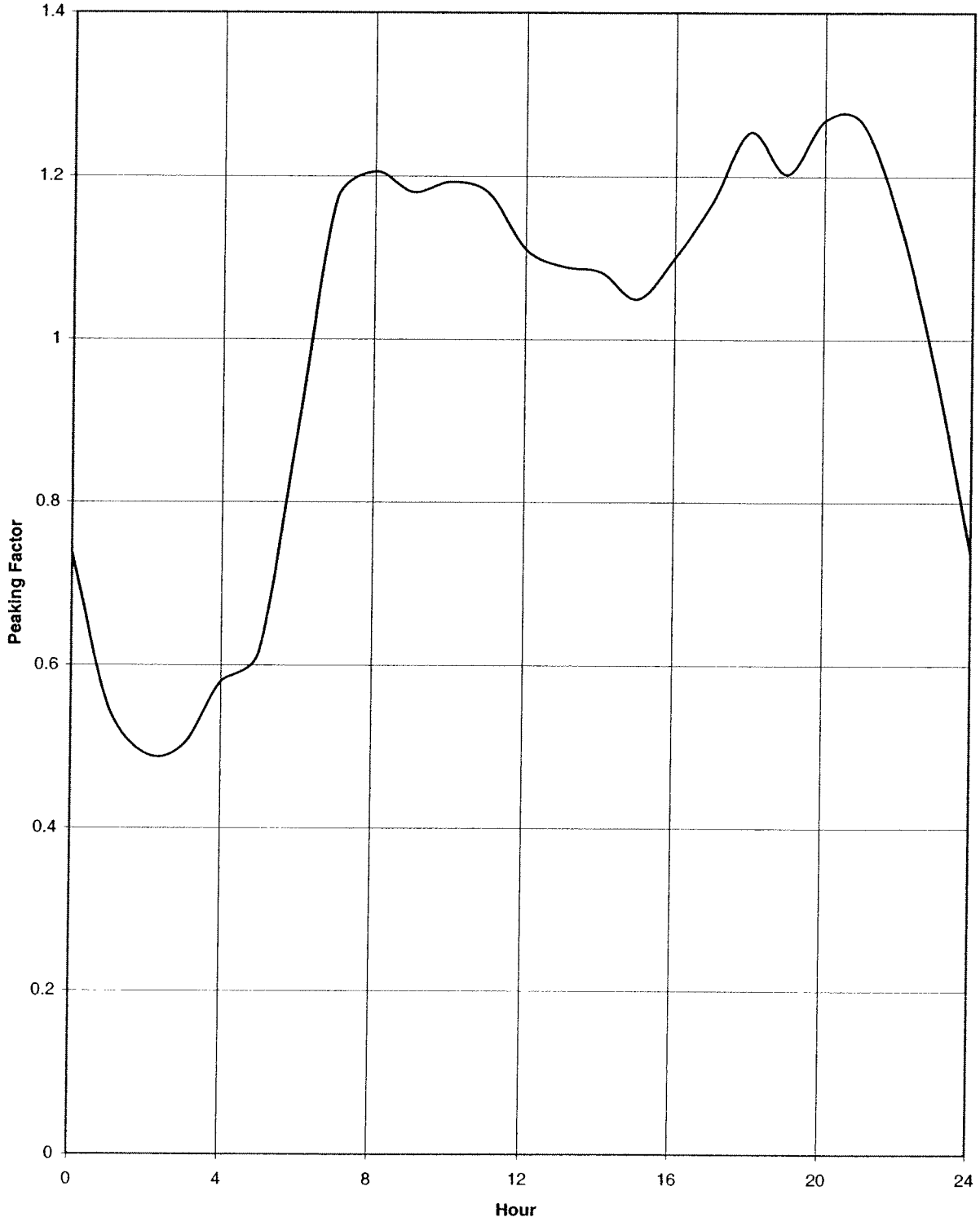


Figure 20

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 4

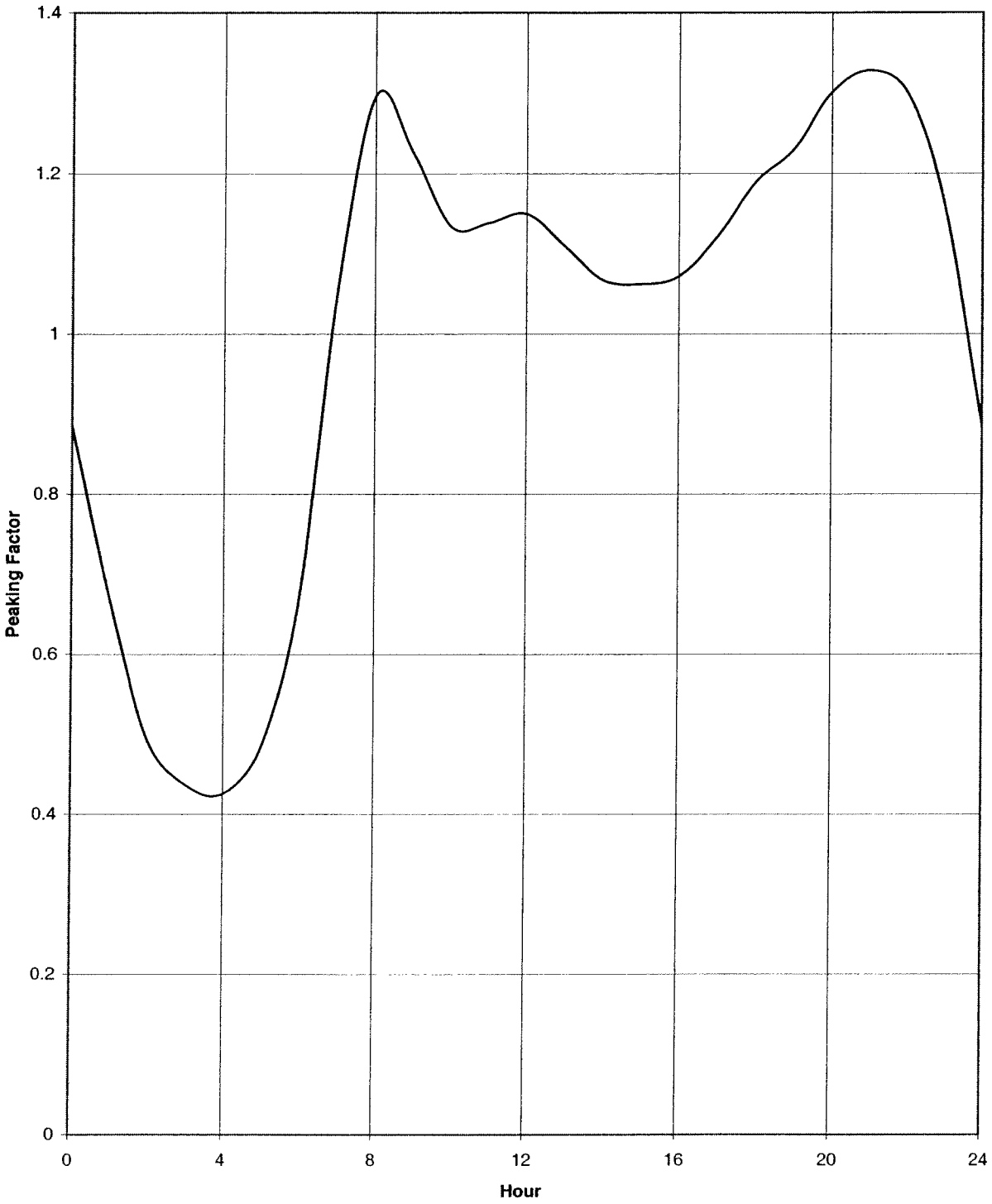


Figure 21

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 5

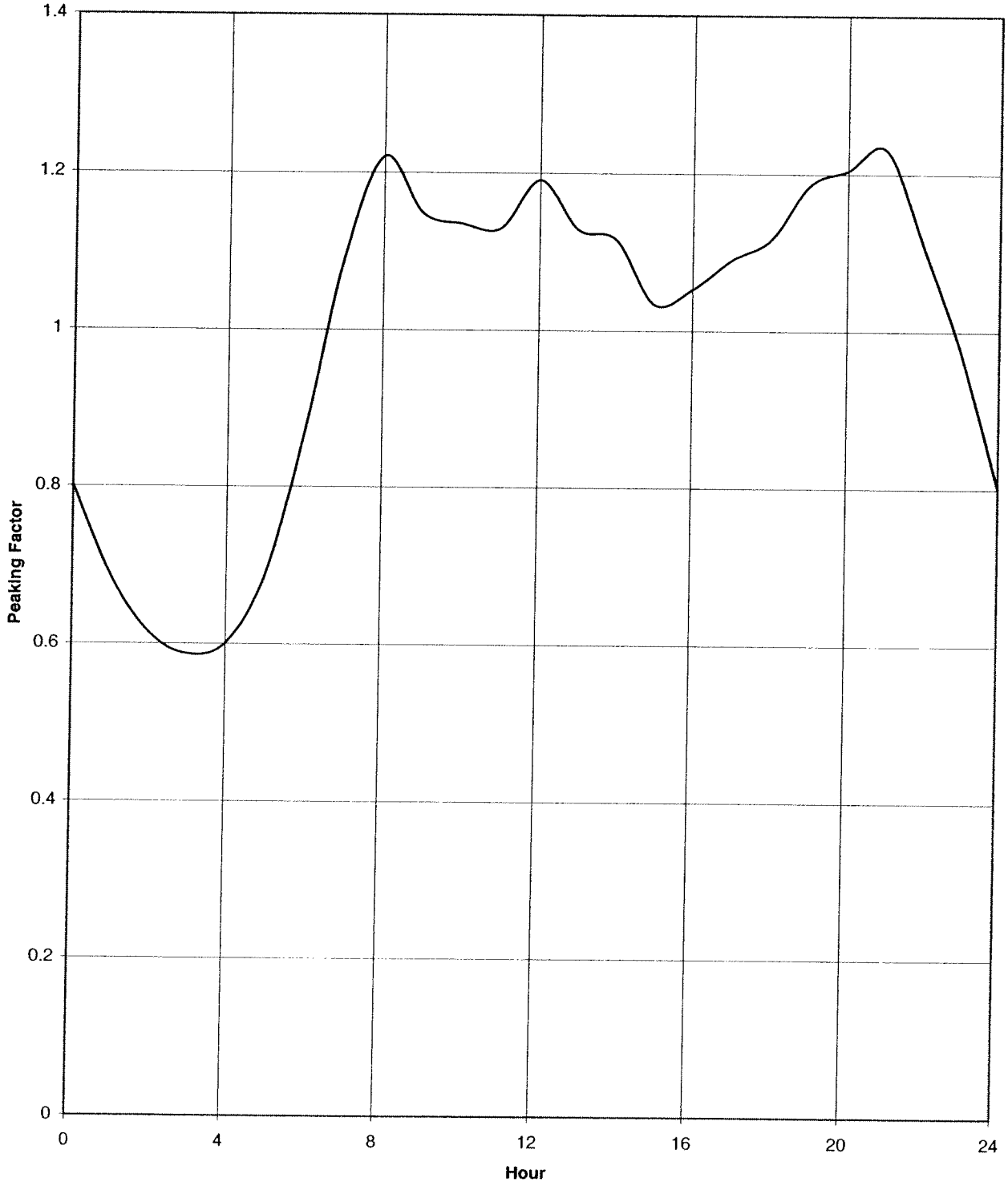


Figure 22

Representative Diurnal Pattern for Residential Land Use
Meter Location - 6

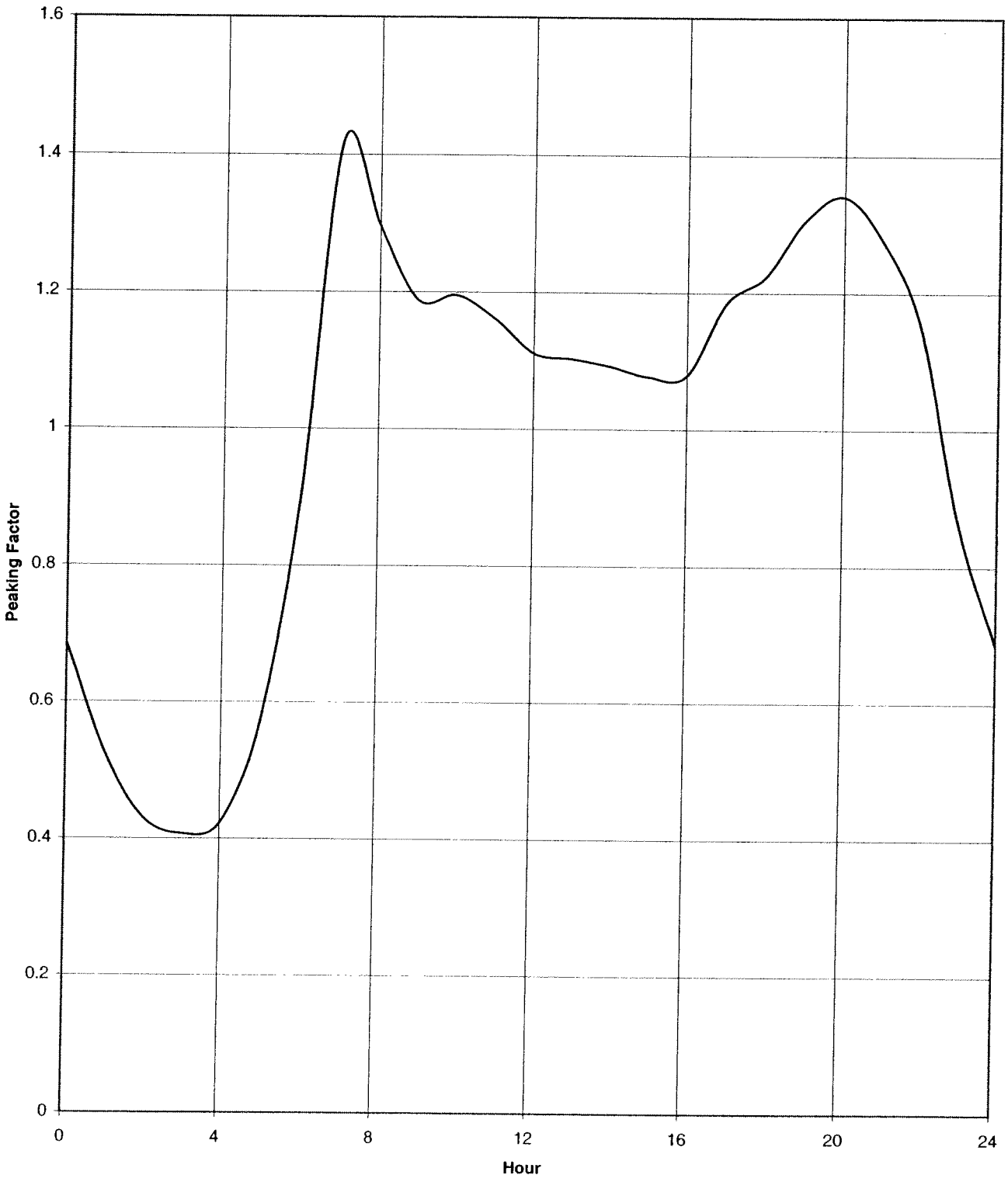


Figure 23

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 7

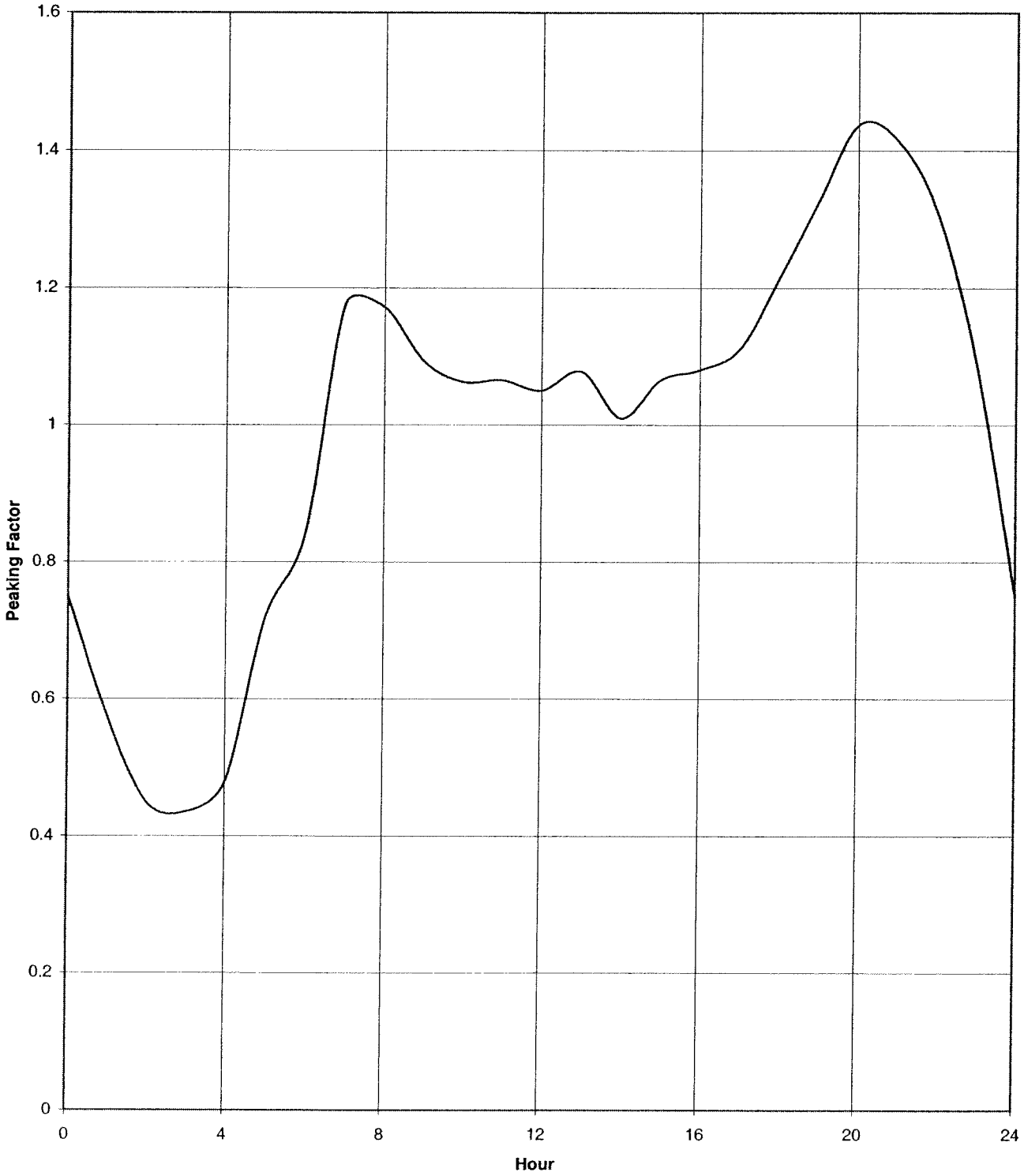
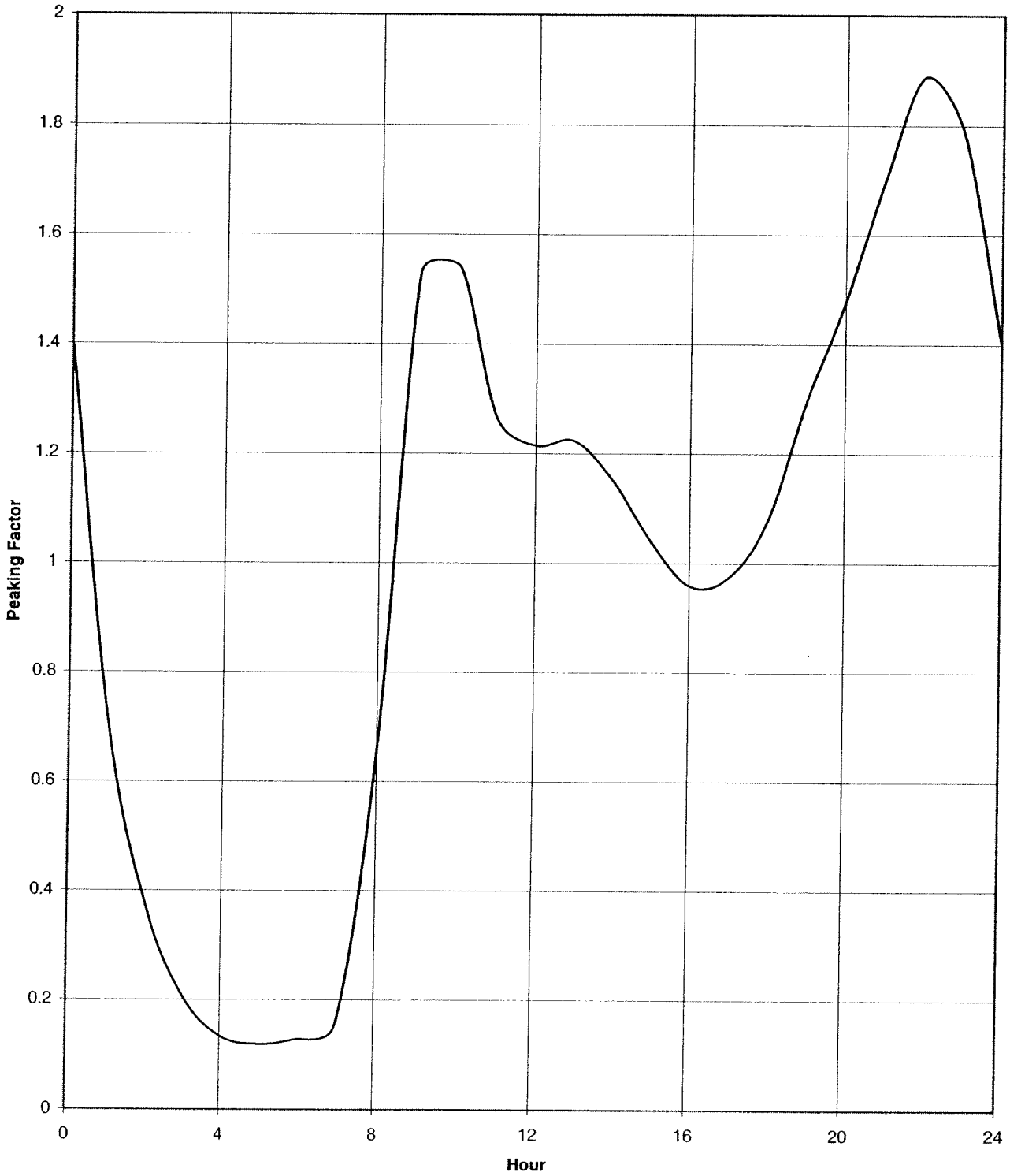


Figure 24

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 8



6.0 COMPUTER MODEL SIMULATION ANALYSIS

6.1 Methodology

Capacity analysis involved the evaluation of the available capacity in the existing collection system under present and future development conditions. Based on results of the analysis, phased facility improvements were identified to allow for projected growth within the service area.

This section describes the analytical methodology and hydraulic model development and summarizes the results of the analyses.

The principal tool utilized in the capacity analysis was a hydraulic model that simulates flow conditions using inflow and sewer system characteristic input data. With this input information, the model is able to output sewage depth of flow, rate of flow, and velocity of flow, in selected pipes and manholes during different times of the day. The model selected for use in this study is XP-SWMM (XP Software, Version 9.10). This modeling software belongs to a class of software referred to as "dynamic wave models". These types of models provide an accurate simulation of hydraulic flow conditions over an extended period of time.

Data required to create the model include information describing the physical wastewater collection system, such as pipe diameters and reach lengths, manhole invert elevations, and estimated pipe roughness coefficients. Additionally, data describing the sewage loading at selected manholes expressed as a varying flow rate over time (i.e. a diurnal curve), must be provided. Model output consists of a variety of hydraulic parameters, most importantly peak flow velocity and discharge rates.

Calibration of the model consisted of simulating existing sewer flow conditions and comparing the modeled flows with the recorded flows at the meter locations. The assumed diurnal curves that serve as input to the model were iteratively adjusted until the recorded and recorded sewage flow hydrographs achieved reasonable agreement.

Simulations of future sewage flow conditions were performed by developing input data sets that included sewage generation projections for the assumed ultimate conditions. Pipe reaches, in which simulated peak flows exceeded a specified trigger criterion, were identified as potential improvement reaches. Improvements required to provide adequate capacity for projected flows were then determined through an iterative modeling process. The process consists of simulating flow conditions after increasing the diameter of downstream portions of the identified reaches. In

subsequent iterations, pipes were increased in diameter until the projected peak flow could be conveyed through the reach without exceeding the specified design flow criteria.

6.2 Limitations of Modeling

The hydraulic model, which was utilized as the primary planning tool for the sewer capacity analysis, provides an accurate simulation of flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation, however, is directly related to the accuracy of the model input data, including physical parameters and sewage loading projections. For example, in a case where roots had entered the pipeline, thereby causing a restriction of flow, the model would be unable to predict the reduction in flow through this obstruction. Consequently, a general understanding of the data sources is critical in interpreting the modeling results.

The physical parameters of the model, including the pipe diameter, slope, and roughness coefficients were based principally on City's GIS database information. Where this data appeared to be inaccurate, construction drawings were reviewed and the input data corrected.

Network connectivity refers to the flow path followed by sewage within the sewer system. The connectivity is a function of the relative slope of each sewer pipe and the relative invert elevations of the incoming and outgoing sewer pipes at manholes. For example, a manhole may have two or more sewer pipes, which could convey flow away from the manhole. If the invert (bottom) of one of these pipes is lower than the other, the downstream flow path at this manhole would follow the lower pipe.

Sewage loading projections were based on calibrated flow rates. As previously described, flow rates used for calibration were based on actual monitored flows at key points in the trunk system measured in October 2005. This period included the weekends.

Since a degree of uncertainty exists in both the physical data and the sewage loading projections used as model inputs, reaches identified by model simulations as near or at capacity should be subject to additional engineering evaluation prior to improvement. Such evaluation may include field inspection, video monitoring and flow metering.

The results of model run evaluating the existing collection system for existing and ultimate flow conditions are summarized in Table 7-1.

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P001	3	0.4923	46.79	28.52	61%	36.70	78%
P002	2.5	0.0800	11.59	22.98	198%	27.69	239%
P003	2.5	0.0800	11.59	22.98	198%	27.69	239%
P004	4.25	0.0810	48.10	22.98	48%	27.69	58%
P005	4.25	0.1382	62.84	22.98	37%	27.69	44%
P006	4.25	0.0810	48.10	22.98	48%	27.70	58%
P007	4.25	0.0780	47.20	22.99	49%	27.71	59%
P008	4.25	0.0790	47.50	22.99	48%	27.72	58%
P009	4.25	0.0820	48.40	22.99	48%	27.73	57%
P010	4.25	0.0800	47.80	22.99	48%	27.74	58%
P011	4.25	0.0750	46.29	22.99	50%	27.75	60%
P012	3.5	0.0800	28.47	2.48	9%	3.05	11%
P013	2.25	0.6190	24.34	2.49	10%	3.07	13%
P014	2.25	0.6190	24.34	2.49	10%	3.07	13%
P015	2.25	0.6510	24.96	2.49	10%	3.07	12%
P016	2.25	0.7000	25.88	2.49	10%	3.07	12%
P017	2.25	0.6750	25.42	2.49	10%	3.07	12%
P018	2.25	0.5590	23.13	2.49	11%	3.07	13%
P019	2.25	0.5490	22.92	2.49	11%	3.07	13%
P020	2.25	0.8200	28.01	2.49	9%	3.07	11%
P021	2.25	0.6600	25.13	2.29	9%	2.86	11%
P022	2.25	0.7060	25.99	2.29	9%	2.86	11%
P023	2.25	0.6190	24.34	2.29	9%	2.86	12%
P024	2.25	0.5530	23.00	2.29	10%	2.86	12%
P025	2.25	0.6020	24.00	2.29	10%	2.86	12%
P026	2.25	0.6050	24.06	2.29	9%	2.86	12%
P027	1.25	0.1960	2.85	0.29	10%	0.73	26%
P028	1.25	0.1990	2.87	0.29	10%	0.73	25%
P029	1.25	0.2000	2.88	0.19	7%	0.49	17%
P030	1.25	0.5670	4.85	0.19	4%	0.49	10%
P031	1.25	0.2750	3.38	0.19	6%	0.49	14%
P032	1.25	0.3000	3.53	0.19	5%	0.49	14%
P033	1.25	0.1990	2.87	0.19	7%	0.49	17%
P034	1.25	0.2830	3.43	0.19	6%	0.49	14%
P035	1.25	0.1990	2.87	0.19	7%	0.49	17%
P036	1.25	0.1999	2.88	0.19	7%	0.49	17%
P037	1.25	0.1979	2.86	0.10	3%	0.24	9%
P038	1.25	0.3033	3.55	0.10	3%	0.24	7%
P039	1.25	0.2098	2.95	0.10	3%	0.24	8%
P040	1.25	0.2880	3.46	0.10	3%	0.24	7%
P041	1.25	0.2000	2.88	0.10	3%	0.24	9%
P042	3	1.5263	82.39	5.57	7%	9.02	11%
P043	2.25	1.6142	39.30	5.57	14%	9.02	23%
P044	2.25	0.0900	9.28	5.57	60%	9.02	97%
P045	2.25	0.0920	9.38	5.24	56%	8.19	87%
P046	2.25	0.0910	9.33	5.24	56%	8.19	88%
P047	2.25	0.0920	9.38	4.44	47%	6.34	68%
P048	2.25	0.0910	9.33	4.45	48%	6.35	68%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P049	2.25	0.0890	9.23	4.45	48%	6.35	69%
P050	2.25	0.0900	9.28	4.45	48%	6.35	68%
P051	2.25	0.0320	5.53	4.45	80%	6.35	115%
P052	2.25	0.0400	6.19	4.45	72%	6.36	103%
P053	2.25	0.1500	11.98	4.45	37%	6.36	53%
P054	2.25	0.1500	11.98	4.45	37%	6.36	53%
P055	2.25	0.0910	9.33	4.45	48%	6.36	68%
P056	2	0.1660	9.20	3.18	35%	4.86	53%
P057	2	0.1630	9.12	3.19	35%	4.86	53%
P058	2	0.0935	6.91	3.19	46%	4.86	70%
P059	3	0.1192	23.02	6.03	26%	7.72	34%
P059B	2	0.1547	8.88	2.15	24%	3.50	39%
P059C	2.75	0.3256	30.16	4.99	17%	6.37	21%
P060	3	0.0970	20.77	6.02	29%	7.72	37%
P061	3	0.1020	21.30	6.02	28%	7.72	36%
P062	3	0.0980	20.88	6.02	29%	7.72	37%
P063	3	0.0970	20.77	6.02	29%	7.72	37%
P064	3	0.1560	26.34	6.02	23%	7.72	29%
P065	3	0.0990	20.98	6.02	29%	7.72	37%
P066	3	0.0970	20.77	6.02	29%	7.72	37%
P067	3	0.0990	20.98	6.02	29%	7.72	37%
P068	3	0.1000	21.09	6.02	29%	7.73	37%
P069	3	0.0990	20.98	6.02	29%	7.73	37%
P070	3	0.1080	21.91	6.02	27%	7.73	35%
P071	3	0.2410	32.74	6.02	18%	7.73	24%
P072	3	0.1010	21.19	6.02	28%	7.73	36%
P073	3	0.0980	20.88	6.02	29%	7.73	37%
P074	3	0.1050	21.61	6.02	28%	7.74	36%
P075	3	0.1015	21.24	6.02	28%	7.74	36%
P076	2.75	0.1665	21.57	12.22	57%	14.94	69%
P077	2.75	0.2221	24.91	12.22	49%	14.94	60%
P078	2.75	0.2010	23.70	12.22	52%	14.94	63%
P079	2.75	0.1980	23.52	12.22	52%	14.94	64%
P080	2.75	0.2000	23.64	12.22	52%	14.94	63%
P081	2.75	0.1890	22.98	12.22	53%	14.94	65%
P082	2.75	0.2180	24.68	12.22	50%	14.94	61%
P083	2.75	0.2280	25.24	12.22	48%	14.94	59%
P084	2.75	0.3370	30.69	12.22	40%	14.95	49%
P085	2.75	0.1990	23.58	12.22	52%	14.95	63%
P086	2.75	0.2040	23.88	12.22	51%	14.95	63%
P087	2.75	0.2038	23.86	12.22	51%	14.95	63%
P088	2.75	0.2035	23.85	12.22	51%	14.95	63%
P089	2.75	0.2030	23.82	12.22	51%	14.96	63%
P090	2.75	0.2010	23.70	12.22	52%	15.02	63%
P091	2.75	0.2000	23.64	0.02	0%	10.82	46%
P092	2	1.1250	23.96	12.22	51%	4.24	18%
P093	3.5	0.1010	31.98	20.44	64%	24.30	76%
P094	3.5	0.0990	31.67	20.43	65%	24.30	77%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P095	3.5	0.0990	31.67	20.43	65%	24.30	77%
P096	3.5	0.0960	31.18	20.43	66%	24.31	78%
P097	3.5	0.0980	31.51	20.44	65%	24.31	77%
P098	3.5	0.1010	31.98	20.46	64%	24.33	76%
P099	3.5	6.6670	259.86	20.35	8%	24.22	9%
P100	2.75	0.2080	24.11	18.24	76%	21.85	91%
P101	2.75	0.2000	23.64	18.22	77%	21.84	92%
P102	2.75	0.2000	23.64	18.22	77%	21.84	92%
P103	2.75	0.1990	23.58	18.22	77%	21.84	93%
P104	2.75	0.2030	23.82	18.23	77%	21.84	92%
P105	2.75	0.2000	23.64	18.23	77%	21.84	92%
P106	2.75	0.2000	23.64	18.23	77%	21.84	92%
P107A	2.75	0.2271	25.19	16.97	67%	20.32	81%
P109	2.75	0.2289	25.29	16.97	67%	20.32	80%
P110	2.75	0.2400	25.90	12.04	46%	13.97	54%
P111	2.25	0.1200	10.72	8.58	80%	10.23	95%
P112	2.25	0.1200	10.72	8.58	80%	10.23	95%
P113	2.25	0.1200	10.72	8.58	80%	10.23	95%
P114	2.25	0.1200	10.72	8.58	80%	10.23	95%
P115	2.25	0.1200	10.72	8.58	80%	10.23	95%
P116	2.25	0.1200	10.72	8.58	80%	10.23	95%
P117	2.25	0.1200	10.72	8.58	80%	10.23	96%
P118	2.25	0.1170	10.58	8.58	81%	10.24	97%
P119	2.25	0.1170	10.58	8.58	81%	10.24	97%
P120	2.25	0.1170	10.58	8.58	81%	10.25	97%
P121	2.25	0.1170	10.58	8.58	81%	10.25	97%
P122	2.25	0.1170	10.58	8.58	81%	10.25	97%
P122A	2.75	0.1954	23.36	6.21	27%	7.19	31%
P123	2.25	0.3057	17.10	2.46	14%	3.07	18%
P124	1.5	0.8629	9.73	2.46	25%	3.07	32%
P125	1.5	0.9000	9.94	2.46	25%	3.07	31%
P126	1.5	0.8923	9.90	2.46	25%	3.07	31%
P127	2	0.4431	15.04	2.14	14%	2.79	19%
P133	2	0.3170	12.72	2.14	17%	2.79	22%
P134	2	0.3180	12.74	2.14	17%	2.79	22%
P135	1.25	0.4590	4.36	2.14	49%	2.79	64%
P136	1.25	0.6000	4.99	2.14	43%	2.79	56%
P137	1.25	0.6000	4.99	2.14	43%	2.79	56%
P138	1.25	0.6100	5.03	2.14	43%	2.79	55%
P139	1.25	0.4290	4.22	2.14	51%	2.79	66%
P140	1.25	0.7690	5.65	2.14	38%	2.79	49%
P141	1.5	0.1340	3.84	2.14	56%	2.79	73%
P142	1.5	0.1250	3.70	2.14	58%	2.79	75%
P143	1.5	0.1240	3.69	2.14	58%	2.79	76%
P144	1.5	0.1430	3.96	2.14	54%	2.79	70%
P145	1.5	0.1280	3.75	2.14	57%	2.79	74%
P171	1.25	0.3800	3.97	0.74	19%	0.93	24%
P171A	1.25	0.4150	4.15	0.74	18%	0.93	22%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P171B	1.25	0.3210	3.65	0.74	20%	0.93	26%
P172	1.25	0.3820	3.98	0.74	19%	0.93	23%
P173	1.25	0.3790	3.96	0.74	19%	0.93	24%
P174	1.25	0.3870	4.01	0.74	19%	0.93	23%
P175	1.25	0.3920	4.03	0.74	18%	0.93	23%
P176	1.25	0.4040	4.09	0.74	18%	0.93	23%
P177	1.25	0.3920	4.03	0.74	18%	0.93	23%
P178	1.25	0.3880	4.01	0.74	18%	0.93	23%
P179	1.25	0.3820	3.98	0.74	19%	0.93	23%
P180	1.25	0.3870	4.01	0.74	19%	0.93	23%
P181	1.25	0.1240	2.27	1.48	65%	1.86	82%
P182	1.25	0.1200	2.23	1.48	66%	1.86	83%
P183	1.25	0.1200	2.23	1.48	66%	1.86	83%
P184	1.25	0.1220	2.25	1.48	66%	1.86	83%
P185	1.25	0.1480	2.48	1.48	60%	1.86	75%
P186	1.25	0.1180	2.21	1.48	67%	1.86	84%
P187	1.25	0.1240	2.27	1.48	65%	1.86	82%
P188	1.25	15.7425	25.55	1.48	6%	1.86	7%
P189	1.5	0.1400	3.92	2.95	75%	3.68	94%
P190	1.5	0.1400	3.92	2.95	75%	3.68	94%
P191	1.5	0.1400	3.92	2.95	75%	3.71	95%
P191A	1.5	0.1400	3.92	2.95	75%	3.72	95%
P192	1.5	0.1400	3.92	3.68	94%	4.57	116%
P193	1.5	0.1400	3.92	3.68	94%	4.57	116%
P194	1.5	0.1400	3.92	3.68	94%	4.57	116%
P195	1.5	0.1400	3.92	3.68	94%	4.57	116%
P196	1.75	0.1796	6.70	2.76	41%	3.39	51%
P197	1.75	0.2803	8.37	2.76	33%	3.39	40%
P198	1.75	0.2690	8.20	2.76	34%	3.39	41%
P199	1.75	0.3470	9.32	2.76	30%	3.39	36%
P200	1.75	0.3490	9.34	2.76	30%	3.39	36%
P201	1.75	0.3480	9.33	2.76	30%	3.39	36%
P202	1.75	0.4020	10.03	2.76	28%	3.39	34%
P203	1.75	0.6220	12.47	2.76	22%	3.39	27%
P204	1.75	0.4070	10.09	2.76	27%	3.39	34%
P205	1	1.5380	4.40	1.65	37%	1.82	41%
P206	1	1.5530	4.42	0.83	19%	0.91	21%
P207	1.25	0.4420	4.28	0.83	19%	0.91	21%
P208	1.25	0.4400	4.27	0.83	19%	0.91	21%
P209	1.25	0.4400	4.27	0.83	19%	0.91	21%
P210	1.25	0.4000	4.07	0.83	20%	0.91	22%
P211	1.25	0.4010	4.08	0.83	20%	0.91	22%
P212	1.25	0.3940	4.04	0.83	20%	0.92	23%
P213	1.25	0.6040	5.00	0.83	17%	0.92	18%
P214	2.25	0.1110	10.31	1.12	11%	1.19	12%
P215	2.25	0.0970	9.63	1.12	12%	1.19	12%
P216	2.25	0.1130	10.40	1.12	11%	1.18	11%
P217	2.25	0.1130	10.40	1.12	11%	1.18	11%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P218	2.25	0.1150	10.49	1.12	11%	1.18	11%
P219	2.25	0.1120	10.35	1.12	11%	1.18	11%
P220	2.25	0.1140	10.44	1.12	11%	1.18	11%
P221	2.25	0.0650	7.89	1.12	14%	1.18	15%
P222	2.25	0.2000	13.83	1.12	8%	1.18	9%
P223	2.25	0.2000	13.83	1.12	8%	1.18	9%
P224	1.5	0.2000	4.69	1.12	24%	1.18	25%
P225	1.5	0.2010	4.70	1.12	24%	1.18	25%
P226	1.25	0.1800	2.73	1.12	41%	1.18	43%
P227	1.25	0.1000	2.04	1.12	55%	1.18	58%
P228	1.25	0.1019	2.06	1.12	54%	1.18	58%
P229	1.25	0.1110	2.15	1.12	52%	1.18	55%
P230	1.25	0.1170	2.20	1.12	51%	1.18	54%
P231	1.25	0.1170	2.20	1.12	51%	1.18	54%
P232	1.25	0.5130	4.61	1.12	24%	1.18	26%
P233	1.25	0.4160	4.15	1.12	27%	1.19	29%
P234	1.25	0.6570	5.22	1.12	21%	1.19	23%
P235	1.25	0.6630	5.24	1.12	21%	1.19	23%
P236	1.5	0.2000	4.69	1.12	24%	1.19	25%
P237	1.5	0.2200	4.91	1.12	23%	1.19	24%
P238	1.5	0.2340	5.07	1.12	22%	1.19	23%
P239	1.5	5.7040	25.02	1.12	4%	1.19	5%
P240	1.25	0.4290	4.22	1.12	26%	1.19	28%
P240A	1.25	0.4280	4.21	1.12	27%	1.20	28%
P240B	1	1.9420	4.95	1.12	23%	1.19	24%
P240C	1.25	2.6370	10.46	1.12	11%	1.19	11%
P244	1	1.8870	4.88	1.12	23%	1.19	24%
P245	1	2.2620	5.34	1.12	21%	1.19	22%
P246	1.25	0.7570	5.60	1.12	20%	1.19	21%
P247	1	0.7510	3.08	1.12	36%	1.19	39%
P248	1	2.0730	5.11	1.12	22%	1.19	23%
P249	1	1.8020	4.76	0.90	19%	0.97	20%
P251	1	30.7760	19.69	0.34	2%	0.86	4%
P252	1	0.5500	2.63	0.34	13%	0.86	33%
P253	1	0.5500	2.63	0.34	13%	0.87	33%
P254	1	1.0150	3.58	0.83	23%	1.91	53%
P255	1	1.0000	3.55	0.83	24%	1.91	54%
P256	1	1.1620	3.83	0.83	22%	1.91	50%
P257	1	1.0000	3.55	0.83	24%	1.91	54%
P258A	1	0.2000	1.59	1.27	80%	1.52	96%
P259	1	0.2000	1.59	1.27	80%	1.52	96%
P260	1	0.2000	1.59	1.27	80%	1.52	96%
P261	1	0.2000	1.59	1.27	80%	1.52	96%
P262	1	0.2000	1.59	1.27	80%	1.52	96%
P263	1	0.2000	1.59	1.27	80%	1.52	96%
P264	1	0.2000	1.59	1.27	80%	1.53	96%
P265	1	0.2000	1.59	1.27	80%	1.53	96%
P266	1	0.2000	1.59	1.28	80%	1.53	96%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P267	1	0.2000	1.59	1.28	80%	1.53	96%
P268	1	0.2000	1.59	1.28	80%	1.53	97%
P269	1	0.2000	1.59	1.28	81%	1.53	97%
P270	1	0.2000	1.59	1.28	81%	1.54	97%
P271	1	0.2000	1.59	1.28	81%	1.54	97%
P272	2	0.2110	10.38	5.62	54%	7.24	70%
P273	2	0.2102	10.36	5.62	54%	7.24	70%
P274	2	0.2112	10.38	5.62	54%	7.24	70%
P275	2	0.2033	10.18	5.62	55%	7.24	71%
P276	2	0.2125	10.41	5.62	54%	7.24	70%
P277	2	0.3700	13.74	5.62	41%	7.24	53%
P278	2	0.3730	13.79	5.62	41%	7.24	53%
P279	2	0.3710	13.76	5.62	41%	7.24	53%
P280	2	0.3700	13.74	5.62	41%	7.24	53%
P281	2	0.1400	8.45	5.62	67%	7.24	86%
P282	2	0.1400	8.45	5.62	67%	7.24	86%
P283	2	0.1400	8.45	5.62	67%	7.24	86%
P284	2	0.1400	8.45	5.62	67%	7.24	86%
P285	2	0.2650	11.63	5.62	48%	7.25	62%
P286	2	0.2440	11.16	5.62	50%	7.25	65%
P287	2	0.1400	8.45	5.62	67%	7.25	86%
P288	2	0.1400	8.45	5.62	67%	7.25	86%
P289	2	0.1400	8.45	5.62	67%	7.25	86%
P290	2	0.1010	7.18	5.62	78%	7.25	101%
P291	1.25	0.4990	4.55	1.48	33%	1.79	39%
P292	1.25	0.4980	4.54	1.48	33%	1.79	39%
P293	1.25	0.5230	4.66	0.45	10%	0.53	11%
P294	1.25	0.3060	3.56	0.45	13%	0.53	15%
P295	1.17	0.0280	0.90	0.45	50%	0.53	59%
P296	1.17	0.0290	0.92	0.45	49%	0.53	58%
P297	1.17	0.0290	0.92	0.45	49%	0.53	58%
P298	1.17	0.0290	0.92	0.45	49%	0.54	58%
P299	1.17	0.2420	2.66	0.46	17%	0.54	20%
P300	1.17	0.1360	1.99	0.46	23%	0.54	27%
P301	1.17	0.1360	1.99	0.46	23%	0.54	27%
P302	1.17	0.1370	2.00	0.46	23%	0.54	27%
P303	1.17	0.1450	2.06	0.46	22%	0.55	27%
P304	1	0.1400	1.33	0.46	35%	0.55	41%
P305	1	0.1400	1.33	0.46	35%	0.55	41%
P306	1	0.1390	1.32	0.46	35%	0.55	42%
P307	0.67	14.5960	4.65	1.08	23%	1.31	28%
P308	1.67	0.2200	6.55	1.08	16%	1.31	20%
P309	1.75	0.1570	6.27	0.51	8%	0.68	11%
P310	1.75	0.1330	5.77	0.51	9%	0.69	12%
P311	1.75	0.1130	5.32	0.51	10%	0.69	13%
P312	1.75	0.0990	4.98	0.51	10%	0.69	14%
P313	1.75	0.0940	4.85	0.51	11%	0.70	14%
P314	1.5	0.2130	4.84	0.51	11%	0.70	14%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P315	1.5	0.1730	4.36	0.51	12%	0.70	16%
P316	1.5	0.1930	4.60	0.51	11%	0.70	15%
P317	1.5	0.1850	4.51	0.51	11%	0.70	15%
P318	1.5	0.0380	2.04	0.51	25%	0.70	34%
P319	1.5	0.2670	5.41	0.51	9%	0.70	13%
P319A	1.5	0.2513	5.25	0.08	1%	0.18	3%
P319B	1.5	0.1447	3.99	0.47	12%	0.55	14%
P320	1.75	0.2860	8.46	2.84	34%	3.79	45%
P321	1.75	0.1714	6.55	2.84	43%	3.80	58%
P322	1.75	0.1673	6.47	2.84	44%	3.80	59%
P323	1.75	0.2020	7.11	2.84	40%	3.80	53%
P324	1.75	0.2010	7.09	2.84	40%	3.80	54%
P325	1.75	0.2120	7.28	2.84	39%	3.80	52%
P326	1.75	0.2160	7.35	2.84	39%	3.80	52%
P327	1.75	0.2160	7.35	2.84	39%	3.80	52%
P328	1.75	0.2120	7.28	2.84	39%	3.80	52%
P329	1.75	0.2380	7.71	2.84	37%	3.80	49%
P330	1.75	0.2000	7.07	2.84	40%	3.80	54%
P331	1.75	0.2000	7.07	2.85	40%	3.80	54%
P332	1.25	0.3500	3.81	1.64	43%	2.53	66%
P333	1.25	0.3500	3.81	1.64	43%	2.54	67%
P334	1.25	0.3500	3.81	1.64	43%	2.54	67%
P335	1.25	0.3500	3.81	1.64	43%	2.54	67%
P336	1.25	1.2360	7.16	1.64	23%	2.54	35%
P337	1.25	1.2290	7.14	1.64	23%	2.54	36%
P338	1.25	1.2290	7.14	1.64	23%	2.54	36%
P339	1.25	1.7020	8.40	1.64	20%	2.54	30%
P340	1.25	1.6830	8.35	1.64	20%	2.54	30%
P341	1.25	1.0110	6.48	1.64	25%	2.54	39%
P342	1.25	1.0100	6.47	1.64	25%	2.54	39%
P343	1.25	1.0350	6.55	1.64	25%	2.54	39%
P344	1.25	0.9600	6.31	1.64	26%	2.54	40%
P345	1	21.8900	16.60	1.64	10%	2.54	15%
P346	1	0.5300	2.58	1.64	64%	2.54	98%
P347	1	0.5300	2.58	1.64	64%	2.56	99%
P348	1	0.5300	2.58	1.64	64%	2.57	100%
P349	1	0.5300	2.58	1.64	64%	2.60	101%
P350	1	0.6070	2.77	0.94	34%	1.11	40%
P351	1	0.4710	2.44	0.94	39%	1.11	46%
P352	1	0.4870	2.48	0.94	38%	1.11	45%
P353	1	0.8530	3.28	0.94	29%	1.11	34%
P355	1	0.3890	2.21	0.94	43%	1.11	50%
P356	1	2.0500	5.08	0.47	9%	0.56	11%
P357	1	1.4000	4.20	0.47	11%	0.56	13%
P358	1	1.3620	4.14	0.47	11%	0.56	14%
P359	1	1.4860	4.33	0.47	11%	0.56	13%
P360	1	1.4050	4.21	0.47	11%	0.56	13%
P361	1	14.2770	13.41	0.47	4%	0.56	4%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P362	1	1.3950	4.19	0.47	11%	0.56	13%
P363	1	1.7200	4.65	0.48	10%	0.56	12%
P364	1	1.7210	4.66	0.48	10%	0.56	12%
P365	1	1.7480	4.69	0.48	10%	0.56	12%
P366A	1.25	0.3440	3.78	1.24	33%	1.30	34%
P366B	1.25	0.3330	3.72	1.24	33%	1.30	35%
P367	1.25	0.3350	3.73	1.24	33%	1.30	35%
P368	1.25	0.1260	2.29	1.24	54%	1.30	57%
P369	1.25	0.1410	2.42	1.24	51%	1.30	54%
P370	1.25	0.1360	2.37	1.24	52%	1.30	55%
P371	1.25	0.1420	2.43	1.24	51%	1.30	54%
P372	1.25	0.1390	2.40	1.25	52%	1.30	54%
P373	1.25	0.1400	2.41	1.25	52%	1.31	54%
P374	1.25	0.1420	2.43	1.25	51%	1.31	54%
P375	1.25	0.1410	2.42	1.25	52%	1.31	54%
P376	1.25	0.1380	2.39	1.26	52%	1.31	55%
P377	1.5	0.7450	9.04	0.71	8%	1.49	16%
P378	1.5	2.1050	15.20	0.71	5%	1.49	10%
P379	1.5	1.1010	10.99	0.71	6%	1.49	14%
P380	1.5	0.7010	8.77	0.71	8%	1.49	17%
P381	1.5	0.7010	8.77	0.71	8%	1.49	17%
P382	1.5	0.7000	8.77	0.71	8%	1.49	17%
P383	1.5	1.0000	10.48	0.71	7%	1.49	14%
P384	1.5	1.0000	10.48	0.71	7%	1.49	14%
P385	1.5	1.4720	12.71	0.71	6%	1.49	12%
P386	1.5	1.2090	11.52	0.71	6%	1.49	13%
P387	1.5	0.9780	10.36	0.71	7%	1.50	14%
P388	1.5	0.9750	10.35	0.71	7%	1.49	14%
P389	1	0.9370	3.44	0.71	21%	1.49	44%
P390	1.5	1.8220	14.14	0.71	5%	1.49	11%
P391	1.5	1.6730	13.55	0.36	3%	0.81	6%
P392	1	1.3460	4.12	0.36	9%	0.81	20%
P393	1	1.3310	4.09	0.36	9%	0.81	20%
P394	1	1.3340	4.10	0.36	9%	0.69	17%
P395	1.5	0.1700	4.32	2.02	47%	2.66	62%
P396	1.5	0.1230	3.67	2.02	55%	2.66	72%
P397	1.5	0.1260	3.72	2.02	54%	2.66	72%
P398	1.5	0.1260	3.72	2.02	54%	2.66	72%
P399	1.5	0.1280	3.75	2.02	54%	2.66	71%
P400	1.5	0.1270	3.73	2.02	54%	2.66	71%
P401	1.5	0.1270	3.73	2.02	54%	2.67	71%
P402	1.5	0.1260	3.72	2.03	54%	2.67	72%
P403	1.5	0.1300	3.78	2.03	54%	2.67	71%
P404	1.5	0.1260	3.72	2.03	54%	2.67	72%
P405	1.5	0.1260	3.72	2.03	54%	2.67	72%
P406	1.5	0.1260	3.72	2.03	54%	2.67	72%
P407	1	1.4410	4.26	0.10	2%	0.28	7%
P408	1	1.9400	4.94	0.10	2%	0.28	6%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P409	1.25	0.7700	5.65	0.10	2%	0.28	5%
P410	1.25	0.5580	4.81	0.10	2%	0.28	6%
P411	1.25	0.5680	4.85	0.10	2%	0.28	6%
P412	1	2.3650	5.46	0.10	2%	0.28	5%
P413	1	1.7840	4.74	0.10	2%	0.28	6%
P414	1	2.1600	5.22	0.10	2%	0.28	5%
P415	1	1.6800	4.60	0.10	2%	0.28	6%
P416	1	1.7060	4.64	0.10	2%	0.28	6%
P417	1	1.5500	4.42	0.10	2%	0.28	6%
P418	1	1.5000	4.35	0.10	2%	0.28	6%
P419	1	1.5010	4.35	0.10	2%	0.28	6%
P420	1	1.5000	4.35	0.10	2%	0.28	6%
P421	1	1.4970	4.34	0.10	2%	0.28	6%
P422	1	2.4400	5.54	0.10	2%	0.28	5%
P423	1	2.2840	5.36	0.10	2%	0.28	5%
P424	1	1.3890	4.18	1.43	34%	1.75	42%
P425	1	1.0000	3.55	1.43	40%	1.75	49%
P426	1	1.0000	3.55	1.43	40%	1.75	49%
P427	1	1.0010	3.55	1.43	40%	1.75	49%
P428	1	1.1770	3.85	0.94	24%	1.11	29%
P429	1	1.3020	4.05	0.94	23%	1.11	27%
P430	1	1.3020	4.05	0.94	23%	1.11	27%
P431	1	0.9610	3.48	0.94	27%	1.11	32%
P432	1	1.1770	3.85	0.72	19%	0.86	22%
P433	0.83	1.5470	2.68	0.49	18%	0.64	24%
P434	1	0.8030	3.18	0.49	16%	0.64	20%
P435	1	0.6000	2.75	0.49	18%	0.64	23%
P436	1	12.4740	12.53	0.49	4%	0.64	5%
P437	1	0.9150	3.39	0.21	6%	0.25	7%
P438	1	0.9150	3.39	0.21	6%	0.25	7%
P439	1	0.9170	3.40	0.21	6%	0.25	7%
P440	2	0.1000	7.14	0.36	5%	0.44	6%
P441	2	0.1010	7.18	0.36	5%	0.41	6%
P442	2	0.1030	7.25	0.36	5%	0.41	6%
P443	2	0.0850	6.59	0.36	6%	0.42	6%
P444	2	0.1150	7.66	0.36	5%	0.42	5%
P445	1.5	0.0990	3.30	1.55	47%	1.70	51%
P446	1.5	0.0990	3.30	1.55	47%	1.70	51%
P447	1.5	0.1040	3.38	1.55	46%	1.70	50%
P448	1.5	0.1000	3.31	1.55	47%	1.70	51%
P449	1.5	0.1000	3.31	1.55	47%	1.70	51%
P450	1.5	0.0880	3.11	1.55	50%	1.70	55%
P451	1.5	0.1040	3.38	1.55	46%	1.70	50%
P452	1.5	0.1080	3.44	1.55	45%	1.70	49%
P453	1.5	0.1060	3.41	1.55	45%	1.70	50%
P454	1.75	0.1250	5.59	1.55	28%	1.70	30%
P455	1.75	0.1090	5.22	1.55	30%	1.70	33%
P456	1.75	0.1080	5.20	1.55	30%	1.70	33%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P457	1.75	0.1080	5.20	1.55	30%	1.70	33%
P458	1.75	0.1020	5.05	1.23	24%	1.33	26%
P459A	1	-4.6817	Siphon	0.32		0.33	Siphon
P459B	1	-15.1909	Siphon	0.32		0.33	Siphon
P459C	1	0.0000	Siphon	0.32		0.33	Siphon
P459D	1	15.1910	Siphon	0.32		0.33	Siphon
P459E	1	4.0115	Siphon	0.32		0.33	Siphon
P459F	1	4.0115	Siphon	0.32		0.33	Siphon
P459G	1	15.1910	Siphon	0.32		0.33	Siphon
P459H	1	0.0000	Siphon	0.32		0.33	Siphon
P459I	1	-15.1909	Siphon	0.32		0.33	Siphon
P459J	1	-4.6817	Siphon	0.32		0.33	Siphon
P460	1.75	0.1370	5.85	0.64	11%	0.67	11%
P461	1.75	0.1450	6.02	0.43	7%	0.45	7%
P462	1.75	0.1440	6.00	0.22	4%	0.23	4%
P463	1.75	0.1430	5.98	0.22	4%	0.23	4%
P464	1.75	0.1420	5.96	0.22	4%	0.23	4%
P465	1	0.2070	1.61	0.22	14%	0.23	14%
P466	1	0.2000	1.59	0.22	14%	0.23	14%
P467	1	0.2000	1.59	0.22	14%	0.23	14%
P468	1	0.2010	1.59	0.22	14%	0.23	14%
P469	1	0.2010	1.59	0.22	14%	0.23	14%
P470	1	0.2010	1.59	0.22	14%	0.23	15%
P471	1	0.2020	1.60	0.22	14%	0.23	14%
P472	1	0.2000	1.59	0.22	14%	0.23	15%
P473	1.5	0.1180	3.60	0.45	13%	0.51	14%
P474	1.5	0.1440	3.98	0.45	11%	0.51	13%
P475	1.5	0.3700	6.37	0.45	7%	0.51	8%
P476	1.5	0.1730	4.36	0.22	5%	0.23	5%
P477	1	0.3700	2.16	0.15	7%	0.17	8%
P478	1	0.3680	2.15	0.15	7%	0.17	8%
P479	1.25	0.1800	2.73	0.30	11%	0.34	12%
P480	1.25	0.1800	2.73	0.30	11%	0.34	12%
P481	1.25	0.1820	2.75	0.30	11%	0.34	12%
P482	1	0.1810	1.51	0.15	10%	0.17	11%
P483	1	0.1040	1.14	0.15	13%	0.17	15%
P484	1	1.8500	4.83	0.15	3%	0.17	4%
P485	1	0.2000	1.59	0.15	10%	0.17	11%
P486	1	0.2000	1.59	0.15	10%	0.17	11%
P487	1	0.1940	1.56	0.15	10%	0.17	11%
P488	1	0.2060	1.61	0.15	9%	0.17	11%
P489	1	0.2010	1.59	0.15	10%	0.17	11%
P490	1	0.1990	1.58	0.15	10%	0.17	11%
P491	1	0.2000	1.59	0.15	10%	0.17	11%
P492	1	0.2000	1.59	0.15	10%	0.17	11%
P493	1	0.2000	1.59	0.15	10%	0.17	11%
P494	1	0.1990	1.58	0.15	10%	0.17	11%
P495	1	0.3060	1.96	0.15	8%	0.17	9%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P496	1	0.2670	1.83	0.15	8%	0.17	9%
P497	1	0.2650	1.83	0.15	8%	0.17	9%
P498	1	0.3830	2.20	0.15	7%	0.17	8%
P520	1.25	0.0830	1.86	0.74	40%	0.93	50%
P521	1.25	0.0790	1.81	0.74	41%	0.93	52%
P522	1.25	0.0970	2.01	0.74	37%	0.93	46%
P523	1.25	0.1020	2.06	0.74	36%	0.93	45%
P524	1.25	0.1010	2.05	0.74	36%	0.93	45%
P525	1.25	0.0990	2.03	0.74	37%	0.93	46%
P526	1.25	0.1010	2.05	0.74	36%	0.93	45%
P527	1.25	0.1010	2.05	0.74	36%	0.93	45%
P528	1.25	0.1000	2.04	0.74	36%	0.93	46%
P529	1.25	0.1000	2.04	0.74	36%	0.93	46%
P530	1.25	0.1000	2.04	0.74	36%	0.93	46%
P531	1.25	0.0910	1.94	0.74	38%	0.93	48%
P531A	1.25	0.1776	2.71	0.74	27%	0.93	34%
P534	1.25	0.6090	5.03	0.74	15%	0.93	19%
P535	1	0.1770	1.49	0.74	50%	0.93	62%
P536	1	0.1100	1.18	0.74	63%	0.93	79%
P537	1	0.1126	1.19	0.74	62%	0.93	78%
P538	1	0.1130	1.19	0.74	62%	0.93	78%
P539	1	0.1120	1.19	0.74	62%	0.93	78%
P540	1	0.1510	1.38	0.74	54%	0.93	68%
P541	1	0.1510	1.38	0.74	54%	0.93	68%
P542	2	0.2154	10.48	0.78	7%	0.96	9%
P543	2	0.0150	2.77	0.78	28%	0.95	34%
P544	2	0.1150	7.66	0.82	11%	0.99	13%
P545	1.75	0.1710	6.54	0.92	14%	1.11	17%
P546	1.75	1.1380	16.87	1.77	11%	2.06	12%
P547	1.75	0.1490	6.10	0.81	13%	0.97	16%
P548	1	11.3770	11.97	0.70	6%	0.81	7%
P548A	0.67	0.5770	0.93	0.08	8%	0.13	14%
P548B	0.67	0.5810	0.93	0.08	8%	0.13	14%
P549	1	0.4010	2.25	0.70	31%	0.81	36%
P550	1	0.4620	2.41	0.78	32%	0.94	39%
P551	1	0.4810	2.46	0.78	32%	0.94	38%
P552	1	0.7960	3.17	0.78	25%	0.94	30%
P553	1	0.3990	2.24	0.78	35%	0.94	42%
P554	1	0.4010	2.25	0.78	35%	0.94	42%
P555	1	0.5970	2.74	0.78	28%	0.94	34%
P556	1	0.5000	2.51	0.78	31%	0.94	38%
P557	1	0.5010	2.51	0.78	31%	0.94	37%
P558	1	0.7120	2.99	0.78	26%	0.94	31%
P559	1	0.7150	3.00	0.78	26%	0.94	31%
P560	1	0.7170	3.01	0.78	26%	0.94	31%
P561	1	0.7150	3.00	0.78	26%	0.94	31%
P562	1	1.3920	4.19	0.78	19%	0.94	22%
P563	0.67	1.1670	1.32	0.78	59%	0.94	72%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P564	1	0.5980	2.74	0.78	28%	0.94	34%
P565	1	0.6030	2.76	0.78	28%	0.94	34%
P566	1	0.5420	2.61	0.78	30%	0.94	36%
P567	1	0.6960	2.96	0.78	26%	0.94	32%
P574	2	0.1140	7.63	0.78	10%	0.93	12%
P575	2	0.1150	7.66	0.78	10%	0.92	12%
P576	2	0.1150	7.66	0.78	10%	0.99	13%
P577	2	0.1110	7.53	0.78	10%	1.20	16%
P582	1	0.5449	2.62	1.14	44%	1.52	58%
P583	1	0.2801 0.32	1.88	1.15	61%	1.53	81%
P584	1	0.2990 - 0.32	1.94	1.15	59%	1.53	79%
P585	1	0.1000	1.12	1.15	102%	1.53	136%
P586	1	0.1000	1.12	1.15	102%	1.53	136%
P587	0.83	1.0020	2.16	1.15	53%	1.53	71%
P588	0.83	0.5000	1.53	1.15	75%	1.53	100%
P589	0.83	0.6700	1.77	1.15	65%	1.53	87%
P590	0.83	0.6710	1.77	1.15	65%	1.53	87%
P591	0.83	1.4610	2.61	0.81	31%	0.93	36%
P592	0.83	1.2520	2.41	0.81	34%	0.93	38%
P593	0.83	1.3160	2.48	0.81	33%	0.93	37%
P594	0.83	0.2180	1.01	0.81	81%	0.93	92%
P595	0.83	0.2180	1.01	0.81	81%	0.93	92%
P596	0.83	2.7580	3.58	0.81	23%	0.93	26%
P597	0.67	1.8270	1.65	0.81	49%	0.93	56%
P598	0.67	1.8270	1.65	0.81	49%	0.93	56%
P599	0.67	1.4910	1.49	0.81	55%	0.93	62%
P59A	2	0.2000	10.10	2.15	21%	3.50	35%
P600	0.67	1.1020	1.28	0.81	63%	0.93	73%
P601	0.67	1.0380	1.24	0.81	65%	0.93	75%
P602	0.67	1.3060	1.39	0.81	58%	0.93	67%
P603	0.67	1.3030	1.39	0.81	58%	0.93	67%
P604	0.67	1.2700	1.37	0.81	59%	0.93	68%
P605	0.67	1.2730	1.37	0.81	59%	0.93	67%
P606	0.67	1.0850	1.27	0.81	64%	0.93	73%
P607	0.67	1.1110	1.28	0.81	63%	0.93	72%
P608	0.67	1.0670	1.26	0.81	64%	0.93	74%
P609	0.67	1.0920	1.27	0.81	64%	0.93	73%
P610	0.67	1.1430	1.30	0.81	62%	0.93	71%
P611	0.67	1.0930	1.27	0.81	64%	0.93	73%
P612	0.67	0.9220	1.17	0.81	69%	0.93	79%
P613	0.67	0.8660	1.13	0.81	72%	0.93	82%
P614	1.25	0.3620	3.87	0.41	10%	0.46	12%
P615	1.25	0.3590	3.86	0.41	11%	0.46	12%
P616	1.25	0.2790	3.40	0.41	12%	0.46	14%
P617	1.25	1.4720	7.81	0.41	5%	0.46	6%
P618	1.25	0.3590	3.86	0.41	11%	0.46	12%
P619	1.25	1.2130	7.09	0.41	6%	0.46	7%
P620	1.25	0.7400	5.54	0.41	7%	0.46	8%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P621	1.25	0.3550	3.84	0.41	11%	0.46	12%
P622	1	0.3600	2.13	1.92	90%	2.34	110%
P623	1	0.3600	2.13	1.92	90%	2.34	110%
P624	1	0.3600	2.13	1.92	90%	2.34	110%
P625	1	0.4400	2.35	1.92	81%	2.34	99%
P626	1	0.5400	2.61	1.92	73%	2.34	90%
P627	1	0.6400	2.84	1.92	67%	2.34	82%
P628	1	0.5750	2.69	1.92	71%	2.34	87%
P629	1	0.6380	2.83	1.92	68%	2.34	82%
P630	1	0.7950	3.16	1.92	61%	2.34	74%
P631	2.25	0.1950	13.66	9.05	66%	11.41	84%
P632	2.25	0.1930	13.59	9.05	67%	11.41	84%
P633	2.25	0.1920	13.55	9.05	67%	11.41	84%
P634	2.25	0.1900	13.48	9.05	67%	11.41	85%
P635	2.25	0.1910	13.52	9.05	67%	11.41	84%
P636	2.25	0.1910	13.52	9.05	67%	11.41	84%
P637	2.25	0.3870	19.24	9.05	47%	11.41	59%
P638	2.25	0.4320	20.33	9.52	47%	11.99	59%
P639	2.25	0.4210	20.07	9.51	47%	11.99	60%
P640	2.25	0.4200	20.05	9.42	47%	11.99	60%
P641	2.25	0.4110	19.83	9.21	46%	11.99	60%
P642	2.5	0.3554	24.43	12.26	50%	15.89	65%
P643	2.5	0.3570	24.49	5.36	22%	7.24	30%
P644	2.5	0.1080	13.47	5.36	40%	7.24	54%
P644A	2.5	0.5460	30.28	7.32	24%	8.65	29%
P645	2.25	0.3359	17.93	6.43	36%	7.93	44%
P646	2.25	0.1600	12.37	6.43	52%	7.93	64%
P647	2.25	0.1600	12.37	6.43	52%	7.93	64%
P648	2.25	0.1600	12.37	6.43	52%	7.93	64%
P649	2.25	0.1590	12.34	6.43	52%	7.93	64%
P650	2.25	0.1780	13.05	6.83	52%	8.52	65%
P651	1.25	0.3360	3.73	0.41	11%	0.59	16%
P652	1	0.2180	1.66	0.31	19%	0.39	24%
P653	1	0.2190	1.66	0.12	7%	0.21	13%
P654	1	0.2200	1.66	0.12	7%	0.21	13%
P655	1	0.2200	1.66	0.12	7%	0.21	13%
P656	1	0.2200	1.66	0.12	7%	0.21	13%
P657	1.25	0.2740	3.37	2.18	65%	2.31	68%
P658	1	1.1760	3.85	1.46	38%	1.54	40%
P659	1	0.2500	1.77	0.73	41%	0.77	43%
P660	1	0.3050	1.96	0.73	37%	0.77	39%
P662	1	0.3700	2.16	0.73	34%	0.77	36%
P663	1	0.2750	1.86	0.73	39%	0.77	41%
P664	1	0.1970	1.58	0.73	47%	0.77	49%
P665	1	0.2010	1.59	0.73	46%	0.77	48%
P666	1	0.1970	1.58	0.73	47%	0.77	49%
P667	1	0.1970	1.58	0.73	47%	0.77	49%
P668	1	0.2000	1.59	0.73	46%	0.77	48%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P669	1	0.1970	1.58	0.73	47%	0.77	49%
P670	1	1.0470	3.63	0.73	20%	0.77	21%
P671	1	1.0000	3.55	0.73	21%	0.77	22%
P672	1	2.2060	5.27	0.73	14%	0.77	15%
P673	1.25	0.4560	4.35	0.73	17%	0.77	18%
P674	1.75	0.1010	5.03	2.12	42%	1.61	32%
P675	1.75	0.0990	4.98	2.03	41%	1.61	32%
P676	1.75	0.0990	4.98	1.91	38%	1.61	32%
P677	1.75	0.1000	5.00	1.74	35%	1.61	32%
P678	1.25	5.9420	15.70	0.27	2%	0.33	2%
P679	1.25	0.5980	4.98	0.27	6%	0.33	7%
P680	1.25	0.5940	4.96	0.27	6%	0.33	7%
P681	1.25	7.1190	17.18	0.27	2%	0.33	2%
P682	1.25	0.8000	5.76	0.14	2%	0.17	3%
P683	1.25	0.5430	4.75	0.14	3%	0.17	4%
P684	1.25	0.4000	4.07	0.14	3%	0.17	4%
P685	1.25	1.5790	8.09	0.14	2%	0.17	2%
P686	1.25	0.5110	4.60	0.14	3%	0.17	4%
P687	1.25	0.5000	4.55	0.14	3%	0.17	4%
P688	1.25	0.3970	4.06	0.14	3%	0.17	4%
P689	1.25	0.3980	4.06	0.14	3%	0.17	4%
P690	1.25	0.3980	4.06	0.14	3%	0.17	4%
P691	1.25	0.5760	4.89	0.14	3%	0.17	3%
P692	1.25	0.5000	4.55	0.14	3%	0.17	4%
P693	1.25	0.2360	3.13	0.14	4%	0.17	5%
P694	1.25	0.1010	2.05	1.39	68%	1.28	63%
P695	1.25	0.1010	2.05	1.27	62%	1.28	63%
P696	1.25	0.1010	2.05	1.16	57%	1.28	63%
P697	1.25	0.0930	1.96	1.12	57%	1.28	65%
P698	1.25	0.1070	2.11	1.12	53%	1.28	61%
P699	1.25	0.1260	2.29	1.12	49%	1.28	56%
P700	1.25	0.1010	2.05	1.12	55%	1.28	63%
P701	1.25	0.0940	1.97	1.12	57%	1.28	65%
P702	0.67	3.3869	2.24	1.12	50%	1.28	57%
P703	1	2.4720	5.58	0.57	10%	0.57	10%
P704	1	0.2960	1.93	0.34	18%	0.61	31%
P705	1	0.2940	1.92	0.34	18%	0.61	31%
P706	1	0.2960	1.93	0.34	18%	0.61	31%
P707	1	0.3050	1.96	0.34	17%	0.61	31%
P708	1	0.2950	1.93	0.34	18%	0.61	31%
P709	1	0.2950	1.93	0.34	18%	0.61	31%
P710	1	0.2920	1.92	0.34	18%	0.61	32%
P711	1	0.2940	1.92	0.34	18%	0.61	31%
P712	1	0.2930	1.92	0.34	18%	0.61	32%
P713	1	0.2980	1.94	0.34	18%	0.61	31%
P714	1.25	0.1412	2.42	1.48	61%	1.85	76%
P715	1.25	0.1360	2.37	1.48	62%	1.85	78%
P716	1.25	0.1450	2.45	1.48	60%	1.86	76%

Table 7-1
Sewer Analysis Results (Existing and Ultimate Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P717	1.25	0.1390	2.40	1.48	62%	1.86	78%
P718	1.25	0.1340	2.36	1.48	63%	1.86	79%
P719	1	0.9750	3.50	1.48	42%	1.86	53%
P720	1.5	0.1450	3.99	0.74	19%	0.93	23%
P722	1.5	0.1580	4.16	0.74	18%	0.93	22%
P723	1.5	0.0360	1.99	0.74	37%	0.93	47%
P724	1.25	0.3200	3.64	0.74	20%	0.93	26%
P725	1.25	1.3291	7.42	0.74	10%	0.93	13%
P726	0.67	2.2770	1.84	0.74	40%	0.93	51%
P727	1.25	0.2620	3.30	0.74	23%	0.93	28%
P728	1.25	0.7680	5.64	1.12	20%	1.58	28%
P729	1.25	0.4810	4.47	1.12	25%	1.58	35%
P730	1.5	0.1580	4.16	1.12	27%	1.57	38%
P731	1.5	0.1610	4.20	1.12	27%	1.57	37%
P732	1.5	0.1600	4.19	1.12	27%	1.57	38%
P733	1.25	0.5580	4.81	1.12	23%	1.57	33%
P735	1	1.5910	4.48	1.12	25%	1.57	35%
P736	1	1.6410	4.55	1.12	25%	1.57	35%
P737	1	0.5565	2.65	1.12	42%	1.57	59%
P738	1.25	0.5410	4.74	1.12	24%	1.57	33%
P739	1.25	0.5650	4.84	1.12	23%	1.57	33%
P740	1.25	0.5620	4.83	1.12	23%	1.58	33%
P741	1.25	0.5570	4.81	1.12	23%	1.58	33%
P742	1	1.6700	4.59	0.77	17%	1.11	24%
P743	1	0.6990	2.97	0.77	26%	1.11	38%
P744	1	0.7000	2.97	0.77	26%	1.12	38%
P745	1	0.7000	2.97	0.77	26%	1.12	38%
P746	1	0.7000	2.97	0.77	26%	1.12	38%
P747	1	0.7000	2.97	0.77	26%	1.12	38%
P748	1	0.6970	2.96	0.77	26%	1.12	38%

Note:

Deficient pipes in volume (flowing at > 90% capacity) are highlighted in dark color and marginally deficient pipes (flowing at >75% and < 90%) are highlighted in light color.

7.0 DEFICIENCIES AND SOLUTIONS

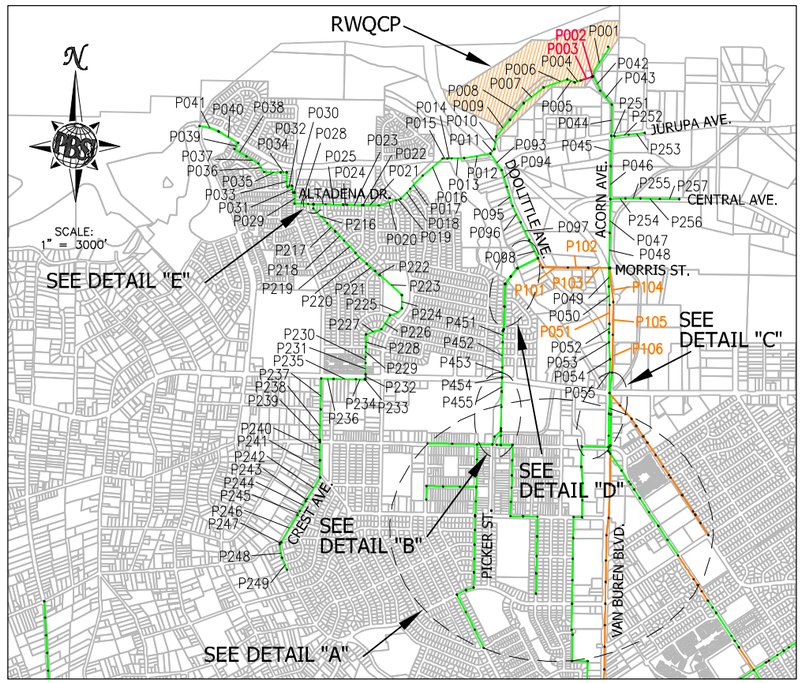
7.1 Deficient and Marginally Deficient Pipes

The Computer model simulations of the City's wastewater system have evaluated pipe reaches in terms of both volume and velocity criteria.

The City's design criterion for sewer lines allows pipes to flow at a ratio of 75% of "full" hydraulic capacity. Assuming that "full" capacity is the maximum hydraulic capacity of a pipe flowing under gravity (non-pressure) conditions, Manning's equation shows that maximum flow occurs when a pipe reaches a flow depth ratio of about 95% depth/diameter (d/D). For the purpose of this study, pipes flowing at 90% or greater capacity are considered "deficient", and pipes flowing at greater than 75% and less than 90% are considered "marginally deficient".

Pipe reaches which fail the "75% full" volume criterion for both existing and future flow conditions are shown in Table 7-2 and Figures 25A, 25B, 25C, 27A, 27B and 27C. It is seen that portions of the modeled trunk system are already flowing at greater than 75% full, and several reaches are computed to be over 100% full (surcharging) for existing and ultimate flow conditions. At ultimate conditions, numerous additional reaches are shown to surcharge or exceed the "75% full" criteria.

A velocity more than 10 feet per second is considered to be the threshold for scouring. The pipes having a maximum velocity of more than 10 feet per second are considered "deficient" in velocity, due to the potential erosion of the interiors of pipe walls over time. A velocity less than 2 feet per second is not considered self- cleansing and pipe reaches that have a maximum flow velocity less than 2 feet per second under existing flow conditions are also considered "deficient" in velocity. These pipes are shown in Figures 26A, 26B and 26C.



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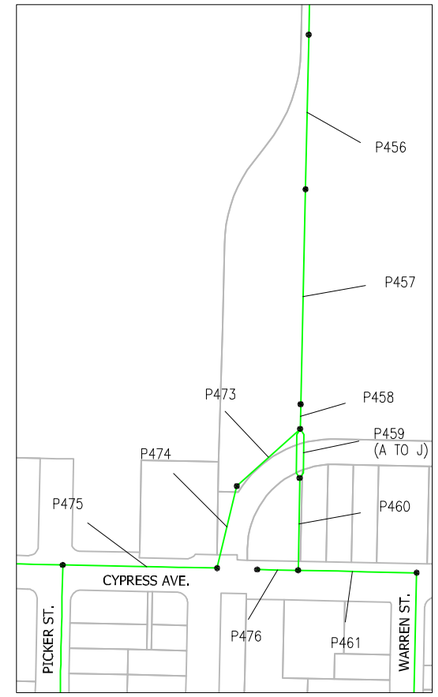

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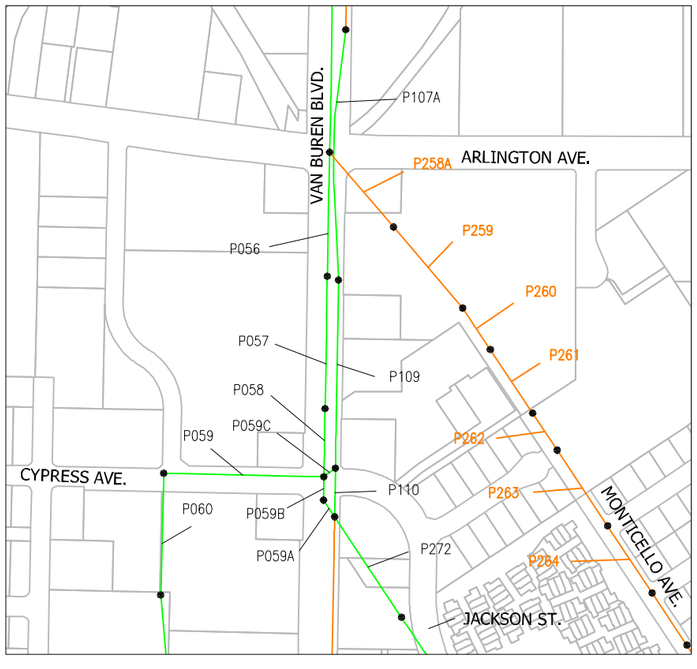

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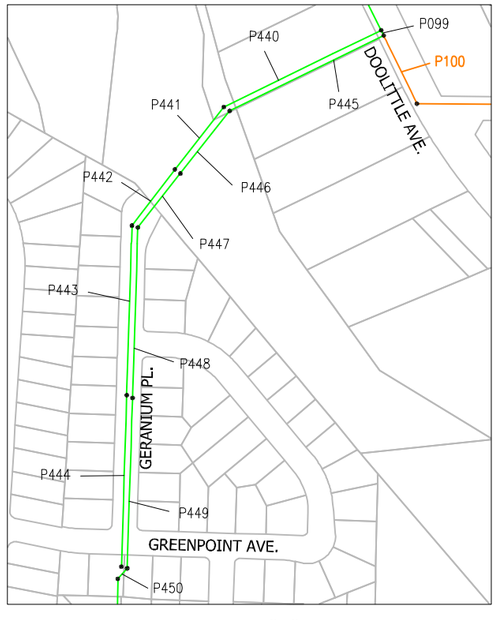

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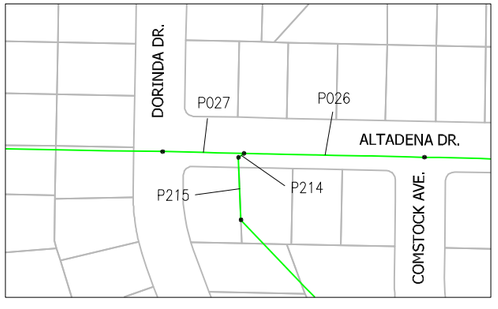


DETAIL "E"
NTS

LEGEND

- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 25B AND 25C FOR CONTINUATION OF SEWER BASIN SYSTEM

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

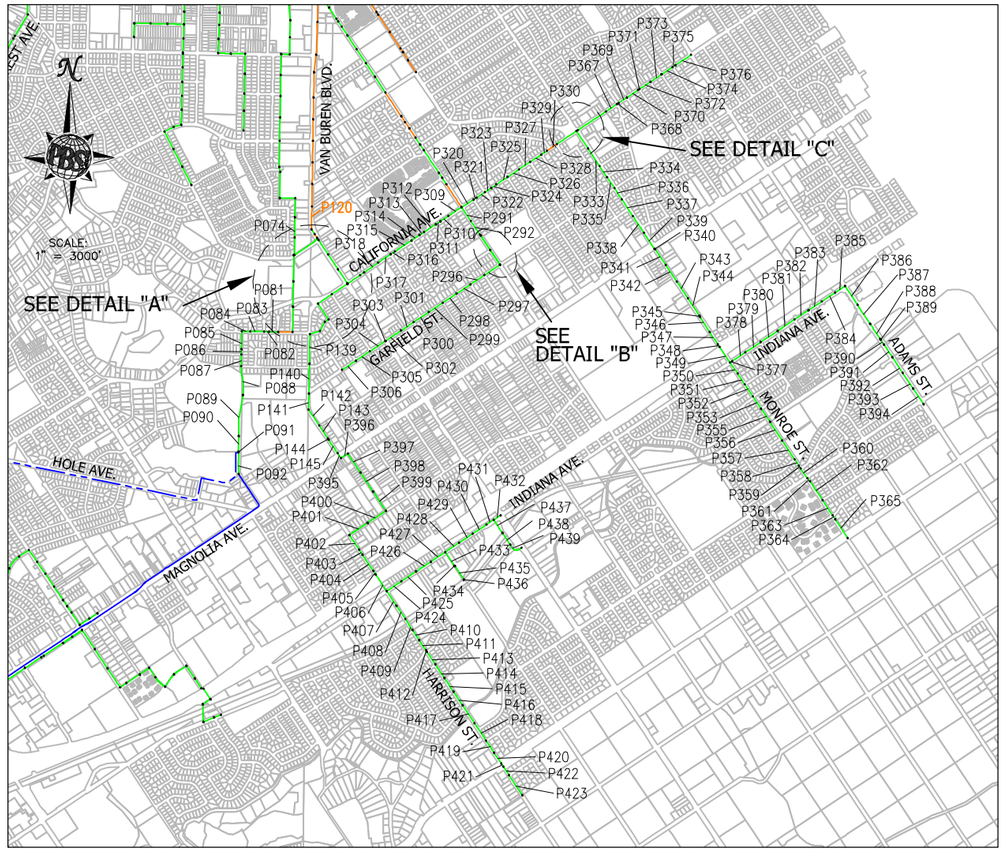
DATE: 12/21/05 | DWN BY: CD

CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 25A

VOLUME DEFICIENCIES - PART 1

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-VolumeDef.dwg, 9/28/2006 10:46:20 AM



DETAIL "A"
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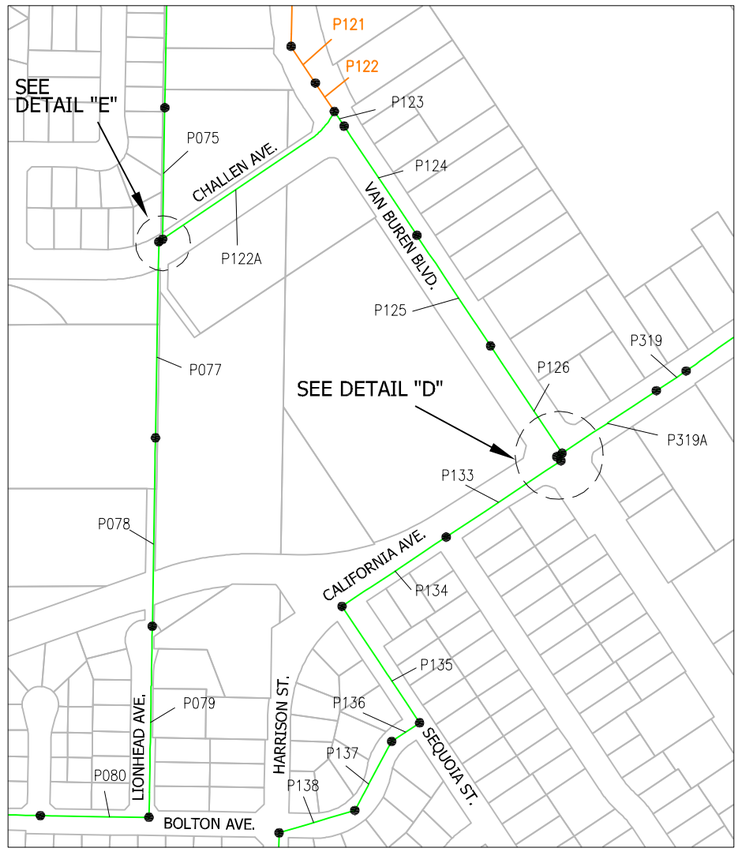
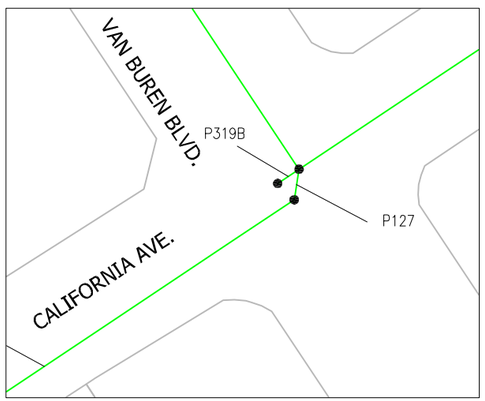


DETAIL "B"
NTS

DETAIL "C"
NTS

DETAIL "D"
NTS



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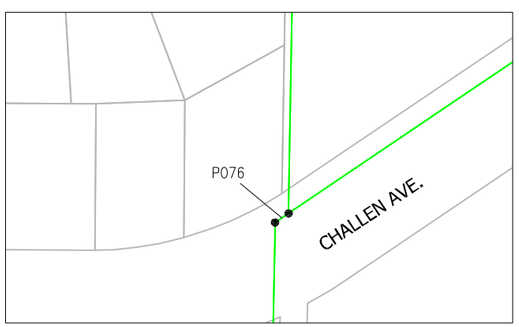


LEGEND

———	MAGNOLIA FORCE MAIN
— - —	LA SIERRA FORCE MAIN
———	VOLUME ≤ 75 % FULL
———	VOLUME > 75 < 90 % FULL
———	VOLUME ≥ 90 % FULL
P001	PIPE SEGMENT NUMBER

SEE FIGURES 25A AND 25C FOR CONTINUATION OF SEWER BASIN SYSTEM

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

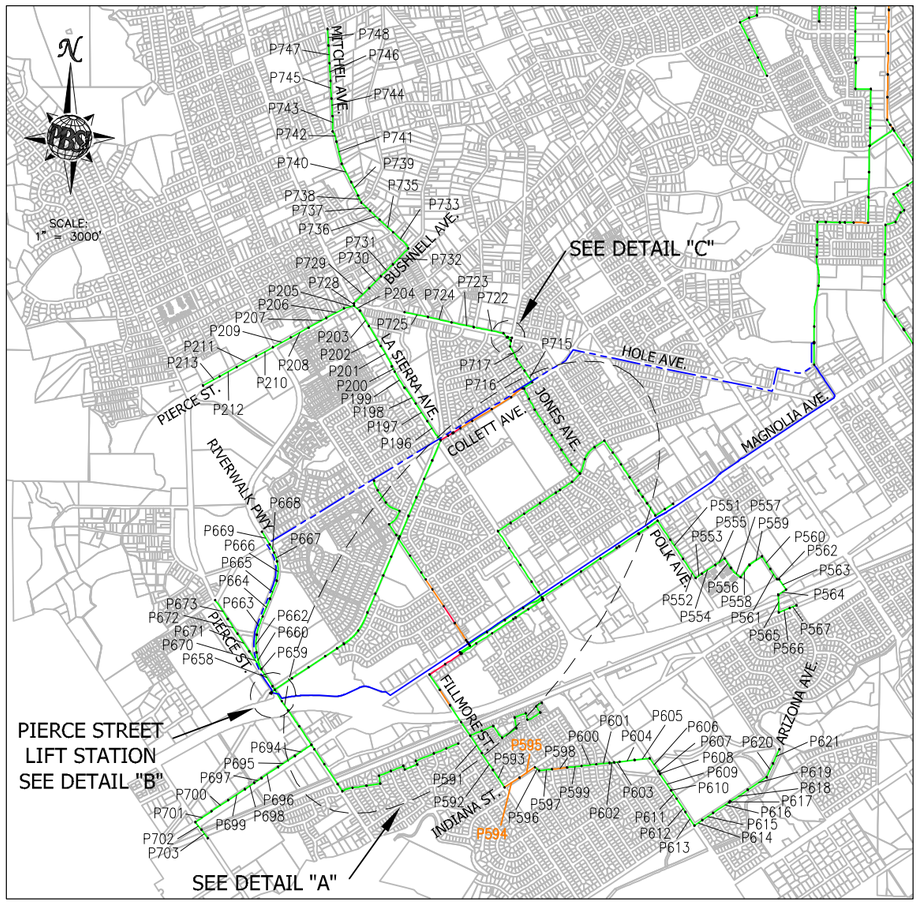
DATE: 12/21/05 | DWN BY: CD

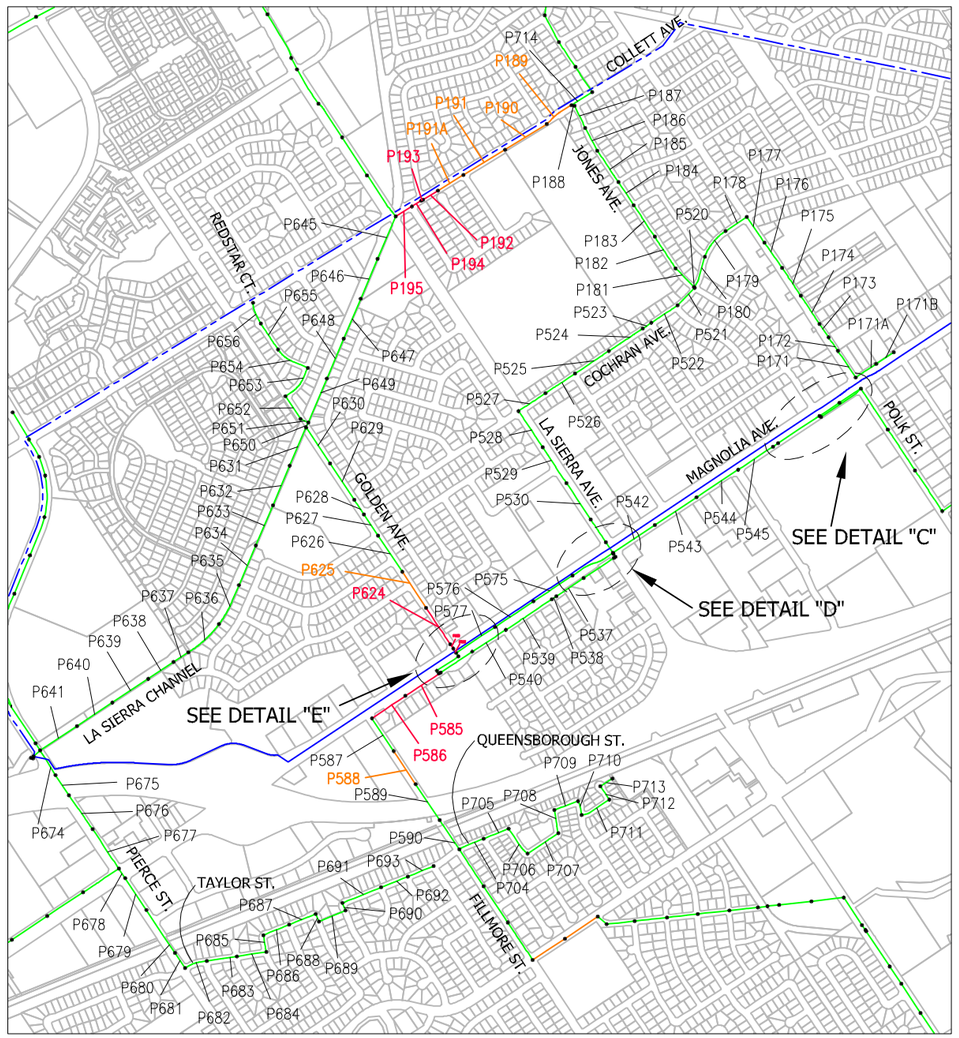
CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 25B

VOLUME DEFICIENCIES - PART 2

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-VolumeDefB.dwg, 9/28/2006 10:47:22 AM





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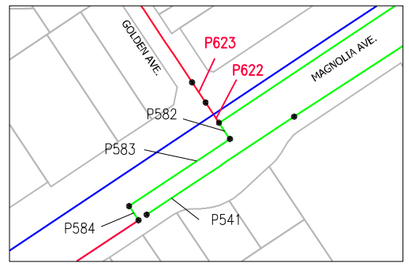

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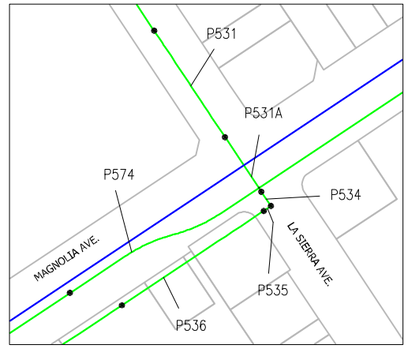

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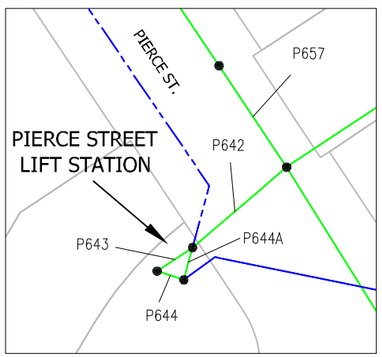
DETAIL "F"
NTS



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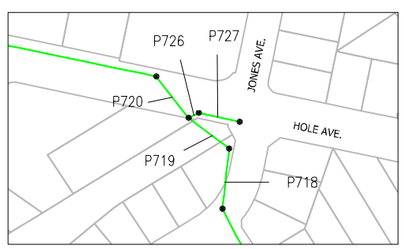

DETAIL "C"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 25A AND 25B FOR CONTINUATION OF SEWER BASIN SYSTEM

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ARLANZA SEWER STUDY

FIGURE 25C

VOLUME DEFICIENCIES - PART 3

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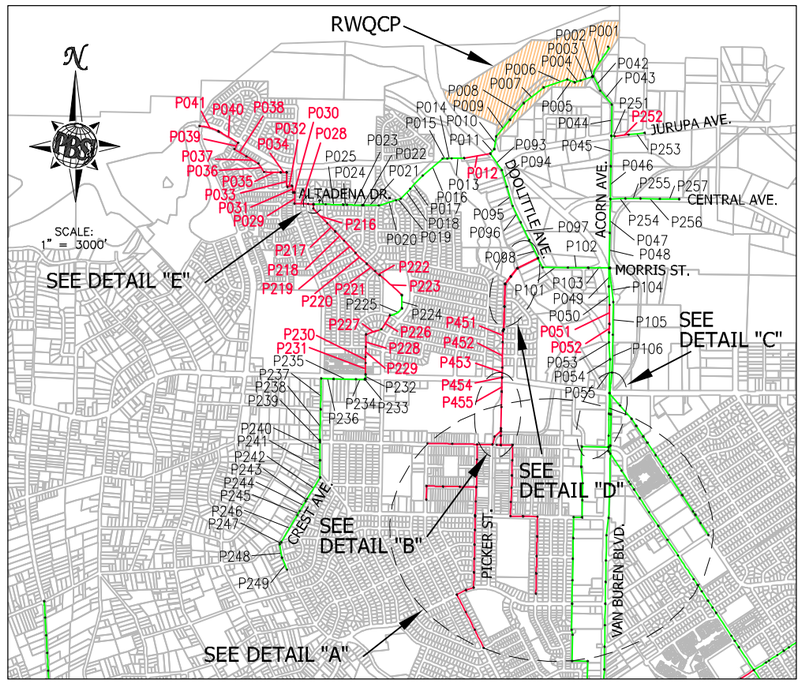

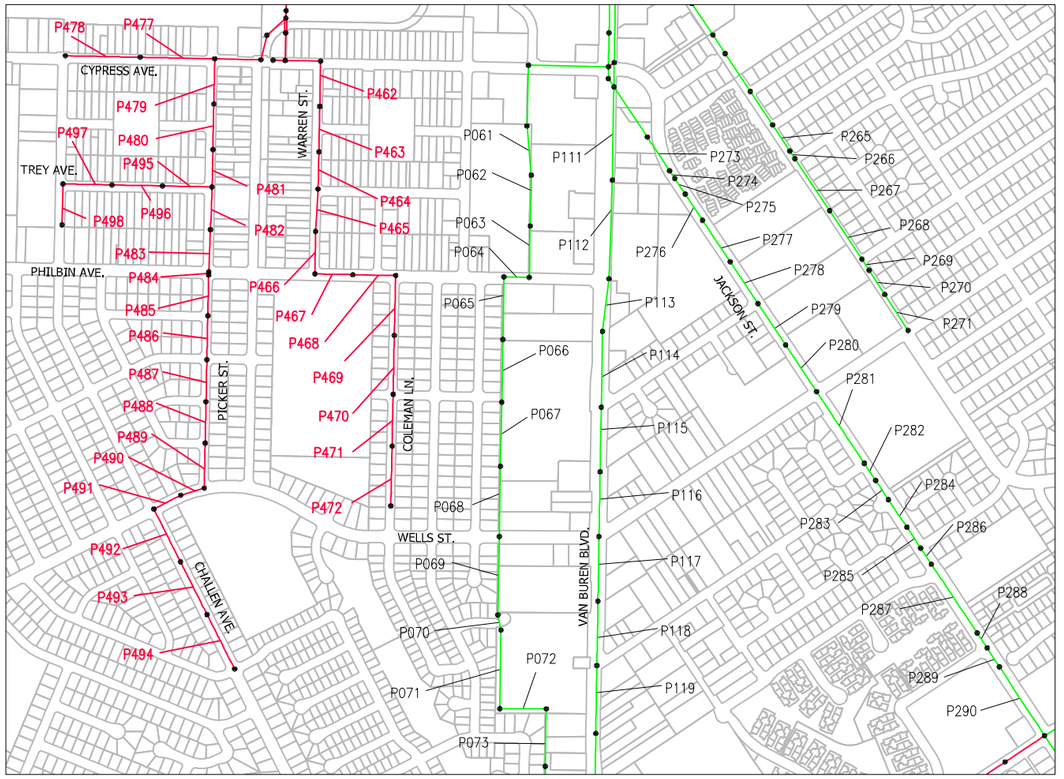

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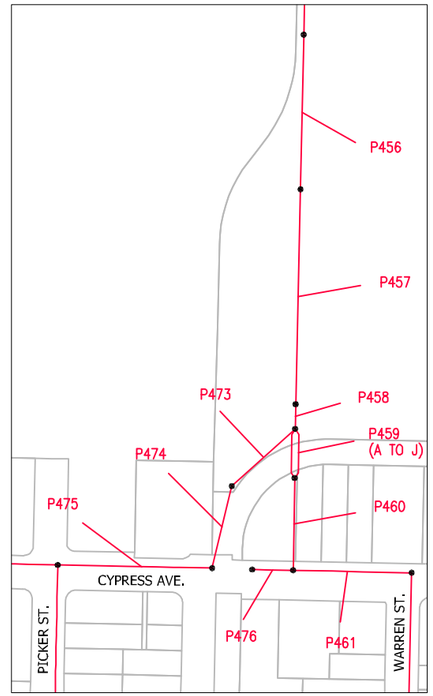

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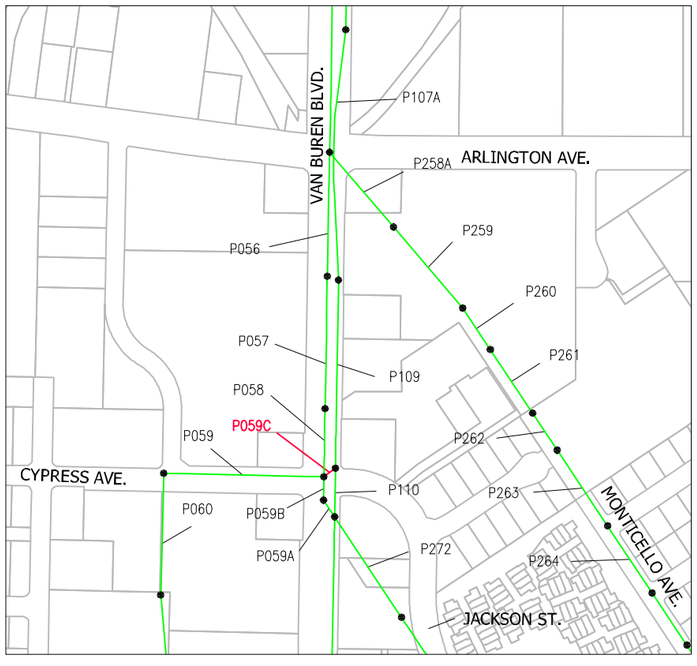

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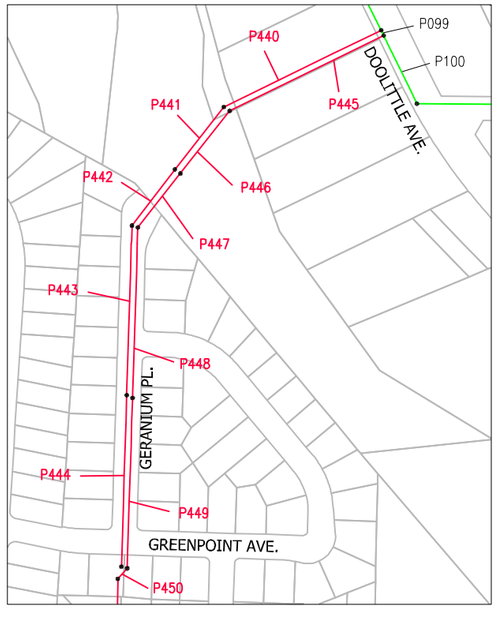

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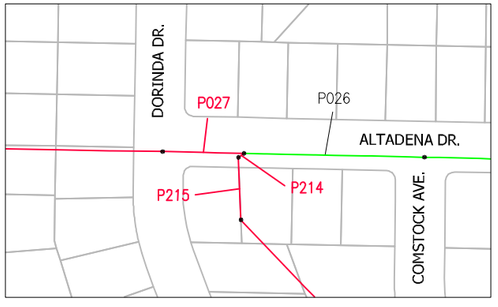

DETAIL "E"
NTS

LEGEND

- GRAVITY SEWER
- VELOCITY < 2 FPS
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 26B AND 26C FOR CONTINUATION OF SEWER BASIN SYSTEM

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Fax:(951) 358-1434

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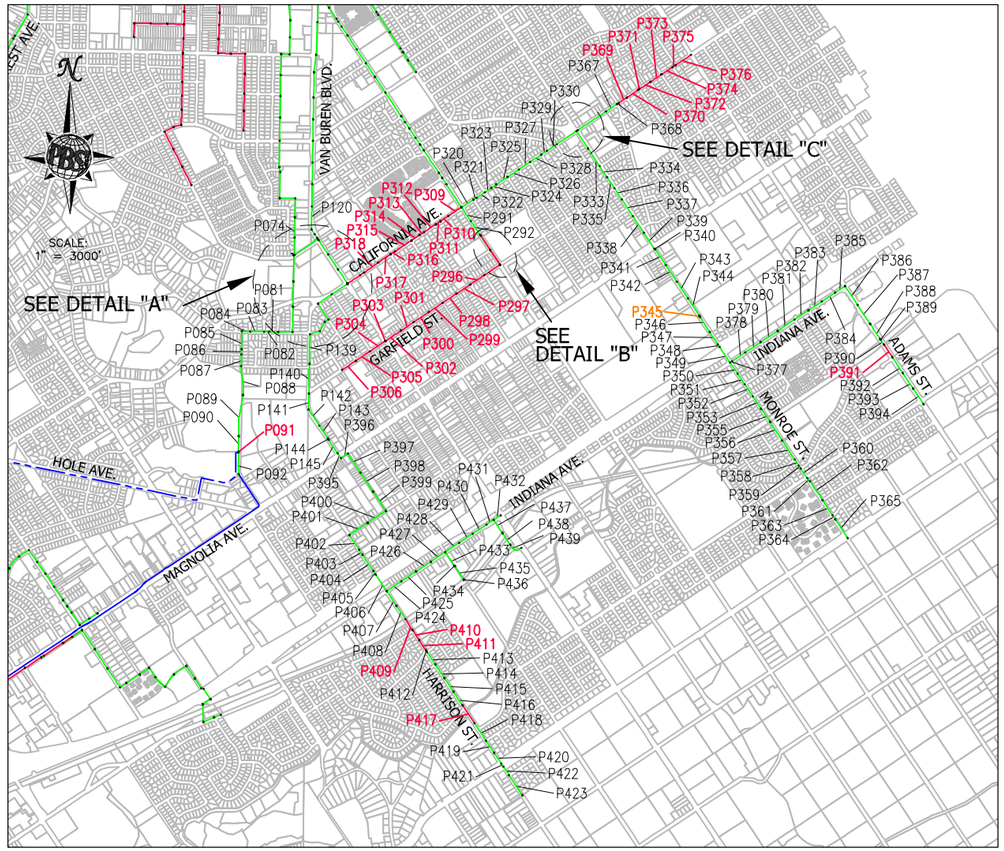
ARLANZA SEWER STUDY

FIGURE 26A

VELOCITY DEFICIENCIES - PART 1

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-VelocityDef.dwg, 9/28/2006 10:40:24 AM



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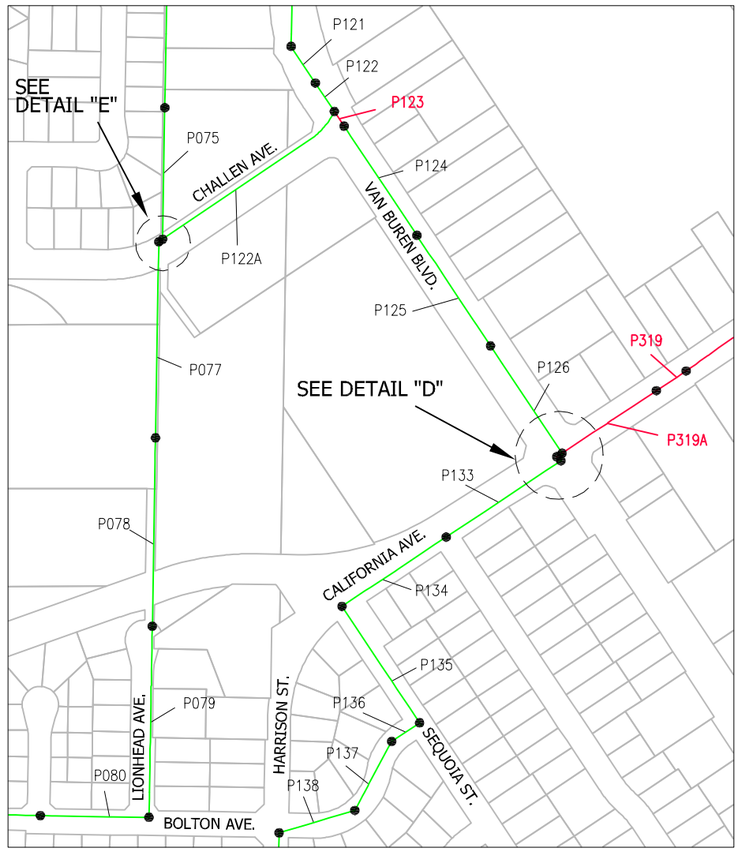

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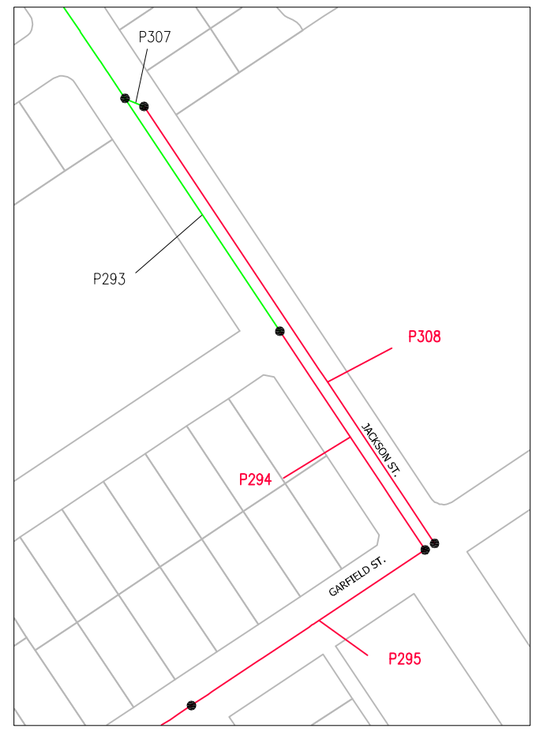
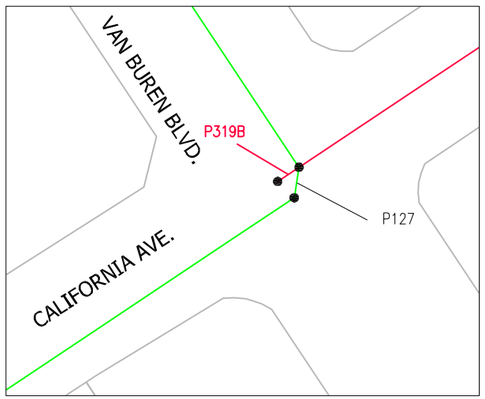


DETAIL "C"
NTS

DETAIL "D"
NTS



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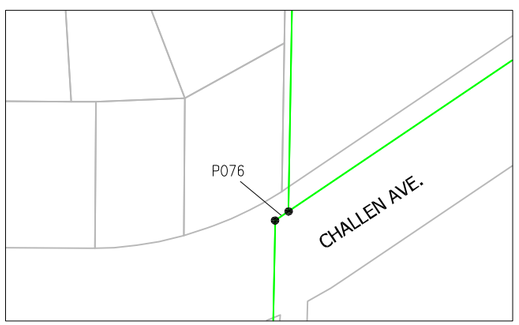

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- VELOCITY < 2 FPS
- VELOCITY > 10 FPS
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 26A AND 26C FOR CONTINUATION OF SEWER BASIN SYSTEM

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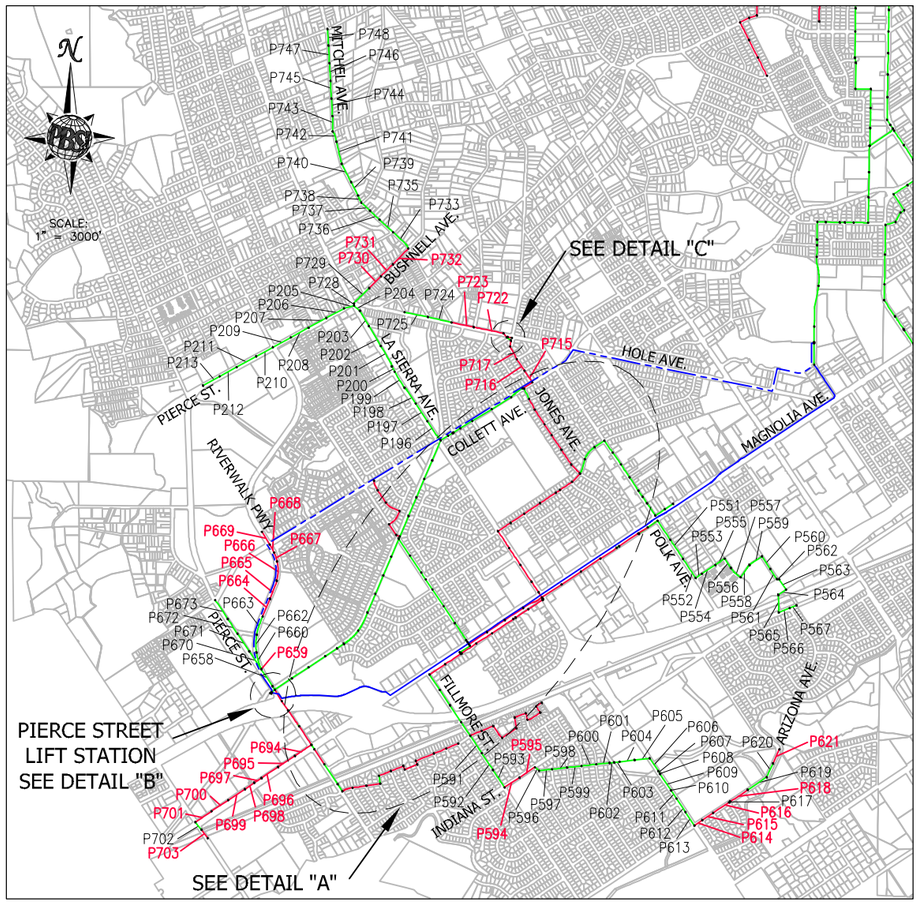
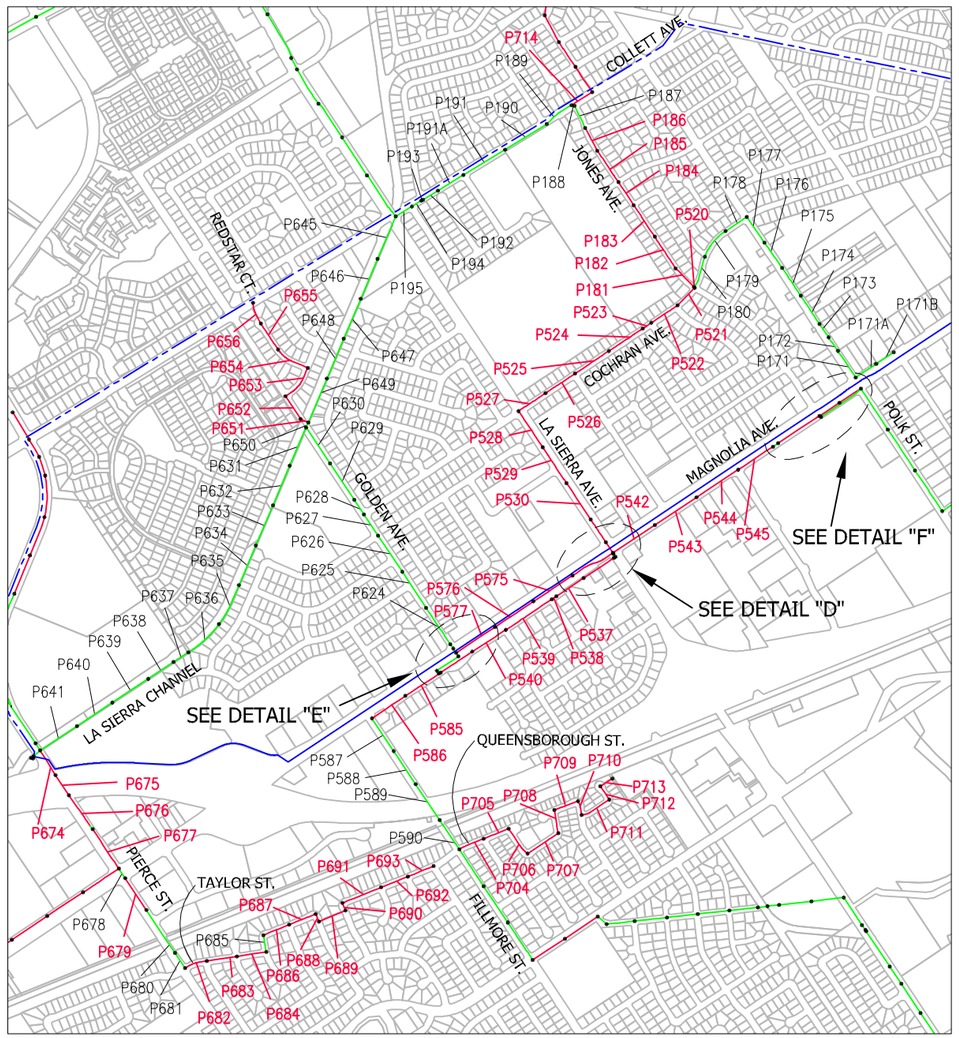
ARLANZA SEWER STUDY

FIGURE 26B

VELOCITY DEFICIENCIES - PART 2

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-VelocityDefB.dwg, 9/28/2006 10:41:54 AM





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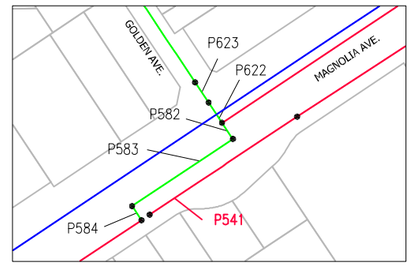

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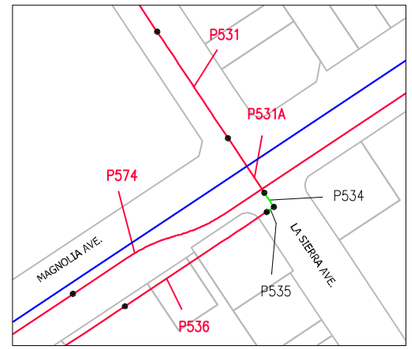

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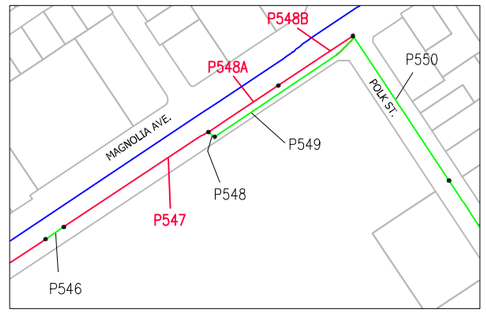

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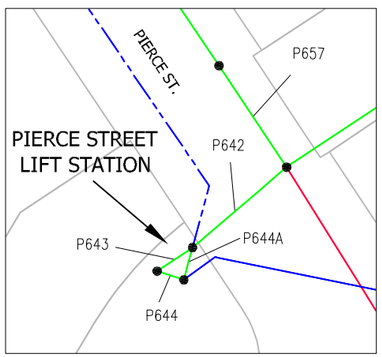

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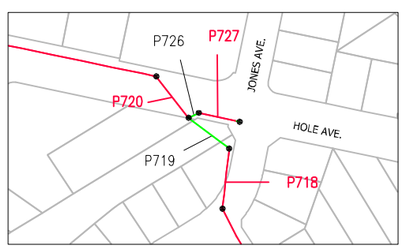

DETAIL "C"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- VELOCITY < 2 FPS
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 26A AND 26B FOR CONTINUATION OF SEWER BASIN SYSTEM

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PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
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Fax:(951) 358-1434

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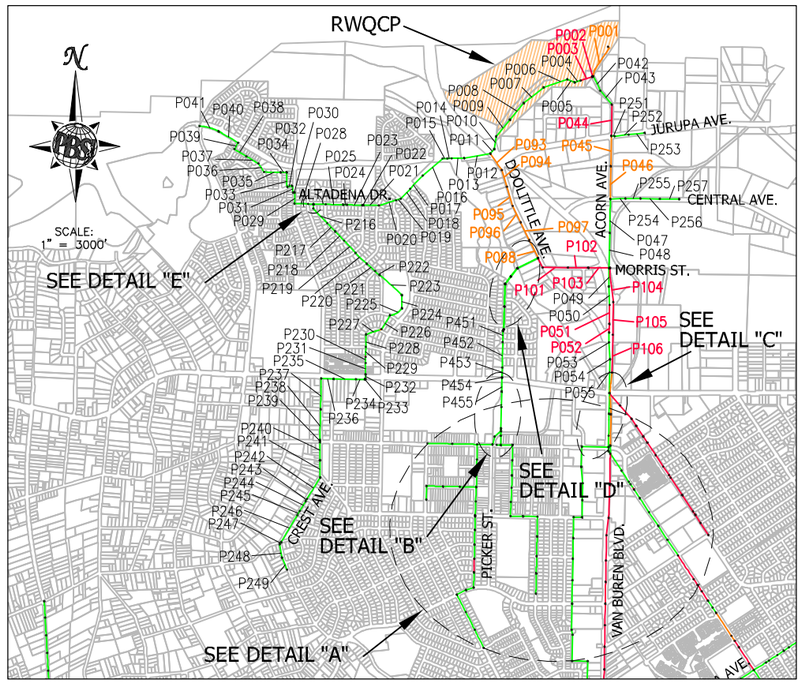
FIGURE 26C

VELOCITY DEFICIENCIES - PART 3

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-VelocityDefC.dwg, 9/28/2006 10:44:36 AM



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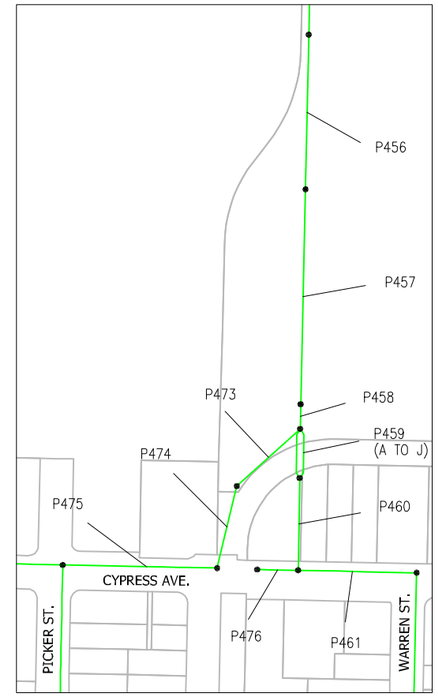

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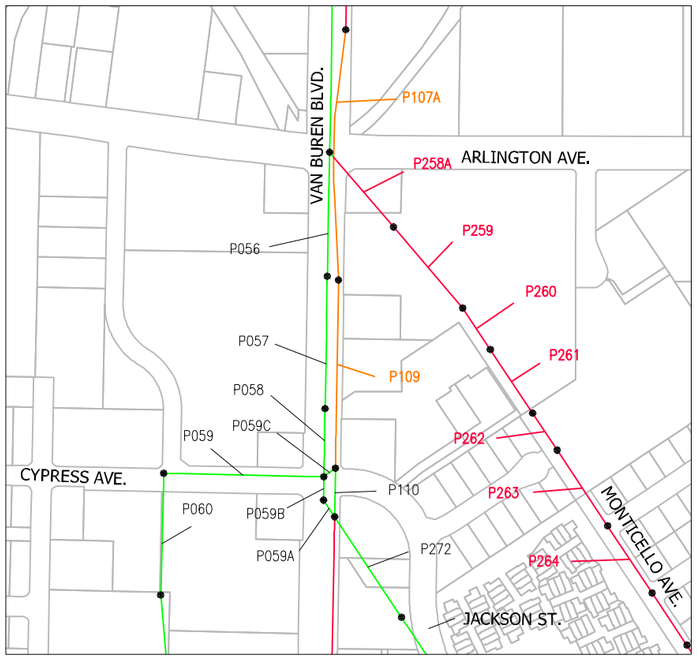

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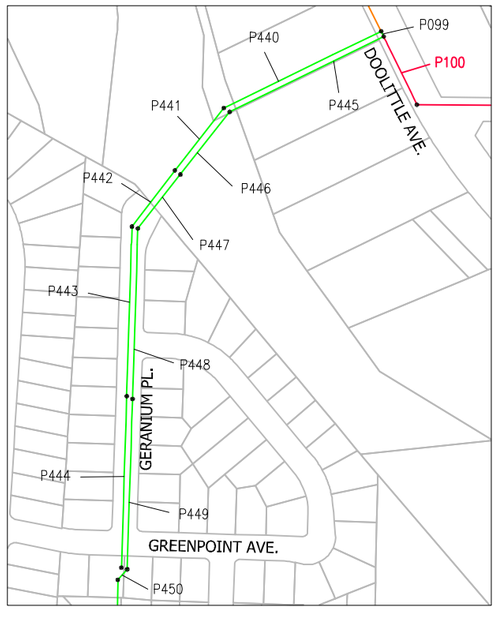

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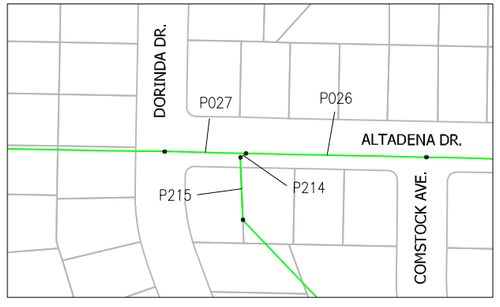

DETAIL "E"
NTS

LEGEND

- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 27B AND 27C FOR CONTINUATION OF SEWER BASIN SYSTEM

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FIGURE 27A

ULTIMATE VOLUME DEFICIENCIES - PART 1

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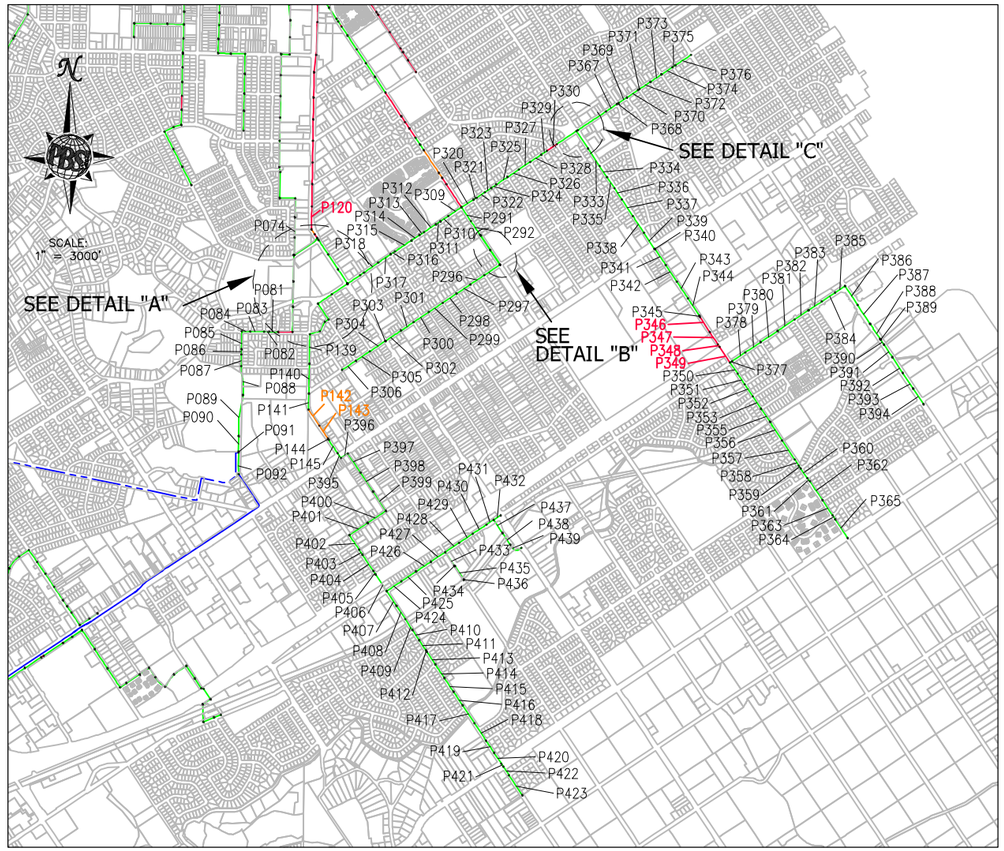
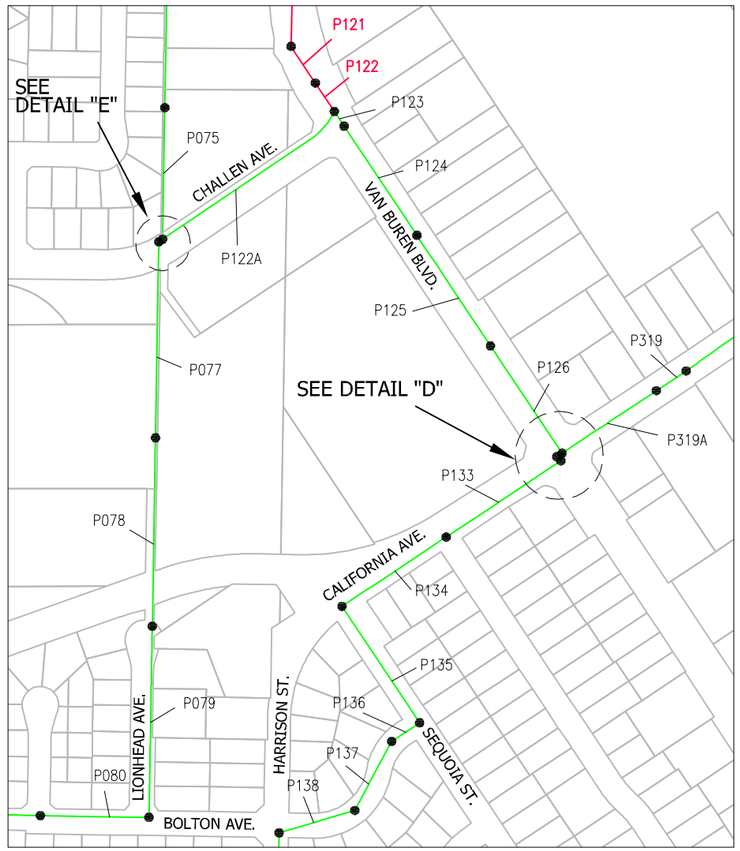
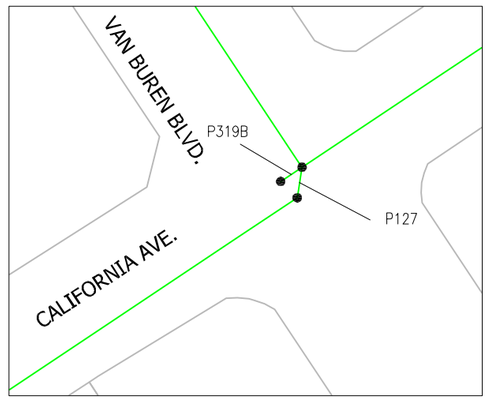




DETAIL "A"
NTS

DETAIL "B"
NTS

DETAIL "C"
NTS



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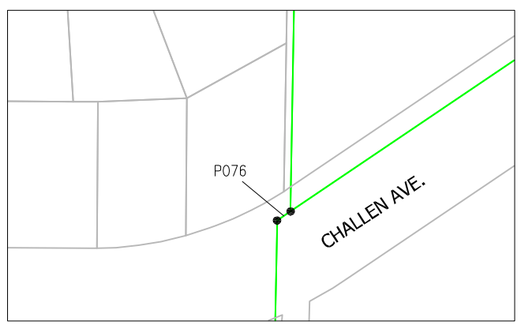

DETAIL "E"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 27A AND 27C FOR CONTINUATION OF SEWER BASIN SYSTEM

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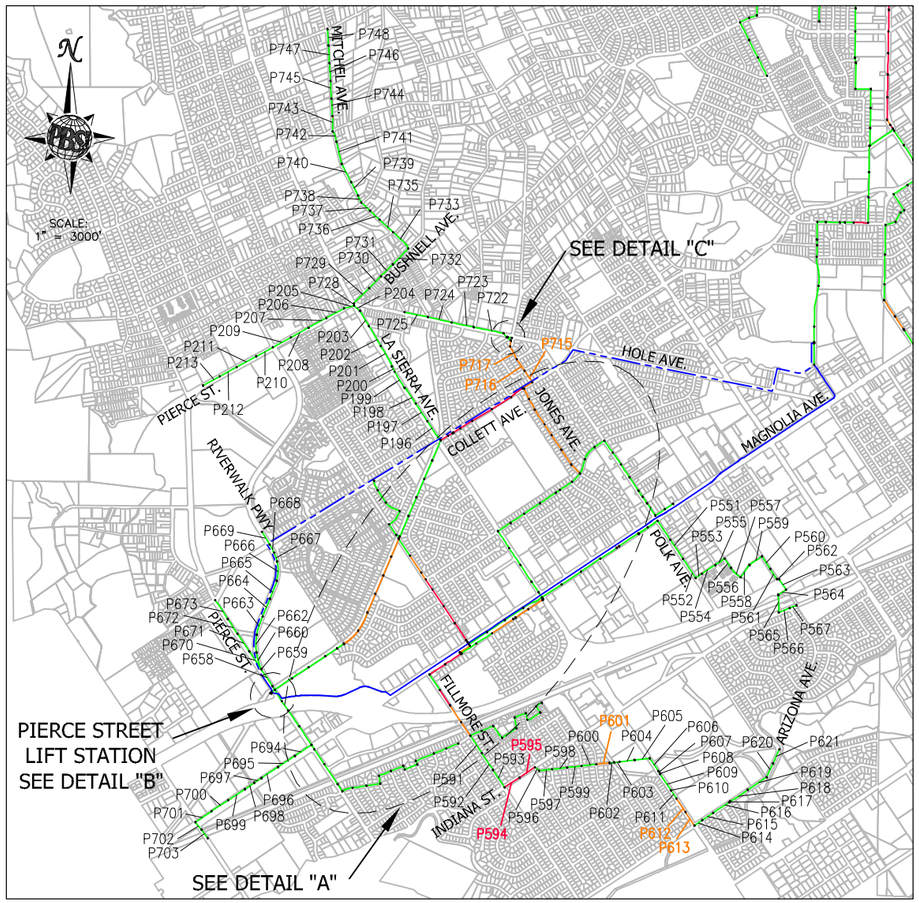
FIGURE 27B

ULTIMATE VOLUME DEFICIENCIES - PART 2

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-Ult\VolumeDefB.dwg, 9/28/2006 10:36:02 AM



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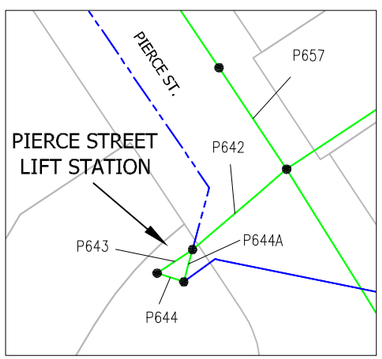

DETAIL "B"
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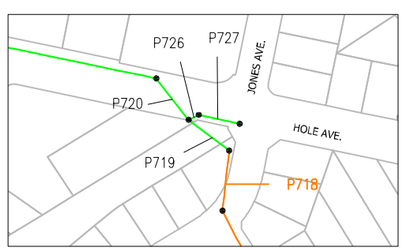

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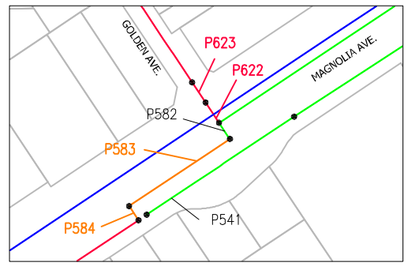

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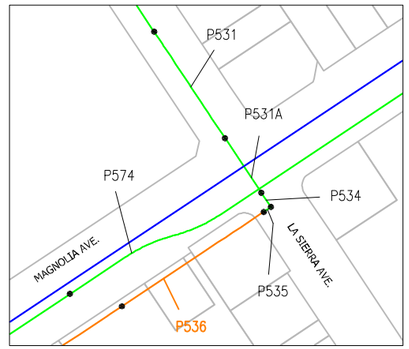

DETAIL "D"
NTS

DETAIL "F"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 27A AND 27B FOR CONTINUATION OF SEWER BASIN SYSTEM

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PBS&J
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Riverside, CA 92503
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FIGURE 27C

ULTIMATE VOLUME DEFICIENCIES - PART 3

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7.2 Project Prioritization Methodology

The 75% full criterion is useful for analyzing deficient pipes and as a basis for sizing new facilities. However, the criterion is not necessarily the trigger point for replacement or augmentation of an existing sewer line. In most cases, a sewer entity would not implement a relief project until capacity problems are actually observed or known to be imminent. Velocity deficiencies are an indication of potential maintenance concerns, but are not ground for replacement.

A recommended system of project prioritization is the categorization of deficient sewer lines based on modeled % full results. The "A" priority projects are immediately needed and the "B" and "C" projects require further consideration for replacement. Priority classifications are described as follows:

Priority "A" – The pipes listed within this priority are currently flowing more than 90% full under maximum flow condition. These pipes are grouped for replacement/re-habilitation in the period (2005-2010); preferably as soon as practically possible.

Priority "B" – The pipes, listed in this priority are projected to be flowing more than 90% full in the future under estimated maximum flow conditions. A linear interpolation was done for anticipation of the mid-term flow in pipes between year 2005 and ultimate year (2020). The pipes that would be flowing more than 90% full in the year 2015 are placed under priority "B". These pipes need evaluation as new development takes place in the tributary areas. Flow monitoring within the study area should be considered for observation of actual flows. The pipes under this priority are grouped for replacement/re-habilitation in the period (2011-2015).

Priority "C" – The pipes listed in this priority would be flowing more than 75% full in the future under maximum flow conditions. The pipes that are not part of priority "A" and "B" and will flow more than 75% full by the year 2020 are considered under priority "C". These pipes need evaluation as new development takes place in the tributary areas. These may or may not be replaced or paralleled depending on actual observed flow conditions in the future. If tributary areas are at or near ultimate development and the metered flows are still below 90% of capacity, the pipes would not likely be replaced. Flow monitoring within the study area should be considered when significant development occurs. The pipes under this priority are grouped for replacement/re-habilitation in the period (2016-2020).

7.3 Recommended Improvements

Table 7-3 lists project priority, project location, problem, solution and approximate cost for problem reaches. This table identifies immediate and future problems in the sewer lines and suggested solutions. The project cost is based on year 2005 indices.

Note that the first order of priority is field observation of all pipes where model results indicate surcharging conditions to verify that the flows are indeed exceeding pipe capacity.

7.4 Grouping of Projects

Proposed improvements under different priorities have been combined or grouped into projects to improve deficient and marginally deficient pipes based on the following criteria:

Pipes identified as marginally deficient in near future (Priority "B"), and marginally deficient in more distant future (Priority "C") located geographically close to one another and requiring improvements in future are grouped to reduce improvement costs.

7.5 Construction Schedule

A summary of the proposed construction prioritization and recommended scheduling is shown in Table 7-2. This table lists construction priorities and the year in which these activities are proposed. Also, the pipes falling under priorities "B" and "C" will need re-evaluation before their replacement.

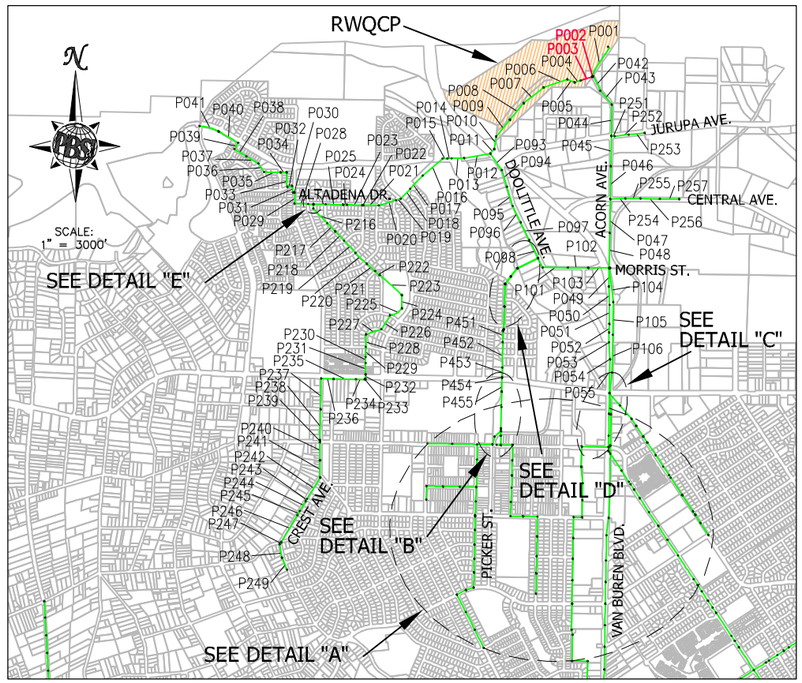
7.6 Cost Estimate

Unit costs of pipes are based on bid prices for similar projects and from the web site www.get-a-quote.net. The cost of construction includes labor, materials, excavation, backfill and all other items associated with pipe laying. To estimate total cost, cost of mobilization / demobilization (7%), traffic control (7%), bond (1%), contractor's profit (15%) and construction contingency (25%) is added to the cost of construction. The cost of engineering, right of way acquisition, permits, soil conditions remediation and by-pass pumping is not included in the construction cost. For priorities "B" and "C", the cost estimate is based on year 2005 prices and no escalation has been added to estimate future cost. Following is the summary of cost for the various priorities:

- Priority “A” - $0.75 Million (2005 $’s) (See Figures 28A, 28B, 28C and Table 7-6-A for details)

- Priority “B” - $3.32 Million (2005 $’s) (See Figures 28A, 28B, 28C and Table 7-6-B for details)

- Priority “C” - $ 10.13 Million (2005 $’s) (See Figures 28A, 28B, 28C and Table 7-6-C for details)



DETAIL "A"
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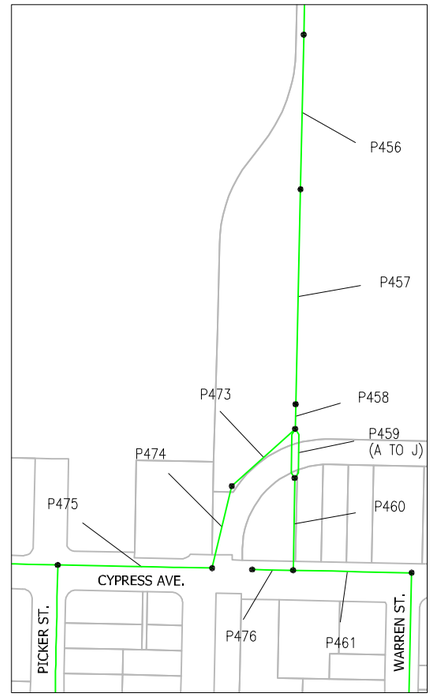
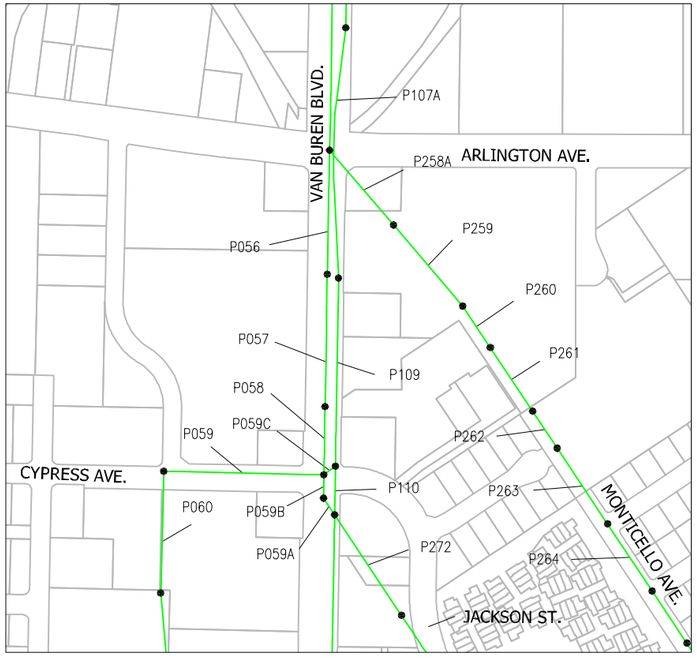


DETAIL "B"
NTS



DETAIL "C"
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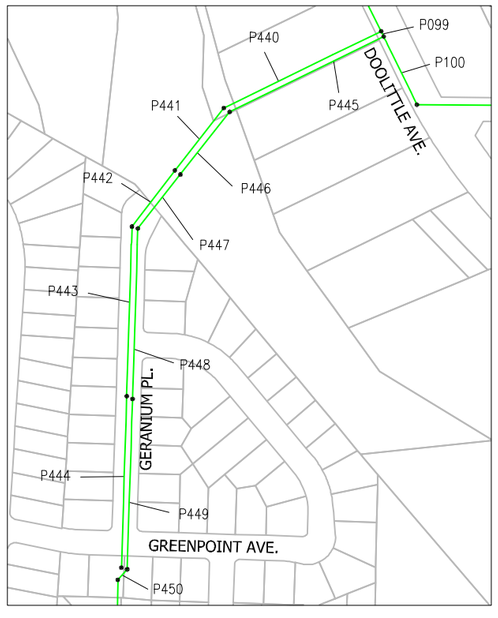

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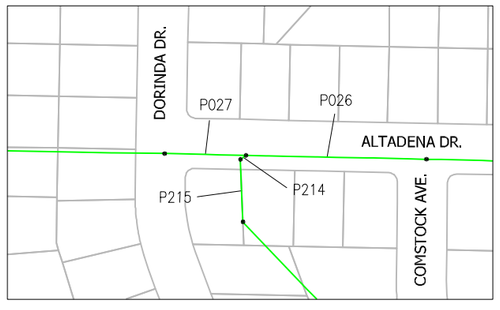

DETAIL "E"
NTS

LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2005 - 2010)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 28B AND 28C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 28A
PRIORITY A - PART 1	

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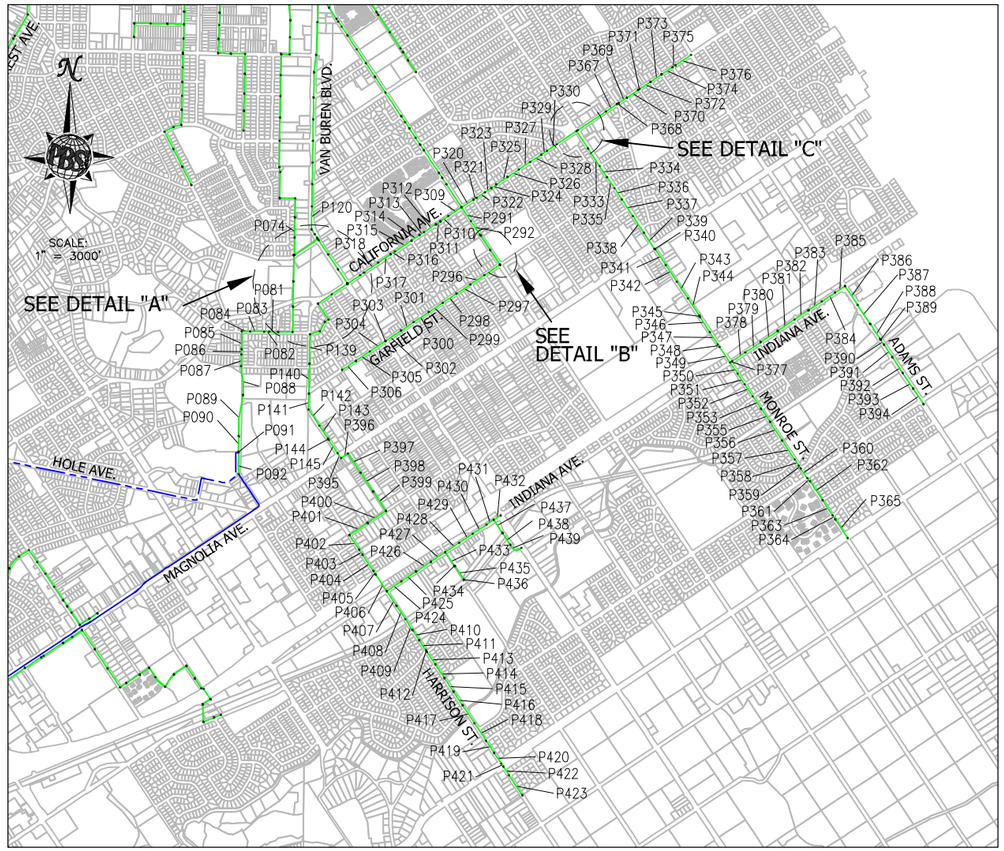

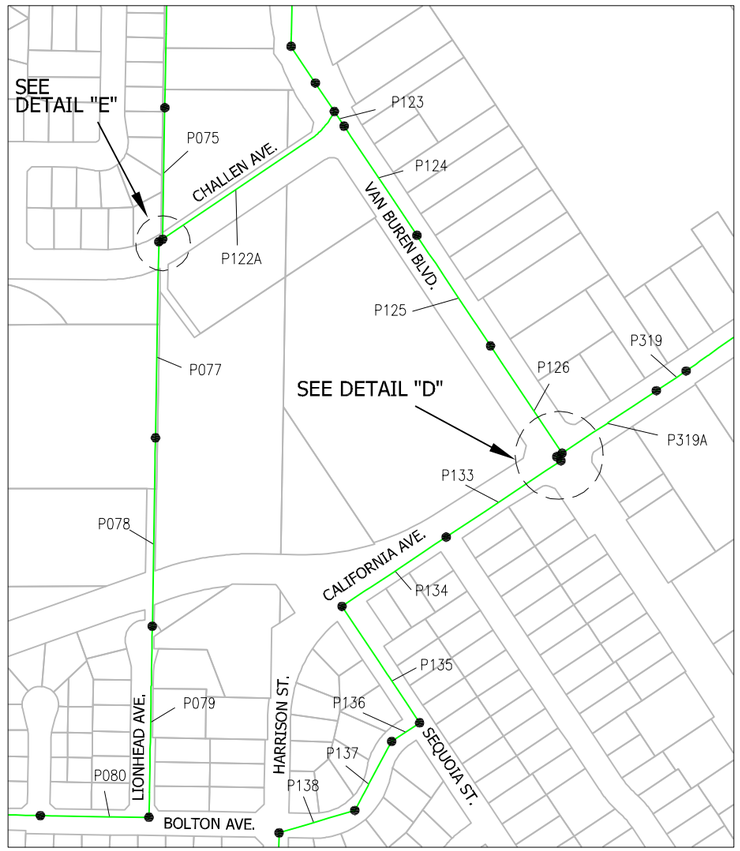

DETAIL "A"
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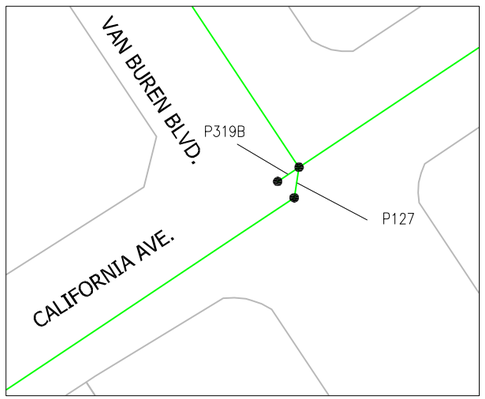
DETAIL "B"
NTS

DETAIL "C"
NTS



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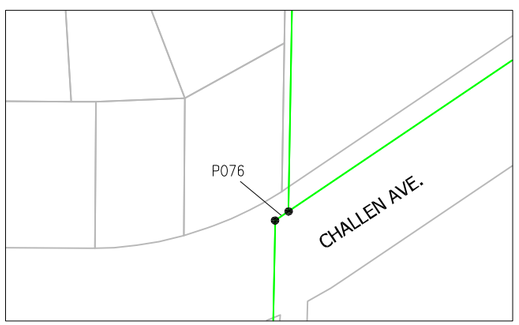

DETAIL "E"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2005 - 2010)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 28A AND 28C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 28B

PRIORITY A - PART 2

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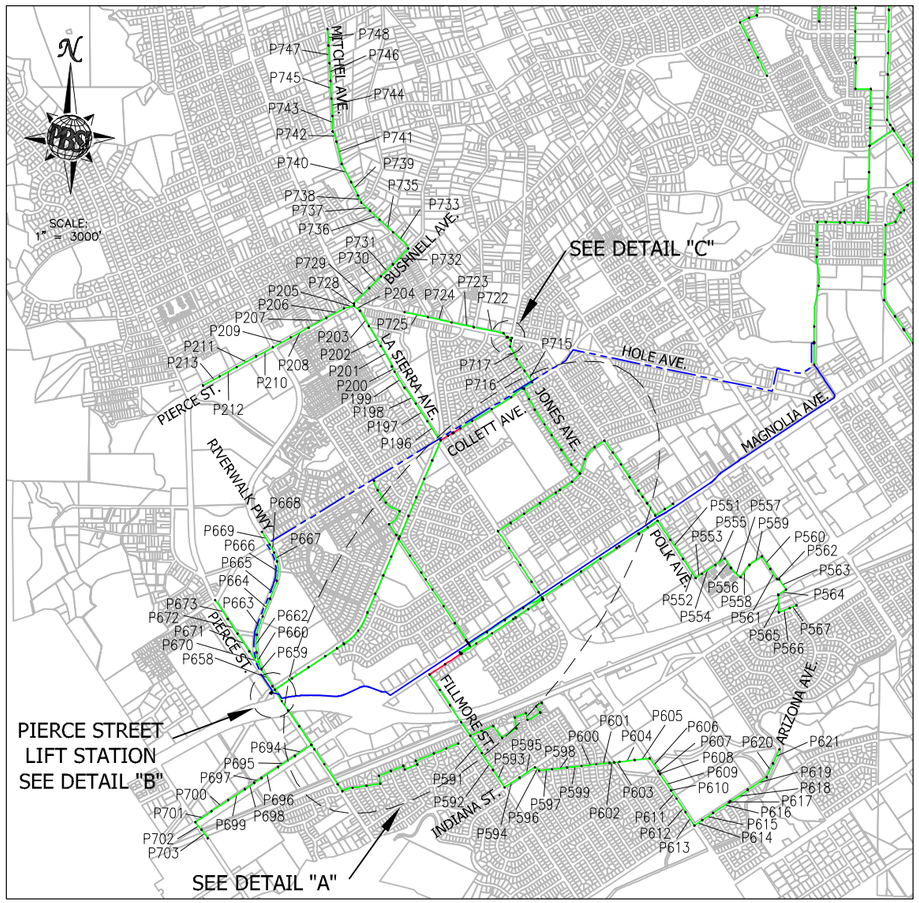

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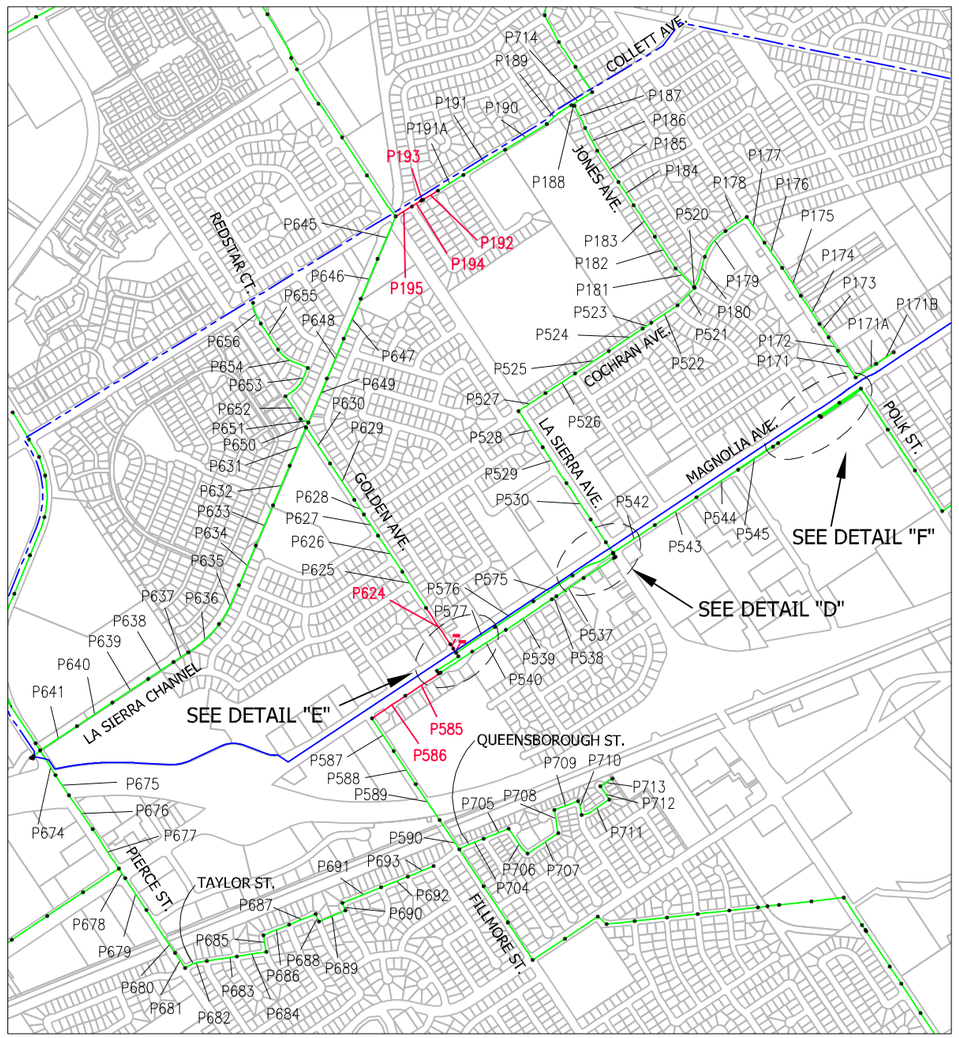

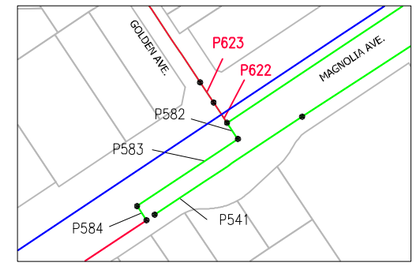

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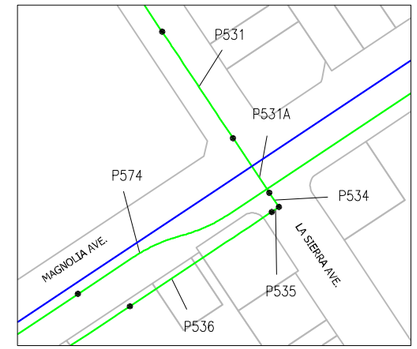

DETAIL "D"
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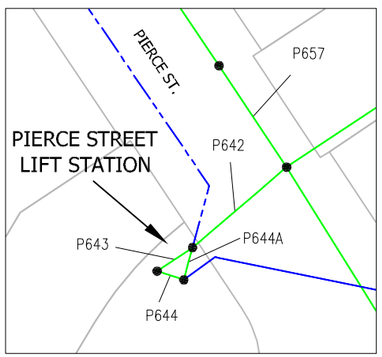
DETAIL "F"
NTS



DETAIL "B"
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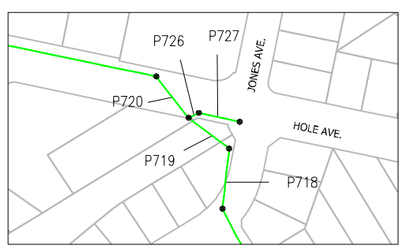

DETAIL "C"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2005 - 2010)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 28A AND 28B FOR CONTINUATION OF SEWER BASIN SYSTEM

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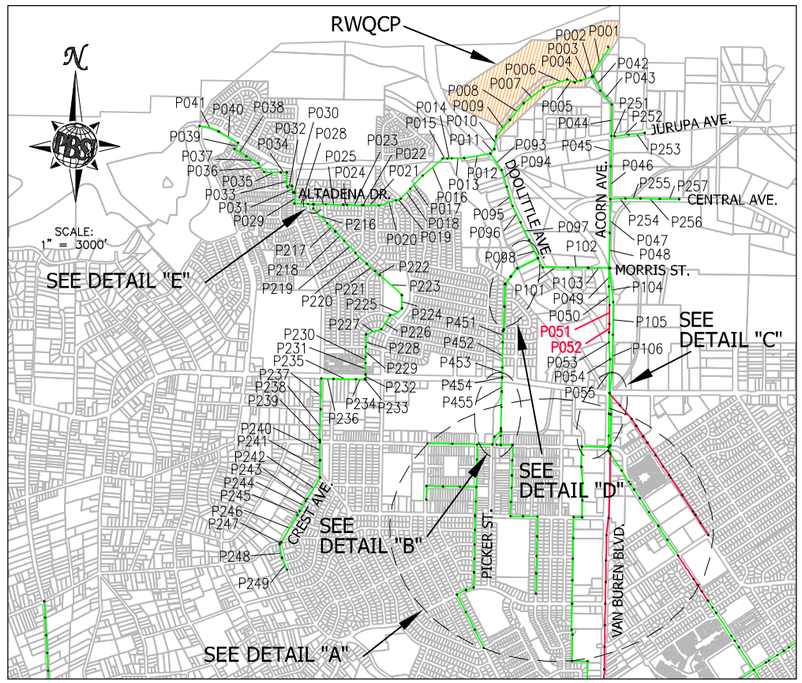
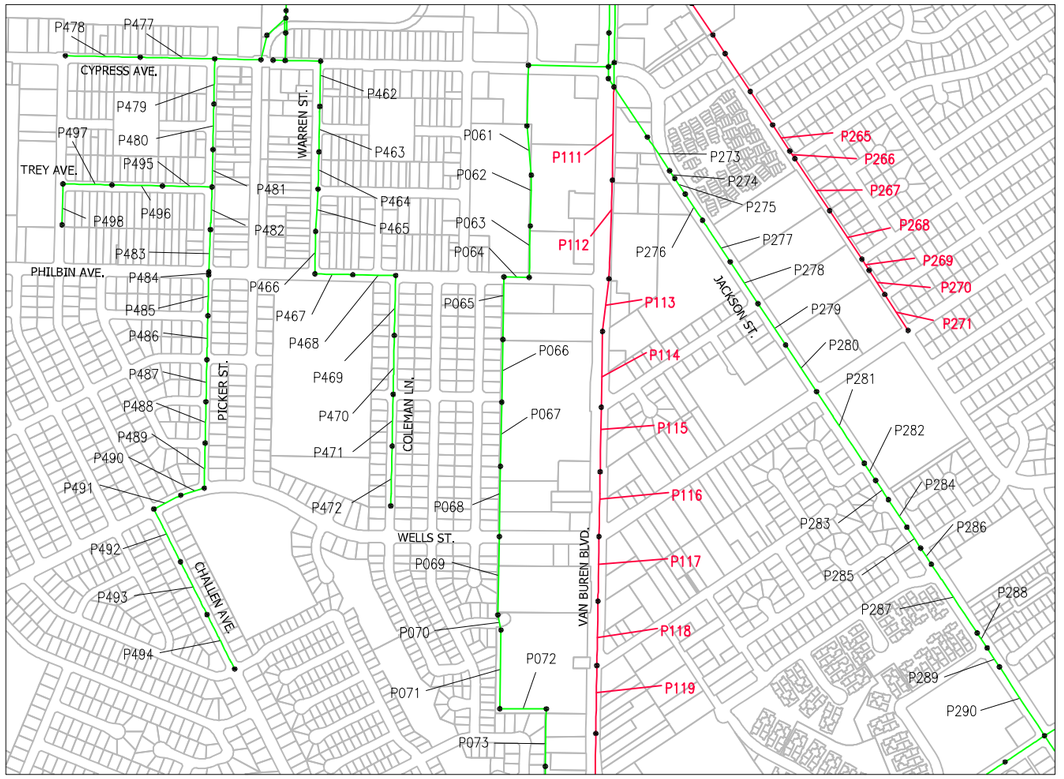
CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 28C

PRIORITY A - PART 3

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-PriorityA-C.dwg, 9/28/2006 10:10:00 AM





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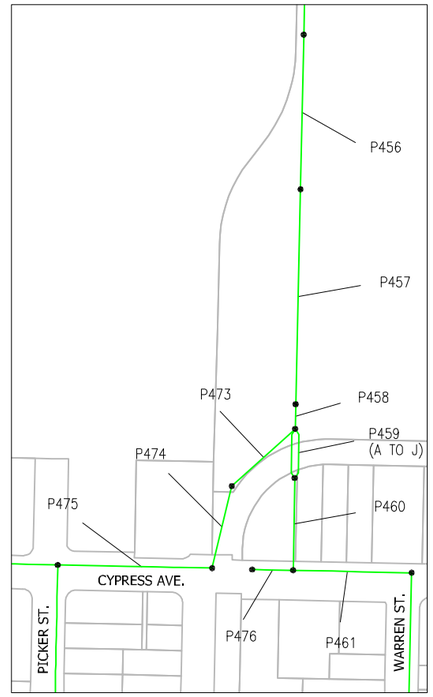

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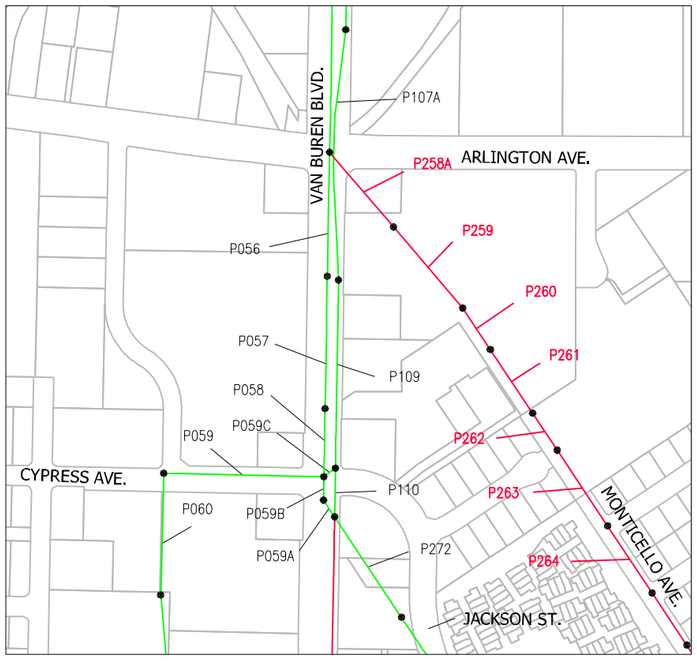

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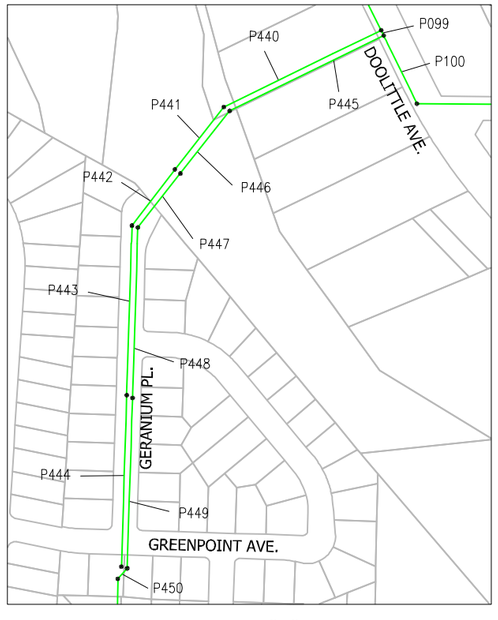

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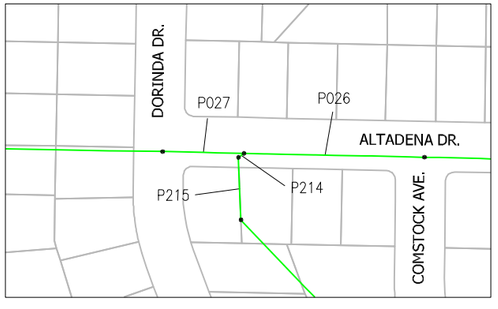

DETAIL "E"
NTS

LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2011 - 2015)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 29B AND 29C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 29A
PRIORITY B - PART 1	

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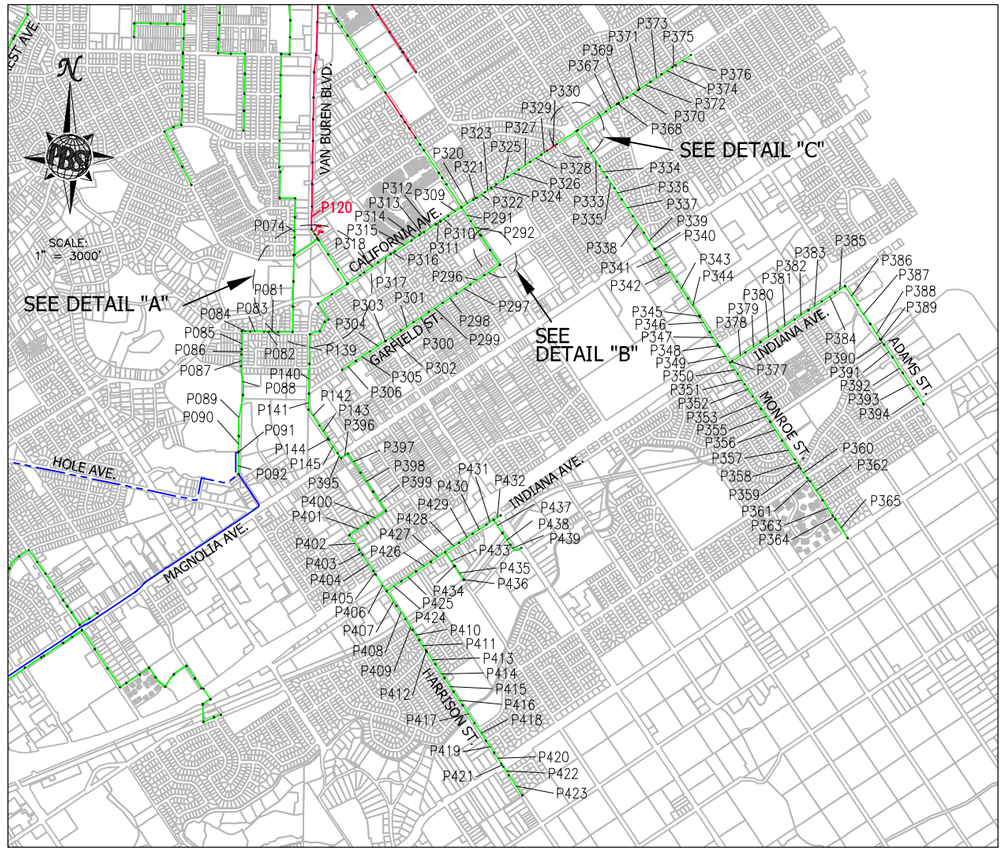

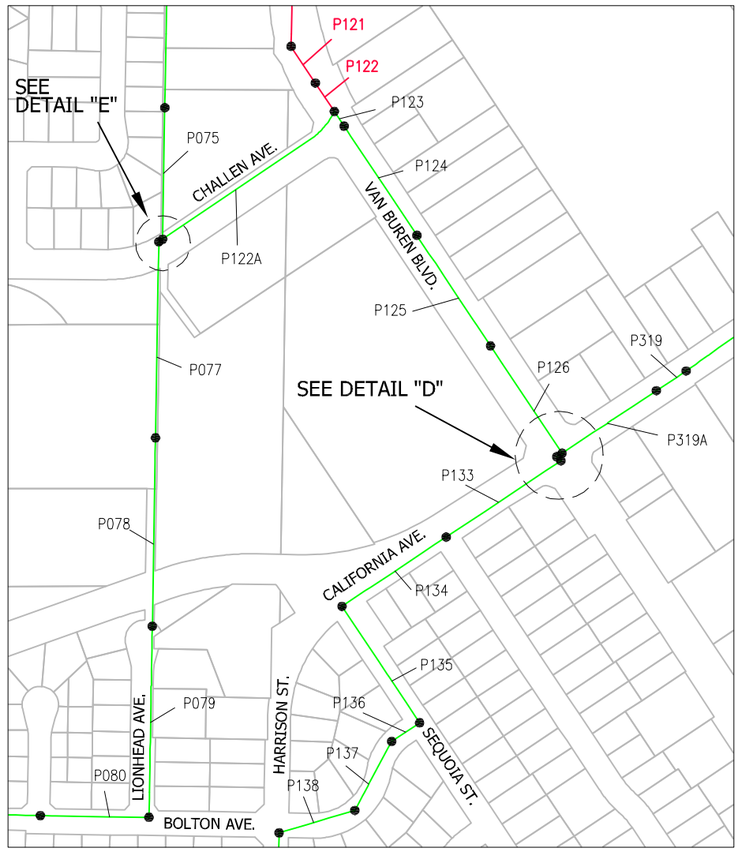

DETAIL "A"
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DETAIL "B"
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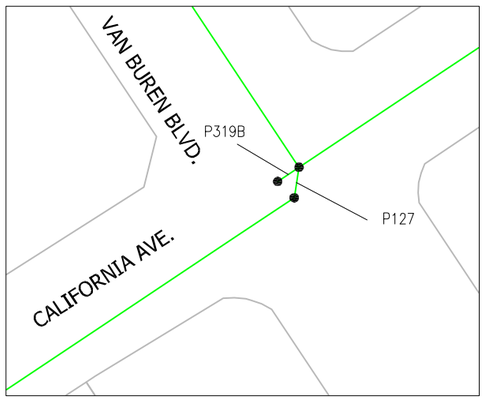

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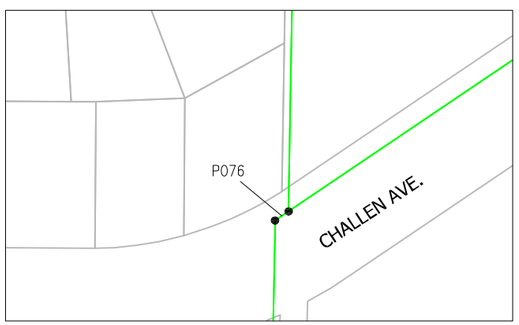

DETAIL "E"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2011 - 2015)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 29A AND 29C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 29B

PRIORITY B - PART 2

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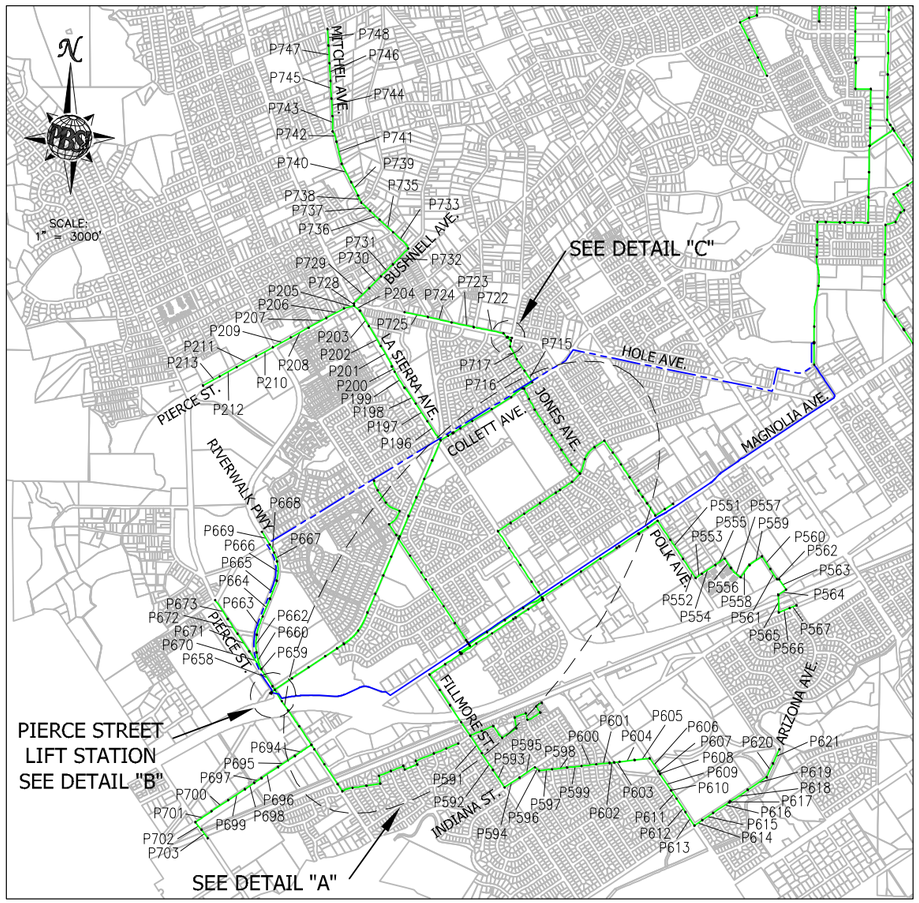

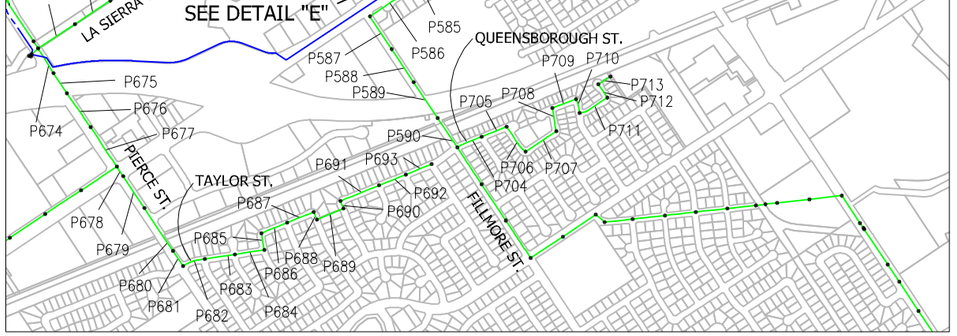

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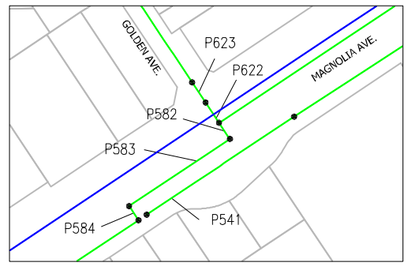

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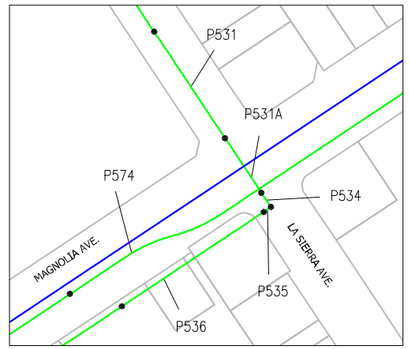

DETAIL "D"
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DETAIL "F"
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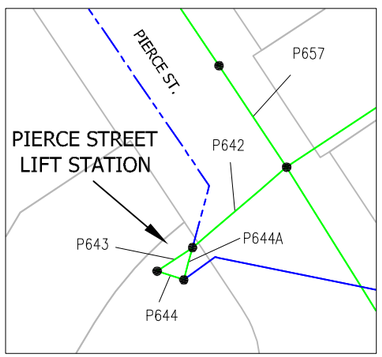

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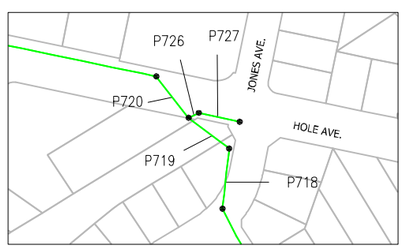

DETAIL "C"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2011 - 2015)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 29A AND 29B FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 29C

PRIORITY B - PART 3

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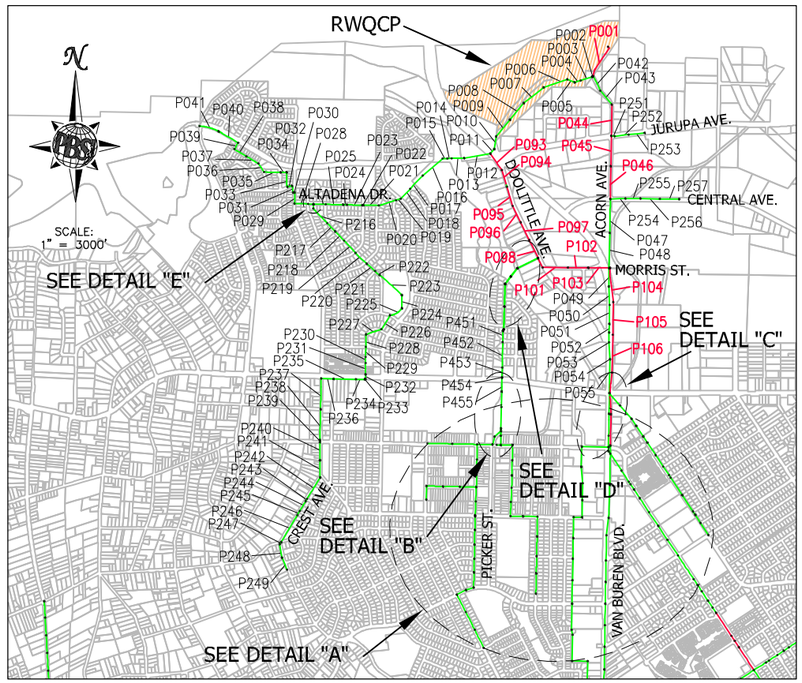

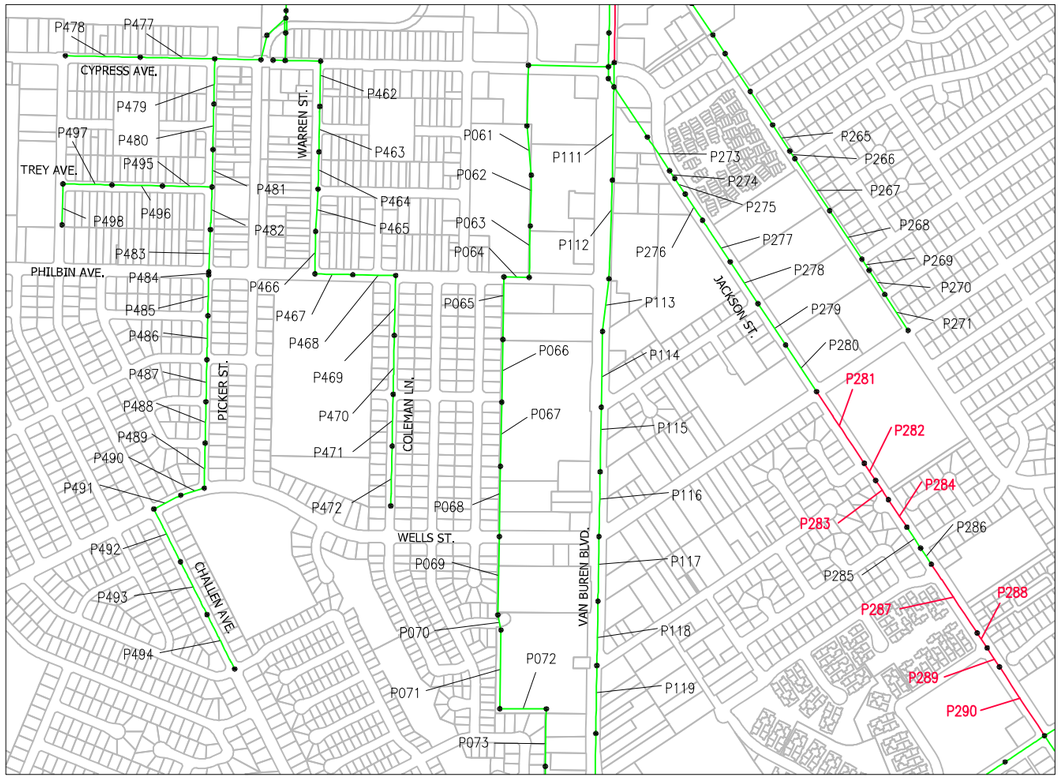

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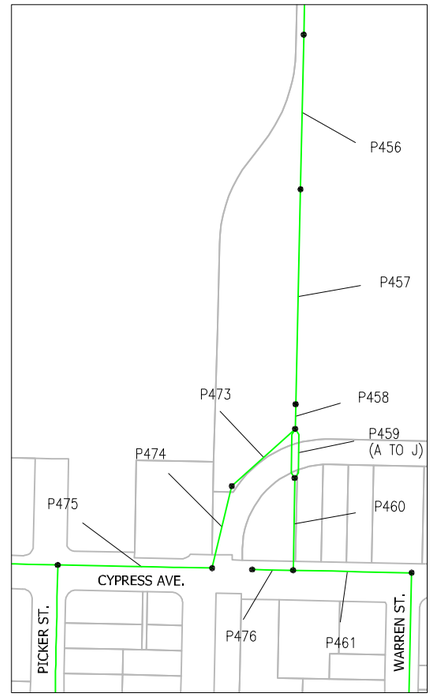

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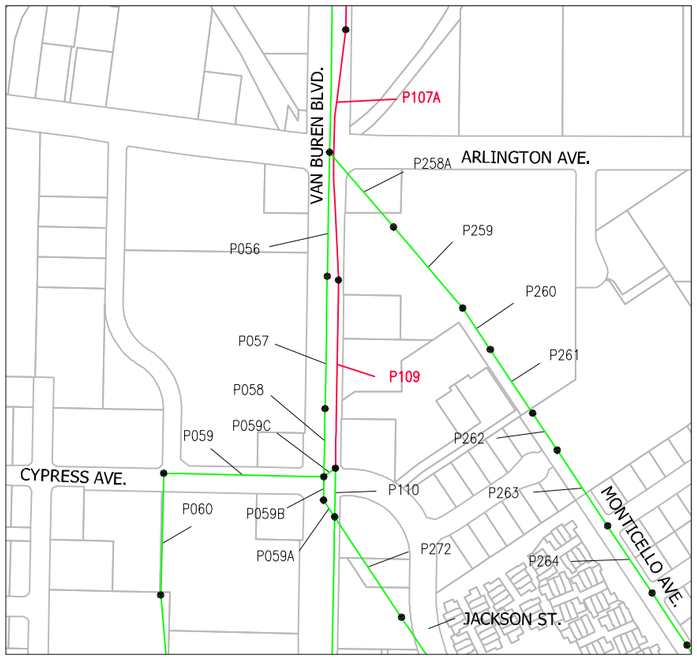

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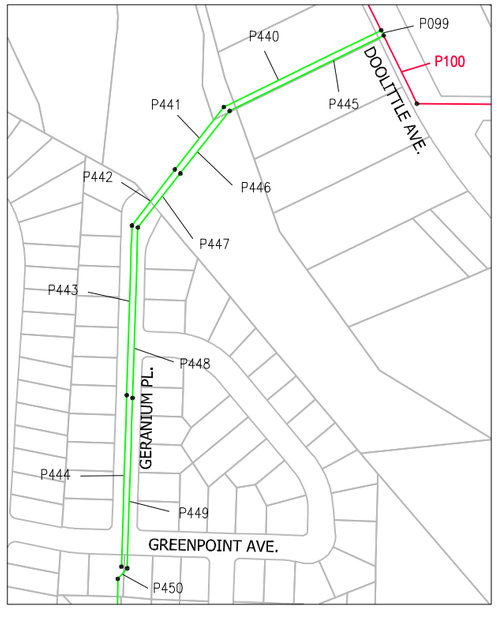

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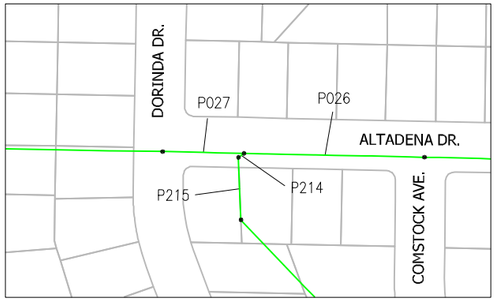

DETAIL "E"
NTS

LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2016 - 2020)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 30B AND 30C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE ARLANZA SEWER STUDY	FIGURE 30A
PRIORITY C - PART 1	

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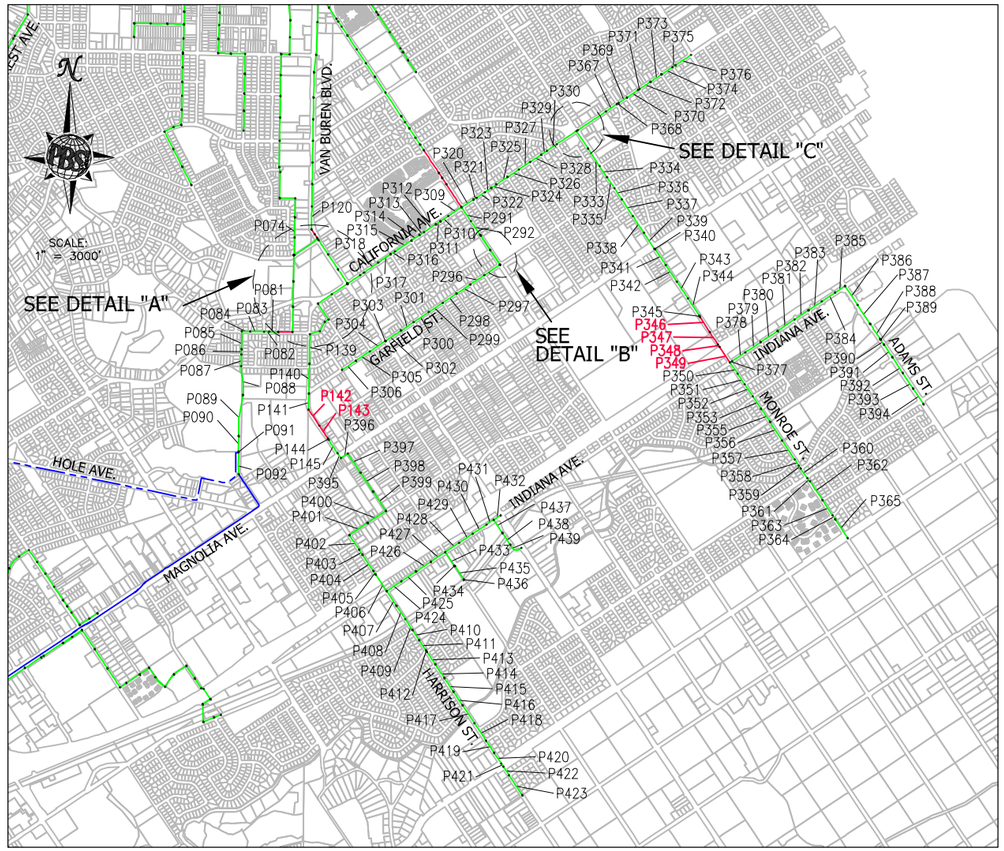
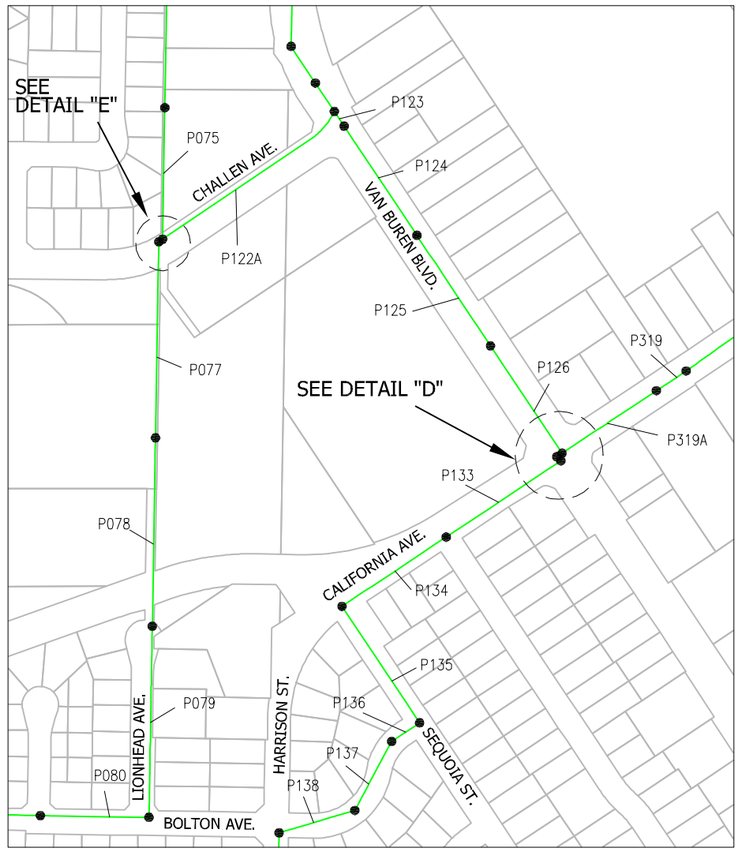
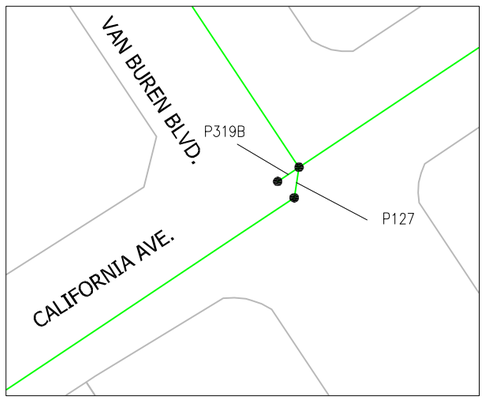




DETAIL "A"
NTS

DETAIL "B"
NTS

DETAIL "C"
NTS



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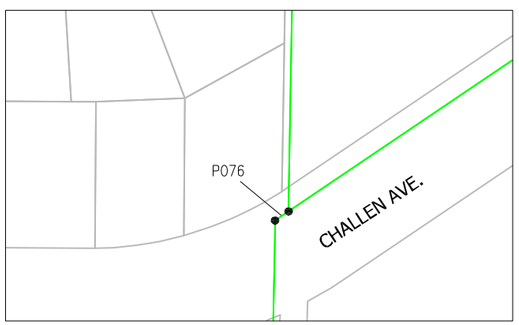

DETAIL "E"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2016 - 2020)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 30A AND 30C FOR CONTINUATION OF SEWER BASIN SYSTEM

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CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 30B

PRIORITY C - PART 2

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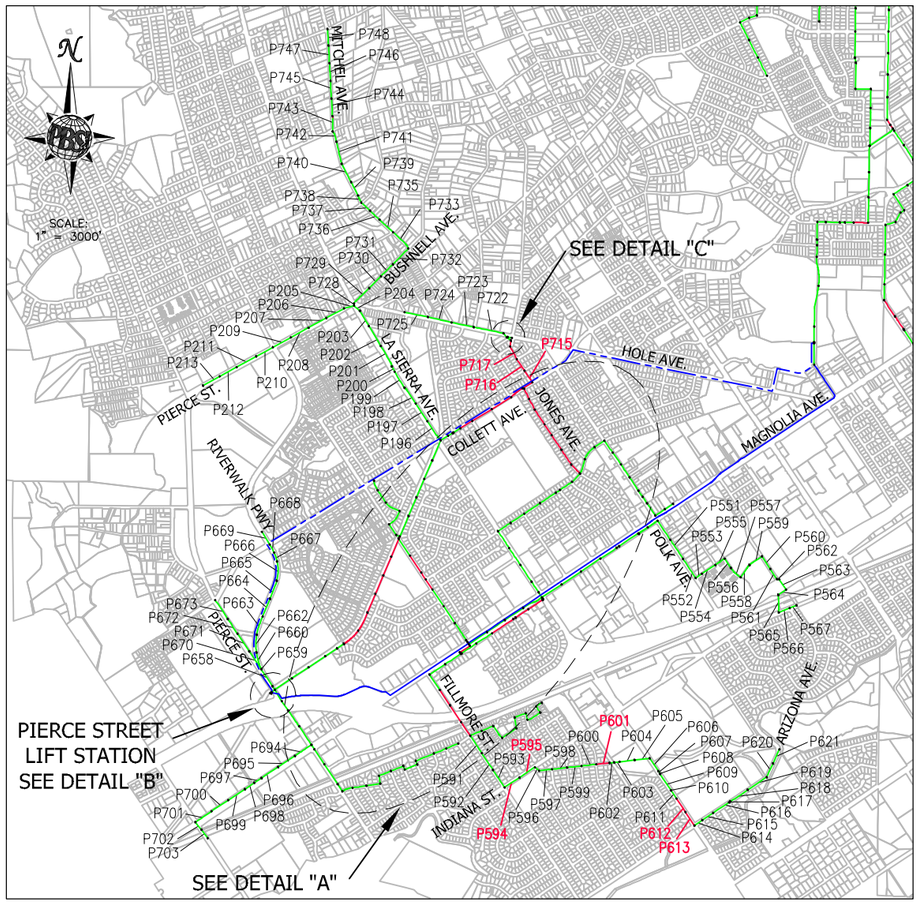

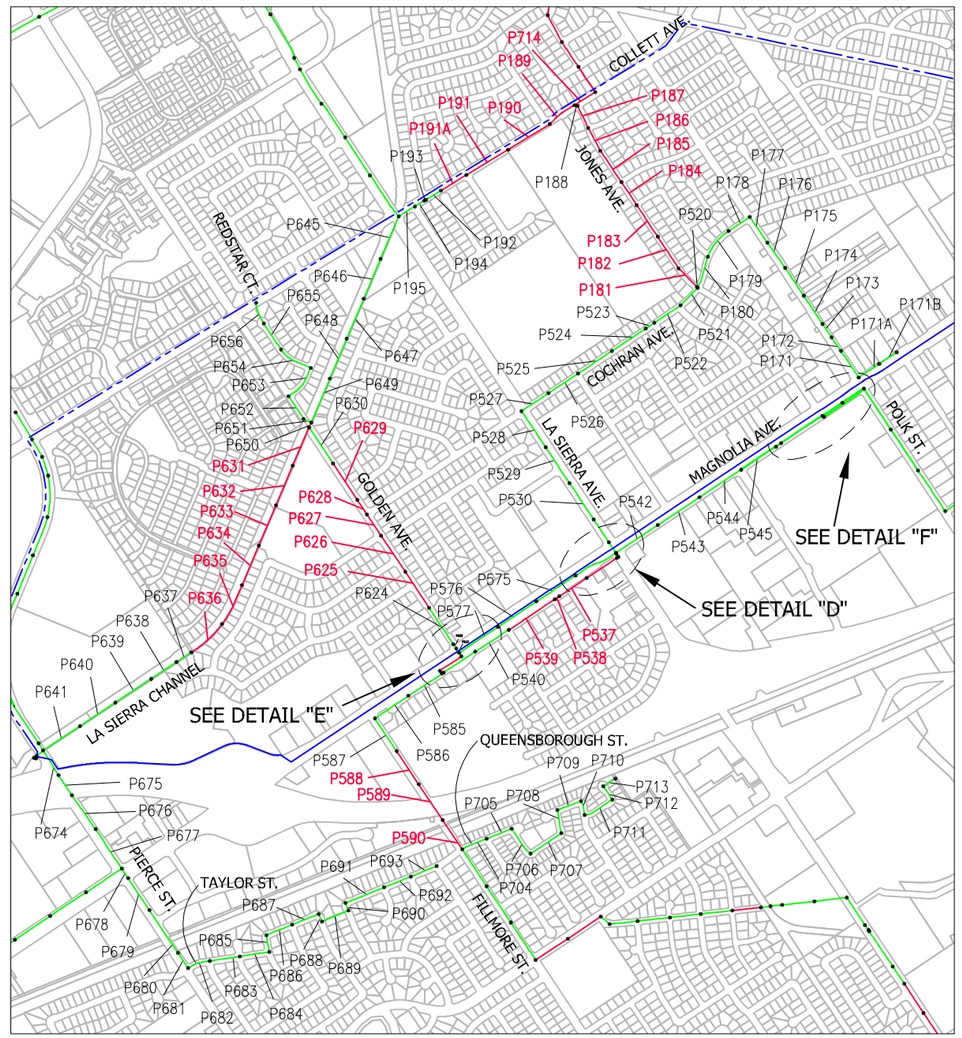

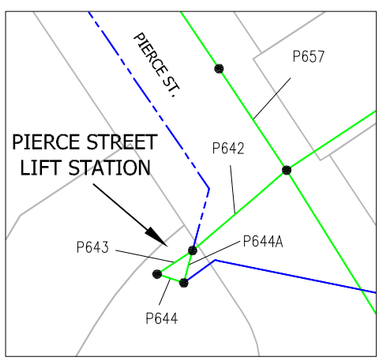

DETAIL "B"
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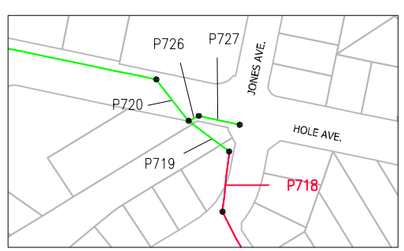
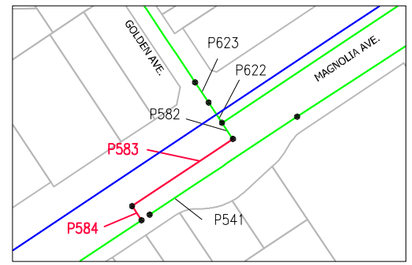
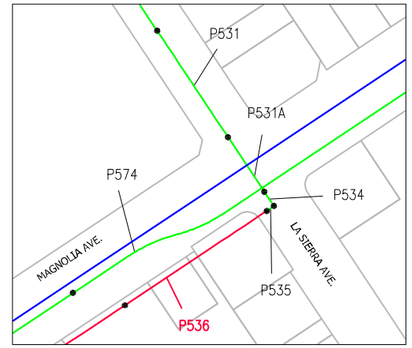


DETAIL "C"
NTS



DETAIL "E"
NTS



DETAIL "D"
NTS

DETAIL "F"
NTS

LEGEND

- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- GRAVITY SEWER
- IMPROVEMENT SEWER (2016 - 2020)
- P001 PIPE SEGMENT NUMBER

SEE FIGURES 30A AND 30B FOR CONTINUATION OF SEWER BASIN SYSTEM

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 12/21/05 | DWN BY: CD

CITY OF RIVERSIDE
ARLANZA SEWER STUDY

FIGURE 30C

PRIORITY C - PART 3

Y:\City of Riverside\Arlanza\DWG\Exhibits\AZ-PriorityC-C.dwg, 9/28/2006 10:28:15 AM

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P001	697	36	61%	73%	78%	C	39	63%	2016-2020
P002	19	30	198%	225%	239%		48	68%	2005-2010
P003	240	30	198%	225%	239%		48	68%	2005-2010
P004	124	51	48%	54%	58%				
P005	159	51	37%	42%	44%				
P006	495	51	48%	54%	58%				
P007	502	51	49%	55%	59%				
P008	428	51	48%	55%	58%				
P009	429	51	48%	54%	57%				
P010	250	51	48%	55%	58%				
P011	121	51	50%	57%	60%				
P012	523	42	9%	10%	11%				
P013	251	27	10%	12%	13%				
P014	84	27	10%	12%	13%				
P015	95	27	10%	12%	12%				
P016	521	27	10%	11%	12%				
P017	357	27	10%	11%	12%				
P018	274	27	11%	12%	13%				
P019	97	27	11%	13%	13%				
P020	359	27	9%	10%	11%				
P021	303	27	9%	11%	11%				
P022	24	27	9%	10%	11%				
P023	301	27	9%	11%	12%				
P024	72	27	10%	12%	12%				
P025	350	27	10%	11%	12%				
P026	238	27	9%	11%	12%				
P027	107	15	10%	20%	26%				
P028	271	15	10%	20%	25%				
P029	220	15	7%	14%	17%				
P030	30	15	4%	8%	10%				
P031	131	15	6%	12%	14%				
P032	97	15	5%	11%	14%				
P033	291	15	7%	14%	17%				
P034	120	15	6%	11%	14%				
P035	332	15	7%	14%	17%				
P036	200	15	7%	14%	17%				
P037	278	15	3%	7%	9%				
P038	277	15	3%	5%	7%				
P039	143	15	3%	7%	8%				
P040	312	15	3%	6%	7%				
P041	394	15	3%	7%	9%				
P042	317	36	7%	10%	11%				
P043	356	27	14%	20%	23%				
P044	624	27	60%	85%	97%	C	33	57%	2016-2020
P045	600	27	56%	77%	87%	C	30	66%	2016-2020
P046	650	27	56%	77%	88%	C	30	66%	2016-2020
P047	666	27	47%	61%	68%				
P048	703	27	48%	61%	68%				
P049	359	27	48%	62%	69%				
P050	366	27	48%	62%	68%				
P051	372	27	80%	103%	115%	B	33	67%	2011-2015
P052	173	27	72%	92%	103%	B	33	60%	2011-2015
P053	194	27	37%	48%	53%				
P054	333	27	37%	48%	53%				
P055	671	27	48%	61%	68%				
P056	409	24	35%	47%	53%				
P057	436	24	35%	47%	53%				
P058	225	24	46%	62%	70%				
P059	529	36	26%	31%	34%				
P059B	78	24	24%	34%	39%				
P059C	43	33	17%	20%	21%				
P060	402	36	29%	34%	37%				
P061	325	36	28%	34%	36%				
P062	336	36	29%	34%	37%				
P063	339	36	29%	34%	37%				
P064	167	36	23%	27%	29%				
P065	412	36	29%	34%	37%				
P066	414	36	29%	34%	37%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P067	424	36	29%	34%	37%				
P068	462	36	29%	34%	37%				
P069	514	36	29%	34%	37%				
P070	102	36	27%	33%	35%				
P071	519	36	18%	22%	24%				
P072	307	36	28%	34%	36%				
P073	378	36	29%	34%	37%				
P074	382	36	28%	33%	36%				
P075	335	36	28%	34%	36%				
P076	12	33	57%	65%	69%				
P077	518	33	49%	56%	60%				
P078	497	33	52%	59%	63%				
P079	504	33	52%	60%	64%				
P080	286	33	52%	59%	63%				
P081	175	33	53%	61%	65%				
P082	101	33	50%	57%	61%				
P083	276	33	48%	56%	59%				
P084	166	33	40%	46%	49%				
P085	351	33	52%	60%	63%				
P086	108	33	51%	59%	63%				
P087	231	33	51%	59%	63%				
P088	113	33	51%	59%	63%				
P089	814	33	51%	59%	63%				
P090	309	33	52%	59%	63%				
P091	20	33	0%	31%	46%				
P092	448	24	51%	29%	18%				
P093	397	42	64%	72%	76%	C	45	63%	2016-2020
P094	345	42	65%	73%	77%	C	45	64%	2016-2020
P095	395	42	65%	73%	77%	C	45	64%	2016-2020
P096	363	42	66%	74%	78%	C	45	65%	2016-2020
P097	388	42	65%	73%	77%	C	45	64%	2016-2020
P098	395	42	64%	72%	76%	C	45	63%	2016-2020
P099	6	42	8%	9%	9%				
P100	204	33	76%	86%	91%	C	39	58%	2016-2020
P101	500	33	77%	87%	92%	C	39	59%	2016-2020
P102	400	33	77%	87%	92%	C	39	59%	2016-2020
P103	433	33	77%	88%	93%	C	39	59%	2016-2020
P104	688	33	77%	87%	92%	C	39	59%	2016-2020
P105	643	33	77%	87%	92%	C	39	59%	2016-2020
P106	748	33	77%	87%	92%	C	39	59%	2016-2020
P107A	727	33	67%	76%	81%	C	36	64%	2016-2020
P109	620	33	67%	76%	80%	C	36	64%	2016-2020
P110	161	33	46%	51%	54%		33	54%	2016-2020
P111	615	27	80%	90%	95%	B	33	56%	2011-2015
P112	651	27	80%	90%	95%	B	33	56%	2011-2015
P113	349	27	80%	90%	95%	B	33	56%	2011-2015
P114	501	27	80%	90%	95%	B	33	56%	2011-2015
P115	425	27	80%	90%	95%	B	33	56%	2011-2015
P116	427	27	80%	90%	95%	B	33	56%	2011-2015
P117	425	27	80%	90%	96%	B	33	56%	2011-2015
P118	424	27	81%	92%	97%	B	33	57%	2011-2015
P119	447	27	81%	92%	97%	B	33	57%	2011-2015
P120	452	27	81%	92%	97%	B	33	57%	2011-2015
P121	116	27	81%	92%	97%	B	33	57%	2011-2015
P122	90	27	81%	92%	97%	B	33	57%	2011-2015
P122A	568	33	27%	29%	31%				
P123	252	27	14%	17%	18%				
P124	347	18	25%	29%	32%				
P125	350	18	25%	29%	31%				
P126	341	18	25%	29%	31%				
P127	7	24	14%	17%	19%				
P133	372	24	17%	20%	22%				
P134	330	24	17%	20%	22%				
P135	379	15	49%	59%	64%				
P136	88	15	43%	52%	56%				
P137	207	15	43%	52%	56%				
P138	208	15	43%	51%	55%				
P139	586	15	51%	61%	66%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P140	590	15	38%	46%	49%				
P141	315	18	56%	67%	73%				
P142	383	18	58%	69%	75%	C	21	50%	2016-2020
P143	307	18	58%	70%	76%	C	21	50%	2016-2020
P144	28	18	54%	65%	70%				
P145	319	18	57%	69%	74%				
P171	295	15	19%	22%	24%				
P171A	229	15	18%	21%	22%				
P171B	193	15	20%	24%	26%				
P172	152	15	19%	22%	23%				
P173	148	15	19%	22%	24%				
P174	315	15	19%	22%	23%				
P175	309	15	18%	22%	23%				
P176	285	15	18%	21%	23%				
P177	288	15	18%	22%	23%				
P178	232	15	18%	22%	23%				
P179	311	15	19%	22%	23%				
P180	300	15	19%	22%	23%				
P181	242	15	65%	76%	82%	C	18	50%	2016-2020
P182	350	15	66%	78%	83%	C	18	51%	2016-2020
P183	350	15	66%	78%	83%	C	18	51%	2016-2020
P184	255	15	66%	77%	83%	C	18	51%	2016-2020
P185	285	15	60%	70%	75%	C	18	46%	2016-2020
P186	238	15	67%	78%	84%	C	18	52%	2016-2020
P187	226	15	65%	76%	82%	C	18	50%	2016-2020
P188	31	15	6%	7%	7%				
P189	283	18	75%	88%	94%	C	21	62%	2016-2020
P190	448	18	75%	88%	94%	C	21	62%	2016-2020
P191	446	18	75%	88%	95%	C	21	63%	2016-2020
P191A	276	18	75%	88%	95%	C	21	63%	2016-2020
P192	160	18	94%	109%	116%		24	54%	2005-2010
P193	21	18	94%	109%	116%		24	54%	2005-2010
P194	103	18	94%	109%	116%		24	54%	2005-2010
P195	173	18	94%	109%	116%		24	54%	2005-2010
P196	462	21	41%	47%	51%				
P197	421	21	33%	38%	40%				
P198	383	21	34%	39%	41%				
P199	374	21	30%	34%	36%				
P200	118	21	30%	34%	36%				
P201	463	21	30%	34%	36%				
P202	458	21	28%	32%	34%				
P203	222	21	22%	25%	27%				
P204	155	21	27%	32%	34%				
P205	207	12	37%	40%	41%				
P206	400	12	19%	20%	21%				
P207	400	15	19%	21%	21%				
P208	400	15	19%	21%	21%				
P209	405	15	19%	21%	21%				
P210	375	15	20%	22%	22%				
P211	441	15	20%	22%	22%				
P212	381	15	20%	22%	23%				
P213	379	15	17%	18%	18%				
P214	9	27	11%	11%	12%				
P215	82	27	12%	12%	12%				
P216	399	27	11%	11%	11%				
P217	230	27	11%	11%	11%				
P218	252	27	11%	11%	11%				
P219	329	27	11%	11%	11%				
P220	315	27	11%	11%	11%				
P221	215	27	14%	15%	15%				
P222	120	27	8%	8%	9%				
P223	591	27	8%	8%	9%				
P224	260	18	24%	25%	25%				
P225	288	18	24%	25%	25%				
P226	321	15	41%	43%	43%				
P227	321	15	55%	57%	58%				
P228	245	15	54%	57%	58%				
P229	199	15	52%	54%	55%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P230	120	15	51%	53%	54%				
P231	223	15	51%	53%	54%				
P232	94	15	24%	25%	26%				
P233	17	15	27%	28%	29%				
P234	175	15	21%	22%	23%				
P235	442	15	21%	22%	23%				
P236	245	18	24%	25%	25%				
P237	605	18	23%	24%	24%				
P238	611	18	22%	23%	23%				
P239	40	18	4%	5%	5%				
P240	361	15	26%	28%	28%				
P240A	339	15	27%	28%	28%				
P240B	499	12	23%	24%	24%				
P240C	55	15	11%	11%	11%				
P244	222	12	23%	24%	24%				
P245	96	12	21%	22%	22%				
P246	621	15	20%	21%	21%				
P247	52	12	36%	38%	39%				
P248	274	12	22%	23%	23%				
P249	251	12	19%	20%	20%				
P251	61	12	2%	4%	4%				
P252	278	12	13%	26%	33%				
P253	322	12	13%	26%	33%				
P254	296	12	23%	43%	53%				
P255	300	12	24%	44%	54%				
P256	382	12	22%	41%	50%				
P257	382	12	24%	44%	54%				
P258A	324	12	80%	91%	96%	B	15	53%	2011-2015
P259	351	12	80%	91%	96%	B	15	53%	2011-2015
P260	164	12	80%	91%	96%	B	15	53%	2011-2015
P261	253	12	80%	91%	96%	B	15	53%	2011-2015
P262	146	12	80%	91%	96%	B	15	53%	2011-2015
P263	300	12	80%	91%	96%	B	15	53%	2011-2015
P264	266	12	80%	91%	96%	B	15	53%	2011-2015
P265	206	12	80%	91%	96%	B	15	53%	2011-2015
P266	60	12	80%	91%	96%	B*	15	53%	2011-2015
P267	412	12	80%	91%	96%	B	15	53%	2011-2015
P268	385	12	80%	91%	97%	B	15	53%	2011-2015
P269	87	12	81%	91%	97%	B	15	53%	2011-2015
P270	190	12	81%	91%	97%	B	15	53%	2011-2015
P271	284	12	81%	92%	97%	B	15	53%	2011-2015
P272	398	24	54%	65%	70%				
P273	266	24	54%	65%	70%				
P274	62	24	54%	65%	70%				
P275	123	24	55%	66%	71%				
P276	207	24	54%	64%	70%				
P277	330	24	41%	49%	53%				
P278	330	24	41%	49%	53%				
P279	329	24	41%	49%	53%				
P280	370	24	41%	49%	53%				
P281	567	24	67%	79%	86%	C	27	63%	2016-2020
P282	135	24	67%	79%	86%	C	27	63%	2016-2020
P283	153	24	67%	79%	86%	C	27	63%	2016-2020
P284	218	24	67%	79%	86%	C	27	63%	2016-2020
P285	166	24	48%	58%	62%				
P286	127	24	50%	60%	65%				
P287	545	24	67%	79%	86%	C	27	63%	2016-2020
P288	118	24	67%	79%	86%	C	27	63%	2016-2020
P289	148	24	67%	79%	86%	C	27	63%	2016-2020
P290	544	24	78%	93%	101%	C*	30	56%	2016-2020
P291	327	15	33%	37%	39%				
P292	325	15	33%	37%	39%				
P293	369	15	10%	11%	11%				
P294	346	15	13%	14%	15%				
P295	371	14	50%	56%	59%				
P296	331	14	49%	55%	58%				
P297	330	14	49%	55%	58%				
P298	330	14	49%	55%	58%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P299	330	14	17%	19%	20%				
P300	361	14	23%	26%	27%				
P301	301	14	23%	26%	27%				
P302	365	14	23%	26%	27%				
P303	7	14	22%	25%	27%				
P304	370	12	35%	39%	41%				
P305	330	12	35%	39%	41%				
P306	330	12	35%	39%	42%				
P307	24	8	23%	26%	28%				
P308	692	20	16%	19%	20%				
P309	313	21	8%	10%	11%				
P310	188	21	9%	11%	12%				
P311	106	21	10%	12%	13%				
P312	282	21	10%	13%	14%				
P313	106	21	11%	13%	14%				
P314	192	18	11%	13%	14%				
P315	393	18	12%	15%	16%				
P316	99	18	11%	14%	15%				
P317	298	18	11%	14%	15%				
P318	343	18	25%	31%	34%				
P319	94	18	9%	12%	13%				
P319A	299	18	1%	3%	3%				
P319B	7	18	12%	13%	14%				
P320	283	21	34%	41%	45%				
P321	70	21	43%	53%	58%				
P322	197	21	44%	54%	59%				
P323	154	21	40%	49%	53%				
P324	119	21	40%	49%	54%				
P325	269	21	39%	48%	52%				
P326	269	21	39%	47%	52%				
P327	269	21	39%	47%	52%				
P328	264	21	39%	48%	52%				
P329	134	21	37%	45%	49%				
P330	234	21	40%	49%	54%				
P331	467	21	40%	49%	54%				
P332	417	15	43%	59%	66%				
P333	414	15	43%	59%	67%				
P334	263	15	43%	59%	67%				
P335	263	15	43%	59%	67%				
P336	263	15	23%	31%	35%				
P337	398	15	23%	31%	36%				
P338	398	15	23%	31%	36%				
P339	376	15	20%	27%	30%				
P340	18	15	20%	27%	30%				
P341	377	15	25%	35%	39%				
P342	396	15	25%	35%	39%				
P343	396	15	25%	34%	39%				
P344	411	15	26%	36%	40%				
P345	24	12	10%	13%	15%				
P346	362	12	64%	87%	98%	C	15	54%	2016-2020
P347	290	12	64%	87%	99%	C	15	55%	2016-2020
P348	61	12	64%	88%	100%	C	15	55%	2016-2020
P349	373	12	64%	88%	101%	C	15	56%	2016-2020
P350	262	12	34%	38%	40%				
P351	255	12	39%	43%	46%				
P352	288	12	38%	43%	45%				
P353	291	12	29%	32%	34%				
P355	321	12	43%	48%	50%				
P356	436	12	9%	10%	11%				
P357	450	12	11%	13%	13%				
P358	145	12	11%	13%	14%				
P359	67	12	11%	12%	13%				
P360	237	12	11%	13%	13%				
P361	79	12	4%	4%	4%				
P362	452	12	11%	13%	13%				
P363	354	12	10%	11%	12%				
P364	96	12	10%	11%	12%				
P365	445	12	10%	11%	12%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P366A	32	15	33%	34%	34%				
P366B	670	15	33%	34%	35%				
P367	260	15	33%	34%	35%				
P368	40	15	54%	56%	57%				
P369	199	15	51%	53%	54%				
P370	265	15	52%	54%	55%				
P371	35	15	51%	53%	54%				
P372	260	15	52%	54%	54%				
P373	264	15	52%	53%	54%				
P374	260	15	51%	53%	54%				
P375	71	15	52%	53%	54%				
P376	371	15	52%	54%	55%				
P377	47	18	8%	14%	16%				
P378	315	18	5%	8%	10%				
P379	365	18	6%	11%	14%				
P380	404	18	8%	14%	17%				
P381	404	18	8%	14%	17%				
P382	330	18	8%	14%	17%				
P383	316	18	7%	12%	14%				
P384	316	18	7%	12%	14%				
P385	232	18	6%	10%	12%				
P386	450	18	6%	11%	13%				
P387	450	18	7%	12%	14%				
P388	361	18	7%	12%	14%				
P389	19	12	21%	36%	44%				
P390	110	18	5%	9%	11%				
P391	300	18	3%	5%	6%				
P392	373	12	9%	16%	20%				
P393	375	12	9%	16%	20%				
P394	373	12	9%	14%	17%				
P395	118	18	47%	57%	62%				
P396	162	18	55%	67%	72%				
P397	454	18	54%	66%	72%				
P398	453	18	54%	66%	72%				
P399	453	18	54%	65%	71%				
P400	433	18	54%	66%	71%				
P401	433	18	54%	66%	71%				
P402	350	18	54%	66%	72%				
P403	116	18	54%	65%	71%				
P404	390	18	54%	66%	72%				
P405	79	18	54%	66%	72%				
P406	397	18	54%	66%	72%				
P407	347	12	2%	5%	7%				
P408	315	12	2%	4%	6%				
P409	257	15	2%	4%	5%				
P410	242	15	2%	5%	6%				
P411	241	15	2%	5%	6%				
P412	32	12	2%	4%	5%				
P413	304	12	2%	5%	6%				
P414	325	12	2%	4%	5%				
P415	325	12	2%	5%	6%				
P416	324	12	2%	5%	6%				
P417	422	12	2%	5%	6%				
P418	410	12	2%	5%	6%				
P419	290	12	2%	5%	6%				
P420	257	12	2%	5%	6%				
P421	76	12	2%	5%	6%				
P422	200	12	2%	4%	5%				
P423	469	12	2%	4%	5%				
P424	252	12	34%	39%	42%				
P425	350	12	40%	46%	49%				
P426	350	12	40%	46%	49%				
P427	342	12	40%	46%	49%				
P428	331	12	24%	27%	29%				
P429	325	12	23%	26%	27%				
P430	325	12	23%	26%	27%				
P431	171	12	27%	30%	32%				
P432	166	12	19%	21%	22%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P433	325	10	18%	22%	24%				
P434	12	12	16%	19%	20%				
P435	315	12	18%	22%	23%				
P436	15	12	4%	5%	5%				
P437	317	12	6%	7%	7%				
P438	270	12	6%	7%	7%				
P439	286	12	6%	7%	7%				
P440	460	24	5%	6%	6%				
P441	208	24	5%	6%	6%				
P442	185	24	5%	5%	6%				
P443	446	24	6%	6%	6%				
P444	452	24	5%	5%	5%				
P445	453	18	47%	50%	51%				
P446	211	18	47%	50%	51%				
P447	183	18	46%	49%	50%				
P448	451	18	47%	50%	51%				
P449	450	18	47%	50%	51%				
P450	34	18	50%	53%	55%				
P451	221	18	46%	49%	50%				
P452	508	18	45%	48%	49%				
P453	188	18	45%	48%	50%				
P454	16	21	28%	29%	30%				
P455	267	21	30%	32%	33%				
P456	306	21	30%	32%	33%				
P457	425	21	30%	32%	33%				
P458	49	21	24%	26%	26%				
P459A	11	12							
P459B	23	12							
P459C	26	12							
P459D	23	12							
P459E	14	12							
P459F	14	12							
P459G	23	12							
P459H	26	12							
P459I	23	12							
P459J	11	12							
P460	183	21	11%	11%	11%				
P461	234	21	7%	7%	7%				
P462	298	21	4%	4%	4%				
P463	300	21	4%	4%	4%				
P464	246	21	4%	4%	4%				
P465	271	12	14%	14%	14%				
P466	280	12	14%	14%	14%				
P467	250	12	14%	14%	14%				
P468	283	12	14%	14%	14%				
P469	394	12	14%	14%	14%				
P470	389	12	14%	14%	15%				
P471	342	12	14%	14%	14%				
P472	395	12	14%	15%	15%				
P473	169	18	13%	14%	14%				
P474	167	18	11%	12%	13%				
P475	305	18	7%	8%	8%				
P476	81	18	5%	5%	5%				
P477	492	12	7%	8%	8%				
P478	494	12	7%	8%	8%				
P479	298	15	11%	12%	12%				
P480	300	15	11%	12%	12%				
P481	247	15	11%	12%	12%				
P482	282	12	10%	11%	11%				
P483	278	12	13%	14%	15%				
P484	20	12	3%	3%	4%				
P485	270	12	10%	10%	11%				
P486	290	12	10%	10%	11%				
P487	278	12	10%	10%	11%				
P488	272	12	9%	10%	11%				
P489	298	12	10%	10%	11%				
P490	161	12	10%	10%	11%				
P491	200	12	10%	10%	11%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P492	390	12	10%	10%	11%				
P493	390	12	10%	10%	11%				
P494	403	12	10%	10%	11%				
P495	327	12	8%	8%	9%				
P496	333	12	8%	9%	9%				
P497	324	12	8%	9%	9%				
P498	227	12	7%	7%	8%				
P520	12	15	40%	47%	50%				
P521	229	15	41%	48%	52%				
P522	288	15	37%	43%	46%				
P523	98	15	36%	42%	45%				
P524	375	15	36%	42%	45%				
P525	375	15	37%	43%	46%				
P526	328	15	36%	42%	45%				
P527	298	15	36%	42%	45%				
P528	400	15	36%	43%	46%				
P529	400	15	36%	43%	46%				
P530	400	15	36%	43%	46%				
P531	253	15	38%	45%	48%				
P531A	130	15	27%	32%	34%				
P534	35	15	15%	17%	19%				
P535	17	12	50%	58%	62%				
P536	337	12	63%	74%	79%	C	15	44%	2016-2020
P537	302	12	62%	73%	78%	C	15	43%	2016-2020
P538	53	12	62%	73%	78%	C	15	43%	2016-2020
P539	508	12	62%	73%	78%	C	15	43%	2016-2020
P540	370	12	54%	63%	68%				
P541	350	12	54%	63%	68%				
P542	464	24	7%	9%	9%				
P543	462	24	28%	32%	34%				
P544	462	24	11%	12%	13%				
P545	385	21	14%	16%	17%				
P546	58	21	11%	12%	12%				
P547	456	21	13%	15%	16%				
P548	8	12	6%	6%	7%				
P548A	222	8	8%	12%	14%				
P548B	236	8	8%	12%	14%				
P549	451	12	31%	34%	36%				
P550	450	12	32%	37%	39%				
P551	455	12	32%	36%	38%				
P552	451	12	25%	28%	30%				
P553	150	12	35%	40%	42%				
P554	317	12	35%	39%	42%				
P555	224	12	28%	32%	34%				
P556	220	12	31%	35%	38%				
P557	272	12	31%	35%	37%				
P558	300	12	26%	30%	31%				
P559	299	12	26%	30%	31%				
P560	300	12	26%	30%	31%				
P561	236	12	26%	30%	31%				
P562	47	12	19%	21%	22%				
P563	245	8	59%	67%	72%				
P564	184	12	28%	32%	34%				
P565	348	12	28%	32%	34%				
P566	232	12	30%	34%	36%				
P567	144	12	26%	30%	32%				
P574	430	24	10%	12%	12%				
P575	434	24	10%	11%	12%				
P576	426	24	10%	12%	13%				
P577	431	24	10%	14%	16%				
P582	39	12	44%	53%	58%				
P583	239	12	61%	74%	81%	C	15	45%	2016-2020
P584	34	12	59%	72%	79%	C	15	43%	2016-2020
P585	370	12	102%	125%	136%		18	46%	2005-2010
P586	372	12	102%	125%	136%		18	46%	2005-2010
P587	364	10	53%	65%	71%				
P588	365	10	75%	92%	100%	C*	12	61%	2016-2020
P589	400	10	65%	79%	87%	C	12	53%	2016-2020

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P590	325	10	65%	79%	87%	C	12	53%	2016-2020
P591	411	10	31%	34%	36%				
P592	399	10	34%	37%	38%				
P593	418	10	33%	36%	37%				
P594	355	10	81%	88%	92%	C	12	56%	2016-2020
P595	367	10	81%	88%	92%	C	12	56%	2016-2020
P596	107	10	23%	25%	26%				
P597	260	8	49%	54%	56%				
P598	300	8	49%	54%	56%				
P599	285	8	55%	60%	62%				
P59A	66	24	21%	30%	35%				
P600	295	8	63%	69%	73%				
P601	265	8	65%	72%	75%	C	10	42%	2016-2020
P602	84	8	58%	64%	67%				
P603	109	8	58%	64%	67%				
P604	300	8	59%	65%	68%				
P605	300	8	59%	65%	67%				
P606	305	8	64%	70%	73%				
P607	54	8	63%	69%	72%				
P608	15	8	64%	71%	74%				
P609	382	8	64%	70%	73%				
P610	7	8	62%	68%	71%				
P611	194	8	64%	70%	73%				
P612	321	8	69%	76%	79%	C	10	45%	2016-2020
P613	321	8	72%	78%	82%	C	10	46%	2016-2020
P614	188	15	10%	11%	12%				
P615	257	15	11%	12%	12%				
P616	380	15	12%	13%	14%				
P617	30	15	5%	6%	6%				
P618	415	15	11%	12%	12%				
P619	451	15	6%	6%	7%				
P620	301	15	7%	8%	8%				
P621	304	15	11%	12%	12%				
P622	49	12	90%	103%	110%		15	60%	2005-2010
P623	48	12	90%	103%	110%		15	60%	2005-2010
P624	405	12	90%	103%	110%		15	60%	2005-2010
P625	400	12	81%	93%	99%	C*	15	55%	2016-2020
P626	400	12	73%	84%	90%	C	15	49%	2016-2020
P627	237	12	67%	77%	82%	C	15	45%	2016-2020
P628	163	12	71%	82%	87%	C	15	48%	2016-2020
P629	401	12	68%	77%	82%	C	15	45%	2016-2020
P630	400	12	61%	69%	74%				
P631	384	27	66%	78%	84%	C	30	63%	2016-2020
P632	400	27	67%	78%	84%	C	30	63%	2016-2020
P633	401	27	67%	78%	84%	C	30	64%	2016-2020
P634	400	27	67%	79%	85%	C	30	64%	2016-2020
P635	403	27	67%	79%	84%	C	30	64%	2016-2020
P636	388	27	67%	79%	84%	C	30	64%	2016-2020
P637	163	27	47%	55%	59%				
P638	280	27	47%	55%	59%				
P639	397	27	47%	56%	60%				
P640	395	27	47%	56%	60%				
P641	406	27	46%	56%	60%				
P642	82	30	50%	60%	65%				
P643	28	30	22%	27%	30%				
P644	18	30	40%	49%	54%				
P644A	22	30	24%	27%	29%				
P645	429	27	36%	41%	44%				
P646	400	27	52%	60%	64%				
P647	399	27	52%	60%	64%				
P648	401	27	52%	60%	64%				
P649	439	27	52%	60%	64%				
P650	51	27	52%	61%	65%				
P651	72	15	11%	14%	16%				
P652	252	12	19%	22%	24%				
P653	343	12	7%	11%	13%				
P654	327	12	7%	11%	13%				
P655	291	12	7%	11%	13%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P656	205	12	7%	11%	13%				
P657	80	15	65%	67%	68%				
P658	403	12	38%	39%	40%				
P659	8	12	41%	43%	43%				
P660	342	12	37%	39%	39%				
P662	351	12	34%	35%	36%				
P663	382	12	39%	41%	41%				
P664	381	12	47%	48%	49%				
P665	379	12	46%	48%	48%				
P666	386	12	47%	48%	49%				
P667	183	12	47%	48%	49%				
P668	185	12	46%	48%	48%				
P669	294	12	47%	48%	49%				
P670	425	12	20%	21%	21%				
P671	425	12	21%	21%	22%				
P672	349	12	14%	14%	15%				
P673	447	15	17%	17%	18%				
P674	267	21	42%	35%	32%				
P675	223	21	41%	35%	32%				
P676	382	21	38%	34%	32%				
P677	438	21	35%	33%	32%				
P678	104	15	2%	2%	2%				
P679	353	15	6%	6%	7%				
P680	475	15	6%	6%	7%				
P681	168	15	2%	2%	2%				
P682	215	15	2%	3%	3%				
P683	280	15	3%	3%	4%				
P684	275	15	3%	4%	4%				
P685	158	15	2%	2%	2%				
P686	255	15	3%	3%	4%				
P687	266	15	3%	3%	4%				
P688	76	15	3%	4%	4%				
P689	266	15	3%	4%	4%				
P690	75	15	3%	4%	4%				
P691	387	15	3%	3%	3%				
P692	264	15	3%	3%	4%				
P693	258	15	4%	5%	5%				
P694	395	15	68%	64%	63%				
P695	398	15	62%	62%	63%				
P696	395	15	57%	61%	63%				
P697	171	15	57%	62%	65%				
P698	224	15	53%	58%	61%				
P699	397	15	49%	54%	56%				
P700	396	15	55%	60%	63%				
P701	384	15	57%	62%	65%				
P702	205	8	50%	55%	57%				
P703	212	12	10%	10%	10%				
P704	247	12	18%	27%	31%				
P705	248	12	18%	27%	31%				
P706	291	12	18%	27%	31%				
P707	341	12	17%	26%	31%				
P708	217	12	18%	27%	31%				
P709	234	12	18%	27%	31%				
P710	134	12	18%	27%	32%				
P711	296	12	18%	27%	31%				
P712	147	12	18%	27%	32%				
P713	121	12	18%	27%	31%				
P714	227	15	61%	71%	76%	C	18	47%	2016-2020
P715	280	15	62%	73%	78%	C	18	48%	2016-2020
P716	276	15	60%	71%	76%	C	18	47%	2016-2020
P717	280	15	62%	72%	78%	C	18	48%	2016-2020
P718	120	15	63%	74%	79%	C	18	49%	2016-2020
P719	101	12	42%	50%	53%				
P720	104	18	19%	22%	23%				
P722	603	18	18%	21%	22%				
P723	448	18	37%	44%	47%				
P724	481	15	20%	24%	26%				
P725	471	15	10%	12%	13%				

Table 7-2
Proposed Construction Prioritization and Schedule

Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P726	22	8	40%	47%	51%				
P727	76	15	23%	26%	28%				
P728	43	15	20%	25%	28%				
P729	428	15	25%	32%	35%				
P730	330	18	27%	34%	38%				
P731	335	18	27%	34%	37%				
P732	438	18	27%	34%	38%				
P733	441	15	23%	30%	33%				
P735	367	12	25%	32%	35%				
P736	251	12	25%	31%	35%				
P737	235	12	42%	54%	59%				
P738	155	15	24%	30%	33%				
P739	297	15	23%	29%	33%				
P740	408	15	23%	29%	33%				
P741	451	15	23%	30%	33%				
P742	220	12	17%	22%	24%				
P743	300	12	26%	34%	38%				
P744	350	12	26%	34%	38%				
P745	350	12	26%	34%	38%				
P746	350	12	26%	34%	38%				
P747	350	12	26%	34%	38%				
P748	327	12	26%	34%	38%				

* Placed under different category due to geographical location.

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "A"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"A" (See Figures 28A, 28B, 28C and Table 7-2 for details of pipes)	Collett Avenue	Pipes P192 to P195	Immediate Capacity Problem in reach M192 to M195 due to flat slopes. Surcharging conditions.	Field verify surcharging conditions Replace pipe with larger size pipe maintaining the same slope	$207,000
	Fillmore Street	Pipes P585 to P586	Immediate Capacity Problem in reach M585 to M587 due to flat slopes. Surcharging conditions.	Field verify surcharging conditions Replace pipe with larger size pipe maintaining the same slope	$220,000
	Golden Avenue	Pipes P622 to P624	Immediate Capacity Problem in reach M623 to M625 due to flat slopes. Surcharging conditions.	Field verify surcharging conditions Replace pipe with larger size pipe maintaining the same slope	$143,000
	RWQCP Sewer	Pipes P002 to P003	Immediate Capacity Problem in reach M002 to M004 due to flat slope. Surcharging conditions.	Field verify surcharging conditions Replace pipe with larger size pipe maintaining the same slope	$178,000
				Total Construction Cost for Priority "A" Projects (2005-2010 Replacement / Rehabilitation)	**$748,000**

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "B"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"B" (See Figures 29A, 29B, 29C and Table 7-2 for details of pipes)	Monticello Avenue	Pipes P258A and P259 to P271	Future Capacity Problem in reaches M258 to M056 and M258 to M271 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining same slopes.	$866,000
	Van Buren Boulevard	Pipes P051 to P052 and P111 to P122	Future Capacity Problem in reaches M051 to M053 and M111 to M122 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining same slopes.	$2,458,000
				Total Construction Cost for Priority "B" Projects (2011-2015 Replacement / Rehabilitation)	**$3,324,000**

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "C"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"C" (See Figures 30A, 30B, 30C and Table 7-2 for details of pipes)	Acorn Street	Pipes 044 to P046	Future Capacity Problem in reach M044 to M047 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$782,000
	Arizona Avenue	Pipes P594 to P595, P601, P612 to P613	Future Capacity Problem in reach M594 to M596, M601 to M602 and M612 to M614 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$373,000
	Collett Avenue	Pipes P189 to P191A	Future Capacity Problem in reach M188 to M192 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$486,000
	Fillmore Street	Pipes P583 to P584, P588 to P590	Future Capacity Problem in reaches M583 to M585 and M588 to M591 due to smaller pipe sizes, flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$337,000
	Golden Avenue	Pipes P625 to P629	Future Capacity Problem in reach M625 to M630 due to smaller pipe sizes, flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$396,000
	Harrison Street	Pipes P142 to P143	Future Capacity Problem in reach M138 to M140 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$236,000
	Hole Avenue	Pipes P714 to P718	Future Capacity Problem in reaches M188 to M713 and M713 to M717 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$365,000
	Jackson Street	Pipes P281 to P284, P287 to P290	Future Capacity Problem in the reach M280 to M284, M286 to M290 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$967,000

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "C"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
	Jones Avenue	Pipes P181 to P187	Future Capacity Problem in the reach M180 to M187 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$581,000
	La Sierra Channel	Pipes P631 to P636	Future Capacity Problem in reach M631 to M637 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$976,000
	Magnolia Avenue (2)	Pipes P536 to P539	Future Capacity Problem in reach M539 to M543 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$301,000
	Monroe Street	Pipes P346 and P349	Future Capacity Problem in reach M345 to M349 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$277,000
	RWQCP Sewer	Pipe P001	Future Capacity Problem in reach M001 to M002 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$348,000
	Van Buren Boulevard	Pipes P093 to P098, P100 to P106 and P107A, P109	Future Capacity Problem in reaches M012 to M094, M094 to M099, M100 to M107, M107 to M110 due to flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 75% criteria. Replace pipes with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$3,708,000
				Total Construction Cost for Priority "C" Projects (2016-2020 Replacement / Rehabilitation)	**$10,133,000**

Table 7-6-A
Preliminary Construction Cost Estimate For Priority "A" Projects
(2005- 2010 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Collett Avenue	Replace Pipes P192 to P195	18	24	LF	457	$200	$91,400
	Rehab / Replace Manhole			EA	5	$5,500	$27,500
	Reconnect Sewer Laterals			EA	5	$1,650	$8,250
						Total:	$127,150
Mobilization / Demobilization (7%)							$8,901
Traffic Control (7%)							$8,901
Bond (1%)							$1,272
Contractor's Profit(15%)							$19,073
Subtotal:							$165,295
Construction Contingency(25%)							$41,324
Total Construction Cost (Collett Avenue Sewer)							**$207,000**
Fillmore Street	Replace Pipes P585 and P586	12	18	LF	742	$145	$107,590
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	7	$1,650	$11,550
						Total:	$135,640
Mobilization / Demobilization (7%)							$9,495
Traffic Control (7%)							$9,495
Bond (1%)							$1,356
Contractor's Profit(15%)							$20,346
Subtotal:							$176,332
Construction Contingency(25%)							$44,083
Total Construction Cost (Fillmore Street Sewer)							**$220,000**
Golden Avenue	Replace Pipes P622 to P624	12	15	LF	502	$115	$57,730
	Rehab / Replace Manhole			EA	4	$5,500	$22,000
	Reconnect Sewer Laterals			EA	5	$1,650	$8,250
						Total:	$87,980
Mobilization / Demobilization (7%)							$6,159
Traffic Control (7%)							$6,159
Bond (1%)							$880
Contractor's Profit(15%)							$13,197

Table 7-6-A
Preliminary Construction Cost Estimate For Priority "A" Projects
(2005- 2010 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Subtotal:							$114,374
Construction Contingency(25%)							$28,594
Total Construction Cost (Golden Avenue Sewer)							**$143,000**
RWQCP	Replace Pipe P002 and P003	30	48	LF	259	$340	$88,060
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	3	$1,650	$4,950
						Total:	$109,510
Mobilization / Demobilization (7%)							$7,666
Traffic Control (7%)							$7,666
Bond (1%)							$1,095
Contractor's Profit(15%)							$16,427
Subtotal:							$142,363
Construction Contingency(25%)							$35,591
Total Construction Cost (RWQCP Sewer)							**$178,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "A" PROJECTS							**$748,000**

Table 7-6-B
Preliminary Cost Estimate For Priority "B" Projects
(2011- 2015 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Monticello Avenue							
	Replace Pipe P258A, P259-P271	12	15	LF	3428	$115	$394,220
	Rehab / Replace Manhole			EA	15	$5,500	$82,500
	Reconnect Sewer Laterals			EA	34	$1,650	$56,100
						Total:	$532,820
Mobilization / Demobilization (7%)							$37,297
Traffic Control (7%)							$37,297
Bond (1%)							$5,328
Contractor's Profit(15%)							$79,923
Subtotal:							$692,666
Construction Contingency(25%)							$173,167
Total Construction Cost (Monticello Avenue Sewer)							**$866,000**
Van Buren Boulevard							
	Replace Pipe P051, P052	27	33	LF	545	$245	$133,525
	Replace Pipe P111-P122	27	33	LF	4922	$245	$1,205,890
	Rehab / Replace Manhole			EA	15	$5,500	$82,500
	Reconnect Sewer Laterals			EA	55	$1,650	$90,750
						Total:	$1,512,665
Mobilization / Demobilization (7%)							$105,887
Traffic Control (7%)							$105,887
Bond (1%)							$15,127
Contractor's Profit(15%)							$226,900
Subtotal:							$1,966,465
Construction Contingency(25%)							$491,616
Total Construction Cost (Van Buren Boulevard Sewer)							**$2,458,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "B" PROJECTS							**$3,324,000**

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Acorn Street	Replace Pipe P044	27	33	LF	624	$245	$152,880
	Replace Pipe P045, P046	27	30	LF	1,250	$220	$275,000
	Rehab / Replace Manhole			EA	4	$5,500	$22,000
	Reconnect Sewer Laterals			EA	19	$1,650	$31,350
						Total:	$481,230
Mobilization / Demobilization (7%)							$33,686
Traffic Control (7%)							$33,686
Bond (1%)							$4,812
Contractor's Profit(15%)							$72,185
Subtotal:							$625,599
Construction Contingency(25%)							$156,400
Total Construction Cost (Acorn Street Sewer)							**$782,000**
Arizona Avenue	Replace Pipes P594, P595	10	12	LF	722	$110	$79,420
	Replace Pipes P601, P612, P613	8	10	LF	907	$100	$90,700
	Rehab / Replace Manhole			EA	6	$5,500	$33,000
	Reconnect Sewer Laterals			EA	16	$1,650	$26,400
						Total:	$229,520
Mobilization / Demobilization (7%)							$16,066
Traffic Control (7%)							$16,066
Bond (1%)							$2,295
Contractor's Profit(15%)							$34,428
Subtotal:							$298,376
Construction Contingency(25%)							$74,594
Total Construction Cost (Arizona Avenue Sewer)							**$373,000**
Collett Avenue	Replace Pipe P189-P191, P191A	18	21	LF	1453	$170	$247,010
	Rehab / Replace Manhole			EA	5	$5,500	$27,500
	Reconnect Sewer Laterals			EA	15	$1,650	$24,750
						Total:	$299,260
Mobilization / Demobilization (7%)							$20,948
Traffic Control (7%)							$20,948
Bond (1%)							$2,993

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Contractor's Profit(15%)							$44,889
Subtotal:							$389,038
Construction Contingency(25%)							$97,260
Total Construction Cost (Collett Avenue Sewer)							**$486,000**
Fillmore Street	Replace Pipe P583-P584	12	15	LF	273	$115	$31,395
	Replace Pipe P588-P590	10	12	LF	1,090	$110	$119,900
	Rehab / Replace Manhole			EA	6	$5,500	$33,000
	Reconnect Sewer Laterals			EA	14	$1,650	$23,100
						Total:	$207,395
Mobilization / Demobilization (7%)							$14,518
Traffic Control (7%)							$14,518
Bond (1%)							$2,074
Contractor's Profit(15%)							$31,109
Subtotal:							$269,614
Construction Contingency(25%)							$67,403
Total Construction Cost (Fillmore Street Sewer)							**$337,000**
Golden Avenue	Replace Pipe P625-P629	12	15	LF	1601	$115	$184,115
	Rehab / Replace Manhole			EA	6	$5,500	$33,000
	Reconnect Sewer Laterals			EA	16	$1,650	$26,400
						Total:	$243,515
Mobilization / Demobilization (7%)							$17,046
Traffic Control (7%)							$17,046
Bond (1%)							$2,435
Contractor's Profit(15%)							$36,527
Subtotal:							$316,570
Construction Contingency(25%)							$79,142
Total Construction Cost (Golden Avenue Sewer)							**$396,000**
Harrison Street	Replace Pipes P142, P143	18	21	LF	690	$170	$117,300
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	7	$1,650	$11,550

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
						Total:	$145,350
Mobilization / Demobilization (7%)							$10,175
Traffic Control (7%)							$10,175
Bond (1%)							$1,454
Contractor's Profit(15%)							$21,803
Subtotal:							$188,955
Construction Contingency(25%)							$47,239
Total Construction Cost (Harrison Street Sewer)							**$236,000**
Hole Avenue	Replace Pipes P714-P718	15	18	LF	1,183	$145	$171,535
	Rehab / Replace Manhole			EA	6	$5,500	$33,000
	Reconnect Sewer Laterals			EA	12	$1,650	$19,800
						Total:	$224,335
Mobilization / Demobilization (7%)							$15,703
Traffic Control (7%)							$15,703
Bond (1%)							$2,243
Contractor's Profit(15%)							$33,650
Subtotal:							$291,636
Construction Contingency(25%)							$72,909
Total Construction Cost (Hole Avenue Sewer)							**$365,000**
Jackson Street	Replace Pipe P281 - P284	24	27	LF	1,073	$205	$219,965
	Replace Pipe P290	24	30	LF	544	$220	$119,680
	Replace Pipe P287-P289	24	27	LF	811	$205	$166,255
	Rehab / Replace Manhole			EA	9	$5,500	$49,500
	Reconnect Sewer Laterals			EA	24	$1,650	$39,600
						Total:	$595,000
Mobilization / Demobilization (7%)							$41,650
Traffic Control (7%)							$41,650
Bond (1%)							$5,950
Contractor's Profit(15%)							$89,250
Subtotal:							$773,500

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Construction Contingency(25%)							$193,375
Total Construction Cost (Jackson Street Sewer)							**$967,000**
Jones Avenue	Replace Pipes P181-P187	15	18	LF	1,946	$145	$282,170
	Rehab / Replace Manhole			EA	8	$5,500	$44,000
	Reconnect Sewer Laterals			EA	19	$1,650	$31,350
						Total:	$357,520
Mobilization / Demobilization (7%)							$25,026
Traffic Control (7%)							$25,026
Bond (1%)							$3,575
Contractor's Profit(15%)							$53,628
Subtotal:							$464,776
Construction Contingency(25%)							$116,194
Total Construction Cost (Jones Avenue Sewer)							**$581,000**
La Sierra Channel	Replace Pipes P631-P636	27	30	LF	2,376	$220	$522,720
	Rehab / Replace Manhole			EA	7	$5,500	$38,500
	Reconnect Sewer Laterals			EA	24	$1,650	$39,600
						Total:	$600,820
Mobilization / Demobilization (7%)							$42,057
Traffic Control (7%)							$42,057
Bond (1%)							$6,008
Contractor's Profit(15%)							$90,123
Subtotal:							$781,066
Construction Contingency(25%)							$195,267
Total Construction Cost (La Sierra Channel Sewer)							**$976,000**
Magnolia Avenue (2)	Replace Pipes P536 - P539	12	15	LF	1,200	$115	$138,000
	Rehab / Replace Manhole			EA	5	$5,500	$27,500
	Reconnect Sewer Laterals			EA	12	$1,650	$19,800
						Total:	$185,300
Mobilization / Demobilization (7%)							$12,971
Traffic Control (7%)							$12,971

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Bond (1%)							$1,853
Contractor's Profit(15%)							$27,795
Subtotal:							$240,890
Construction Contingency(25%)							$60,223
Total Construction Cost (Magnolia Avenue (2) Sewer)							**$301,000**
Monroe Street	Replace Pipes P346 - P349	12	15	LF	1086	$115	$124,890
	Rehab / Replace Manhole			EA	5	$5,500	$27,500
	Reconnect Sewer Laterals			EA	11	$1,650	$18,150
						Total:	$170,540
Mobilization / Demobilization (7%)							$11,938
Traffic Control (7%)							$11,938
Bond (1%)							$1,705
Contractor's Profit(15%)							$25,581
Subtotal:							$221,702
Construction Contingency(25%)							$55,426
Total Construction Cost (Monroe Street Sewer)							**$277,000**
RWQCP Sewer	Replace Pipe P001	36	39	LF	697	$275	$191,675
	Rehab / Replace Manhole			EA	2	$5,500	$11,000
	Reconnect Sewer Laterals			EA	7	$1,650	$11,550
						Total:	$214,225
Mobilization / Demobilization (7%)							$14,996
Traffic Control (7%)							$14,996
Bond (1%)							$2,142
Contractor's Profit(15%)							$32,134
Subtotal:							$278,493
Construction Contingency(25%)							$69,623
Total Construction Cost (RWQCP) Sewer)							**$348,000**
Van Buren Boulevard	Replace Pipes P093 - P098	42	45	LF	2283	$320	$730,560
	Replace Pipes P100-P106	33	39	LF	3616	$275	$994,400
	Replace Pipes P107A, P109	33	36	LF	1347	$260	$350,220

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
	Rehab / Replace Manhole			EA	16	$5,500	$88,000
	Reconnect Sewer Laterals			EA	72	$1,650	$118,800
						Total:	$2,281,980
Mobilization / Demobilization (7%)							$159,739
Traffic Control (7%)							$159,739
Bond (1%)							$22,820
Contractor's Profit(15%)							$342,297
Subtotal:							$2,966,574
Construction Contingency(25%)							$741,644
Total Construction Cost (Van Buren Boulevard Sewer)							**$3,708,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "C" PROJECTS							**$10,133,000**

City of Riverside
Arlanza Trunk Sewer Study

Appendices

590110.10

Prepared By:

PBS&J
10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

August, 2006

Appendix A

Flow Data at Meter Locations (On CD)

Appendix B
City of Riverside, Criteria for Sewer Facility Design

CITY OF RIVERSIDE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

CRITERIA FOR SEWER FACILITY DESIGN

~~March 2000~~
Revised May 2004

Determination of Sewage Flows:

The sewer line shall be designed to flow 75% full during peak flows. Use a Manning's "n"=0.013.

Residential sewer flows are determined by using the following sources of information and criteria:

- Land use shown in the City's General Plan.
- Based on the Land Use determine the number of living units per acre.
- The capita per living unit can be determined from the latest census data for the study area. However, not less than an average 2.75 capita per living unit.
- Use 65 gallons per capita per day for average flows.
- Peak to average flow coefficient is to be determined from the attached graphs.

Peak flows for other types of development shall be determined using the following criteria:

- Industrial developments use: 0.012 cfs/acre
- Commercial developments use: 0.010 cfs/acre
- Offices: 30 gallons per capita per day (g/c/d)
- Schools: 30 g/c/d
- Laundromat: 580 gallons per machine per day

The Public Works Department must approve sewer flows for any other specific types of development.

Criteria for Sewage Pump Station Design:

Construction of a sewage pump station shall be considered the last resort for handling sewage flows from any development. An analysis of alternate gravity system alignments must be performed and submitted to the City for review. The analysis shall consider the economics of constructing and maintaining a pump station over a 20-year period versus obtaining right of way and constructing a gravity system.

If the analysis shows that a pump station is the most economical alternative the following criteria shall be used in its design.

Peak flows are determined by the criteria stated above in the Determination of Sewage Flows section.

Configuration of the components of the pump station shall be in such a way to permit easy access by maintenance equipment. Fencing shall be placed around the pump station components with gates provided at locations for access by maintenance personnel and equipment. The fencing is to be 6-feet in height and of materials and color permitted by the City's Planning Department. All metal parts are to be powder coated with the approved color.

All hatches and hardware shall be stainless steel.

The developer/contractor shall submit complete maintenance and spare parts information for all station components.

Force Main Design:

The force main shall be sized in such a way that the pumps will maintain a minimum flow velocity of 2 feet per second. The force main shall be no smaller than 4 inches in diameter and shall be made of ductile iron pipe. However, if the force main is small and located in a residential street, AWWA C900 PVC pipe may be used. The use of PVC pipe will require specific approval by the Public Works Department.

The force main shall have a continuous upward grade from the pump station to the outlet. No low or high points will be permitted between the pump station and outlet.

The force main shall outlet to a manhole connected to a gravity system. The outlet shall be at the flowline of the manhole and channeled as shown in City Standard Drawing No. 500. Within 30 feet of the manhole the force main shall have an elevation high enough to prevent sewage in the gravity system from flowing down the force main during the off cycle of the pumps.

The designer shall analyze bends in the force main for the need to use thrust blocks or restrained joints.

A force main cleaning station must be installed at approximately 500-foot intervals if the following conditions will exist in the completed system.

- Flows from the area served by the pump station are not enough to require the force main to be emptied every 4 hours.
- The force main is over 950 feet long.
- The difference in elevation between the force main at the valve vault and the outlet is greater than 25 feet.

Pump Design:

Pumps are to be sized to provide a minimum flow velocity of 2 feet per second in the force main.

Pumps shall be able to handle 4-inch solids.

Pump selection shall be based on the most efficient drive/pump/impeller combination for the force main system. The discharge flow velocity should be in the range of 10 to 14 feet per second. The designer shall graph the pipe system curve against the pump curve. If multiple pumps are used this graph shall show the curve for each pump. The minimum pump efficiency allowed is 60 percent.

Wet Well Design:

In stations that have 5 to 100 horsepower pumps the wet wells shall be sized to permit the pumps to cycle not less than 15 minutes between stops and starts. In addition the pumps must not run less than 10 minutes per cycle. Stations with pumps greater than 100 horsepower shall have a cycle time between pump stops and starts not be less than 20 minutes with a minimum run time of 15 minutes.

Pumps on and off elevations are to be shown on the plan. These elevations must be below the inlet elevation to the wet well. Flap gates on the wet well inlet are not permitted.

The wet well shall have a 6-foot minimum diameter and lined with PVC or City approved coating.

If the wet well is over 30 feet in depth there must be a "step off" landing designed in the well. The landing is a safety precaution to provide a location for maintenance personnel to step off the wet well access ladder.

All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

A wastewater recirculator or scum breaker shall be provided.

Valve Vault Design:

The vault shall be large enough to permit easy access by maintenance personnel. The bottom shall be a minimum 4-inch thick concrete slab. A 4-inch diameter PVC pipe shall be provided to drain the valve vault into the wet well.

All pipe and fittings from the pumps through the valve vault shall be made of ductile iron. Only flanged fittings shall be used. All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

Discharge and isolation valves shall be plug valves and not gate valves.

Controls and Electric Design:

A 480-volt three-phase power supply is required.

All conduits shall be schedule 80 PVC.

An emergency transfer switch shall be provided. Small stations will require a manual switch where large stations with emergency backup generators will require an automatic transfer switch. When a manual transfer switch is required a 100-amp plug and receptacle such as Killark 8581/21-407 and 8581/22-407 shall be provided. In addition, a minimum 30-foot long jumper cable shall be provided.

Lights shall be provided within the control panel to allow for night work.

The pump station shall have a communications link with the City's wastewater treatment plant. The equipment to provide this link shall be City approved.

An electric schematic diagram shall be provided on the pump station plans.

The wet well level measuring device shall be a Milltronics Hydroranger ultrasonic measuring device.

The station shall be controlled by a Modicon Quantum Programmable Logic Controller(PLC).

The station shall be equipped with a Motorola Moscad Radio Telemetry Unit(RTU).

This RTU shall be installed and completely functional prior to the acceptance by the City.

The Developer/contractor shall coordinate and pay for the integration of this RTU into the City's existing SCADA system.

Control system integration with the City's SCADA shall be performed by an integrator approved by the City.

Three phase 480 VAC power shall be the power source.

The power source for station controls shall be 120 VAC.

Two spare conduits shall be provided between the control panel and the wet well. This conduit shall same size of the largest conduit needed between the control panel and wet well.

One spare conduit shall be provided between the control panel and the valve vault. This conduit shall of the same size of the largest conduit needed between the control panel and valve vault.

The developer/contractor shall provide complete as built drawings of the electrical system. This shall include all wiring, general, and internal to the control panel

All wires must be individually tagged. They must be tagged at every termination and inside every junction box.

The developer/contractor shall provide a copy of the proposed PLC program for review prior to construction. A final fully annotated copy of the PLC program shall be provided, both in electronic format and in a hard copy printed format.

All panels shall be of the appropriate construction for the application. (minimum, NEMA 4X or 3R.

Pump Station Functional Requirements

Milltronics Hydroranger Ultrasonic Level Indicator/Controller

Shall provide analog level input to the Programmable Logic Controller (PLC)

Shall provide off & on starting of pumps in the event of PLC failure

Shall provide alternation of pumps in event of PLC failure

Shall provide ultrasonic failure Input to RTU

Float Switch

Shall provide an input to the RTU (high-high level)

Programmable Logic Controller (PLC)

Shall provide starting and stopping of the pumps in auto

Shall provide alternation of the pumps (after each cycle)

Recognize Milltronics failure and provide an input to the RTU

Shall recognize pump hand switch position and adjust the control logic

Shall provide all timing functions

Shall provide low level alarm output to RTU

Shall provide input to the RTU In event of seal failure of pumps (Each Pump)

Shall provide input to the RTU in event of Thermal overload

Shall call lag pump if required

Shall provide input to the RTU indicating pump failure and identifying the pump

Shall provide output to the RTU for high level alarm

A three-position selector switch shall interface with the PLC to provide for manual override of the automatic changing of lead and lag pumps, in case of pump failure (i.e.: P1-AUTO-P2)

Controls

A manual bypass shall be provided for water levels, PLC, Milltronics; etc. and shall directly energize the motor starters.

The auto function shall be controlled by the PLC or in the event of PLC failure, the Milltronics will start, stop, and alternate lead and lag pumps.

Radio Telemetry Unit (RTU)

Shall monitor only, not control

Transmit Dynamic Wet Well Level (Analog Output)

Indicate low level

Indicate high level

Indicate site entry

Indicate AC failure

Indicate individual pump failure

Indicate pump auto, pump not auto

Indicate pump run status

Indicate ultrasonic failure

Indicate Seal Failure

External Relays

(1) Intrinsically safe for the high, high level float

(2) For seal failure

(2) Motor starters

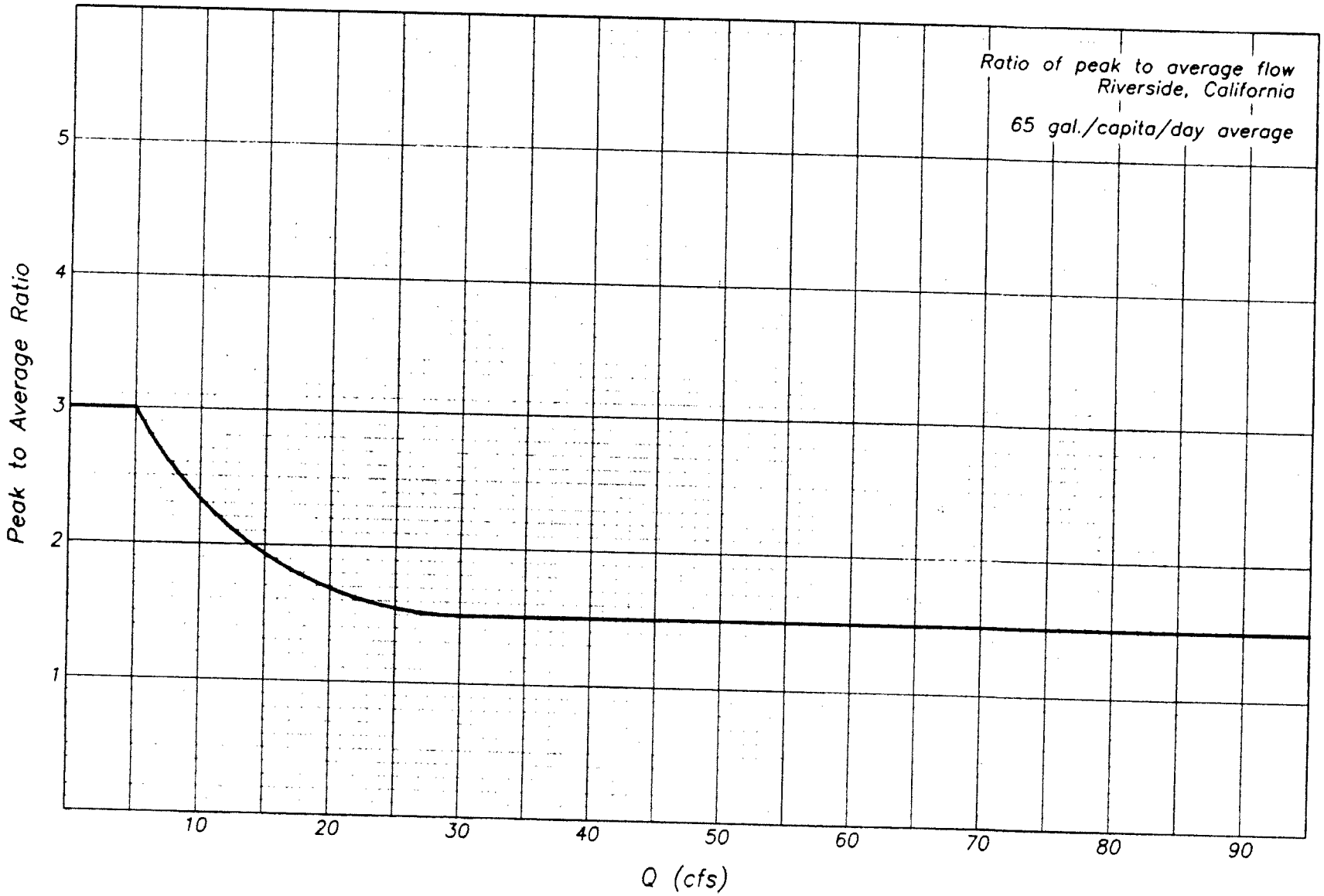
Criteria for Inverted Siphon Design:

Minimum flow velocity of 3 feet per second and maximum velocity of 7 feet per second within the siphon pipe(s) is required. A multiple pipe design should be incorporated with the upstream manhole designed to direct the anticipated average daily flow into one pipe and the anticipated peak flow into all pipes of the siphon. If the siphon will serve future development it may be necessary to design the siphon with more than two pipes in order to maintain the minimum flow velocity until the future development is constructed. Weirs shall be cast into the base of the manholes.

Minimum pipe size to be used in the siphon is 6-inch. Either Vitrified Clay Pipe or Ductile Iron Cement Mortar Lined Pipe (DIP) shall be used in the siphon. Type V cement shall be used for the lining of the DIP. Internal pressure of the siphon shall be considered in material selection.

The siphon shall not exceed 350 feet in length with manholes installed at each end. Flow shall be directed straight through these manholes. No side connections to the manholes will be permitted. The manhole diameter shall be determined by the number, size, and spacing of the siphon pipes plus 3 feet. The shelf elevation shall be above the water level during ultimate peak flows.

During ultimate peak flow the water surface elevation at the first sewer lateral connection upstream of the siphon must be within the sewer main.


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
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50
60
70
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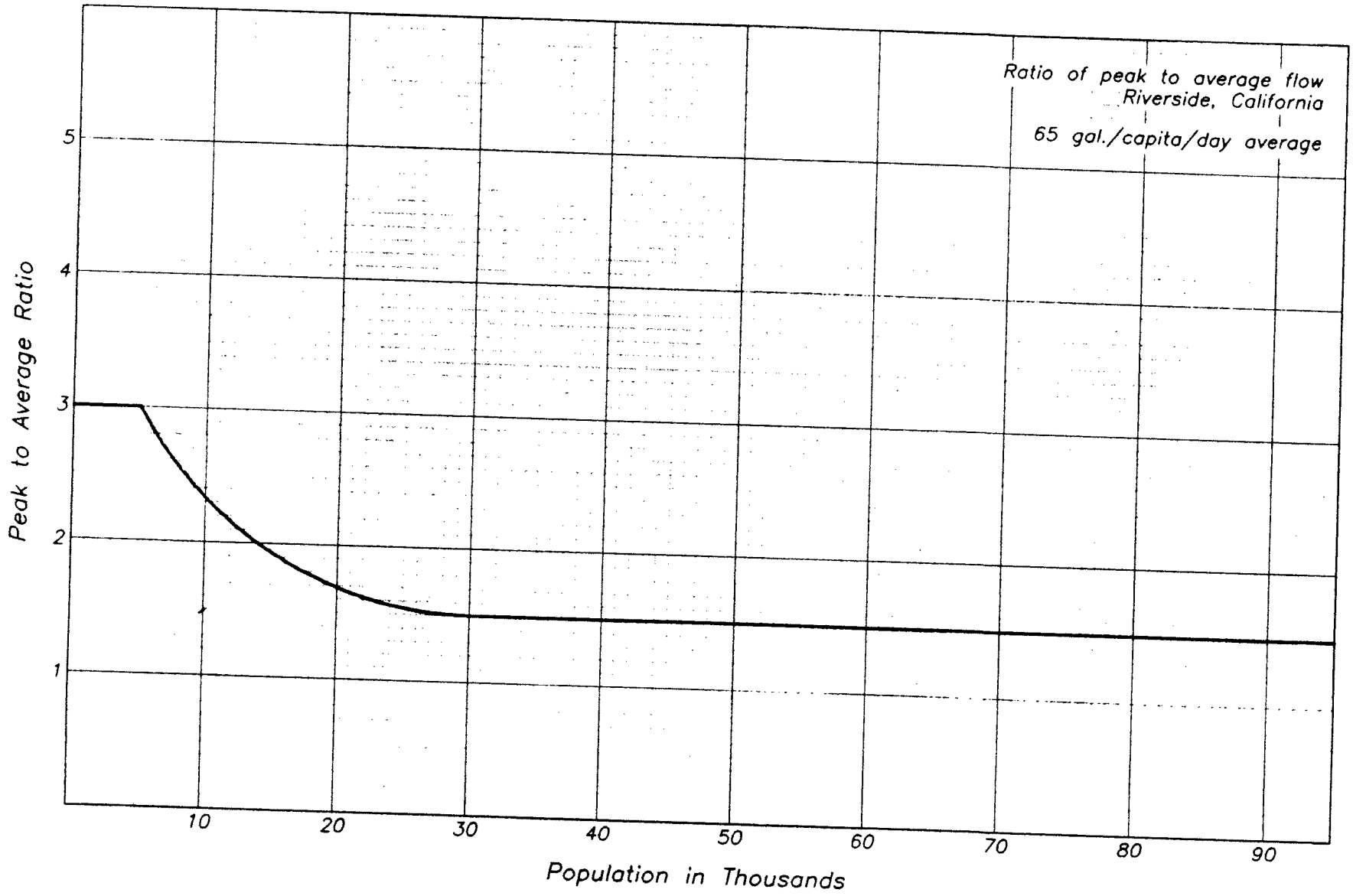
90
Q (cfs)


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
40
50
60
70
80
90
Population in Thousands

Appendix C
Study Sewer Lines

City of Riverside
Arlanza Trunk Sewer System: Study Sewer Lines

Location	Pipe Diameter	Length	Number of Manholes
	(inch)	(feet)	
Adams Street	12	1,121	4
	15	1,691	5
Indiana Avenue (1)	15	2,729	9
Monroe Street	12	5,286	20
	15	4,390	13
Garfield Street	12	1,030	3
	14	2,724	9
California Avenue (1)	15	2,725	12
	21	2,729	12
California Avenue (2)	18	1,723	8
	21	995	5
Indiana Avenue (2)	10	325	0
	12	3,826	16
Harrison Street	12	4,095	14
	15	2,798	9
	18	5,189	17
	24	709	3
Jurupa Avenue	12	660	3
Central Avenue	12	1,360	4
Monticello Avenue	12	3,428	14
Jackson Street	8	24	1
	15	1,367	4
	20	692	1
	24	5,203	20
Van Buren Plaza	24	448	1
	33	5,556	18
	36	6,358	17
Van Buren Boulevard	18	1,037	3
	24	1,148	4
	27	7,597	21
	33	4,964	9
	42	2,290	7

City of Riverside
Arlanza Trunk Sewer System: Study Sewer Lines

Location	Pipe Diameter	Length	Number of Manholes
Crest Avenue	12	1,394	6
	15	4,079	16
	18	1,501	4
	27	2,542	10
Trey Avenue	12	1,212	4
Picker Street	12	3,532	13
	15	845	3
Cypress Avenue	12	986	2
	18	641	3
Warren Street	12	2,798	9
	18	2,780	10
	21	2,323	10
	24	1,751	5
Acorn Street	27	3,598	6
	36	317	1
Riverside Water Quality Control Plant	15	3,204	15
	27	3,326	14
	30	262	2
	36	697	1
	42	523	1
	51	2,507	8
Mitchell Avenue	8	235	1
	12	2,866	9
	15	1,752	5
Bushnell Avenue	15	471	2
	18	1,103	3
Pierce Street	12	607	2
	15	2,781	7
La Sierra Avenue (1)	21	3,053	9
Hole Avenue	8	22	1
	12	101	1
	15	1,984	7
	18	1,154	3
Collett Avenue	18	1,921	8

City of Riverside
Arlanza Trunk Sewer System: Study Sewer Lines

Location	Pipe Diameter	Length	Number of Manholes
Arizona Avenue	8	3,790	16
	10	829	3
	15	2,326	8
Polk Street (1)	15	3,057	12
Polk Street (2)	8	245	1
	12	4,630	17
Magnolia Avenue (1)	8	917	4
	21	899	3
	24	1,721	3
Magnolia Avenue (2)	12	1,937	7
	15	43	2
	24	1,721	3
Magnolia Avenue (3)	8	192	1
	12	212	1
	15	2,760	8
Queensborugh Street	12	2,274	10
Filmore Street	10	2,682	7
	12	1,054	5
Riverwalk Parkway	12	2,891	10
Pierce Street (1)	12	1,602	4
	15	527	2
Pierce Street (2)	15	1,100	4
	21	1,310	4
Taylor Street	15	2,775	12
Stonewall Drive	12	1,418	5
	15	72	1
Golden Avenue	12	2,502	9
La Sierra Avenue (2)	15	1,574	5
Cochran Avenue	15	2,002	8
Jones Avenue	15	1,976	8

City of Riverside
Arlanza Trunk Sewer System: Study Sewer Lines

Location	Pipe Diameter	Length	Number of Manholes
La Sierra Channel	27	6,136	17
	30	150	4
Total of Gravity Study Sewer Lines		**202,409**	**691**
		(38.3 Miles)	

Magnolia Force Main	24	13,861	
La Sierra Force Main	30	15,512	

Total of Force Main Sewer Lines	**29,373**	
	(5.6 Miles)	

Appendix D
PHOENIX TRUNK SEWER STUDY

City of Riverside
Phoenix Trunk Sewer Study

590110.20

Prepared By:

10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

August, 2006

PHOENIX TRUNK SEWER STUDY

City of Riverside

Client Representative	L.F.(Sandy) Caldwell, P.E.

PBS&J

Project Director	Gary H. Eikermann
Project Engineer	Barmeshwar Rai, P.E.
Technical Support	Charlene Drake Cristina Chavez

J.N. 590110.20

August, 2006

10370 Hemet Street, Suite 200, Riverside, CA 92503

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Executive Summary

ES.1 Introduction

This report presents the results of the Phoenix Trunk Sewer System Capacity Study prepared by PBS&J for the City of Riverside. The report contains recommendations regarding system deficiencies as identified by hydraulic model XP-SWMM (XP Software, Version 9.1).

The City of Riverside is located in the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. The study area encompasses approximately 11,000 acres of mixed land use development and is generally bounded by Santa Ana River to the North, Jefferson Street to the West, Van Buren Boulevard to the South and Alessandro Boulevard to the East. The study area is essentially a fully developed community, comprising single family residential, multi family residential, commercial and light industrial areas with some vacant lands to be developed in the future. The portion of study area southwest of Victoria Avenue and designated as "residential semi-rural" would be one of the major contributors of sewage flow to the system. The trunk sewer line along Santa Ana River also intercepts flows from upstream study areas (Spruce, Tequesquite and Northside) besides flows from Phoenix study area.

ES.2 Existing Sewer System

The existing trunk sewer system within the study area is comprised of approximately 23 miles of gravity sewer mains. The gravity sewer main lines range in sizes from 8-inch to 48-inch in diameter and there are 379 manholes. These sewer lines are essentially VCP and the manholes are typically brick lined. The City of Riverside owns, maintains and operates the sewer system.

ES.3 Methodology

For determination of current wastewater flows, flow monitoring was performed at five (5) strategic locations. These meter locations were chosen to observe actual flow characteristics for various sub areas with a distinct land use pattern within the study area. The flow monitoring was accomplished over a three-week period. The flow results were carefully evaluated for their accuracy and some adjustments were made based on depth of flow at meter locations. The readings of first week at meter no. 4 were discarded for inconsistencies.

A theoretical estimate of wastewater flow from vacant areas was estimated based on factors from the City of Riverside "Criteria for Sewer Facility Design". Residential wastewater flow was determined by using future projected population, whereas commercial and industrial flow was determined based on acreage and City estimated flow coefficients.

The Computer Model Simulation Analysis involved evaluation of available capacity in the existing collection system under present and future development conditions. Based on the results of model runs, system deficiencies were identified on a priority basis and a phased facility improvement plan was developed to accommodate for the projected growth within the study area.

ES.4 Project Priorities and Cost

Deficient and marginally deficient pipes were identified from the results of model runs and were prioritized for replacement/rehabilitation purposes. The pipes that are currently flowing more than 90% full under modeled existing maximum flow conditions and needing near term (2005-2010) replacement/rehabilitations are grouped under priority "A". The pipes that would flow more than 90% full in year 2015 under anticipated maximum future flow conditions are classified as priority "B". The pipelines that are not included in priorities "A" and "B" and are anticipated to flow more than 75% full under future flow conditions are categorized as priority "C". Some adjustment of priorities and combining of improvements was done for continuity and efficiency of improvements.

The time phased improvements for various priorities are listed in Table 7-2. The approximate cost of recommended improvements is summarized in Tables 7-4, 7-5 and 7-6.

Under existing flow conditions, a total of approximately 5,700 linear feet of priority "A" deficiencies were identified, requiring near term (2005-2010) attention. Additional deficiencies predicted under ultimate flow conditions (Priority "B") include an additional 900 linear feet of inadequate sewer lines. The estimated capital cost to remedy these identified deficiencies (in year 2005 $'s) is approximately $2,586,000 for Priority "A" and approximately $304,000 for Priority "B". The total length of pipelines under Priority "C" would be approximately 40,000 feet and the cost of Priority "C" projects would be approximately $19,438,000. However, it is probable that majority of Priority "C" improvements will not need to be actually implemented and also that some of Priority "B" improvements may not be needed. Only those where surcharging (within manhole) and other problems are deemed imminent should be considered for improvement. Periodic flow monitoring is also recommended to verify anticipated deficiencies and need for improvements. It is recommended that field observations of all pipes should be done where modeled results indicate surcharging conditions. The priorities are summarized in the table Ex-1:

Table Ex-1
Summary of Priorities

Priority	Approximate Pipeline Length (feet)	Location	Replacement Year	Total Project Cost (Year 2005$'s)
"A"	5,700	Central Avenue, Hillside Avenue, Phoenix Avenue and Santa Ana Trunk Line	2005-2010	$2,586,000
"B"	900	Madison Street	2011-2015	$304,000
"C"	40,000	Madison Street, Phoenix Avenue and Santa Ana Trunk Line	2016-2020	$19,438,000

1.0 INTRODUCTION

1.1 Background

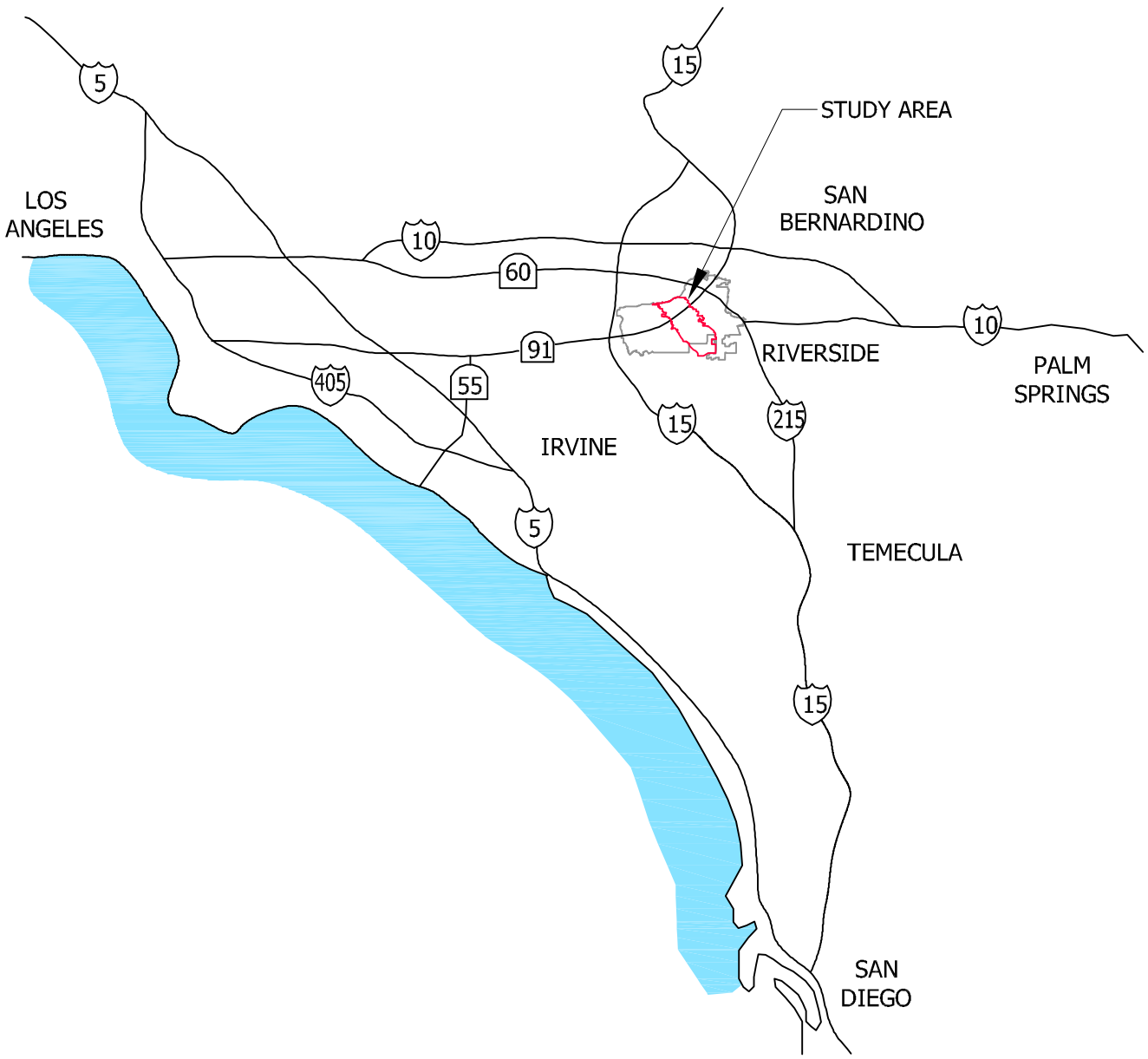
The City of Riverside (City) retained PBS&J to prepare a Trunk Sewer System Study for the central portion of the City. The Sewer System has been designated as Phoenix Trunk Sewer System. The study is necessitated by the fact that the City desires to evaluate the capacity of the existing sewer system and identify needed improvements.

1.2 Study Area

The City of Riverside is located in the northwest corner of the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. Founded in 1870, the City is known for its citrus industry, world famous Mission Inn and other historical monuments. Figure-1 is a Vicinity Map depicting the City's location and its accessibility. Figure 2 shows the study area. The study area shown in Figure 2 encompasses approximately 11,000 acres and is generally bounded by Santa Ana River to the North, Jefferson Street to the West, Van Buren Boulevard to the South and Alessandro Boulevard to the East. For purposes of this study, the study area has been divided into 21 tributary sub-areas, where downstream sub-areas intercept sewage flow from upstream sub-areas. To obtain actual observed flow information for this study, sewage flow meters were placed at five (5) strategic locations to monitor cumulative flows contributed from the tributary sub-areas.

1.3 Objective

The objective of this Sewer System Capacity Study is to provide a comprehensive evaluation of the capacity of the sewer system within the study area, identify deficiencies in the current system and evaluate alternatives to enhance the conveyance capacity to accommodate ultimate wastewater flows anticipated to be generated in the study area.



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CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 1

VICINITY MAP

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Construction Services

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Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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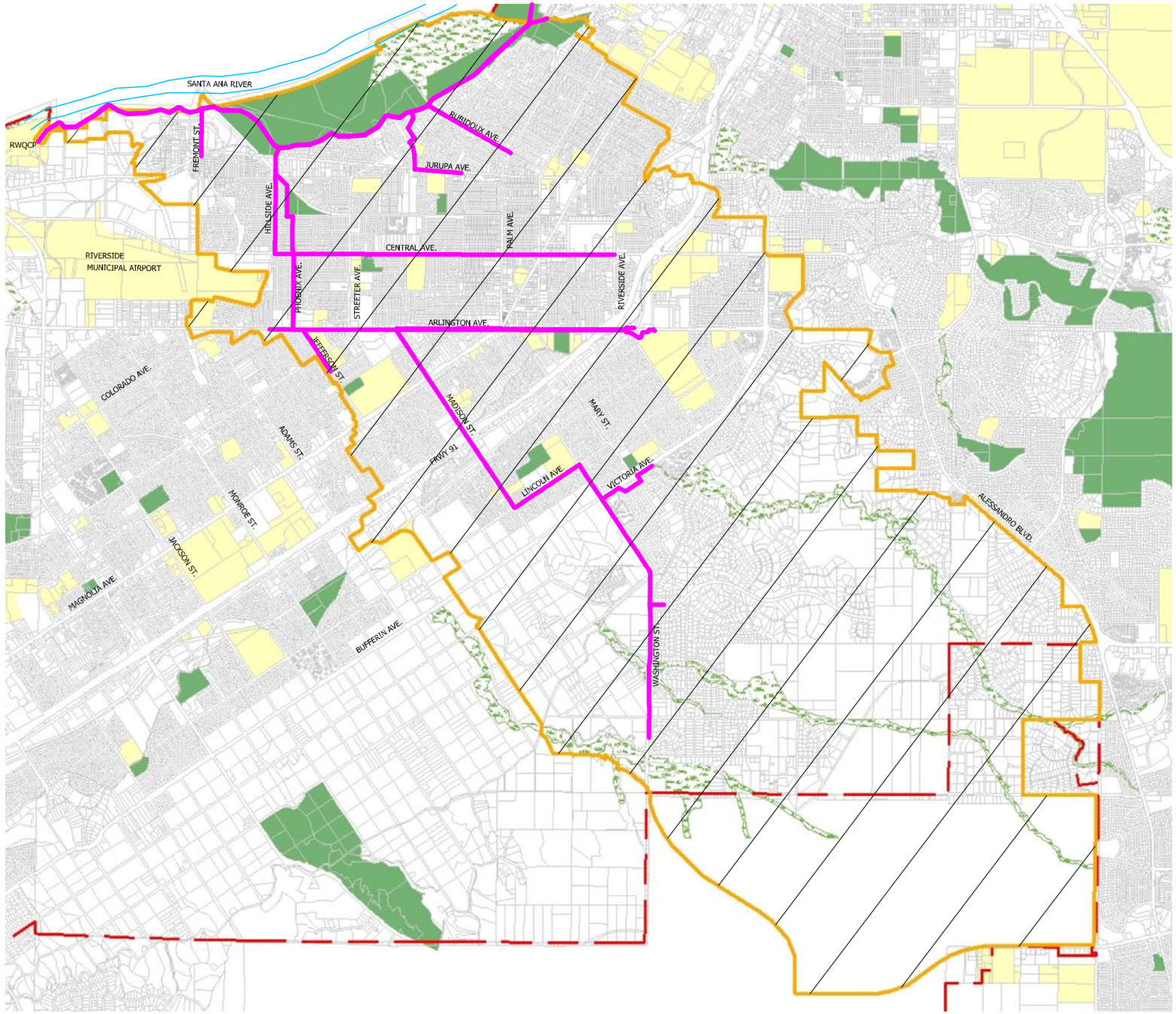

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SCALE:
1" = 4000'

LEGEND

- STUDY AREA BOUNDARY
- STUDY SEWER
- CITY LIMITS

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Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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CITY OF RIVERSIDE PHOENIX SEWER STUDY	FIGURE 2
STUDY AREA	

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1.4 Scope and Study Approach

Specific work tasks undertaken for this study are summarized as follows:

- Kickoff Meeting

  An initial meeting was held between PBS&J and the City to discuss the project scope, communication protocol, explanation of methodology and scheduling of flow monitoring. Field data and other digital files to be provided by the City were also discussed.

- Progress Meetings

  Informal Project Progress Meetings were held to discuss on-going issues and the progress of the study.

- Flow Monitoring and Hydrograph Development

  Downstream Services Inc. installed, maintained, and collected flow data from five (5) monitoring stations throughout the study area. They submitted the collected raw data in electronic/hard copy format to PBS&J. PBS&J then processed and reviewed this information and created a hydraulic database. The City provided a copy of City's General Plan for estimation of current and future flows. Other information including as-built plans of wastewater facilities were provided by the City as and when requested by PBS&J.

- Model Development

  Model development included input data collection, conversion of data and calibration. The City's GIS staff made available data pertaining to roads, sewers, land use, buildings and other utilities in ArcView format on a CD. As-built plans for study sewer lines were reviewed. Data available from GIS system and as-built plans were placed in a database system (MS Excel) as a pre-processor for XP-SWMM model development. Calibration of the model was done after construction of the model and additional data input.

- Draft Report

  Based on the model simulations and the City's criteria for Sewer Facility Design, a Draft Report was prepared that summarized the existing and future capacity situations. Where deficiencies were identified, alternatives were developed for

needed sewer improvements, along with probable costs. The draft report was prepared for submittal / review by the City.

- Final Report

  Draft Report review comments from the City were incorporated into the Final Report along with any additional information or research, in order to reflect a final level of study completion. The Final Report includes data and information assembled, system deficiencies identified, alternatives evaluated, capital improvement recommendations to remediate anticipated deficiencies, prioritization of improvements, and approximate costs.

The comprehensive evaluation of the sewage collection system to accomplish the above-summarized scope of work features the following multi-step approach:

- Review of as built plans provided by the City to determine system configuration, inverts, pipe sizes and slopes
- Use of detailed database provided by the City in Arcview format
- Creation of computer hydraulic model using existing sewer system to study project area
- Identification of flow monitoring station locations
- Identification of tributary areas contributing sewage flow to meter locations or combinations
- Installation of flow meters and monitoring of flows at the selected locations on continuous basis for two-week period
- Review of current land use in study area per GIS information from the City and determination of existing land use, population and vacant land
- Assessment of ultimate land use and projected population
- Review and evaluation of metered data from flow monitoring stations
- Development of flow coefficients and representative diurnal flow patterns based on typical curves for various land uses and observed flows from monitored sub areas which are dominated by a specific land use
- Modeling of sewer system, deficiency identification, and model simulation of remedial alternatives using above-mentioned information as input data
- Evaluation of alternatives, optimization, cost comparison
- Prioritization of recommended improvements, including identification of critical pipelines which need immediate attention
- Draft Report and recommendations including phased improvements and costs
- Review of Draft Report by the City, comments and discussion

- Final Report

2.0 LAND USE

2.1 Existing Land Use

Land use is the basis for estimating sewage flow from the majority of the study area. The land use pattern for this study was developed from the GIS information provided by the City. Figure 3A shows land use within the study area based on the City's "Land Use" GIS layer. For the purpose of this study, land uses in the study area have been broadly classified into four categories: Single Family Residential (SFR), Multi Family Residential (MFR), Commercial and Industrial. Table 2-1 summarizes the land use areas within the study area that would generate wastewater flow.

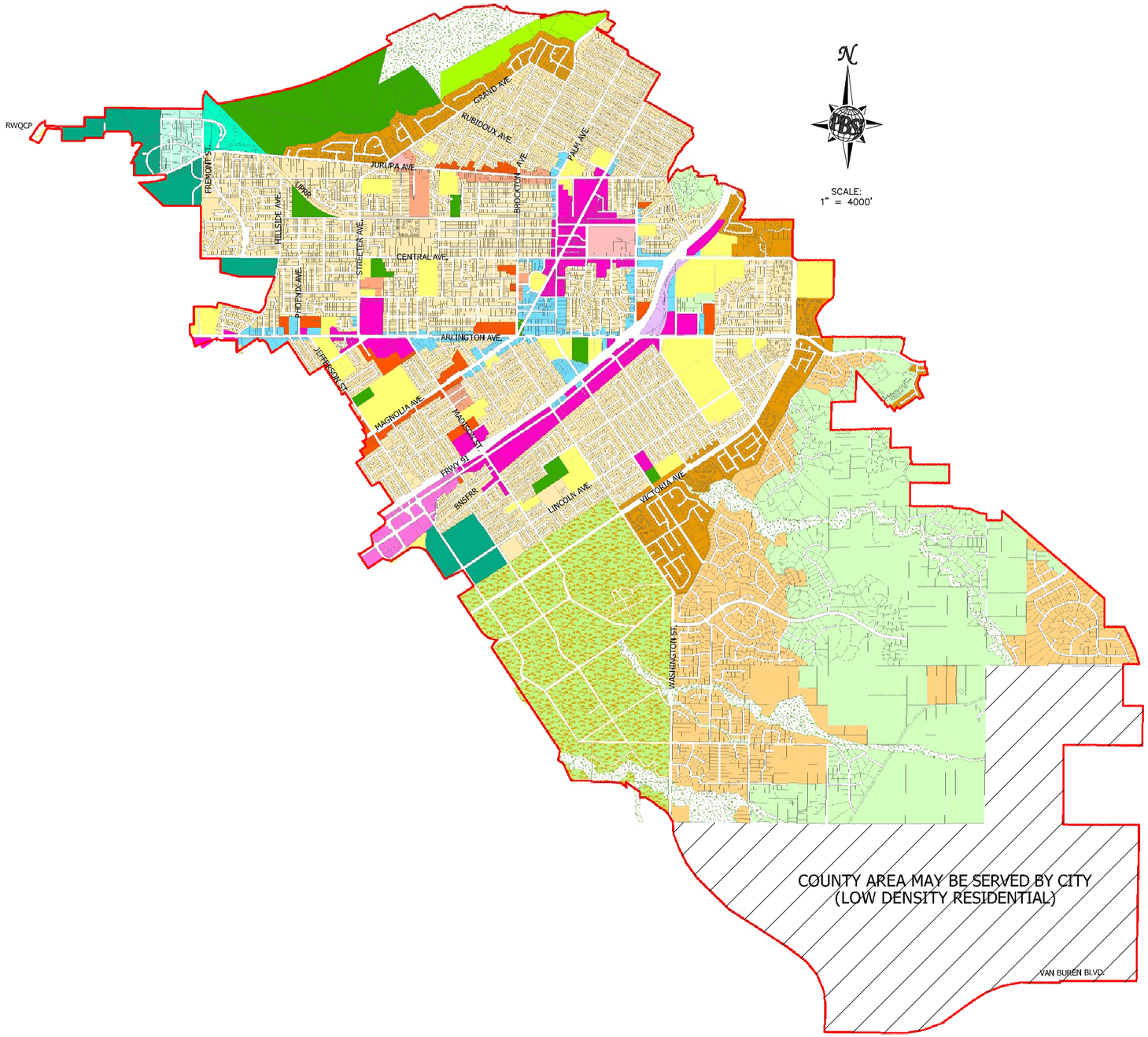
2.2 Future Land Use

The portion of study area on northwest of Victoria Avenue is primarily a mature community. The portion of study area on southeast side of Victoria Avenue has vacant parcels that are designated as "residential semi-rural" and is expected to be developed in the future. This area is primarily designated to be developed as low density Single Family Residential (SFR). The vacant parcels are shown in Figure 3B. It is assumed that the majority of vacant lots within the study area would be fully developed by year 2020.

Table 2-1
Land Use that would produce Wastewater Flow within the Study Area (Acres)

General Category	Existing (Year 2005)	Future (Year 2020)	Change
Single-Family Residential (SFR)	4,500	6,230	1,730 (38 %)
Multi-Family Residential (MFR)	76	78	2 (2.6 %)
Commercial / School	1,100	1,210	110 (10 %)
Industrial	190	215	25 (13 %)

The areas that are marked as open space or public facilities are not included in Table 2-1 because of zero wastewater flow generation.



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SCALE:
1" = 4000'

LEGEND

- Commercial - Automotive Park
- Commercial - Business and Office
- Commercial - Center
- Commercial - Service
- Industrial - Business Park
- Industrial - General
- Industrial - Light
- Natural Open Space
- Office - Low Rise
- Parks - Other Recreation
- Parks - Public
- Public Facilities and Open Space*
- Residential - Estate
- Residential - High Density
- Residential - Hillside
- Residential - Low Density
- Residential - Medium Density
- Residential - Medium-High Density
- Residential - Rural and Residential

*Includes schools and other public use facilities

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10370 Hemet Street
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Riverside, CA 92503
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PHOENIX SEWER STUDY

FIGURE 3A

ZONED LAND USE

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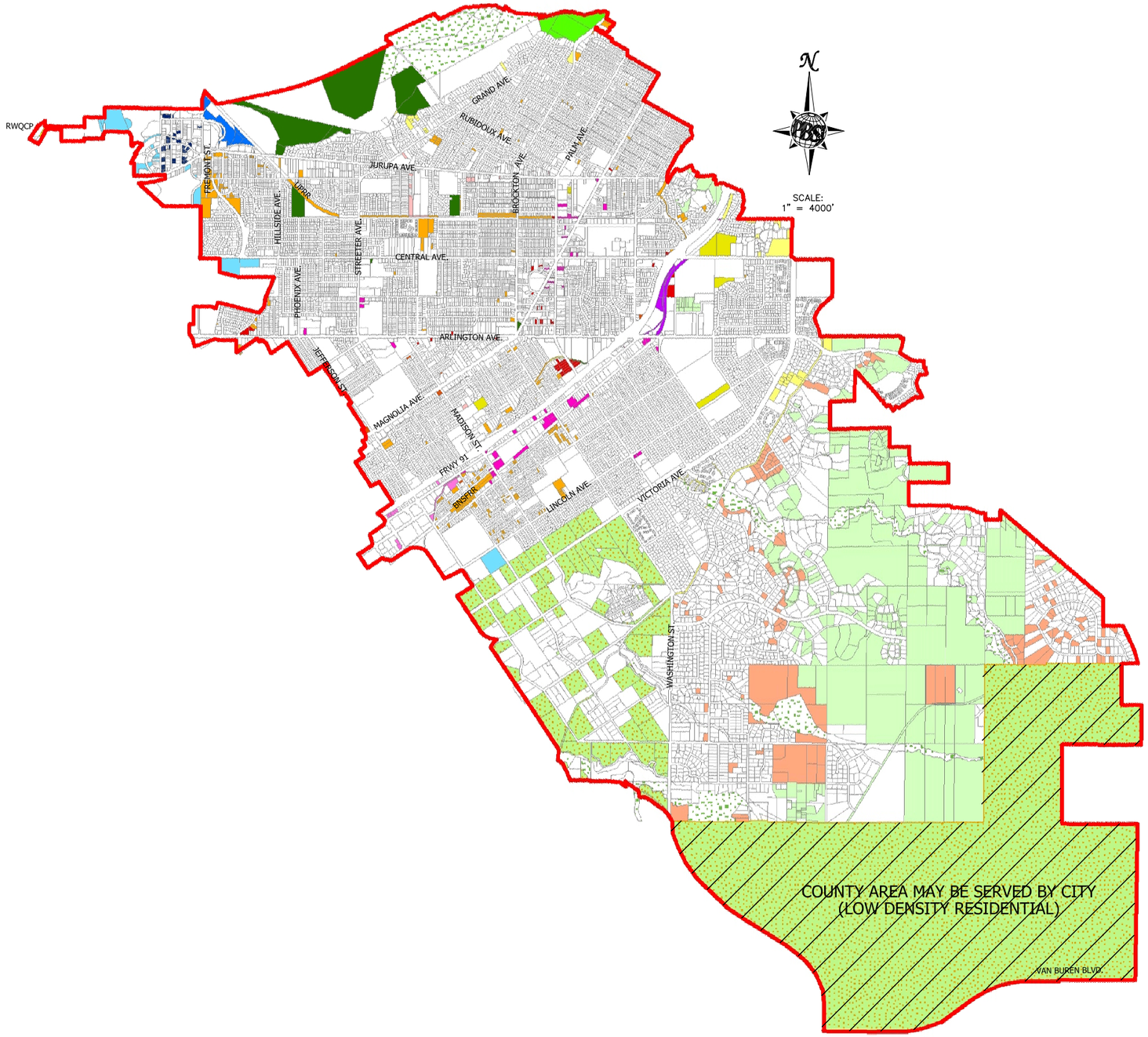

LEGEND

- Commercial - Automotive Park
- Commercial - Business and Office
- Commercial - Service
- Industrial - Business Park
- Industrial - General
- Industrial - Light
- Natural Open Space
- Office - Low Rise
- Parks - Other Recreation
- Parks - Public
- Public Facilities and Open Space*
- Residential - Estate
- Residential - High Density
- Residential - Hillside
- Residential - Low Density
- Residential - Medium Density
- Residential - Medium-High Density
- Residential - Rural and Residential
- Area May be Served by City**
- Occupied Parcels
- Sewer Basin Boundary

*Includes schools and other public use facilities
**Assumed to be Low Density Residential

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PHOENIX SEWER STUDY

FIGURE 3B

ZONED LAND USE (VACANT PARCELS)

3.0 EXISTING SEWER SYSTEM

3.1 System Overview

As previously described, the Phoenix Trunk Sewer Study covers approximately 11,000 acres, which has been divided into 21 tributary sub-areas (See Figure 4). Each sub-area can be considered as a sewer sub-basin where wastewater flow from it is intercepted by a sewer trunk line. The wastewater flow generated from a sub-area can be measured at a meter location or can be reasonably assessed based on land use plan of that sub-area. The location of meters can be seen on Figure 5. The modeled gravity conveyance system is approximately 122,000 linear feet (23 miles) of gravity sewer system, with pipe sizes varying from 8 inches to 48 inches in diameter (See Figure 6). Most of the gravity sewer lines within the system are vitrified clay pipe (VCP) except for northern Santa Ana Trunk Line which is Reinforced Concrete Pipe (RCP).

3.2 Collection System

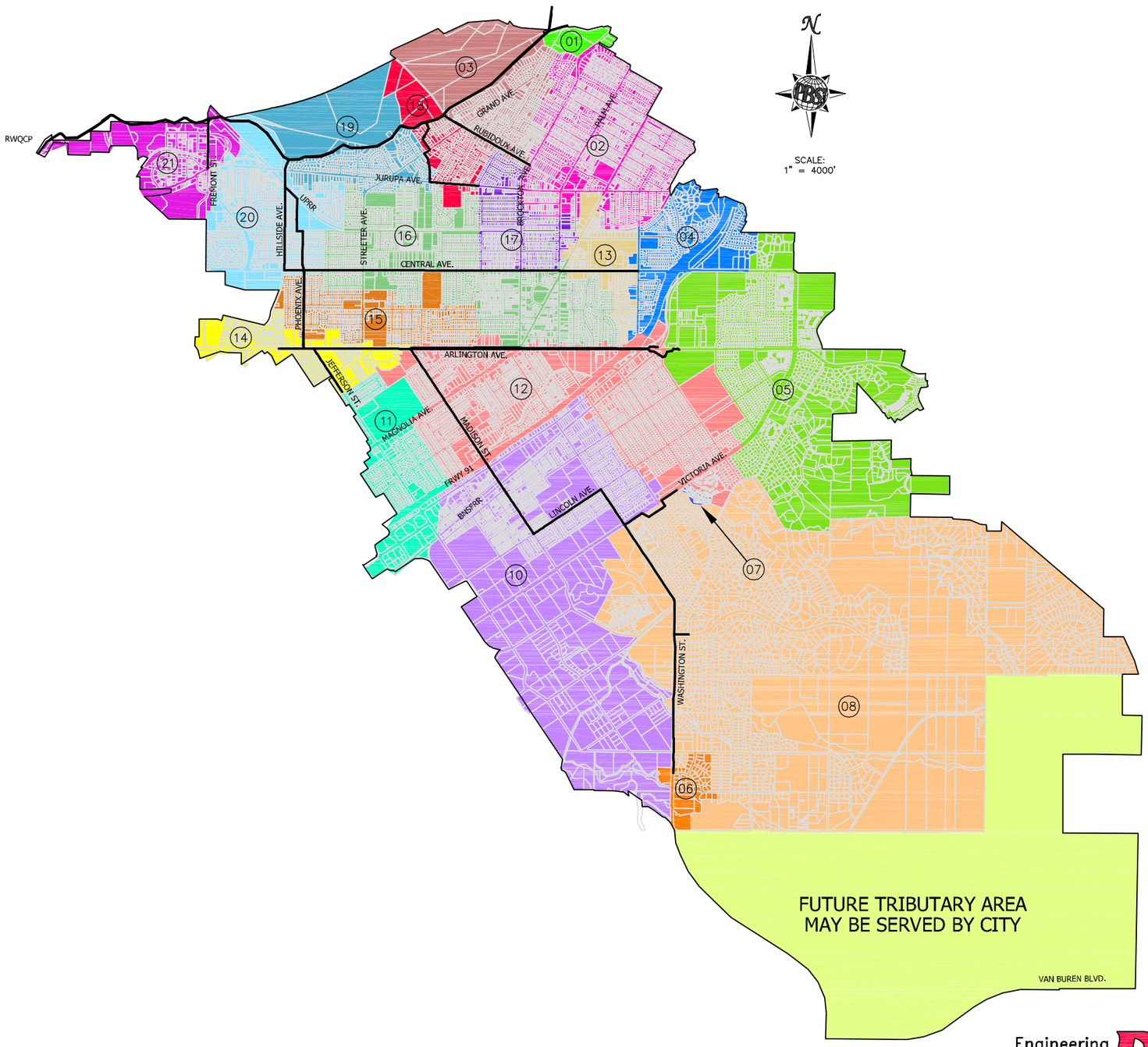
The Phoenix Study Area can be divided into two distinct sub-areas. The portion northwest of Victoria Avenue is a developed matured community and the area southeast of Victoria Avenue, has some vacant parcels that will be developed in the future. The wastewater generated from the study area generally flows in a northwesterly direction.

A major trunk line runs parallel to the Santa Ana River and it picks up wastewater flows from the trunk lines along Phoenix Avenue Rubidoux Avenue and Hillside Avenue. It also collects flows from the Northside, Spruce and Tequesquite Study Areas.

The details of the sewer system are explained in sub-section 3.3 System Description. Pipe sizes, lengths, and number of manholes have been tabulated for major segments of the modeled trunk system (See Appendix “C”).

3.3 System Description

The existing trunk sewer system, which is the subject of this evaluation, is shown on Figure 7A thru 8B. The sewer collection system was constructed over a period of time (50 plus years) to accommodate increasing sewage flow during the development within the City. The GIS data and as-built plans provided by the



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SCALE:
1" = 4000'

LEGEND

- SUB AREA 01
- SUB AREA 02
- SUB AREA 03
- SUB AREA 04
- SUB AREA 05
- SUB AREA 06
- SUB AREA 07
- SUB AREA 08
- SUB AREA 10
- SUB AREA 11
- SUB AREA 12
- SUB AREA 13
- SUB AREA 14
- SUB AREA 15
- SUB AREA 16
- SUB AREA 17
- SUB AREA 18
- SUB AREA 19
- SUB AREA 20
- SUB AREA 21
- COUNTY AREA MAY BE SERVED BY CITY
- TRUNK SEWER STUDIED

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CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 4

TRIBUTARY AREAS

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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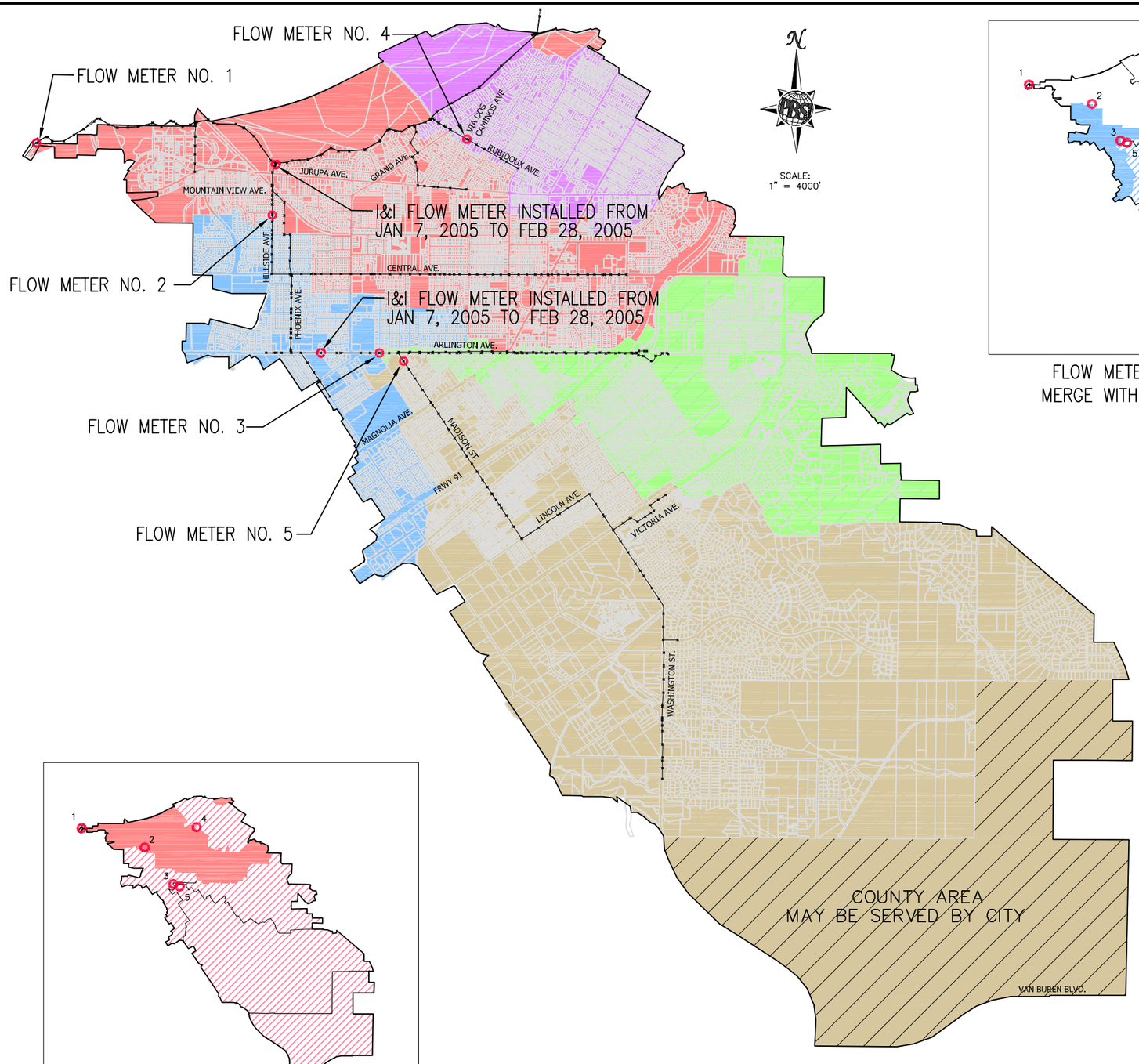
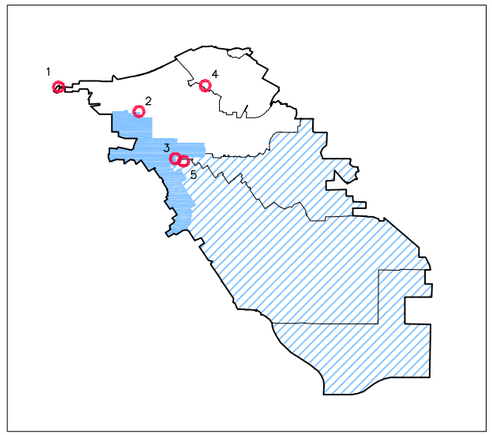
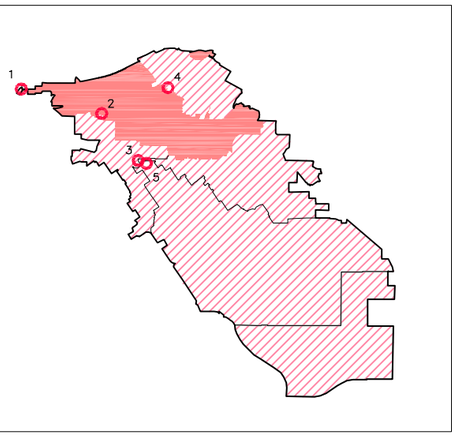




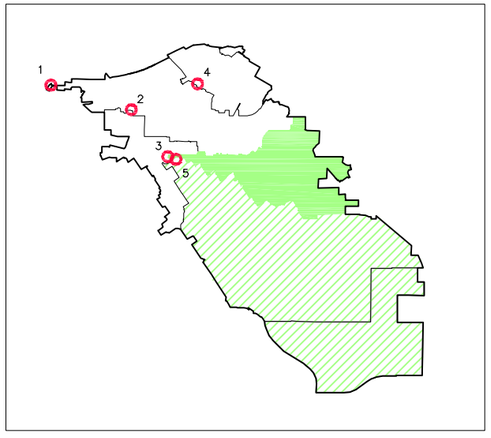
FLOW METER AREAS THAT
MERGE WITH FLOW METER 2

LEGEND

- STUDY MAIN AND MANHOLES
- FLOW METER LOCATION
- FLOW METER 1
- FLOW METER 2
- FLOW METER 3
- FLOW METER 4
- FLOW METER 5
- COUNTY AREA MAY BE SERVED BY CITY (FLOWS TO METER 5)



FLOW METER AREAS THAT
MERGE WITH FLOW METER 1



FLOW METER AREAS THAT
MERGE WITH FLOW METER 3

DATE: 12/15/05	DWN BY: CD
CITY OF RIVERSIDE PHOENIX SEWER STUDY	FIGURE 5
FLOW METER LOCATIONS	

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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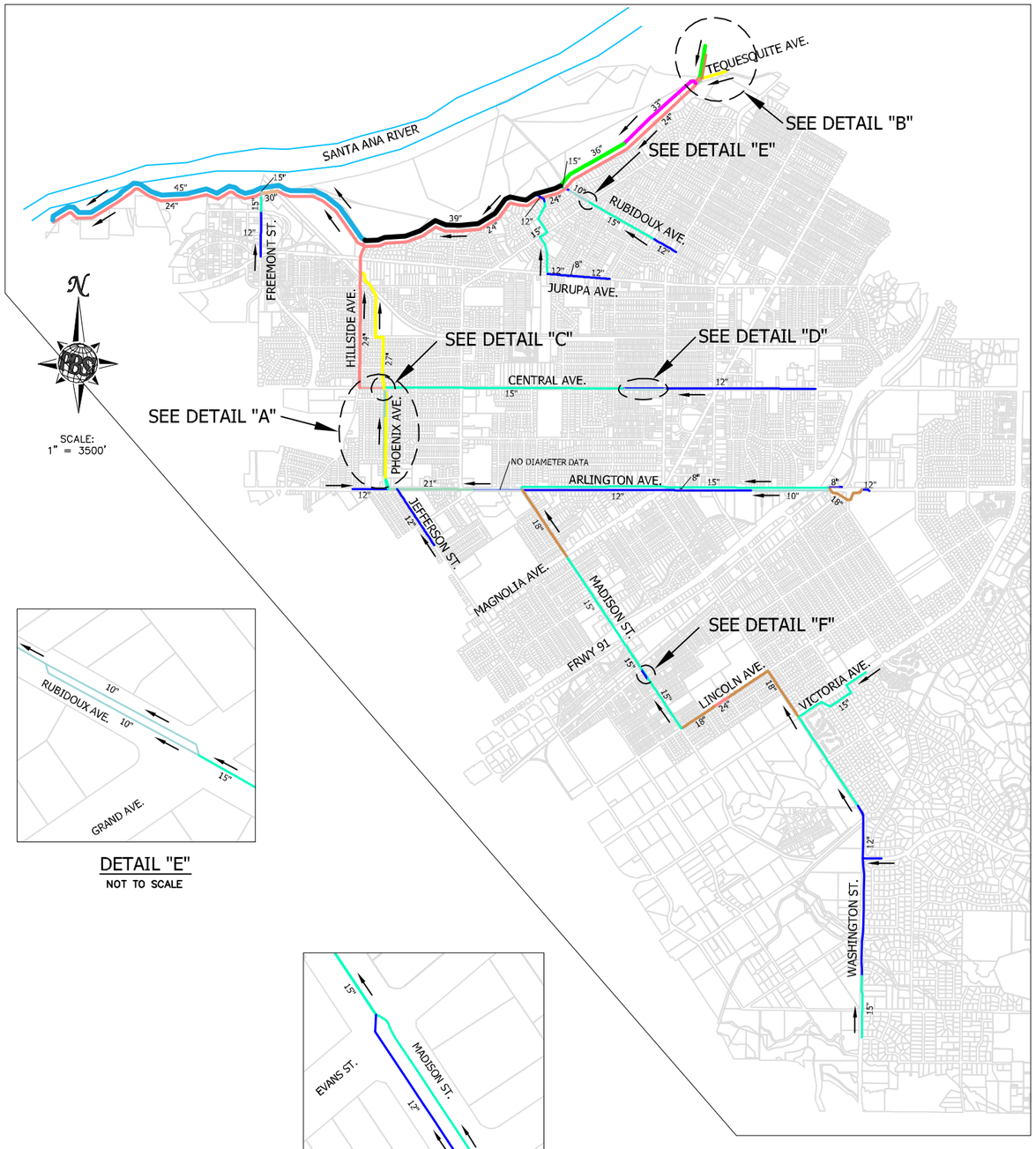

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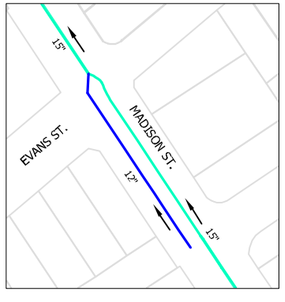

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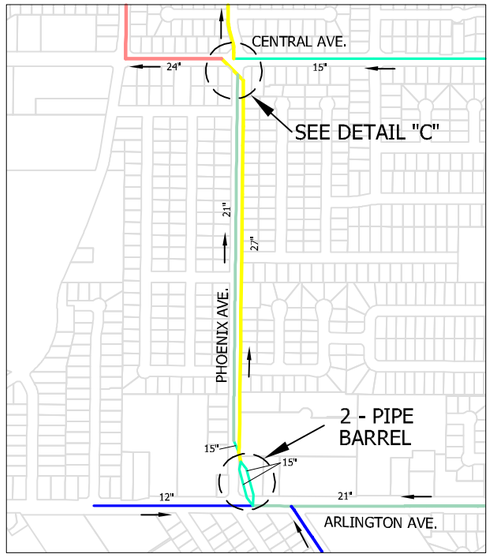

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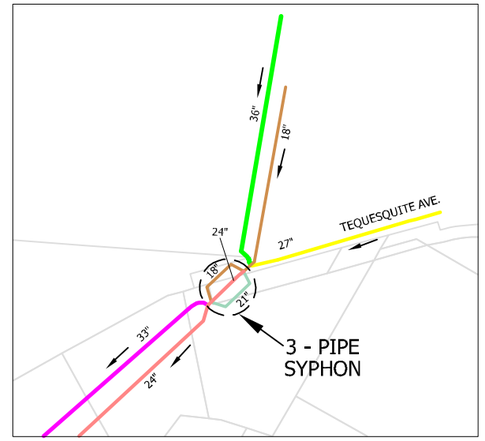

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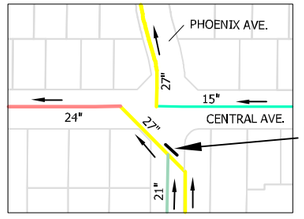

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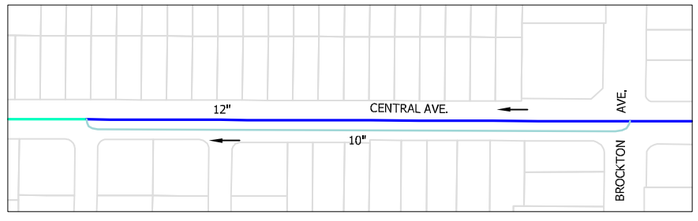

DETAIL "D"
NOT TO SCALE

LEGEND

- 8" DIAMETER PIPE
- 10" DIAMETER PIPE
- 12" DIAMETER PIPE
- 15" DIAMETER PIPE
- 18" DIAMETER PIPE
- 21" DIAMETER PIPE
- 24" DIAMETER PIPE
- 27" DIAMETER PIPE
- 30" DIAMETER PIPE
- 33" DIAMETER PIPE
- 36" DIAMETER PIPE
- 39" DIAMETER PIPE
- 45" DIAMETER PIPE
- NO DIAMETER DATA
- FLOW DIRECTION

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 6

SYSTEM PIPE DIAMETERS

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City were studied to ascertain characteristics of the system. The existing sewer manholes can be seen in Figure 7A and 7B and the pipes can be seen on figures 8A and 8B. The pipelines in the system are prefixed with letter "P" (for pipe) and the manholes are prefixed with letter "M" (for manhole) to match the Hydraulic Model. The description of sewer segments begins at the most upstream manhole and ends at the most downstream manhole. The sewer system is briefly described as follows:

- *Santa Ana River Sewer Line:* The sewer line along the Santa Ana River picks up wastewater flows from the Tequesquite, Northside and Spruce Sewer Basins. Tequesquite flows are collected at manhole M428 and Northside and Spruce flows are collected at manholes M428 and M430. The sewer line between manholes M428 and M426 is 27-inch in diameter. The sewer line between M429 and M426 is 18-inch and between M430 and M426, 36-inch. At manhole M426, which is the upstream manhole of a 3-barrel siphon, wastewater flows from all upstream sewer basins converge. The diameters of barrels in the siphon are 24-inch, 21-inch and 18-inch. These three pipelines converge at manhole M424 and transition into two parallel lines; a 24-inch diameter line and the other a 33-inch diameter line. The 24-inch diameter line begins at manhole M424 and runs southwesterly along the Santa Ana River until it reaches manhole M055. The 33-inch diameter line also runs southwesterly along the Santa Ana River and ends at manhole M088. A 36-inch diameter line extends from manhole M088 to manhole M087. At this junction, a 15-inch diameter connector joins manhole M087 to manhole M094. At that junction, the line transitions into parallel 39-inch and 24-inch lines. The 24-inch line extends from manhole M055 to manhole M053. At that point, it crosses the Jurupa Avenue pipeline and continues as a 24-inch line from M053 to M052. From M052, the line continues as a 24-inch diameter line until it reaches to manhole M001. The 39-inch diameter line begins at manhole M087 and continues to manhole M080. At this junction, the 39-inch line becomes a 45-inch diameter line. This line continues until it terminates at manhole M002 and joins the parallel 24-inch line. This pipeline segment begins near Tequesquite Arroyo Park and crosses the Union Pacific Railroad. This pipeline ends at the Regional Water Quality Control Plant.

- *Overlook Parkway Sewer Line*: The study sewer line along Overlook Parkway begins at manhole M292, located at the intersection of Alton Way and Overlook Parkway. It is a single-segment 12-inch diameter line that flows in the westerly direction from manhole M292 to M291. The sewer line collects wastewater flow from the residential areas

located on both sides of Overlook Parkway. It joins the trunk sewer line along Washington Street at manhole M291.

- *Victoria Avenue Sewer Line*: The 15-inch gravity sewer line along Victoria Avenue begins at manhole M281 located at the intersection of Stonegate Drive and Victoria Avenue. It flows in the westerly direction and joins the Washington Street Pipeline at manhole M271. Washington Elementary School is located on Victoria Avenue and Washington Park is on the intersection of Mary Street and Victoria Avenue. It picks up wastewater flow from the residential developments east of Hwy 91 and along Victoria Avenue.

- *Washington Street Sewer Line*: The study sewer line along Washington Street begins at manhole M307 at the intersection of Highridge Street. This sewer line consists of three different pipe segments: 12-inch, 15-inch and an 18-inch diameter. The 15-inch sewer line collects wastewater flows from the residential development and flows in the northerly direction along Washington Street. The sewer line between manholes M307 and M302 is 15-inch, and it transitions into a 12-inch between manholes M302 and M288. There, it crosses the Overlook Parkway Sewer Line as well as the Gage Canal. The sewer line between M288 and M271 is 15-inch.The sewer line between manholes M271 and M267 is 18-inch. At manhole M267 it joins Lincoln Avenue trunk sewer line.

- *Lincoln Avenue Sewer Line:* The trunk sewer line along Lincoln Avenue begins at manhole M267 located at the intersection of Washington Street and Lincoln Avenue. This trunk line picks up flow from the Washington Street sewer line at this location. This sewer line consists of two different pipe segments: an 18-inch and a 24-inch diameter line. The sewer line between manhole M267 and M263 is 18-inch. There is a short 24-inch diameter segment between M263 and M262. It then returns to an 18-inch line from M262 to M259 where it terminates at the Madison Street sewer line.

- *Madison Street Sewer Line:* The trunk sewer line along Madison Street begins at the intersection of Madison Street and Victoria Avenue. At this location, it picks up wastewater flow from the Victoria Avenue sewer line. This sewer line consists of three different pipe segments (12-inch, 15-inch and an 18-inch). This pipeline begins as a 15-inch line at manhole M259 and continues along Madison Street in the northerly direction up to manhole

M252. At this location a 12-inch pipe segment runs parallel to the 15-inch line between manhole M252 and M249. From manhole M249, a single 15-inch line continues to manhole M238. Finally, an 18-inch diameter sewer line continues in the northerly direction to manhole M228, where it joins the trunk sewer line along Arlington Avenue.

- *Jefferson Street Sewer Line:* The sewer line begins at manhole M413, located at the intersection of Jefferson Street and Willow Avenue. This 12-inch sewer line continues in the northwesterly direction as one size until it reaches manhole M213. At this location, it joins the trunk sewer line along Arlington Avenue. Don Jones Park, adjacent to Sycamore Avenue, and Jefferson Elementary School, are situated on Jefferson Street. There is also a fire station on Streeter Avenue and Arlington Avenue.

- *Arlington Avenue Sewer Line:* The sewer line along Arlington Avenue begins at the intersection of Arlington Avenue and McMahon Street. This line consists of various pipe segments ranging from 8-inch to 21-inch in diameter. The first segment begins at manhole M367 as a 12-inch sewer line and continues to manhole M365. The second pipeline begins at manhole M359 as a 12-inch line and traverses parallel to the first line. At manhole M365, the pipe size changes to 18-inch and continues to manhole M356. From there, it transitions into a 10-inch diameter line until it reaches manhole M340. The parallel line consists of two 8-inch segments from M358 to M355. An 18-inch connector joins these two parallel lines between manholes M356 to M355. The sewer line continues as a 15-inch line from manhole M355 to manhole M315 where it becomes 12-inch until it reaches the end of the parallel segment at manhole M228. At the intersection of Arlington Avenue and the Hwy 91, a 12-inch pipe segment continues in the westerly direction to manhole M358. At this location, it transitions to 8-inch and continues to manhole M355 where it becomes a 15-inch line running westerly to manhole M315. At this location there is a small 12-inch diameter segment. Beyond M315 it continues to manhole M226 as a 15-inch line. At this location the parallel sewer lines join. An 18-inch line connects the parallel lines from manhole M356 to manhole M355. Beyond manhole M226 is a single 21-inch line, crossing the Jefferson Street trunk sewer line and the Phoenix Avenue trunk sewer line. At manhole M219, a 12-inch diameter line runs easterly on Arlington Avenue to manhole M212. The sewer line joins the Phoenix Avenue trunk sewer line at manhole M212.

  The line crosses the Metrolink Railroad near Hwy. 91. The California School for the Deaf on Arlington Avenue is one

of the major contributors of wastewater flow. This sewer line picks up wastewater flow from residential and commercial development all along Arlington Avenue.

- *Central Avenue Sewer Line:* The sewer line on Central Avenue is comprised of 12-inch, 15-inch and 24-inch segments. It begins at manhole M206 at the intersection of Central Avenue and Riverside Avenue as a 12-inch line. It continues from manhole M206 in the westerly direction until it reaches manhole M183, where it transitions to a 15-inch diameter sewer line and continues to manhole M135. From M135, a 24-inch sewer line continues to manhole M123. The line collects wastewater flow generated from the residential development on the north and south side of Central Avenue. It also picks up wastewater flow from Riverside Plaza. This sewer line joins Phoenix Avenue trunk sewer line near Riverside Municipal Airport.

- *Phoenix Avenue Sewer Line:* This sewer is comprised of 15-inch, 21-inch and 27-inch segments. It begins at manhole M212 and continues as a 15-inch line for a short length to manhole M211 at the intersection of Phoenix Avenue and Arlington Avenue. Between manhole M211 and M210, the size is 27-inch. The sewer line between manhole M210 and M209 is 15-inch. At this junction, the single line diverges into two parallel lines running northerly on Phoenix Avenue. The first line begins at manhole M210 and continues as a 27-inch until it reaches manhole M140. The second line begins at manhole M209 and continues as a 21-inch until it reaches manhole M139. At this location, the parallel lines transition into one line running northerly on Phoenix Avenue (27-inch sewer line) to manhole M110. The pipeline joins the Hillside Avenue trunk sewer line at manhole M110. The line collects wastewater flow from the commercial and residential area east of the Riverside Municipal Airport.

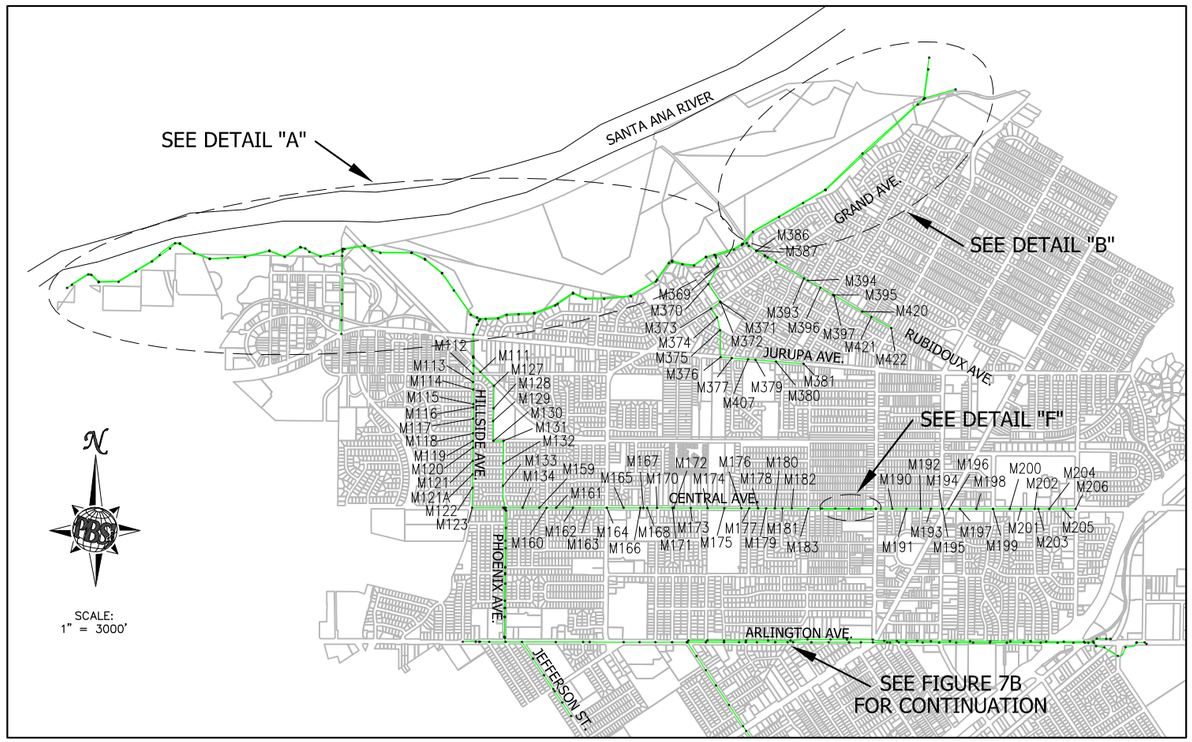
- *Hillside Avenue Sewer Line:* The initial reach of this sewer line is a 24-inch segment that begins at manhole M123 at the intersection of Central Avenue and Hillside Avenue. It continues north until it reaches manhole M107, where it becomes a short 27-inch diameter segment to manhole M106. At manhole M106, it continues as a 24-inch diameter line until it ends at manhole M081, where it crosses the Santa Ana River Pipeline and the Union Pacific Railroad. The pipeline joins the Santa Ana River trunk sewer line at manhole M081. The sewer line collects wastewater flow from the commercial and residential area east of the Riverside Municipal Airport.

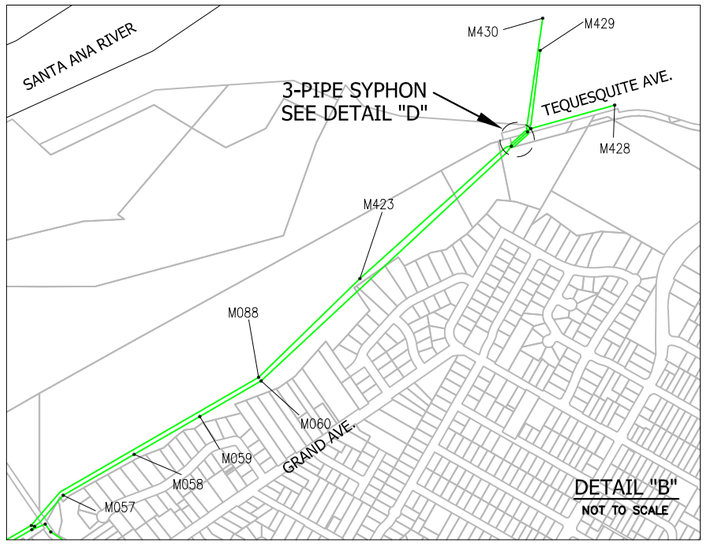
- *Rubidoux Avenue Sewer Line:* The sewer line along Rubidoux Avenue begins at manhole M422 at the intersection of Rubidoux Avenue and Brockton Avenue. It consists of three sewer segments (10-inch, 12-inch and 15-inch). The 12-inch sewer line begins at manhole M422 and continues in a westerly direction to manhole M420. There, it transitions into a 15-inch diameter sewer line until it reaches manhole M392, where it splits into two segments. These are each 10-inch diameter lines ending at manhole M388. The sewer line between M388 and M384 is 10-inch in size. Thereafter, it continues as a 12-inch line to manhole M055, where it joins the Santa Ana River Pipeline. It picks up wastewater flow from the residential area east of Rubidoux Avenue.

- *Jurupa Avenue Sewer Line:* The sewer line along Jurupa Avenue begins at the intersection of Tower Road and Jurupa Avenue. It consists of 8-inch, 12-inch and 15-inch segments. It begins at manhole M381 as a 12-inch diameter line and runs easterly along Jurupa Avenue until it reaches manhole M379. There, it transitions to an 8-inch diameter sewer line for a small segment of pipe between manhole M379 and M407. From manhole M407 to manhole M376, the size is 12-inch. At this location, it continues in a northerly direction as a 15-inch diameter line until it reaches manhole M368. The line from manhole M368 to M053 is 12-inch, where it joins the Santa Ana River trunk sewer line. This sewer line picks up wastewater flow from the residential areas north and south of Jurupa Avenue.

- *Freemont Street Sewer Line:* This study area sewer line begins at Jurupa Avenue. It consists of three sewer segments varying in sizes from 10-inch to 15-inch. A 12-inch diameter line begins at manhole M101 and continues in a northerly direction to manhole M097. From manhole M097 to manhole M096, the line is 15-inch diameter. At this location, the size changes to 10-inch diameter to manhole M076, where it joins the Santa Ana River Pipeline. This sewer line picks up wastewater flow from the commercial areas east and west of Freemont Street.

3.4 Tributary Areas





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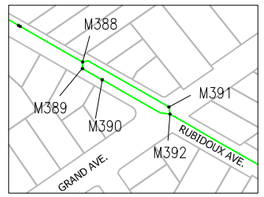

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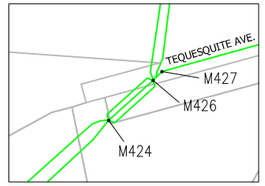

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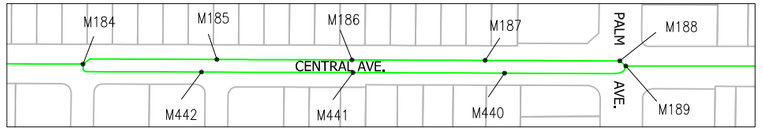

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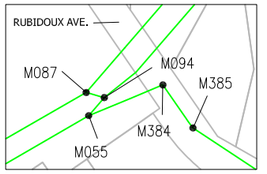

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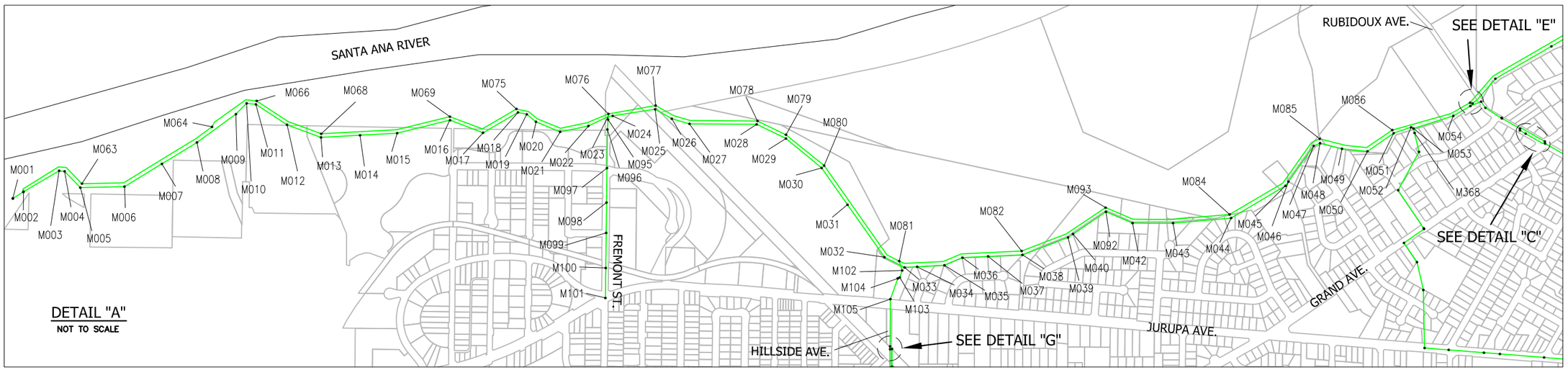

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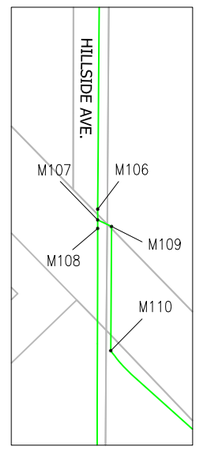


DETAIL "G"
NOT TO SCALE

LEGEND

GRAVITY SEWER

M001 MANHOLE NUMBER

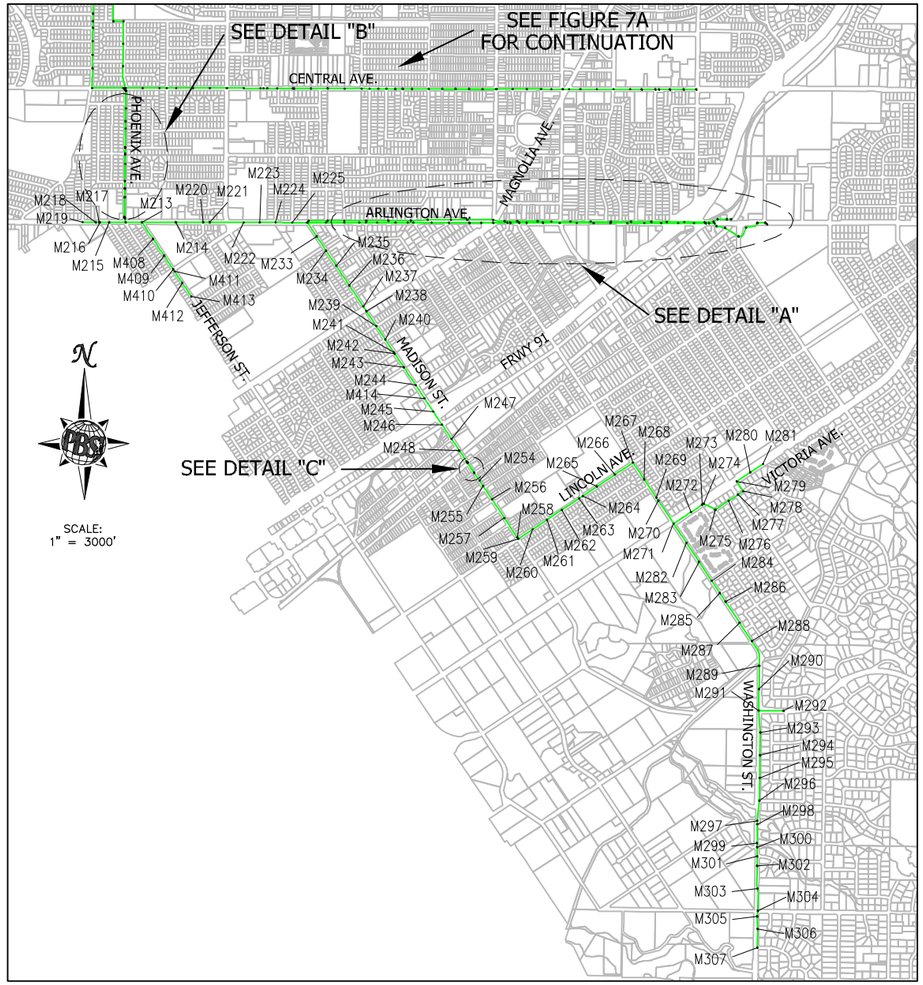
Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

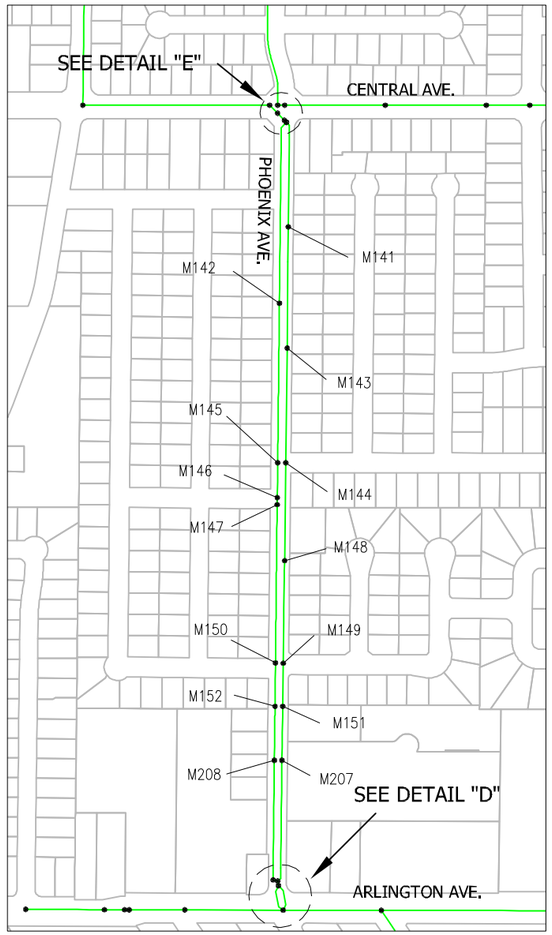
DATE: 12/15/05 | DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 7A

EXISTING MANHOLES - PART 1





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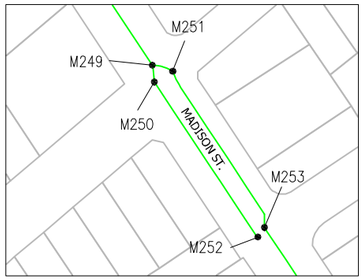

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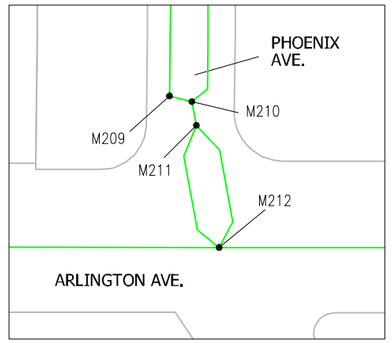

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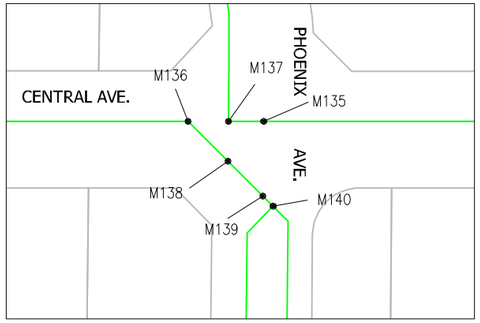

DETAIL "E"
NOT TO SCALE

LEGEND

GRAVITY SEWER

M001 MANHOLE NUMBER

DETAIL "A"
NOT TO SCALE

DATE: 12/15/05 DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 7B

EXISTING MANHOLES - PART 2

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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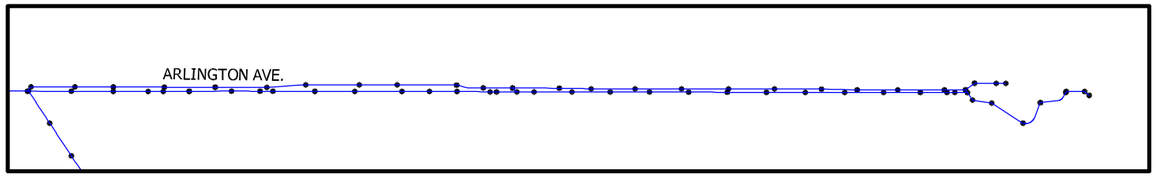

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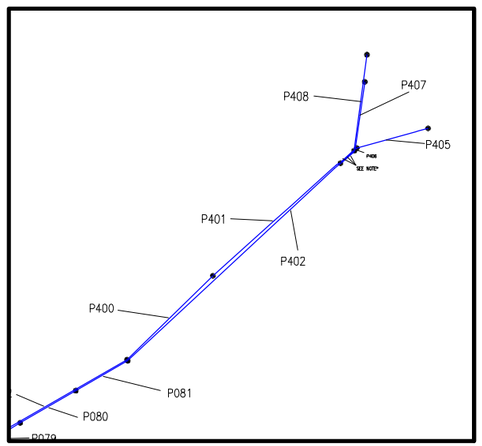

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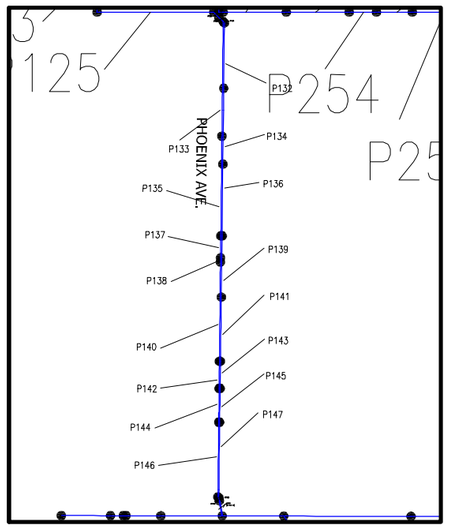

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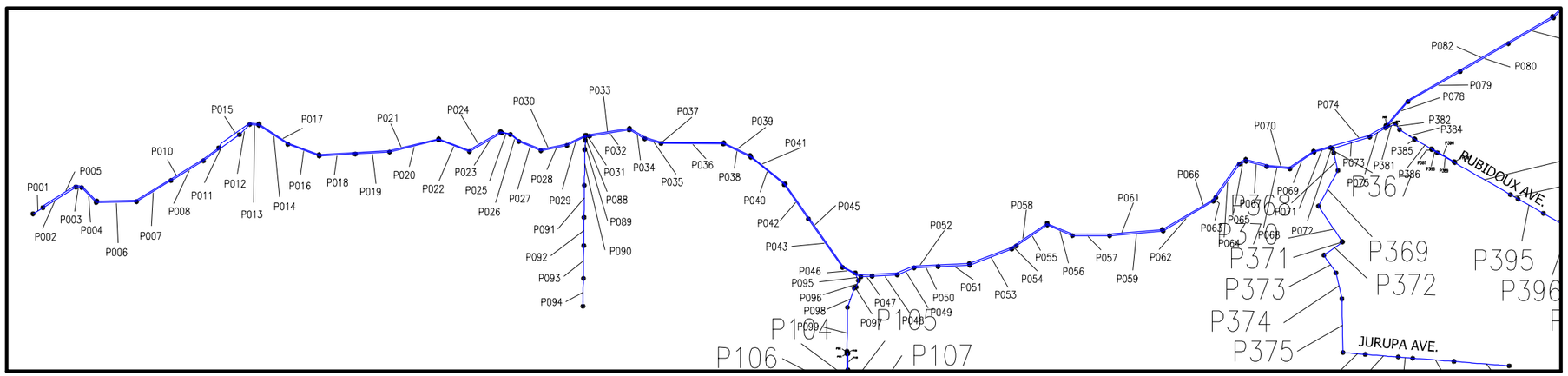

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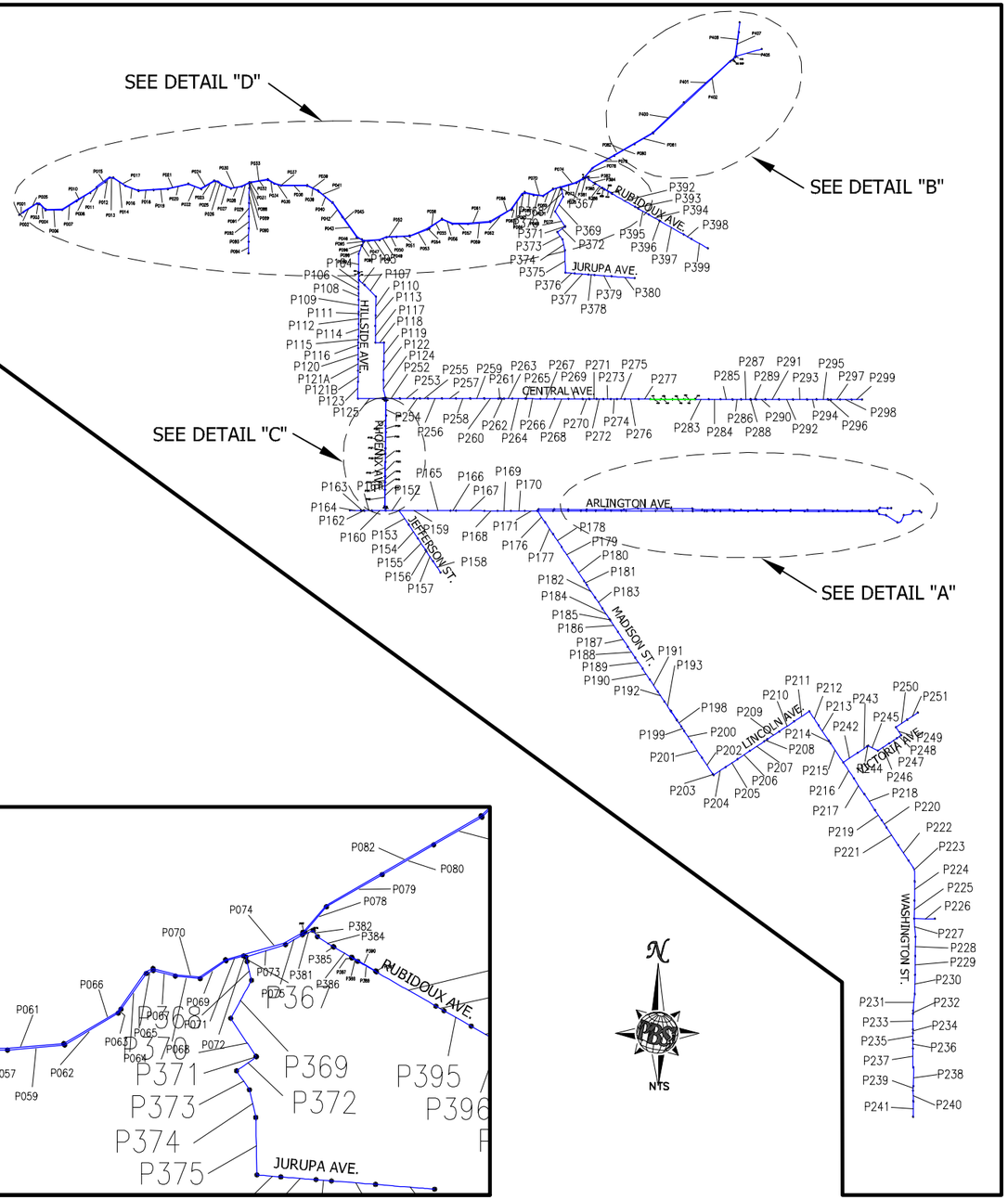

LEGEND

GRAVITY SEWER

P001 PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 8

EXISTING PIPELINES

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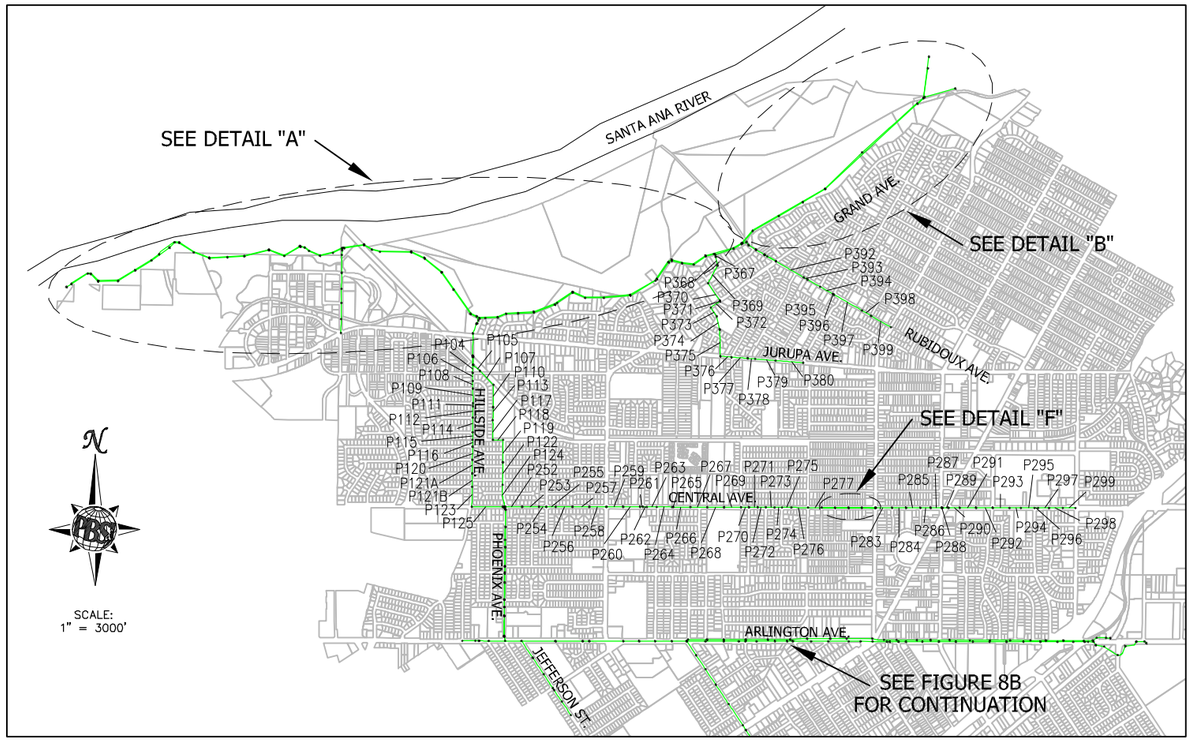

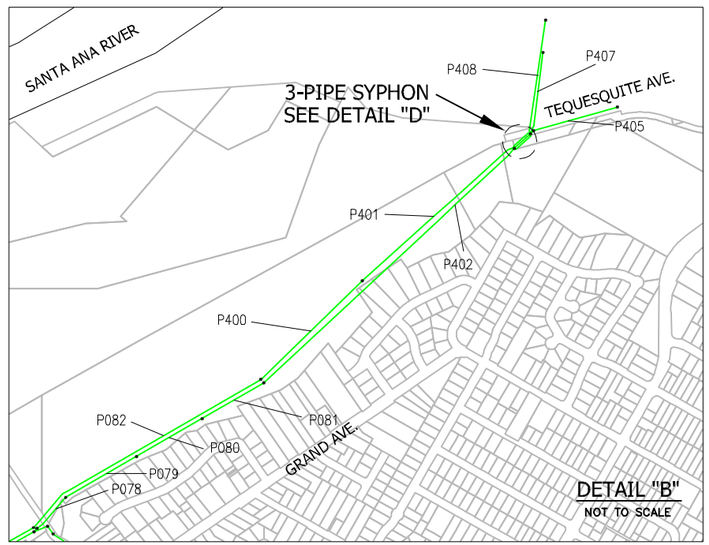

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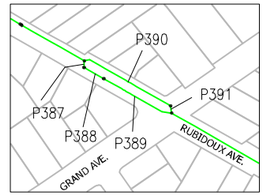

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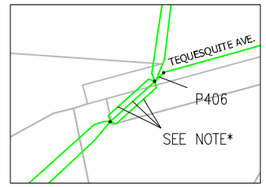

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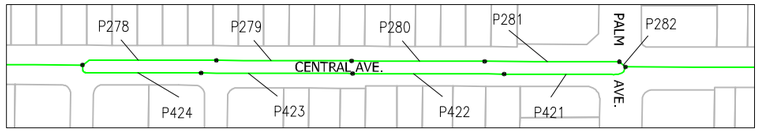

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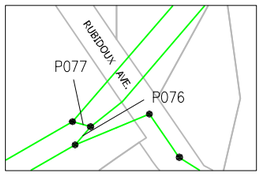

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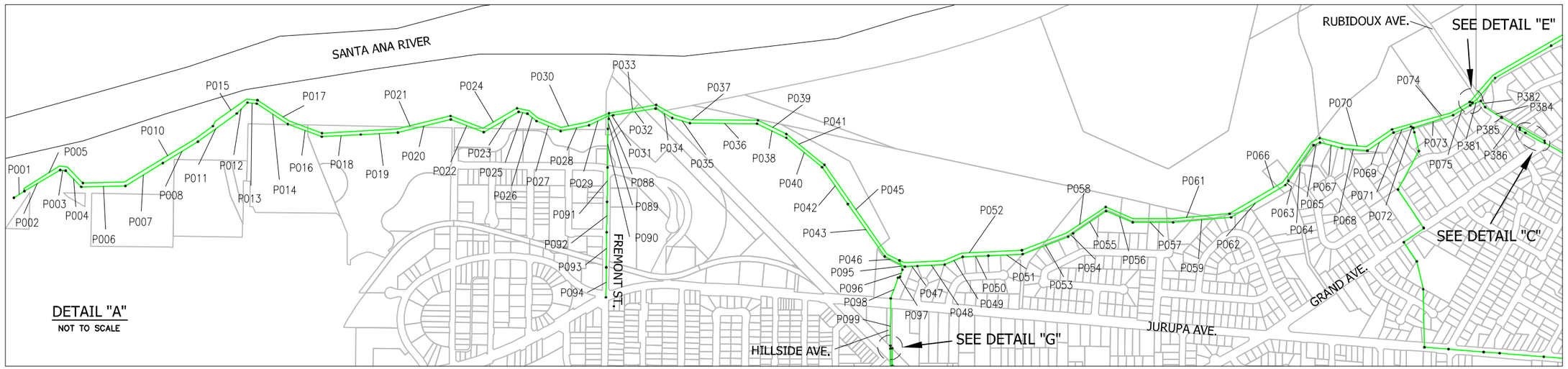

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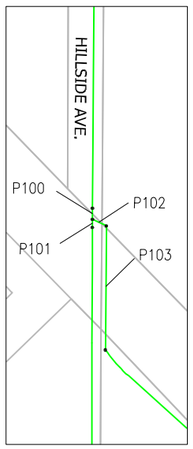

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LEGEND

GRAVITY SEWER

P001 PIPELINE NUMBER

NOTE* THIS 3-PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 12/15/05 DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 8A

EXISTING PIPELINES - PART 1

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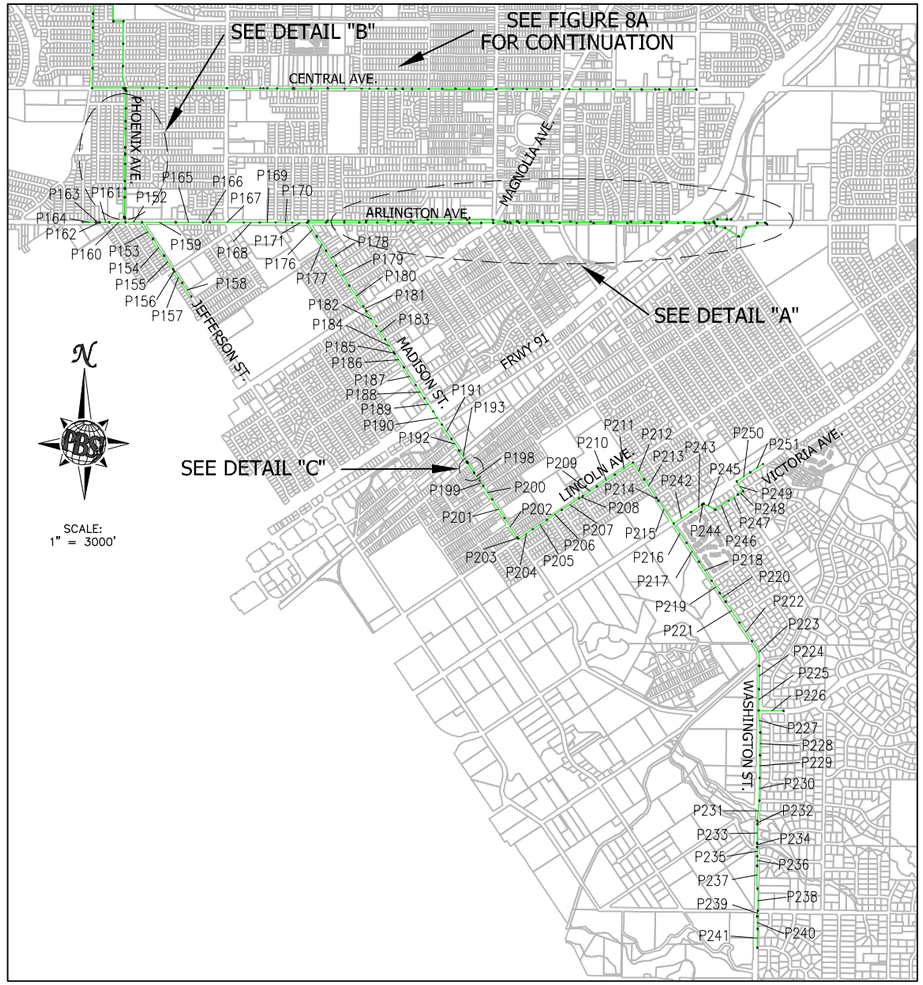

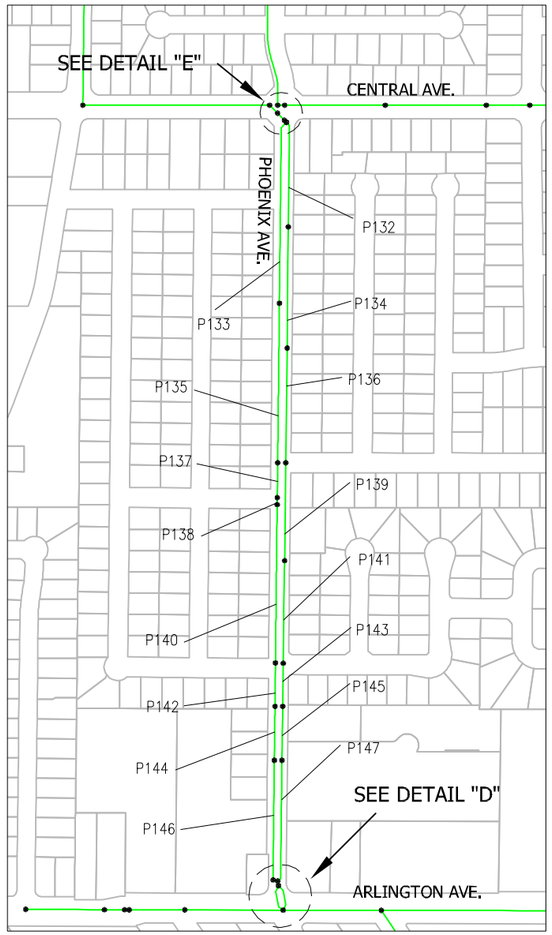

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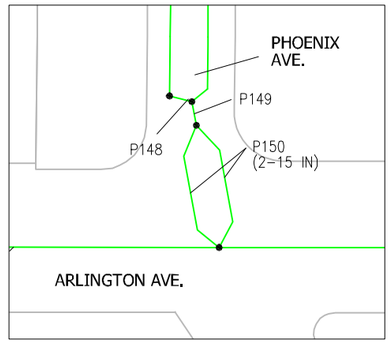

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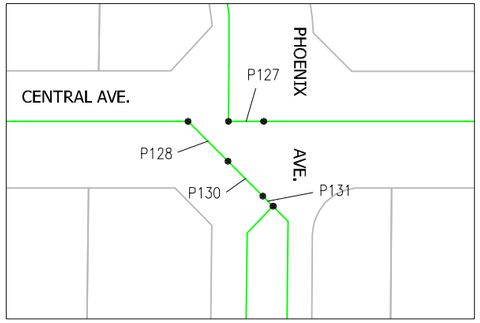

DETAIL "E"
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DETAIL "B"
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LEGEND

GRAVITY SEWER

P001 PIPELINE NUMBER

DETAIL "A"
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DATE: 12/15/05 DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 8B

EXISTING PIPELINES - PART 2

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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The study area is divided into 21 sub-areas, each area having a land use or flow pattern distinctive from the other. These sub-areas are tributary to a particular meter location either individually or collectively. Because of their strategic locations, meters upstream to a cumulative meter can be subtracted out to reduce the cumulative effect. See Figure 4 for details of tributary sub-areas and Figure 5 for meter locations. The following is the listing of tributary sub-areas and their contribution to a particular meter location.

Meter No. 1: All sub-areas are tributary to meter No. 1, located at the entrance of the Regional Water Quality Control Plant.

Meter No. 2: Sub-areas 4, 14 (part), 16 (part) 17 and 20 are tributary to meter No. 2 located on Hillside Avenue near the Mountain View Avenue intersection.

Meter No. 3: Sub-areas 5, 13 (part), 14 (part) 15 and 16 (part) are tributary to meter no. 3, located on Arlington Avenue near Madison Street intersection.

Meter No. 4: Sub-areas 2 and 3 (part) are tributary to meter 4, located on Rubidoux Avenue at the Via Dos Caminos Avenue Intersection.

Meter No. 5: Sub-areas 6, 7, 8, 10 and12 are tributary to meter 5, located on Madison Street at the intersection of Magnolia Avenue.

Within each sub-area there is generally a distinct mixture of land use, that generates a unique quantity and diurnal pattern of wastewater flows. For identification of land use patterns, data provided by the City of Riverside in GIS Arcview format was used. The following table summarizes land uses within the particular sub-areas.

Table 3-1 summarizes the sub-areas and land uses within the sub-areas that are currently contributing to the existing sewer system.

Table 3-1

Developed Tributary Areas and Current Wastewater Generating Land Use

Sub Area	SFR (Acres)	MFR (Acres)	Commercial (Acres)	Industrial (Acres)	School (Acres)	Total (Acres)
1	2	0	0	0	0	2
2	361	9	39	0	8	417
3	142	0	0	0	0	142
4	118	0	30	0	6	154
5	509	0	24	0	78	611
6	36	0	0	0	0	36
7	5	0	0	0	0	5
8	1,126	0	0	0	0	1,126
10	577	0	160	0	0	737
11	104	7	52	0	54	217
12	434	9	112	0	90	645
13	21	0	89	0	0	110
14	61	7	76	0	10	154
15	159	6	25	0	19	209
16	363	22	62	0	12	459
17	117	7	12	0	0	136
18	55	3	15	0	0	73
19	103	7	4	0	12	126
20	203	0	13	0	0	216
21	2	0	97	55	0	154

SFR – Single Family Residential
MFR – Multi Family Residential

4.0 DETERMINATION OF SEWER FLOWS

4.1 Flow Monitoring

Flow Monitoring was conducted at five (5) sites in order to accomplish the following: (See Figure 5 for locations of Flow Monitoring Stations).

- Establish current flow levels.
- Verify or adjust flow coefficients.
- Establish characteristic flow patterns (Diurnal Curves) for the model (See Figures 14-18).
- Confirm peak to average flow relationships.
- Help prioritize recommended improvements.

Meter locations were chosen to observe actual flow characteristics for the various sub-areas and to provide a continuous record of measured flows over a period of time (three weeks for this study). Meter locations were also chosen in such a manner that current flow quantities at the RWQCP could be quantitatively determined. The City measures inflow from Santa Ana Trunk Sewer Line at RWQCP at one minute intervals. The flow records received from the City were used for flow comparison and determination of diurnal pattern at meter location No. 1. The following is an amplification of the logic for placement of each flow meter.

- Meter No. 1; location is at the entrance of the RWQCP where the 45-inch and 24-inch lines join – This location was chosen because it carries all the flow generated from all the residential, industrial and commercial areas in the Phoenix Sewer System and all upstream sewer basins (Tequesquite, Spruce and Northside). The flow pattern at this location reflects a diurnal pattern for mixed land use.

- Meter No. 2; location on Hillside Avenue near Mountain View Avenue – This location was chosen to observe flow generated from the mixed use along the west side of the study area. This meter intercepts flow generated from a matured residential / commercial area. The flow pattern at this location reflects a diurnal pattern for mixed land use. This meter also records majority of cumulative flows from meters 3 and 5.

- Meter No. 3; location on Arlington Avenue west of Madison Street – This location was chosen to measure the flow from residential and commercial areas on both sides of Route 91.

The flow pattern at this location reflects a mixed diurnal pattern for mixed residential-commercial land use. Meter 3 also picks up flows from meter 5.

- Meter No. 4; location on Rubidoux Avenue near the intersection of Via Los Caminos Avenue – Measures wastewater flow from the northerly end of study area mostly west of Magnolia Avenue. This area consists of primarily residential land use.

- Meter No. 5; location on Madison Street south of Arlington Avenue – This location was chosen to measure the flow from residential areas along Madison Street, Lincoln Avenue, Victoria Avenue and Washington Street. The residential land use in this portion of study ranges from low density to medium-high density. The diurnal flow pattern can be used to estimate and calibrate future flow patterns.

4.2 Results of Flow Monitoring

Measurement of sewer flows is an imprecise science, as the in-line equipment is placed in a harsh environment and is subject to solids interference, calibration, turbulence and other problems, which can impede the accuracy. Installed equipment must be frequently inspected and maintained, and monitoring results interpreted, evaluated for reasonableness, and sometimes adjusted. In this particular application, metered flow information was generally good. However, some flows at specific meter locations did not display consistent values. Graphical results at each site were carefully reviewed for consistency and reasonableness, using the following general guidelines.

- Where the magnitude or daily pattern varies significantly from one non-holiday weekday to the next, the data is likely to be flawed.
- Where the base (low) flows are rising during the flow monitoring period, the data is suspect.
- Where the algebraic sum of flows from meters in series are significantly out of sync, the data from one or more meters may be faulty.
- Where minimum (nighttime) flows are abnormally high or algebraically inconsistent, the data is suspect.
- Where the measured depth data and velocity data are inconsistent, the data is suspect.

Metered flows displaying one or more of the above flaws were purged or adjusted based on reasonable assumptions.

At each meter location, the flow-monitoring device measures depth of flow and velocity. Upon reviewing the report submitted by Downstream Services, and from discussions with their staff, it was determined the data (depth or velocity) that is more consistent should be used for determination of flow. By using depth of flow readings and inputting pipe characteristics from record drawings (slope, size and roughness "n" values), sewage flow can be calculated using Manning's equation. The raw flow data have been included in Appendix "A".

The flow data at each meter site, adjusted based on the depth measurement, are shown in Figures 9 through 13. The following relevant observations were made from evaluation of the measured flows:

- Flows measured at meter location 5 shows a low amount of flow although it covers a larger portion of study area. This may be attributed to the fact that most of the areas contributing to meter 5 are low density residential areas (2-3 dwelling units per acre).

- Flows measured at meter location 4 were not consistent for the period October 1 to October 9. Flow hydrographs for October 10 to October 20 were used for analysis.

- At meter location 2, the flows measured during week days are slightly higher than weekends. The land uses contributing to this meter include residential, commercial and institutional establishments. The closures of many commercial and institutional establishments could explain the lower measured flows during weekends

5.0 ESTIMATED ULTIMATE FLOW

5.1 Methodology

Future wastewater flows in the study area are estimated by applying unit (per acre or per capita) flow factors to the projected "ultimate" land use acreage or population in each sub area. As discussed in Section 2, ultimate land uses within the study area are estimated based on the City's current General Plan (which governs future development/redevelopment) and input from City staff. The major contributor to the projected increase in wastewater flow in the future is development of low density residential areas southeast of Victoria Avenue. For purposes of this study, it is assumed that these areas will be developed by the year 2020.

5.2 Flow Coefficients

A review of commonly used flow coefficients (or unit factors) was performed to arrive at preliminary criteria, which is an appropriate starting point for the study area.

Flow coefficients are commonly expressed in terms of cubic feet per second (cfs) of average dry weather flow (ADWF) per acre of a specific land use type. For population based estimates, flows are expressed in gallons per capita per day (gpcd). Peak flow generation rates can be estimated by applying peaking factors to the average flow, with factors often based on observed peak-to-average ratios from previous studies. However peaking factors and diurnal flow patterns vary greatly from one setting to another. Peaks for various uses differ not only in magnitude, but also in time of the day. The diurnal patterns are thus a composite picture of inflows that are not simultaneous, but rather staggered throughout the day. Also, peaks are attenuated by lag times and in-pipe storage as the flows move downstream. Notwithstanding the above, diurnal peaking factors are also estimated for each land use type to estimate peak generation rates.

For preliminary estimation of wastewater flow, the document "Criteria for Sewer Facility Design, Public Works Department, City of Riverside" was used. (See Appendix "B"). The document states the following general guidelines for estimation of wastewater flows.

Flows from Residential Developments:

- Land use shown in the City's General Plan.
- No. of dwelling units per acre within a certain land use.

- Persons per living unit determined from the latest census data for the study area. However, it should not be less than an average of 2.75 persons per living unit.
- Average wastewater flow based on 65 gallons per capita per day.
- Peak to average flows to be determined from the graphs.

Flows from non-residential developments:

- Industrial Developments – Peak flow; 0.012 cfs per acre.
- Commercial Developments – Peak flow 0.01 cfs per acre.
- Offices – 30 gallons per capita (employee on site) per day peak flow.
- Schools – 0.01 cfs/acre peak flow.
- Laundromat – 580 gallons per machine per day peak flow.

5.3 Representative Diurnal Hydrographs

The study area is comprised of a variety of unique land uses. For the purpose of defining characteristic diurnal patterns, flow from each sub-basin was analyzed and percentage of flow contribution from each land use type was estimated. Although only a few of the tributary sub areas flowing to the meter locations are comprised of a single land use category, several are dominated by one or two categories, and are thus selected as being representative of the diurnal flow patterns for those land uses. The diurnal patterns were established at each meter location, and the model was calibrated for mixed land use patterns. The following diurnal patterns were used for the modeled peak flow evaluation.

- Flow at meter location 1: Mixed Land Use Pattern (Residential, Commercial and Industrial). The diurnal pattern was derived from the flow data at meter location 1.
- Flow at meter location 2: Mixed Land Use (Residential and Commercial)
- Flow at meter location 3: Mixed Land Use (Residential and Commercial)
- Flow at meter location 4: Single Family Residential
- Flow at meter location 5: Mixed with residential predominance

These representative diurnal hydrographs are shown in Figures 14-18. The flow patterns are used in the model to estimate the

percentage of Average Dry Weather Flow (ADWF) contributed at specific times throughout the day.

Figure 9

Flows at Meter 1 (Adjusted)

Meter Location - at the entrance of the RWQCP on a 48-inch Sewer

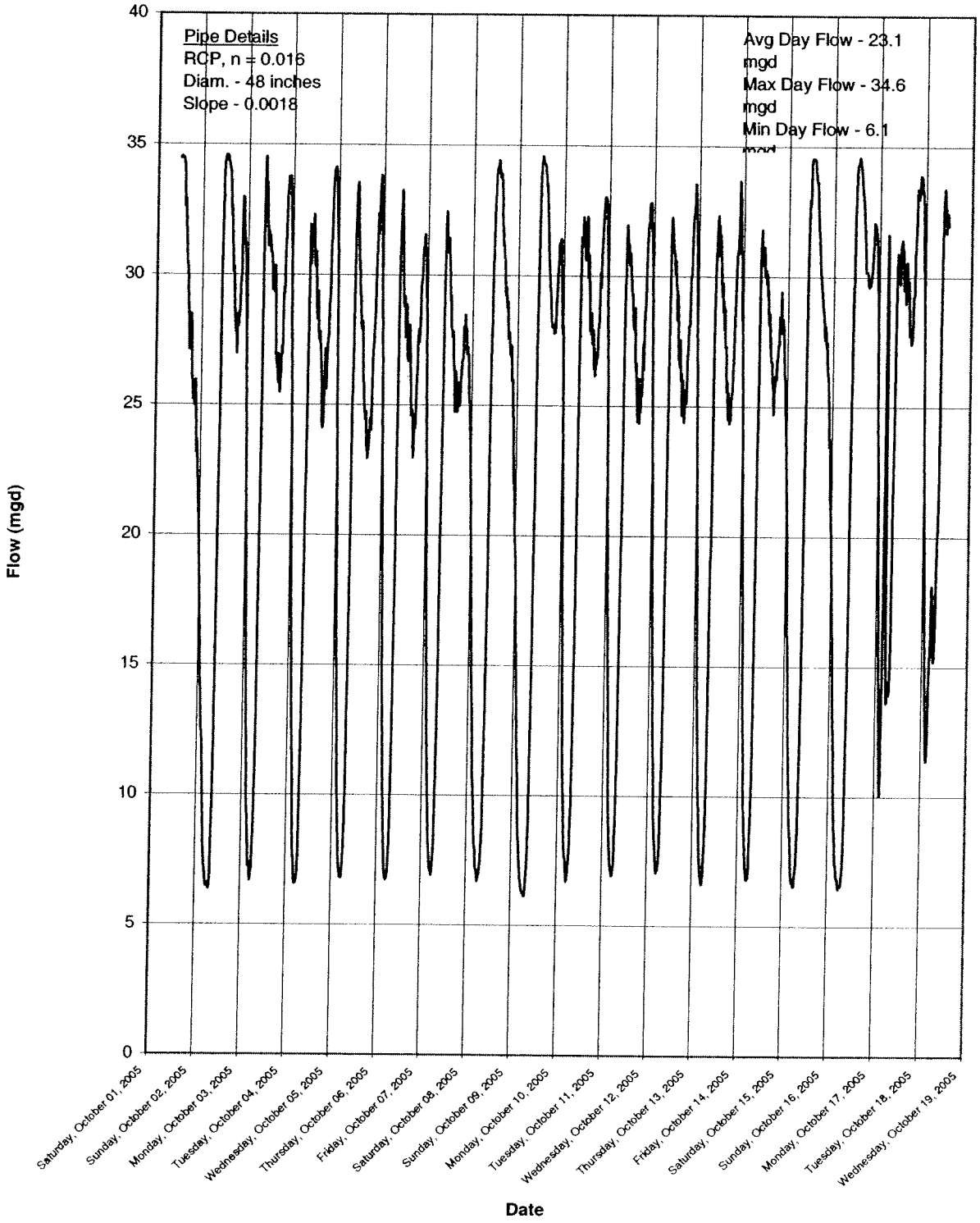


Figure 10

Flow at Meter 2 (Adjusted)

Meter Location - Hillside Ave. near Mountain View Ave. on a 24-inch Sewer

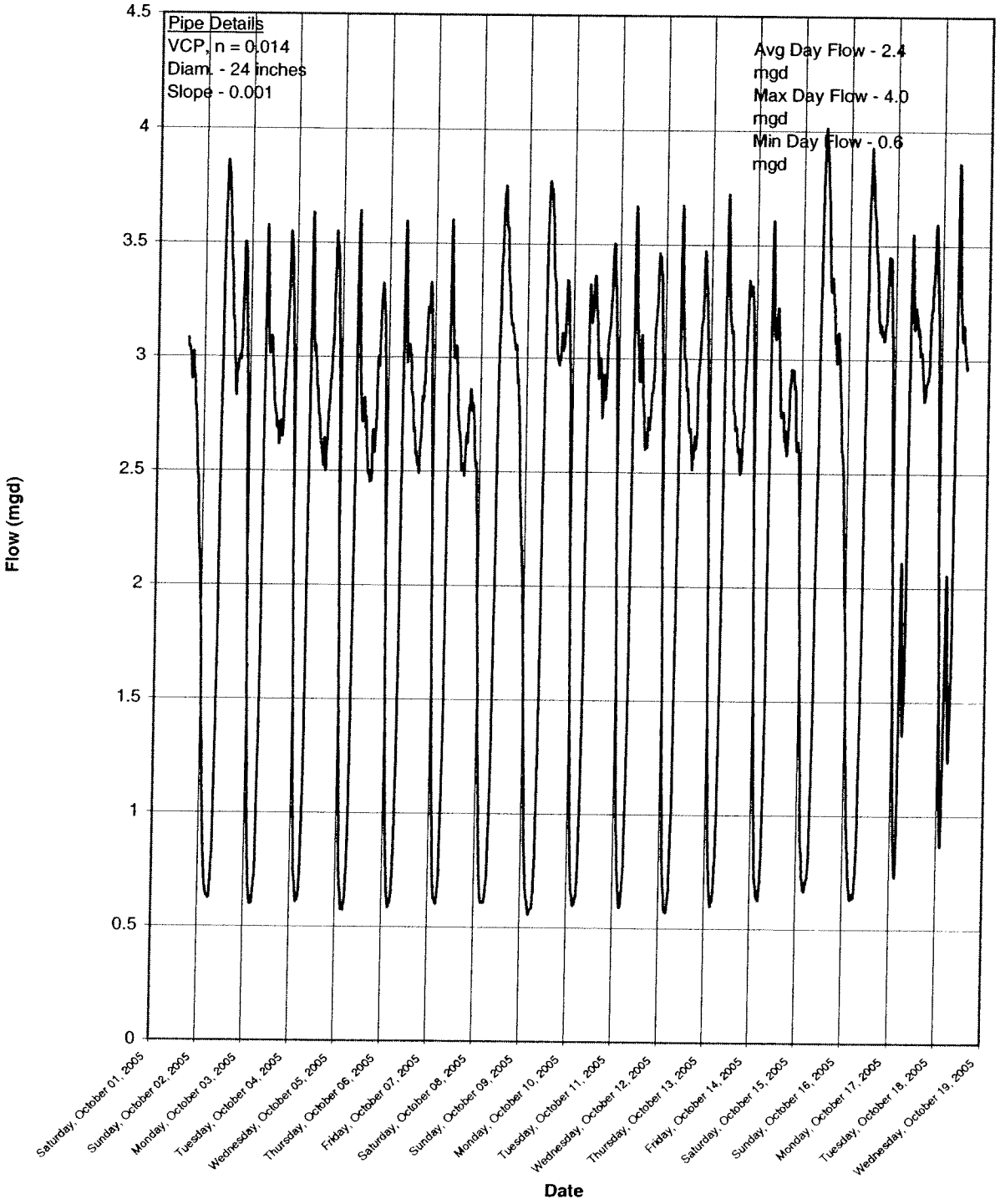


Figure 11

Flow at Meter 3 (Adjusted)

Meter Location - Arlington Ave. near Madison St. on a 21-inch Sewer

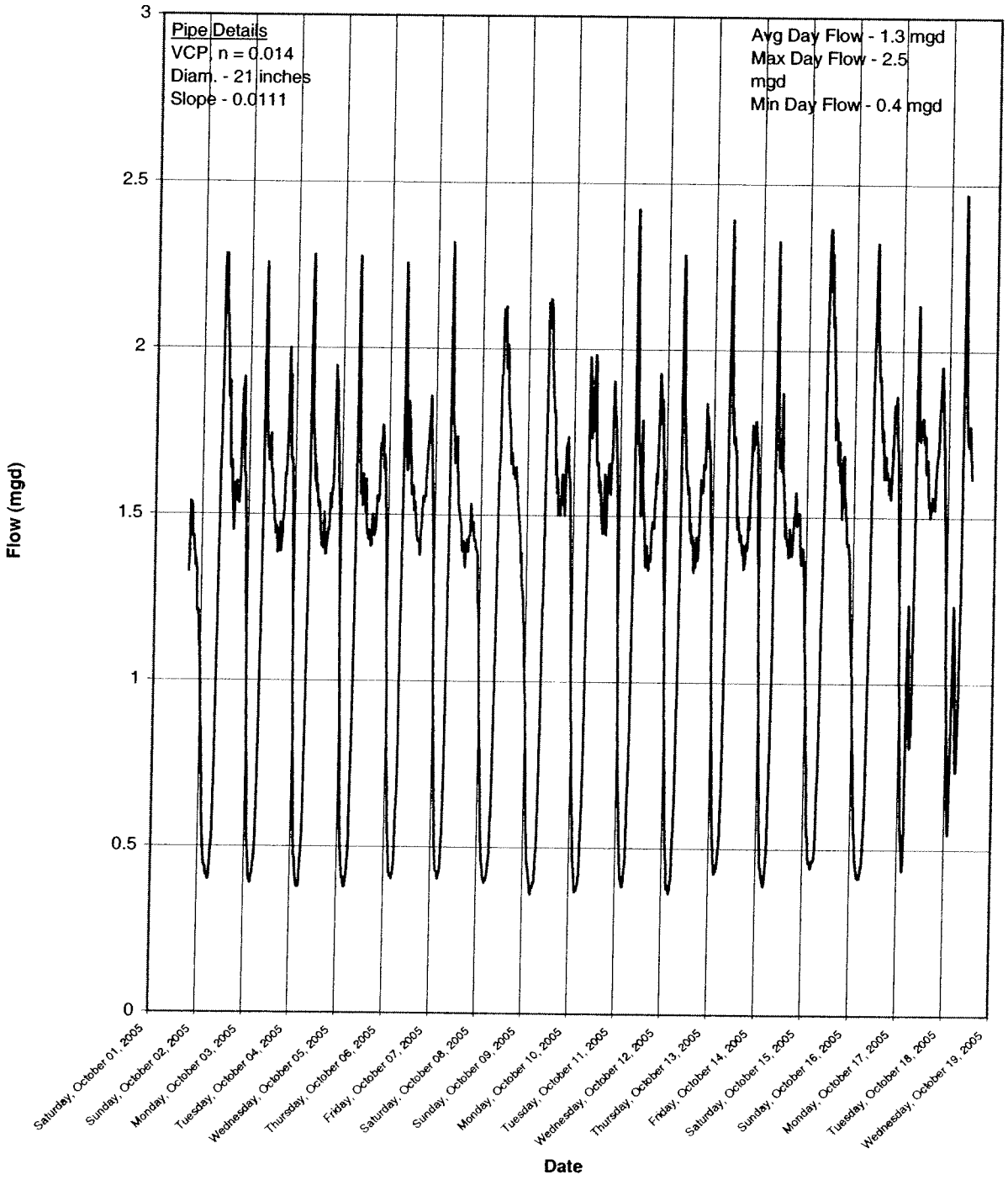


Figure 12

Flow at Meter 4 (Adjusted)
Meter Location - Rubidoux Ave. near Via Dos Caminos Ave.
on a 15-inch sewer

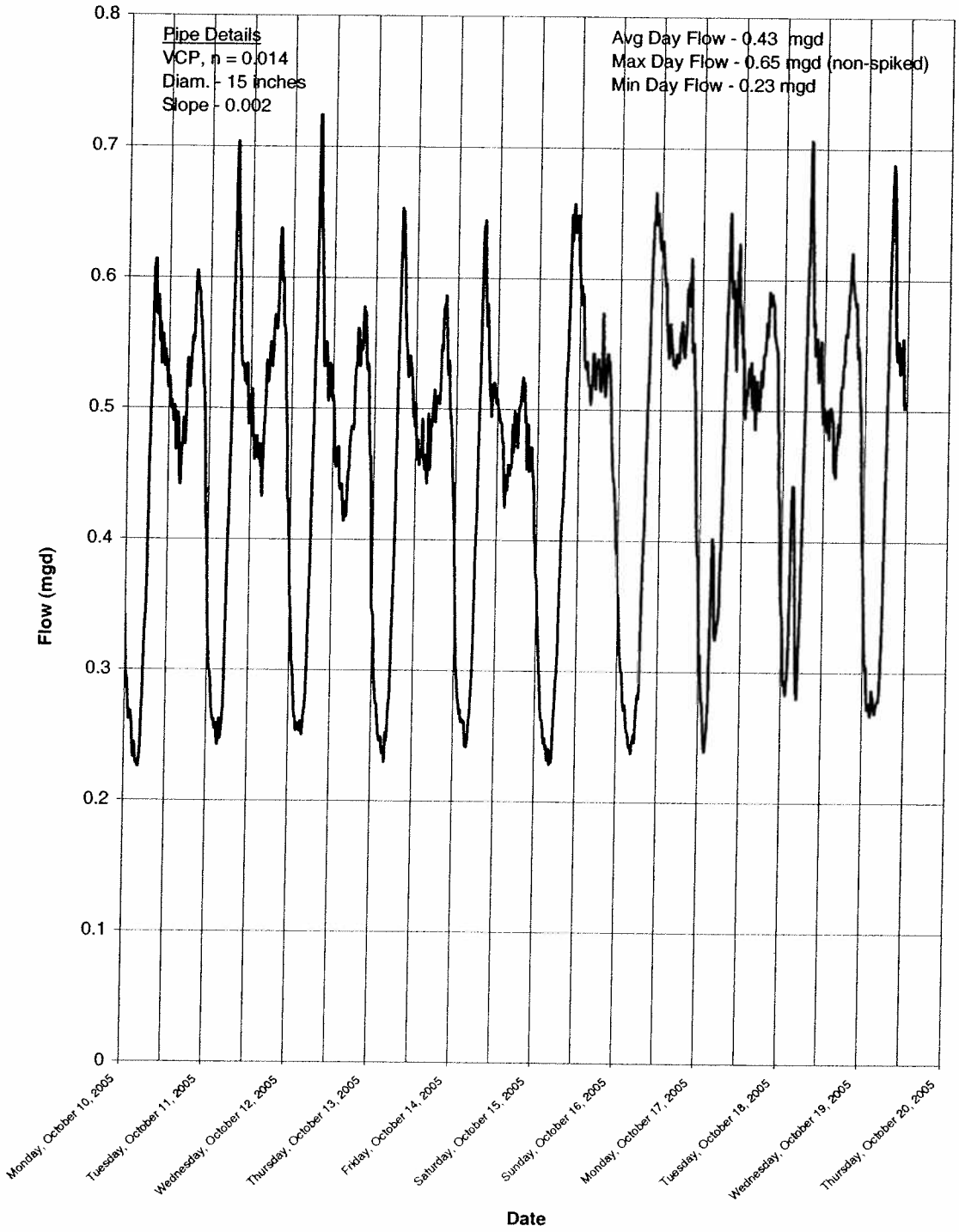


Figure 13

Flow at Meter 5 (Adjusted)

Meter Location - Madison St. near Arlington Ave. on an 18-inch Sewer

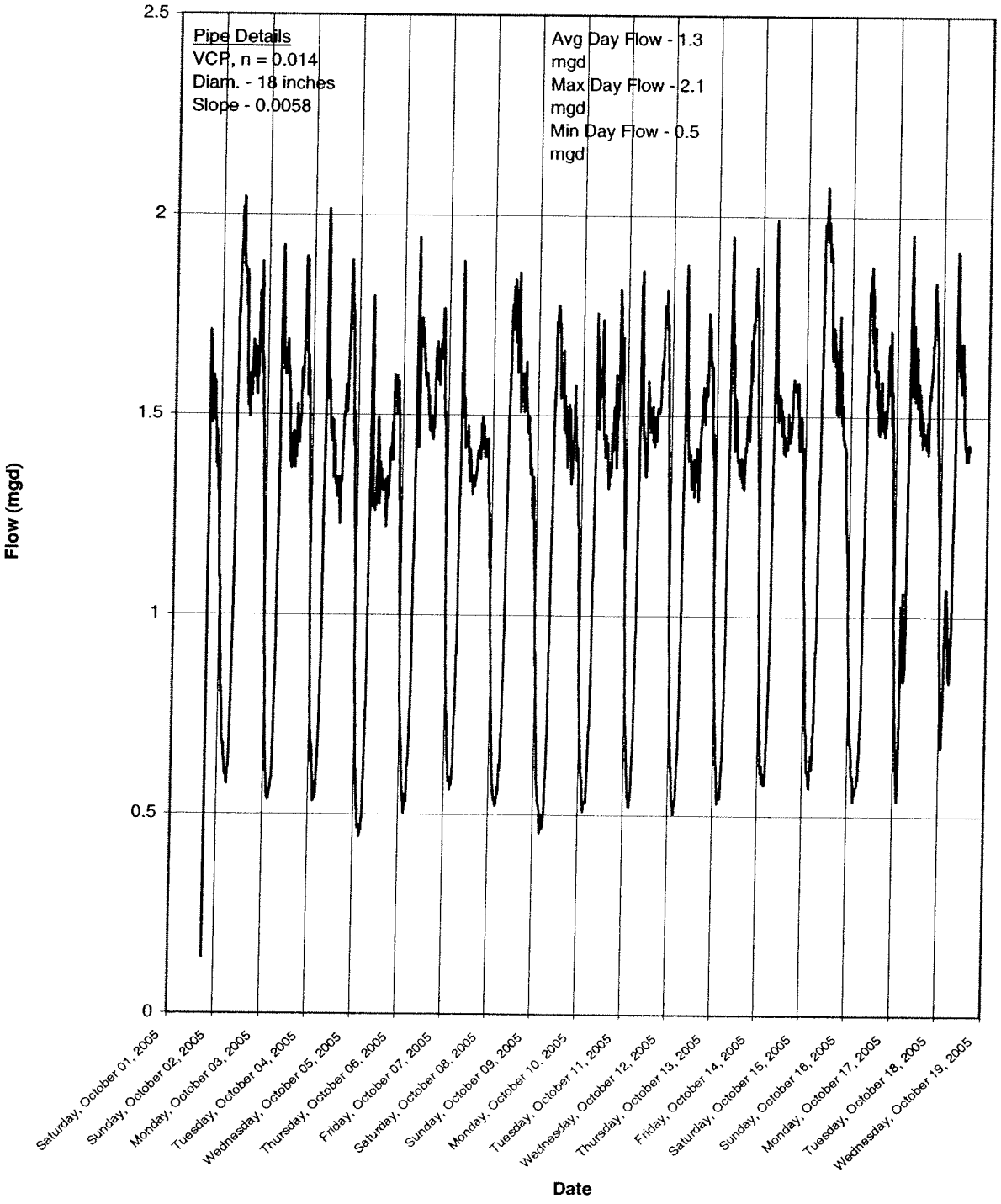


Figure 14

Representative Diurnal Pattern for Mixed Land Use
Meter Location - 1

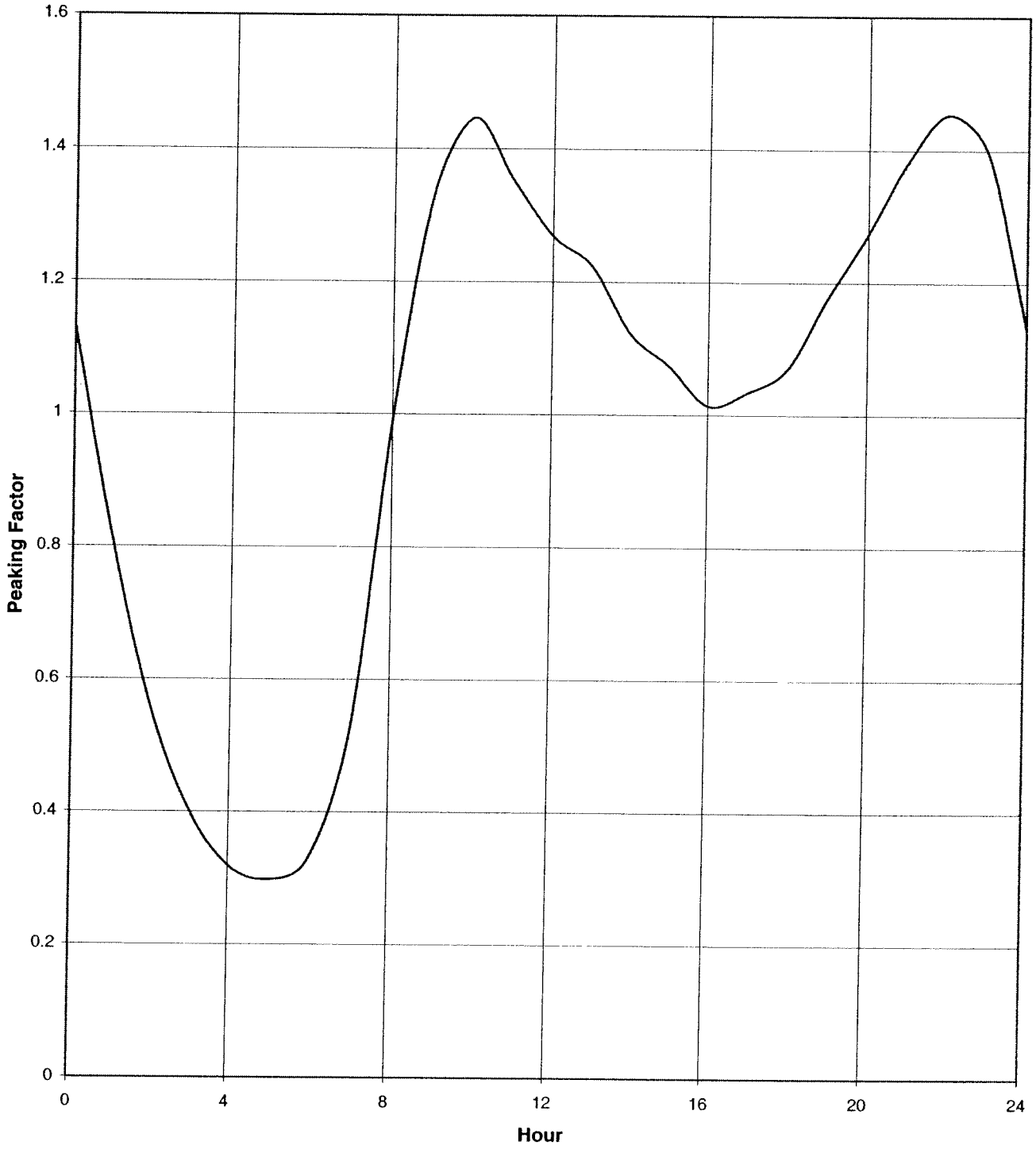


Figure 15

Representative Diurnal Pattern for Mixed Land Use
Wednesday Oct. 5, 2005
Meter Location - 2

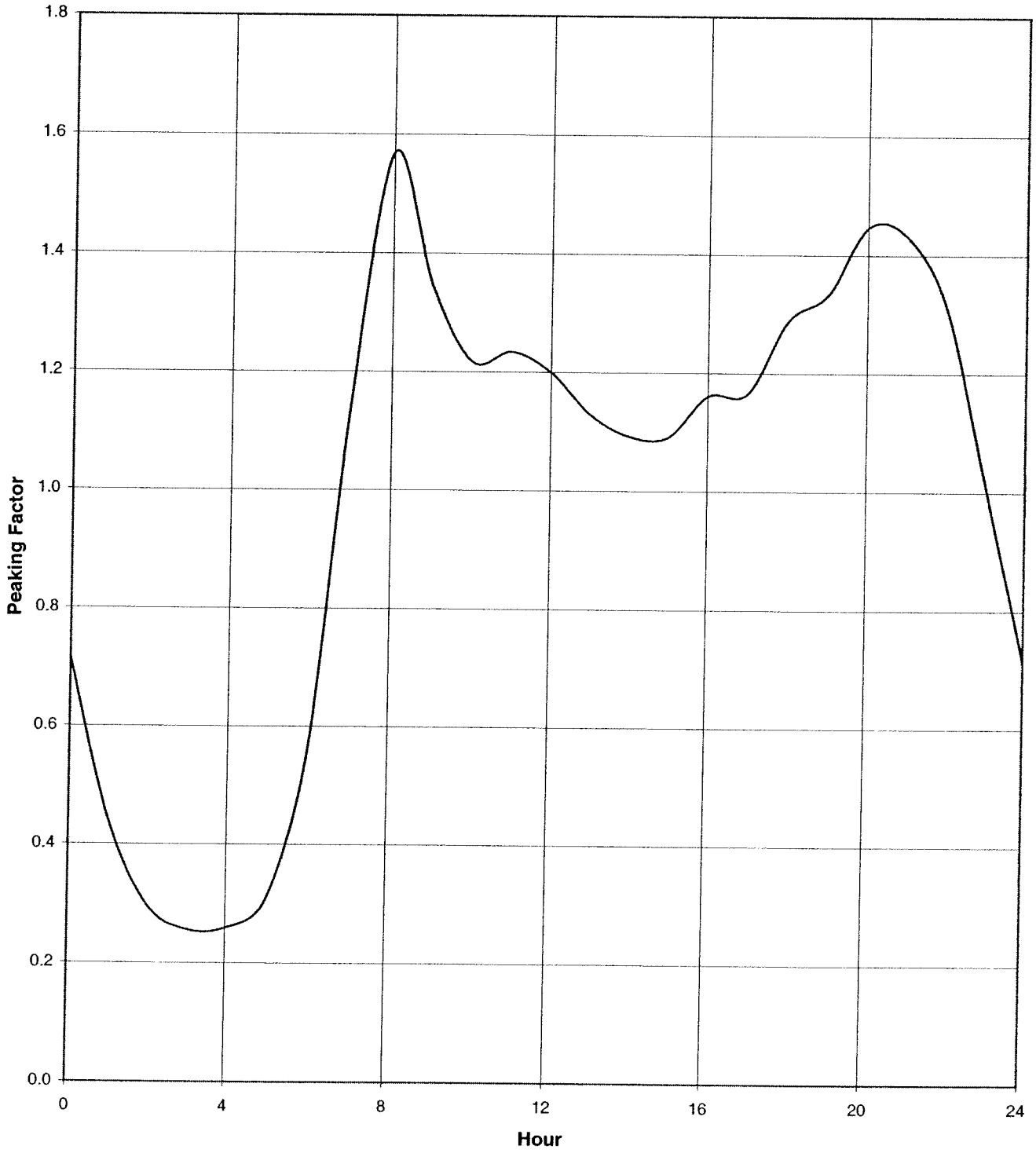


Figure 16

Representative Diurnal Pattern for Mixed Land Use
Wednesday Oct. 5, 2005
Meter Location - 3

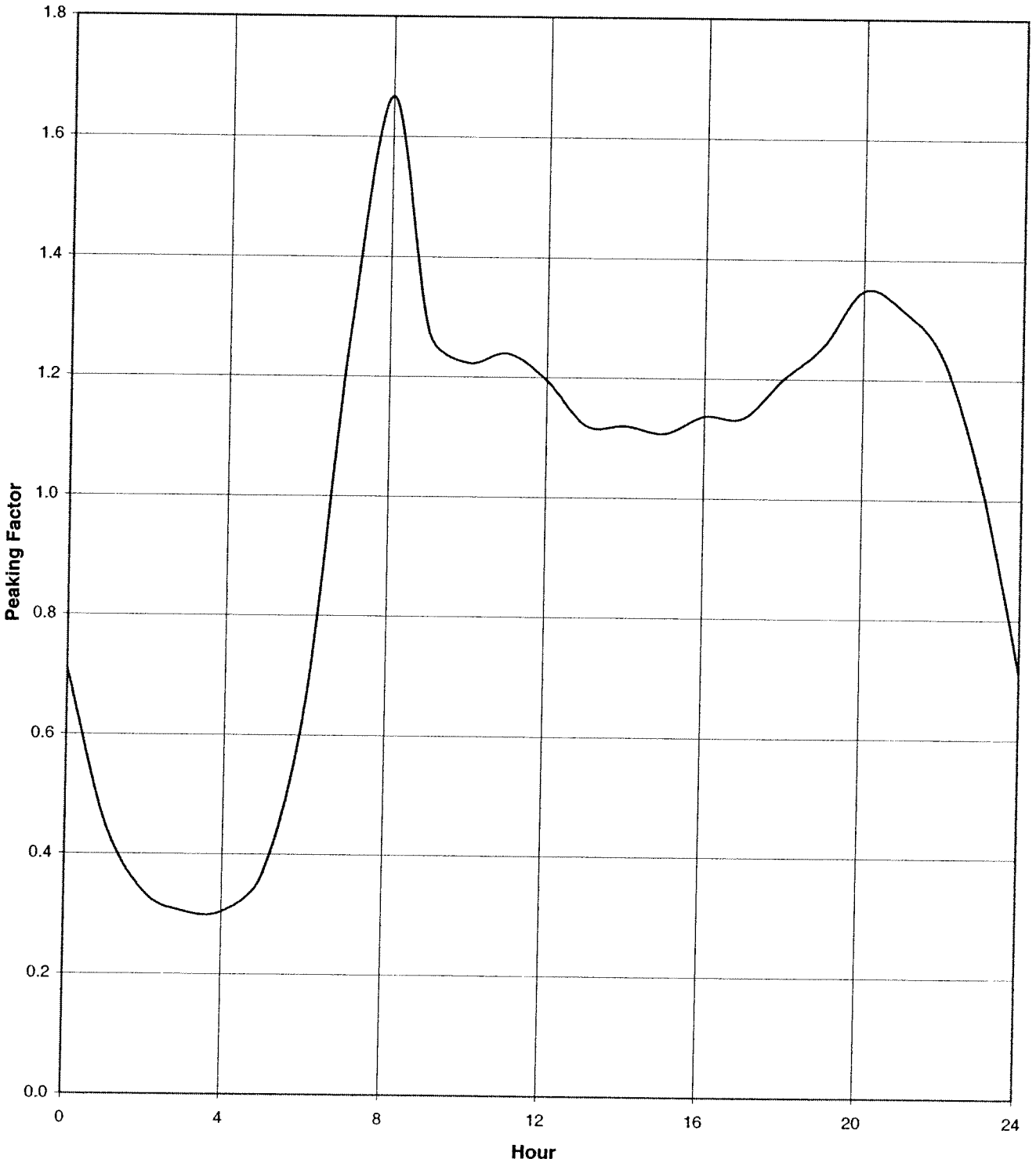


Figure 17

Representative Diurnal Pattern for Residential Land Use
Wednesday Oct. 5, 2005
Meter Location - 4

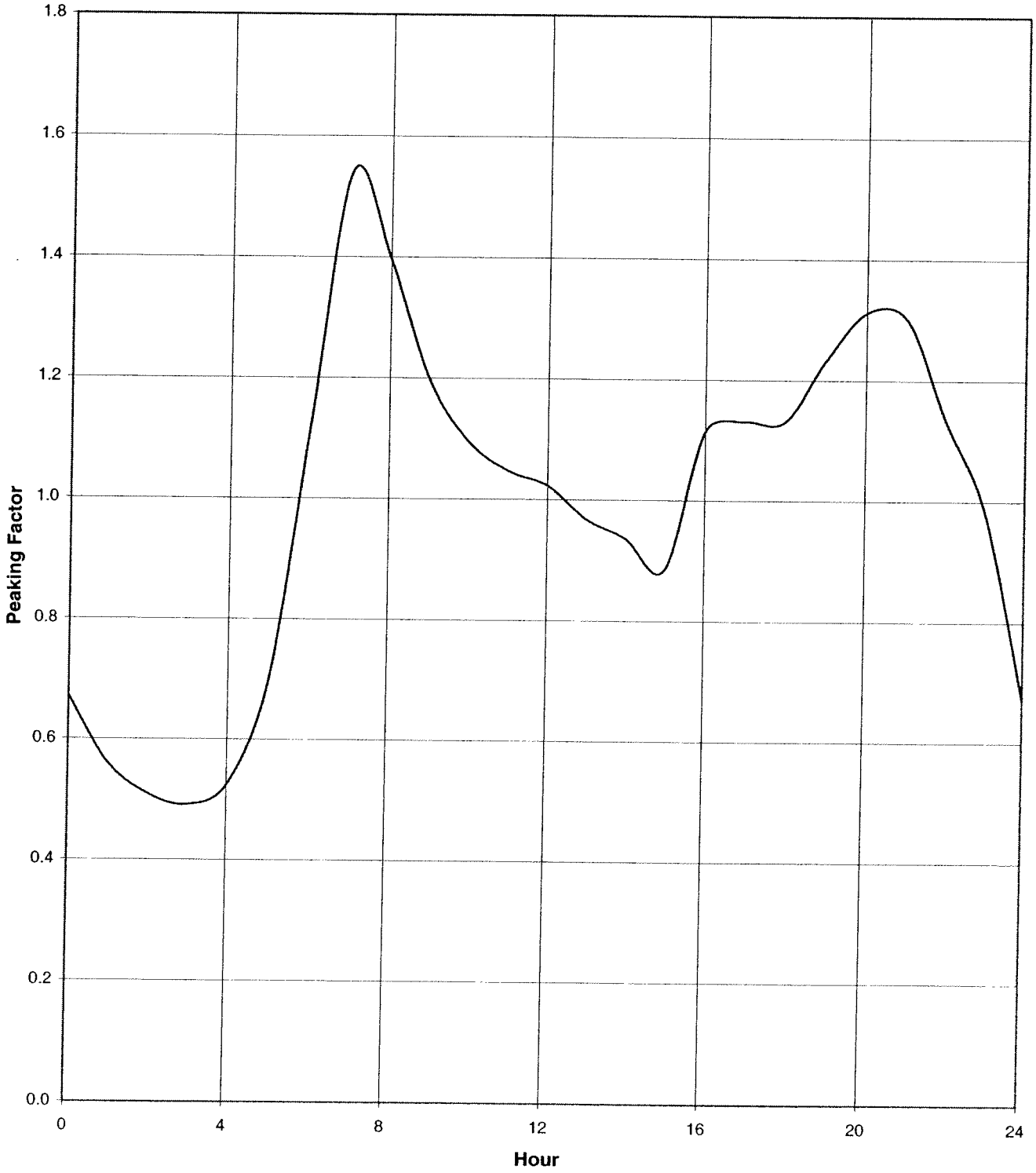
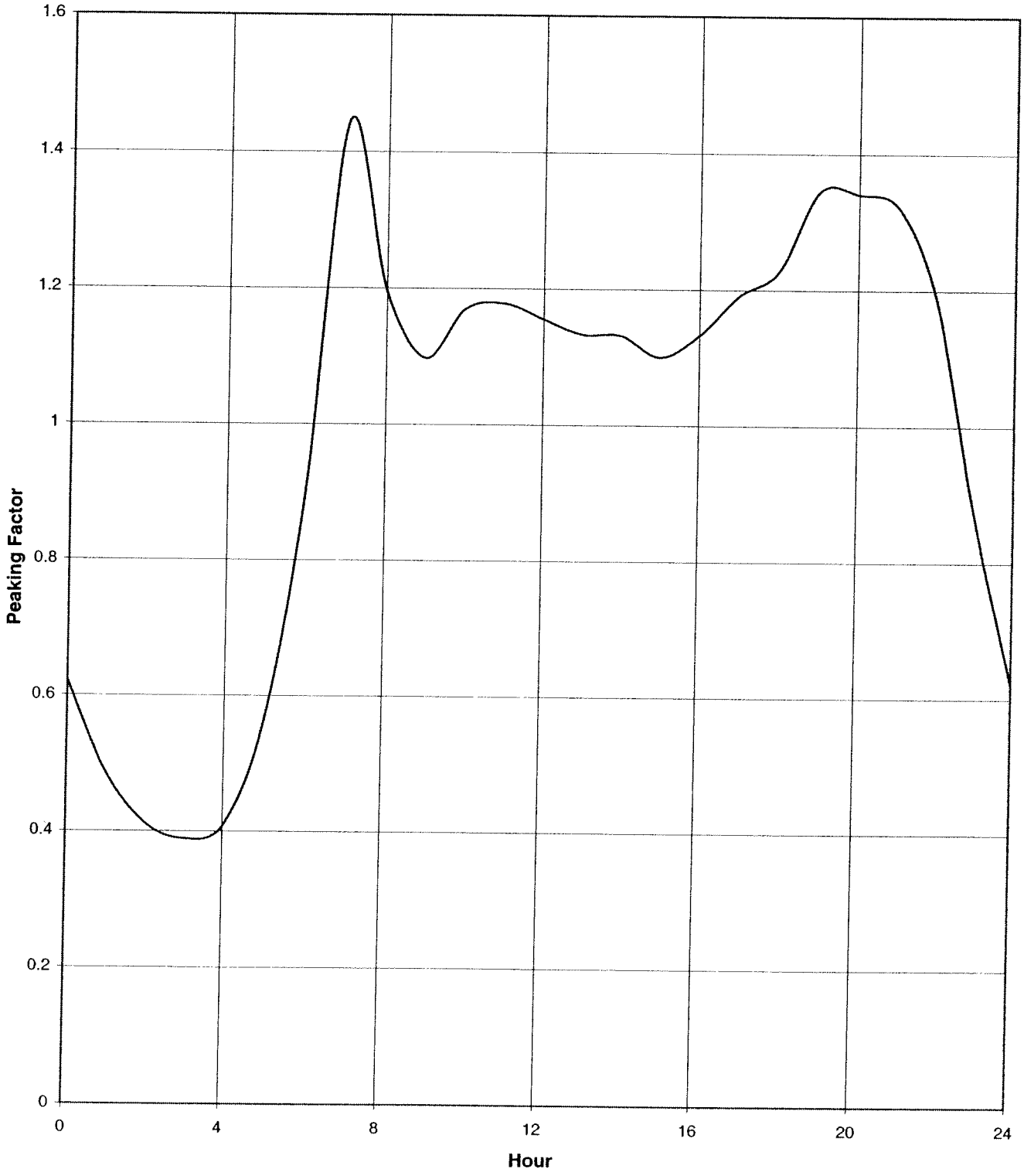


Figure 18

Representative Diurnal Pattern for Residential Land Use
Wednesday Oct. 5, 2005
Meter Location - 5



6.0 COMPUTER MODEL SIMULATION ANALYSIS

6.1 Methodology

Capacity analysis involved the evaluation of the available capacity in the existing collection system under present and future development conditions. Based on results of the analysis, phased facility improvements were identified to allow for projected growth within the service area.

This section describes the analytical methodology and hydraulic model development and summarizes the results of the analyses.

The principal tool utilized in the capacity analysis was a hydraulic model that simulates flow conditions using inflows and sewer system characteristic input data. With this input information, the model is able to compute and output depth of flow, rate of flow, and velocity of flow in selected pipes and manholes during different times of the day. The model selected for use in this study is XP-SWMM (XP Software, Version 9.12). This modeling software belongs to a class of software referred to as "dynamic wave models". These types of models are able to provide an accurate simulation of hydraulic flow conditions over an extended period of time.

Data required to create the model include information describing the physical wastewater collection system, such as pipe diameters and reach lengths, manhole invert elevations, and estimated pipe roughness coefficients. Additionally, data describing the sewage loading at selected manholes expressed as a varying flow rate over time (i.e. a diurnal curve), must be provided. Model output consists of a variety of hydraulic parameters, most importantly peak flow velocity and discharge rates.

Calibration of the model consisted of simulating existing sewer flow conditions and comparing the modeled flows with the recorded flows at the meter locations. The assumed diurnal curves that serve as input to the model were iteratively adjusted until the recorded and modeled hydrographs show reasonable agreement.

Simulations of future sewage flow conditions were performed by developing input data sets that included sewage generation projections for the assumed ultimate development conditions. Pipe reaches in which simulated peak flows exceeded a specified trigger criteria were identified as potential improvement reaches. Improvements required to provide adequate capacity for projected flows were then determined through an iterative modeling process. The process consists of simulating flow conditions after

increasing the diameter of downstream portions of the identified reaches. In subsequent iterations, additional lengths of pipe were increased in diameter until the projected peak flow could be conveyed through the reach without exceeding the specified design flow criteria.

6.2 Limitations of Modeling

The hydraulic model, which was utilized as the primary planning tool for the sewer capacity analysis, provides an accurate simulation of actual flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation, however, is directly related to the accuracy of the model input data, including physical parameters and sewage loading projections. For example, in a case where roots had entered the pipeline, thereby causing a restriction of flow, the model would be unable to predict the reduction in flow through this obstruction. Consequently, a general understanding of the data sources is critical in interpreting the modeling results.

The physical parameters of the model, including the pipe diameter, slope, and roughness coefficients were based principally on City's GIS database information. Where this data appeared to be inaccurate, construction drawings were reviewed and the input data corrected.

Network connectivity refers to the flow path followed by sewage within the sewer system. The connectivity is a function of the relative slope of each sewer pipe and the relative invert elevations of the incoming and outgoing sewer pipes at manholes. For example, a manhole may have two or more sewer pipes, which could convey flow away from the manhole. If the invert (bottom) of one of these pipes is lower than the other, the downstream flow path at this manhole would follow the lower pipe.

Sewage loading projections were based on calibrated flow rates. As previously described, flow rates used for calibration were based on actual monitored flows at key points in the trunk system over a 2-week period in October 2005. This period included the two weekends.

Since a degree of uncertainty exists in both the physical data and the sewage loading projections used as model inputs, reaches identified by model simulations as near or at capacity should be subject to additional engineering evaluation prior to implementing improvements. Such evaluation may include field inspection, video monitoring and flow metering.

The results of model runs for existing and ultimate conditions are summarized in Table 7-1.

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P001	4	0.2091	65.74	37.72	57.38%	54.24	82.50%
P002	2	0.2000	10.10	6.57	64.99%	10.06	99.56%
P003	2	0.2000	10.10	6.56	64.96%	10.05	99.48%
P004	2	0.2000	10.10	6.56	64.92%	10.04	99.42%
P005	3.75	0.1783	51.09	31.35	61.37%	44.38	86.88%
P006	2	0.2000	10.10	6.55	64.86%	10.03	99.29%
P007	2	0.2000	10.10	6.55	64.79%	10.02	99.15%
P008	2	0.2000	10.10	6.54	64.74%	10.00	99.03%
P010	3.75	0.1802	51.36	31.35	61.04%	44.38	86.42%
P011	2	0.2000	10.10	6.54	64.70%	9.99	98.91%
P012	2	0.2000	10.10	6.53	64.67%	9.98	98.82%
P013	2	0.2000	10.10	6.53	64.65%	9.98	98.78%
P014	2	0.2000	10.10	6.54	64.70%	9.97	98.67%
P015	3.75	0.1797	51.29	31.35	61.12%	44.39	86.53%
P016	2	0.2000	10.10	6.52	64.59%	9.95	98.52%
P017	3.75	0.1807	51.43	31.35	60.96%	44.39	86.30%
P018	2	0.2000	10.10	6.52	64.56%	9.94	98.36%
P019	2	0.2000	10.10	6.52	64.52%	9.92	98.20%
P020	2	0.2000	10.10	6.51	64.48%	9.90	98.04%
P021	3.75	0.1798	51.31	31.35	61.11%	44.39	86.52%
P022	2	0.2000	10.10	6.51	64.44%	9.91	98.07%
P023	2	0.2000	10.10	6.51	64.41%	9.94	98.35%
P024	3.75	0.2008	54.22	31.36	57.83%	44.40	81.89%
P025	2	0.2000	10.10	6.50	64.39%	9.95	98.47%
P026	2	0.2000	10.10	6.50	64.38%	9.95	98.52%
P027	2	0.2000	10.10	6.50	64.36%	9.96	98.59%
P028	2	0.2000	10.10	6.50	64.34%	9.97	98.67%
P029	2	0.2000	10.10	6.50	64.33%	9.97	98.73%
P030	3.75	0.1989	53.96	31.36	58.11%	44.41	82.29%
P031	2	0.2000	10.10	6.50	64.32%	9.98	98.76%
P032	2.5	0.2000	18.33	6.49	35.44%	9.99	54.48%
P033	3.75	0.2157	56.20	30.40	54.10%	43.00	76.52%
P034	2	0.2000	10.10	6.49	64.28%	9.99	98.91%
P035	2	0.2000	10.10	6.49	64.27%	9.99	98.91%
P036	2	0.2000	10.10	6.49	64.25%	9.99	98.91%
P037	3.75	0.2065	54.98	30.40	55.30%	43.01	78.22%
P038	2	0.2000	10.10	6.49	64.23%	9.99	98.92%
P039	3.75	0.1815	51.55	30.40	58.98%	43.01	83.43%
P040	2	0.2000	10.10	6.49	64.22%	9.99	98.92%
P041	3.75	0.1768	50.88	30.40	59.76%	43.01	84.54%
P042	2	0.2000	10.10	6.49	64.20%	9.99	98.92%
P043	2	0.2000	10.10	6.48	64.19%	9.99	98.92%
P045	3.75	0.2617	61.90	30.41	49.12%	43.01	69.49%
P046	2	0.2000	10.10	6.48	64.18%	9.99	98.92%
P047	2	0.2000	10.10	6.48	64.18%	9.99	98.93%
P048	2	0.2000	10.10	6.32	62.53%	9.83	97.27%
P049	2	0.2000	10.10	6.32	62.52%	9.83	97.27%
P050	2	0.2000	10.10	6.32	62.52%	9.83	97.27%
P051	2	0.2000	10.10	6.32	62.52%	9.83	97.27%
P052	3.25	0.2004	36.96	21.80	58.98%	31.39	84.92%
P053	2	0.2000	10.10	6.31	62.51%	9.83	97.27%
P054	2	0.2000	10.10	6.31	62.51%	9.83	97.28%
P055	2	0.2000	10.10	6.31	62.51%	9.83	97.35%
P056	2	0.2000	10.10	6.31	62.51%	9.84	97.38%
P057	2	0.2000	10.10	6.31	62.51%	9.85	97.54%
P058	3.25	0.2000	36.92	21.80	59.04%	31.38	84.99%
P059	2	0.2000	10.10	6.31	62.51%	9.91	98.08%
P061	3.25	0.2031	37.21	21.80	58.59%	31.38	84.33%
P062	2	0.2000	10.10	6.15	60.85%	9.82	97.25%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P063	2	0.2000	10.10	6.15	60.85%	9.87	97.74%
P064	2	0.2000	10.10	6.15	60.85%	9.92	98.18%
P065	2	0.2000	10.10	6.15	60.85%	9.95	98.54%
P066	3.25	0.2000	36.93	21.80	59.04%	31.38	84.98%
P067	2	0.2000	10.10	6.15	60.85%	9.97	98.73%
P068	2	0.2000	10.10	6.15	60.85%	10.01	99.05%
P069	2	0.2000	10.10	6.15	60.85%	10.04	99.44%
P070	3.25	0.2000	36.93	21.80	59.04%	31.38	84.98%
P071	2	0.2000	10.10	6.15	60.85%	10.08	99.76%
P072	2	0.2000	10.10	6.15	60.85%	10.09	99.88%
P073	2	0.2000	10.10	5.47	54.15%	9.35	92.55%
P074	3.25	0.1800	35.03	21.80	62.24%	31.38	89.58%
P075	2	0.2000	10.10	5.47	54.15%	9.38	92.86%
P076	2	0.2000	10.10	5.47	54.15%	9.39	92.97%
P077	1.25	0.6000	4.99	4.80	96.15%	6.96	139.59%
P078	2	0.2000	10.10	9.08	89.92%	12.45	123.27%
P079	2	0.2000	10.10	9.08	89.92%	12.46	123.39%
P080	2	0.2000	10.10	9.08	89.92%	12.46	123.39%
P081	2	0.2000	10.10	9.08	89.93%	12.47	123.40%
P082	3	0.2007	29.88	17.06	57.09%	26.98	90.31%
P088	0.833	56.9574	16.44	0.97	5.88%	1.42	8.63%
P089	0.833	16.6048	8.88	0.97	10.89%	1.42	15.98%
P090	1.25	1.2988	7.34	0.97	13.18%	1.42	19.33%
P091	1	1.5014	4.35	0.48	11.13%	0.71	16.31%
P092	1	1.3003	4.05	0.48	11.96%	0.71	17.53%
P093	1	0.1648	1.44	0.48	33.59%	0.71	49.25%
P094	1	1.1055	3.73	0.48	12.99%	0.71	19.05%
P095	2	10.6318	73.65	8.74	11.87%	11.66	15.83%
P096	2	8.5441	66.02	8.63	13.08%	11.45	17.34%
P097	2	5.8621	54.69	8.63	15.79%	11.45	20.93%
P098	2	1.8548	30.76	8.63	28.07%	11.45	37.21%
P099	2	1.8576	30.78	8.63	28.05%	11.45	37.18%
P100	2.25	0.1405	11.59	8.63	74.47%	11.45	98.73%
P101	2	0.0899	6.77	6.13	90.59%	8.83	130.42%
P102	2.25	0.0832	8.92	2.61	29.29%	2.78	31.15%
P103	2.25	0.0808	8.79	2.61	29.70%	2.78	31.59%
P104	2	0.0875	6.68	6.13	91.81%	8.83	132.17%
P105	2.25	0.0767	8.57	2.61	30.44%	2.77	32.37%
P106	2	0.0869	6.66	6.13	92.13%	8.83	132.63%
P107	2.25	0.0755	8.50	2.61	30.65%	2.77	32.58%
P108	2	0.0878	6.69	6.13	91.67%	8.83	131.97%
P109	2	0.0896	6.76	6.14	90.73%	8.83	130.61%
P110	2.25	0.0831	8.92	2.60	29.21%	2.77	31.03%
P111	2	0.0781	6.31	6.14	97.18%	8.83	139.90%
P112	2	0.0905	6.79	6.14	90.31%	8.83	130.01%
P113	2.25	0.0872	9.14	2.60	28.51%	2.77	30.28%
P114	2	0.0895	6.76	6.14	90.81%	8.83	130.73%
P115	2	0.0867	6.65	6.14	92.28%	8.83	132.83%
P116	2	0.0828	6.50	6.14	94.43%	8.83	135.93%
P117	2.25	0.0968	9.63	2.60	27.06%	2.77	28.74%
P118	2.25	0.1234	10.87	2.60	23.97%	2.77	25.46%
P119	2.25	0.0787	8.68	2.61	30.01%	2.77	31.88%
P120	2	0.0875	6.68	6.14	91.83%	8.83	132.19%
P121A	2	0.0875	6.68	6.14	91.84%	8.83	132.19%
P121B	2	0.0875	6.68	6.14	91.87%	8.83	132.22%
P122	2.25	0.0809	8.80	2.61	29.61%	2.77	31.45%
P123	2	0.0983	7.08	6.14	86.68%	8.83	124.73%
P124	2.25	0.0801	8.75	2.61	29.77%	2.77	31.62%
P125	2	0.0341	4.17	6.02	144.33%	8.61	206.33%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P127	2	1.3391	26.14	2.61	9.97%	2.77	10.59%
P128	2.25	0.2059	14.04	6.02	42.92%	8.61	61.35%
P130	2.25	0.2059	14.04	6.02	42.92%	8.61	61.35%
P131	2.25	0.1042	9.98	5.75	57.57%	6.78	67.92%
P132	2.25	0.0812	8.81	5.75	65.24%	6.84	77.57%
P133	1.75	0.1109	5.27	0.25	4.67%	2.86	54.26%
P134	2.25	0.0800	8.75	5.75	65.76%	6.99	79.90%
P135	1.75	0.1122	5.30	0.20	3.81%	2.86	53.95%
P136	2.25	0.0794	8.72	5.76	66.05%	7.15	82.06%
P137	1.75	0.1131	5.32	0.19	3.57%	2.86	53.76%
P138	1.75	0.1717	6.55	0.10	1.49%	2.76	42.17%
P139	2.25	0.0805	8.78	5.76	65.62%	7.28	82.94%
P140	1.75	0.0708	4.21	0.10	2.43%	2.76	65.67%
P141	2.25	0.0799	8.74	5.76	65.91%	7.38	84.43%
P142	1.75	0.0490	3.50	0.10	2.96%	2.76	78.98%
P143	2.25	0.0769	8.58	5.76	67.18%	7.44	86.71%
P144	1.75	0.0562	3.75	0.10	2.77%	2.76	73.69%
P145	2.25	0.0787	8.68	5.67	65.29%	7.37	84.86%
P146	1.75	0.2917	8.54	0.11	1.23%	2.76	32.36%
P147	2.25	0.0829	8.91	5.67	63.64%	7.42	83.28%
P148	1.25	4.9180	14.28	0.00	0.00%	2.67	18.68%
P149	2.25	0.1250	10.94	5.67	51.83%	8.36	76.45%
P150	1.25	0.2000	5.76	5.67	98.42%	8.36	145.22%
P152	1.75	0.8107	14.24	5.35	37.59%	8.03	56.39%
P153	1	0.2331	1.71	0.84	49.20%	0.89	51.94%
P154	1	0.3053	1.96	0.85	43.10%	0.89	45.56%
P155	1	0.2076	1.62	0.85	52.37%	0.90	55.38%
P156	1	0.5980	2.74	0.68	24.63%	0.71	25.97%
P157	1	0.6052	2.76	0.68	24.51%	0.71	25.85%
P158	1	0.5994	2.75	0.68	24.68%	0.72	26.02%
P159	1.75	0.3860	9.82	4.57	46.54%	7.15	72.75%
P160	1	0.1855	1.53	0.17	11.20%	0.33	21.74%
P161	1	0.2342	1.72	0.17	9.99%	0.29	16.62%
P162	1	0.1333	1.30	0.17	13.24%	0.25	19.25%
P163	1	0.1046	1.15	0.17	14.95%	0.23	19.69%
P164	1	0.2008	1.59	0.17	10.83%	0.18	11.59%
P165	1.75	0.3885	9.86	4.57	46.39%	7.17	72.74%
P166	1.75	0.4546	10.66	4.57	42.89%	7.17	67.26%
P167	1.75	1.1248	16.77	4.57	27.26%	7.17	42.76%
P168	1.75	1.1214	16.75	4.57	27.31%	7.17	42.83%
P169	1.75	1.0464	16.18	4.57	28.27%	7.17	44.33%
P170	1.75	1.1061	16.63	4.57	27.49%	7.17	43.12%
P171	1.75	1.2083	17.38	4.57	26.30%	7.17	41.26%
P172	1.75	1.3000	18.03	3.67	20.36%	5.63	31.21%
P173	1.25	1.0715	6.67	1.02	15.32%	1.80	26.99%
P174	1.25	1.0562	6.62	1.02	15.43%	1.80	27.19%
P175	1	1.1102	3.74	0.03	0.71%	0.05	1.24%
P176	1.5	0.5341	7.66	3.65	47.60%	5.59	72.94%
P177	1.5	0.5791	7.97	3.65	45.72%	5.59	70.05%
P178	1.5	0.5440	7.73	3.65	47.17%	5.59	72.28%
P179	1.5	0.3000	5.74	3.65	63.52%	5.59	97.33%
P180	1.5	0.3000	5.74	3.65	63.52%	5.59	97.33%
P181	1.5	0.3000	5.74	3.65	63.52%	5.59	97.33%
P182	1.25	0.7500	5.58	3.39	60.75%	5.25	94.19%
P183	1.25	1.0177	6.50	3.39	52.15%	5.25	80.86%
P184	1.25	1.0287	6.53	3.39	51.87%	5.25	80.42%
P185	1.25	1.0015	6.44	3.39	52.57%	5.25	81.51%
P186	1.25	2.0345	9.19	3.39	36.88%	5.25	57.19%
P187	1.25	1.6953	8.38	3.39	40.41%	5.25	62.65%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P188	1.25	1.2000	7.05	3.13	44.37%	4.92	69.73%
P189	1.25	1.8500	8.76	3.13	35.74%	4.92	56.16%
P190	1.25	1.8400	8.74	3.13	35.84%	4.92	56.31%
P191	1.25	0.3000	3.53	2.61	73.95%	4.14	117.45%
P192	1.25	0.3000	3.53	2.61	73.96%	4.14	117.46%
P193	1.25	0.3000	3.53	2.61	73.97%	4.14	117.47%
P194	1.25	1.0500	6.60	0.55	8.37%	0.82	12.44%
P195	1.25	1.3823	7.57	2.10	27.68%	3.38	44.69%
P196	1	1.9461	4.95	0.56	11.37%	0.84	16.99%
P197	1.25	1.0000	6.44	2.10	32.55%	3.38	52.51%
P198	1.25	1.0000	6.44	2.10	32.55%	3.38	52.52%
P199	1.25	4.7615	14.05	2.10	14.92%	3.38	24.07%
P200	1.25	1.0000	6.44	2.10	32.55%	3.38	52.51%
P201	1.25	2.0269	9.17	2.10	22.86%	3.38	36.89%
P202	1.25	1.0427	6.58	2.10	31.88%	3.38	51.43%
P203	1.25	1.6485	8.27	2.10	25.35%	3.38	40.91%
P204	1.5	0.2735	5.48	2.10	38.25%	3.38	61.72%
P205	1.5	0.2907	5.65	2.10	37.12%	3.38	59.89%
P206	1.5	0.2994	5.73	2.10	36.57%	3.38	59.01%
P207	2	0.2948	12.26	2.10	17.10%	3.38	27.59%
P208	1.5	1.1561	11.27	2.10	18.61%	3.38	30.04%
P209	1.5	1.1681	11.32	2.10	18.52%	3.38	29.88%
P210	1.5	1.1335	11.16	2.10	18.80%	3.38	30.34%
P211	1.5	1.1319	11.15	2.10	18.81%	3.38	30.36%
P212	1.5	1.1850	11.41	1.57	13.75%	2.60	22.78%
P213	1.5	1.1034	11.01	1.57	14.26%	2.60	23.62%
P214	1.5	1.1079	11.03	1.05	9.50%	1.83	16.56%
P215	1.5	1.1303	11.14	1.05	9.41%	1.83	16.39%
P216	1.25	2.1316	9.40	0.70	7.49%	1.35	14.41%
P217	1.25	2.1378	9.42	0.70	7.48%	1.35	14.39%
P218	1.25	1.9678	9.03	0.70	7.80%	1.35	15.00%
P219	1.25	2.5655	10.31	0.70	6.83%	1.36	13.14%
P220	1.25	2.7290	10.64	0.70	6.62%	1.36	12.74%
P221	1.25	1.4120	7.65	0.70	9.20%	1.36	17.71%
P222	1.25	1.5358	7.98	0.70	8.83%	1.36	16.99%
P223	1	4.7241	7.71	0.70	9.14%	1.36	17.58%
P224	1	2.6813	5.81	0.70	12.13%	1.36	23.34%
P225	1	2.3703	5.46	0.70	12.90%	1.36	24.83%
P226	1	2.1922	5.25	0.35	6.73%	0.49	9.37%
P227	1	2.6774	5.81	0.37	6.40%	0.89	15.33%
P228	1	2.3400	5.43	0.37	6.85%	0.89	16.40%
P229	1	1.2178	3.92	0.37	9.49%	0.89	22.74%
P230	1	0.2028	1.60	0.37	23.29%	0.89	55.77%
P231	1	0.2226	1.67	0.38	22.42%	0.90	53.61%
P232	1	1.2913	4.03	0.38	9.30%	0.90	22.24%
P233	1	6.7719	9.24	0.38	4.06%	0.90	9.71%
P234	1	2.5597	5.68	0.38	6.60%	0.90	15.80%
P235	1	2.6842	5.81	0.38	6.45%	0.90	15.43%
P236	1	2.6857	5.82	0.38	6.45%	0.90	15.42%
P237	1.25	0.2867	3.45	0.38	10.88%	0.90	26.02%
P238	1.25	0.2927	3.48	0.38	10.81%	0.90	25.95%
P239	1.25	0.2663	3.32	0.03	0.82%	0.41	12.43%
P240	1.25	0.2717	3.36	0.03	0.81%	0.41	12.31%
P241	1.25	0.2701	3.35	0.03	0.82%	0.03	1.03%
P242	1.25	3.4186	11.91	0.02	0.18%	0.02	0.18%
P243	1.25	1.5317	7.97	0.02	0.26%	0.02	0.27%
P244	1.25	1.5432	8.00	0.02	0.26%	0.02	0.26%
P245	1.25	1.0004	6.44	0.02	0.33%	0.02	0.33%
P246	1.25	0.3994	4.07	0.02	0.52%	0.02	0.52%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

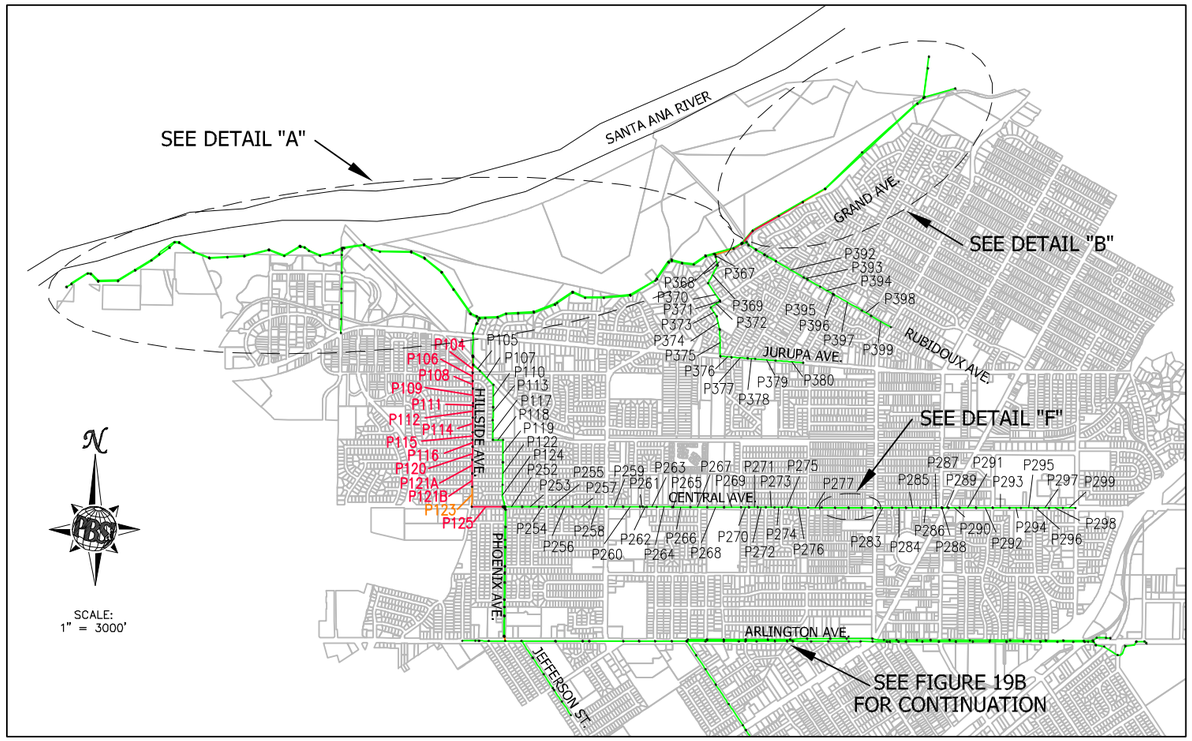
Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P247	1.25	0.3909	4.03	0.02	0.53%	0.02	0.53%
P248	1.25	0.3984	4.06	0.02	0.52%	0.02	0.53%
P249	1.25	0.4007	4.08	0.02	0.52%	0.02	0.52%
P250	1.25	0.4025	4.09	0.02	0.52%	0.02	0.52%
P251	1.25	0.3992	4.07	0.02	0.54%	0.02	0.54%
P252	1.25	1.3692	7.54	2.09	27.77%	2.23	29.65%
P253	1.25	1.3723	7.54	2.09	27.74%	2.23	29.62%
P254	1.25	0.3484	3.80	2.09	55.06%	2.23	58.79%
P255	1.25	0.3117	3.60	2.09	58.21%	2.23	62.16%
P256	1.25	0.3130	3.60	2.09	58.09%	2.23	62.03%
P257	1.25	0.3130	3.60	2.09	58.10%	2.23	62.03%
P258	1.25	0.3196	3.64	2.09	57.49%	2.23	61.39%
P259	1.25	0.2525	3.24	2.09	64.69%	2.24	69.07%
P260	1.25	0.2555	3.26	2.09	64.31%	2.24	68.67%
P261	1.25	0.2582	3.27	2.09	63.98%	2.24	68.31%
P262	1.25	0.2929	3.49	2.09	60.07%	2.24	64.13%
P263	1.25	0.4000	4.07	2.09	51.40%	2.24	54.88%
P264	1.25	0.3118	3.60	2.09	58.22%	2.24	62.17%
P265	1.25	1.3710	7.54	2.09	27.77%	2.24	29.65%
P266	1.25	0.5554	4.80	2.09	43.62%	2.24	46.58%
P267	1.25	1.0991	6.75	2.09	31.01%	2.24	33.11%
P268	1.25	1.1004	6.76	2.09	30.99%	2.24	33.09%
P269	1.25	0.7877	5.72	2.09	36.63%	2.24	39.11%
P270	1.25	0.8077	5.79	1.57	27.20%	1.70	29.29%
P271	1.25	0.7701	5.65	1.57	27.85%	1.70	30.00%
P272	1.25	0.4240	4.19	1.57	37.54%	1.70	40.43%
P273	1.25	0.5345	4.71	1.57	33.43%	1.70	36.01%
P274	1.25	0.3973	4.06	1.57	38.78%	1.70	41.77%
P275	1.25	0.5468	4.76	1.57	33.05%	1.70	35.60%
P276	1.25	0.4717	4.42	1.57	35.59%	1.70	38.33%
P277	1.25	0.7063	5.41	1.57	29.09%	1.70	31.33%
P278	1	0.3999	2.24	0.52	23.39%	0.57	25.28%
P279	1	0.3888	2.21	0.53	23.73%	0.57	25.64%
P280	1	1.1499	3.81	0.53	13.80%	0.57	14.91%
P281	1	1.5078	4.36	0.53	12.05%	0.57	13.02%
P282	1	0.4167	2.29	0.53	22.92%	0.57	24.77%
P283	1	0.4194	2.30	1.57	68.50%	1.70	73.78%
P284	1	0.4289	2.32	1.57	67.74%	1.70	72.96%
P285	1	0.4254	2.31	1.57	68.02%	1.70	73.26%
P286	1	0.4108	2.27	1.57	69.22%	1.70	74.56%
P287	1	0.3810	2.19	1.05	47.96%	1.15	52.56%
P288	1	0.9565	3.47	1.05	30.26%	1.15	33.17%
P289	1	0.3259	2.03	1.05	51.85%	1.15	56.82%
P290	1	0.4665	2.42	0.75	30.73%	0.85	34.89%
P291	1	0.4167	2.29	0.75	32.53%	0.85	36.93%
P292	1	0.4128	2.28	0.75	32.68%	0.85	37.11%
P293	1	0.4214	2.30	0.75	32.35%	0.85	36.73%
P294	1	0.4189	2.30	0.75	32.45%	0.85	36.85%
P295	1	0.4322	2.33	0.75	31.95%	0.85	36.27%
P296	1	0.4028	2.25	0.44	19.46%	0.54	23.94%
P297	1	0.4026	2.25	0.44	19.47%	0.54	23.95%
P298	1	0.4162	2.29	0.44	19.16%	0.54	23.56%
P299	1	0.3692	2.16	0.44	20.35%	0.54	25.03%
P300	1	1.1299	3.77	0.03	0.74%	0.05	1.25%
P301	1.25	0.8781	6.03	1.02	16.93%	1.80	29.83%
P302	1	1.1338	3.78	0.03	0.71%	0.05	1.24%
P303	1.25	1.0204	6.50	1.02	15.71%	1.80	27.67%
P304	1	1.1527	3.81	0.03	0.70%	0.05	1.23%
P305	1	1.1478	3.80	0.03	0.71%	0.05	1.23%

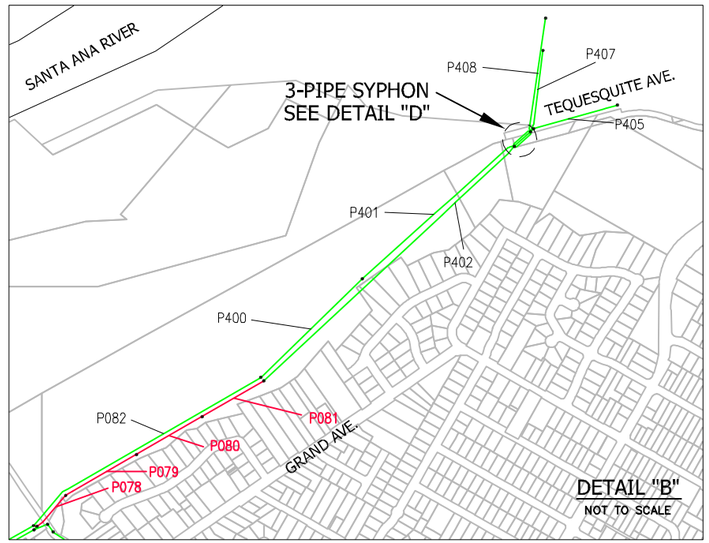
Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P306	1.25	1.0801	6.69	1.02	15.27%	1.80	26.91%
P307	1	1.1065	3.73	0.03	0.72%	0.05	1.26%
P308	1.25	0.9640	6.32	1.02	16.17%	1.80	28.49%
P309	1	1.1216	3.76	0.03	0.71%	0.05	1.25%
P310	1	1.1312	3.77	0.03	0.71%	0.05	1.24%
P311	1	0.3962	2.23	0.03	1.20%	0.05	2.10%
P312	1.25	1.0762	6.68	1.02	15.31%	1.80	26.96%
P313	1.25	0.5536	4.79	1.02	21.35%	1.80	37.61%
P314	1	0.4102	2.27	0.03	1.20%	0.05	2.08%
P315	1.25	0.5828	4.92	1.02	20.81%	1.80	36.66%
P316	1	0.3762	2.18	0.03	1.27%	0.05	2.19%
P317	1.25	0.4479	4.31	1.02	23.76%	1.80	41.84%
P318	1	0.4239	2.31	0.03	1.20%	0.05	2.06%
P319	1	0.4190	2.30	0.03	1.22%	0.05	2.08%
P322	1.25	1.5867	8.11	1.02	12.62%	1.80	22.23%
P324	0.666	4.3313	2.50	0.25	10.17%	0.33	13.08%
P325	1	0.8539	3.28	0.03	0.85%	0.05	1.46%
P326	1	0.9946	3.54	0.03	0.80%	0.05	1.36%
P327	1	0.8656	3.30	0.03	0.85%	0.05	1.45%
P328	1.25	0.7833	5.70	1.02	17.97%	1.80	31.64%
P329	1	0.9945	3.54	0.28	7.97%	0.37	10.57%
P330	1.25	0.1596	2.57	0.81	31.42%	1.52	59.12%
P331	1	0.1477	1.36	0.28	20.70%	0.37	27.46%
P332	1.25	0.3562	3.84	0.81	21.11%	1.53	39.69%
P333	1	0.1525	1.39	0.28	20.47%	0.38	27.09%
P334	1.25	0.3417	3.76	0.81	21.58%	1.53	40.57%
P335	1	0.1482	1.37	0.29	20.90%	0.38	27.59%
P336	1.25	0.3513	3.82	0.81	21.29%	1.53	40.02%
P337	1	0.1375	1.32	0.29	21.80%	0.38	28.69%
P338	1.25	0.3491	3.81	0.81	21.38%	1.53	40.19%
P339	1	0.1656	1.44	0.29	20.01%	0.38	26.24%
P340	1.25	0.6061	5.01	0.81	16.24%	1.53	30.52%
P341	0.833	0.8806	2.04	0.29	14.18%	0.38	18.57%
P342	1.25	0.5955	4.97	0.81	16.40%	1.53	30.81%
P343	0.833	0.8811	2.05	0.29	14.28%	0.38	18.62%
P344	1.25	0.5906	4.95	0.81	16.46%	1.53	30.94%
P345	0.833	0.8771	2.04	0.29	14.37%	0.38	18.68%
P346	1.25	0.6035	5.00	0.81	16.29%	1.53	30.61%
P347	0.833	0.8796	2.04	0.30	14.47%	0.38	18.77%
P348	1.25	0.6000	4.99	0.82	16.35%	1.53	30.72%
P349	0.833	0.9395	2.11	0.30	14.35%	0.39	18.52%
P350	0.833	0.4814	1.51	0.31	20.53%	0.39	26.01%
P351	0.833	0.3445	1.28	0.01	0.82%	0.01	1.10%
P352	1.25	1.9791	9.06	0.82	9.00%	1.53	16.91%
P353	0.833	1.0627	2.25	0.00	0.00%	0.00	0.00%
P354	0.666	1.9210	1.66	0.41	24.85%	0.77	46.60%
P355	0.666	1.9839	1.69	0.41	24.47%	0.77	45.87%
P356	1	1.8705	4.85	0.41	8.52%	0.78	15.97%
P357	1.5	0.1178	3.60	0.41	11.39%	0.77	21.39%
P358	1.5	10.1954	33.46	0.41	1.22%	0.77	2.30%
P359	1.5	0.4119	6.73	0.41	6.09%	0.77	11.44%
P361	1.5	0.4202	6.79	0.41	6.04%	0.77	11.33%
P362	1.5	0.3796	6.46	0.41	6.37%	0.77	11.95%
P363	1.5	0.5889	8.04	0.41	5.12%	0.77	9.61%
P364	1.5	1.1125	11.05	0.41	3.74%	0.77	7.01%
P365	1	0.8154	3.20	0.41	12.89%	0.77	24.16%
P366	1	0.8761	3.32	0.41	12.45%	0.78	23.35%
P367	1	4.4208	7.46	0.70	9.40%	0.79	10.58%
P368	1.25	4.4557	13.59	0.70	5.16%	0.79	5.81%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)		Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Future Estimated Peak Flow (cfs)	Future Estimated % Full
P369	1.25	4.4541		13.59	0.70	5.16%	0.79	5.81%
P370	1.25	4.4537		13.59	0.58	4.30%	0.65	4.75%
P371	1.25	0.1429		2.43	0.58	24.01%	0.65	26.50%
P372	1.25	0.1962		2.85	0.58	20.49%	0.65	22.62%
P373	1.25	0.1978		2.86	0.58	20.40%	0.65	22.53%
P374	1.25	0.1986		2.87	0.58	20.37%	0.65	22.49%
P375	1.25	0.1993		2.87	0.58	20.34%	0.65	22.46%
P376	1	0.1982		1.58	0.58	37.02%	0.65	40.87%
P377	1	0.1999		1.59	0.47	29.41%	0.50	31.49%
P378	1	0.1987		1.58	0.47	29.51%	0.50	31.60%
P379	1	0.4727		2.44	0.47	19.14%	0.50	20.49%
P380	1	0.4752		2.45	0.47	19.11%	0.50	20.46%
P381	1	120.2077		38.91	1.42	3.64%	1.45	3.73%
P382	0.833	12.6748		7.76	1.42	18.28%	1.45	18.69%
P384	0.833	8.8752		6.49	1.42	21.85%	1.45	22.34%
P385	0.833	21.7391		10.16	1.42	13.96%	1.45	14.27%
P386	0.833	2.6306		3.53	1.42	40.13%	1.45	41.03%
P387	0.833	19.6242		9.65	0.86	8.94%	0.88	9.14%
P388	0.833	4.3825		4.56	0.86	18.92%	0.88	19.34%
P389	0.833	2.6861		3.57	0.86	24.17%	0.88	24.70%
P390	0.833	3.7303		4.21	0.55	13.19%	0.57	13.50%
P391	0.833	2.5882		3.51	0.55	15.83%	0.57	16.20%
P392	1.25	0.1996		2.88	1.30	45.14%	1.33	46.24%
P393	1.25	0.3341		3.72	1.30	34.93%	1.33	35.78%
P394	1.25	0.4608		4.37	1.30	29.75%	1.33	30.48%
P395	1.25	0.2235		3.04	1.30	42.73%	1.33	43.77%
P396	1.25	0.5925		4.96	1.18	23.81%	1.21	24.45%
P397	1.25	0.1792		2.73	1.18	43.38%	1.21	44.55%
P398	1	0.6518		2.87	1.19	41.41%	1.22	42.52%
P399	1	0.6494		2.86	1.19	41.56%	1.22	42.68%
P400	2.75	0.3000		28.95	17.06	58.92%	27.31	94.33%
P401	2.75	0.3456		31.08	17.06	54.89%	27.58	88.74%
P402	2	0.3457		13.28	9.09	68.42%	12.62	95.07%
P405	2.25	0.7166		26.19	16.86	64.38%	26.15	99.85%
P406	2.25	1.0030		30.98	16.85	54.38%	26.15	84.39%
P407	1.5	0.4571		7.08	2.80	39.52%	3.53	49.83%
P408	3	0.2336		32.23	6.95	21.56%	15.57	48.31%
P409	1.75	1.0982	Siphon		8.55		13.00	
P410	1.5	0.2402	Siphon		5.62		8.68	
P411	2	0.2402	Siphon		11.99		18.47	
P412	1.75	20.4809	Siphon		8.55		12.96	
P413	2	21.0273	Siphon		11.99		18.43	
P414	1.5	21.0273	Siphon		5.61		8.65	
P415	1.75	0.0000	Siphon		8.55		12.93	
P416	2	0.0000	Siphon		11.99		18.41	
P417	1.5	0.0000	Siphon		5.60		8.62	
P418	1.75	-21.3376	Siphon		8.55		12.91	
P419	1.5	-21.3376	Siphon		5.60		8.59	
P420	2	-21.2627	Siphon		11.99		18.39	
P421	0.833	1.4932		2.66	1.05	39.41%	1.13	42.38%
P422	0.833	1.2400		2.43	1.05	43.25%	1.13	46.50%
P423	0.833	1.2400		2.43	1.05	43.25%	1.13	46.50%
P424	0.833	1.1956		2.38	1.05	44.04%	1.13	47.36%





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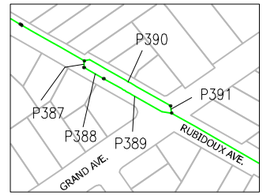

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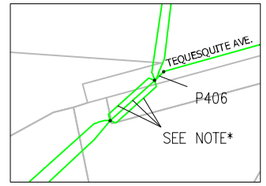

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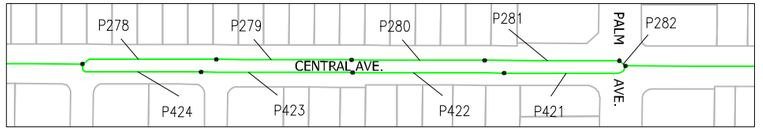

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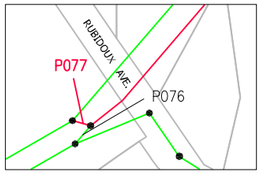

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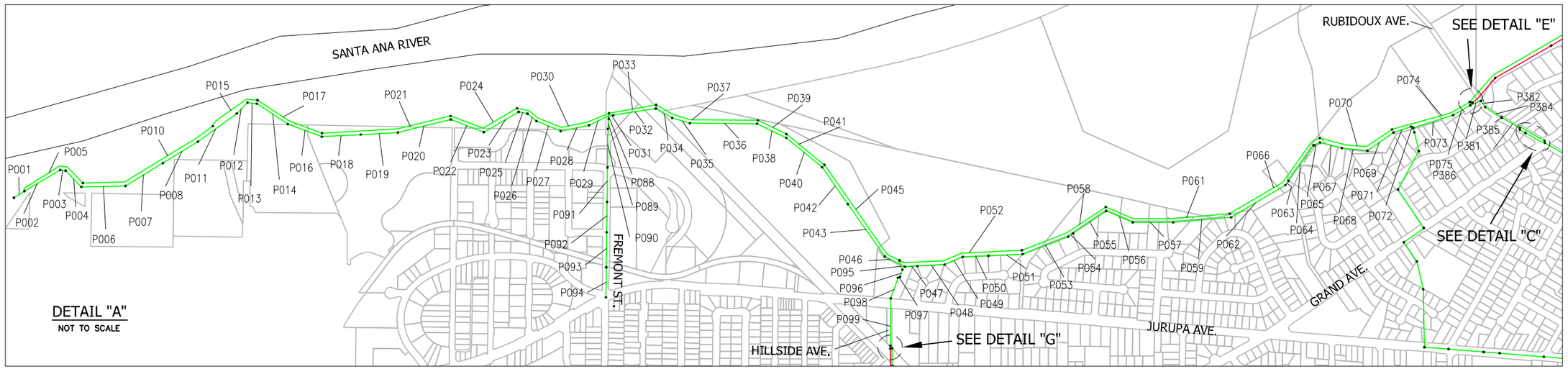

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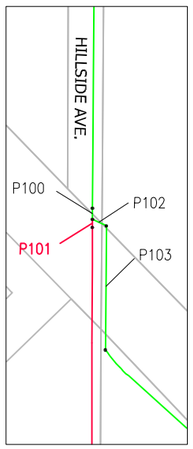

DETAIL "G"
NOT TO SCALE

LEGEND

- EXCEEDS 90% FULL
- > 75% < 90% FULL
- LESS THAN 75% FULL
- P001 PIPELINE NUMBER

NOTE* THIS 3-PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 12/15/05 | DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 19A

EXISTING VOLUME DEFICIENCIES - PART 1

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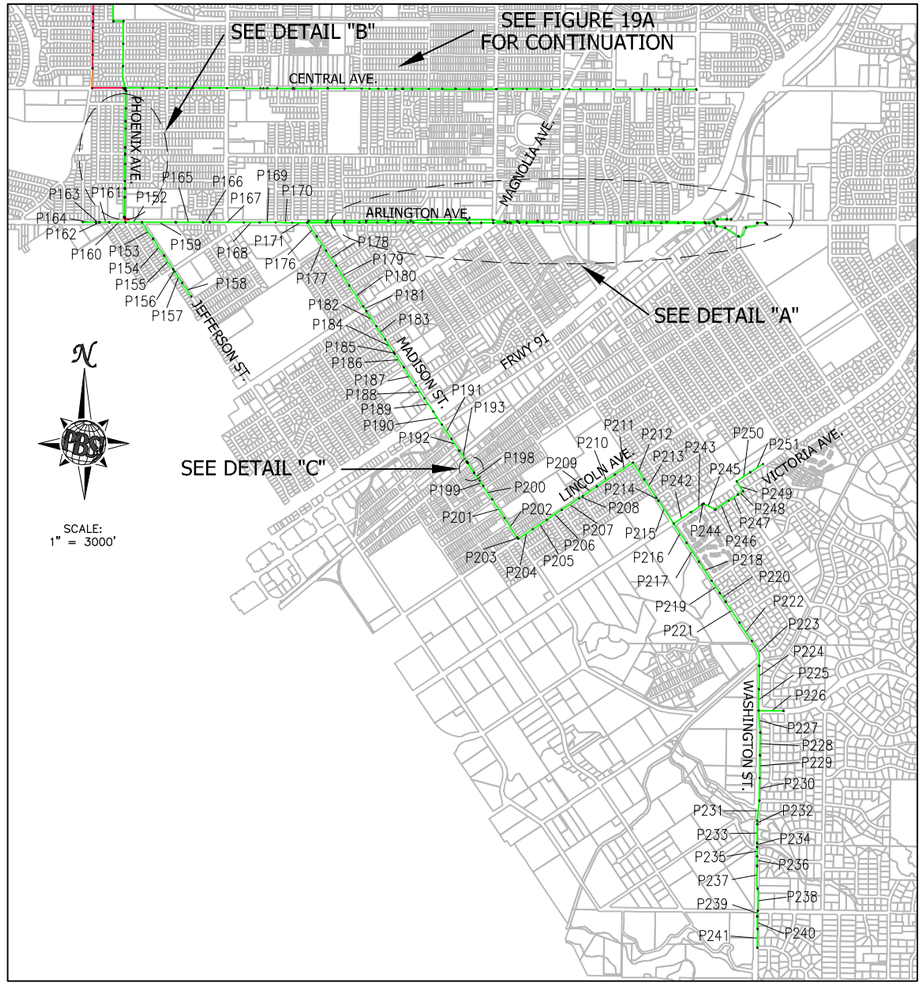

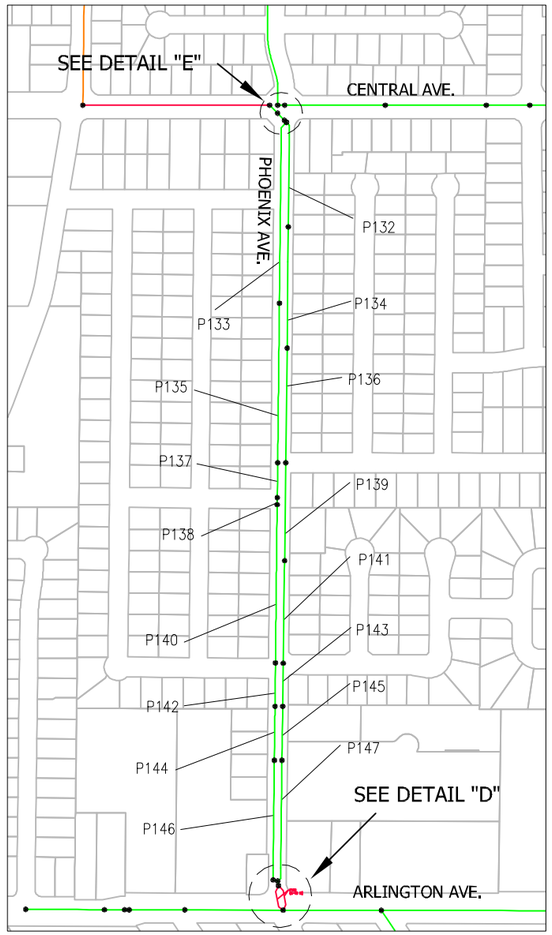

DETAIL "B"
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DETAIL "C"
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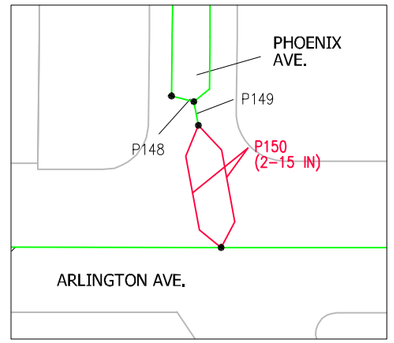

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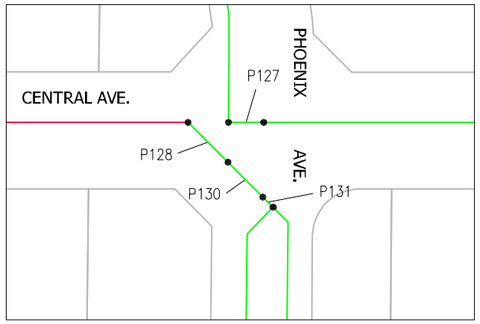
NOT TO SCALE



DETAIL "E"
NOT TO SCALE

LEGEND

	EXCEEDS 90% FULL
	> 75% < 90% FULL
	LESS THAN 75% FULL
P001	PIPELINE NUMBER

DETAIL "A"
NOT TO SCALE

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Riverside, CA 92503
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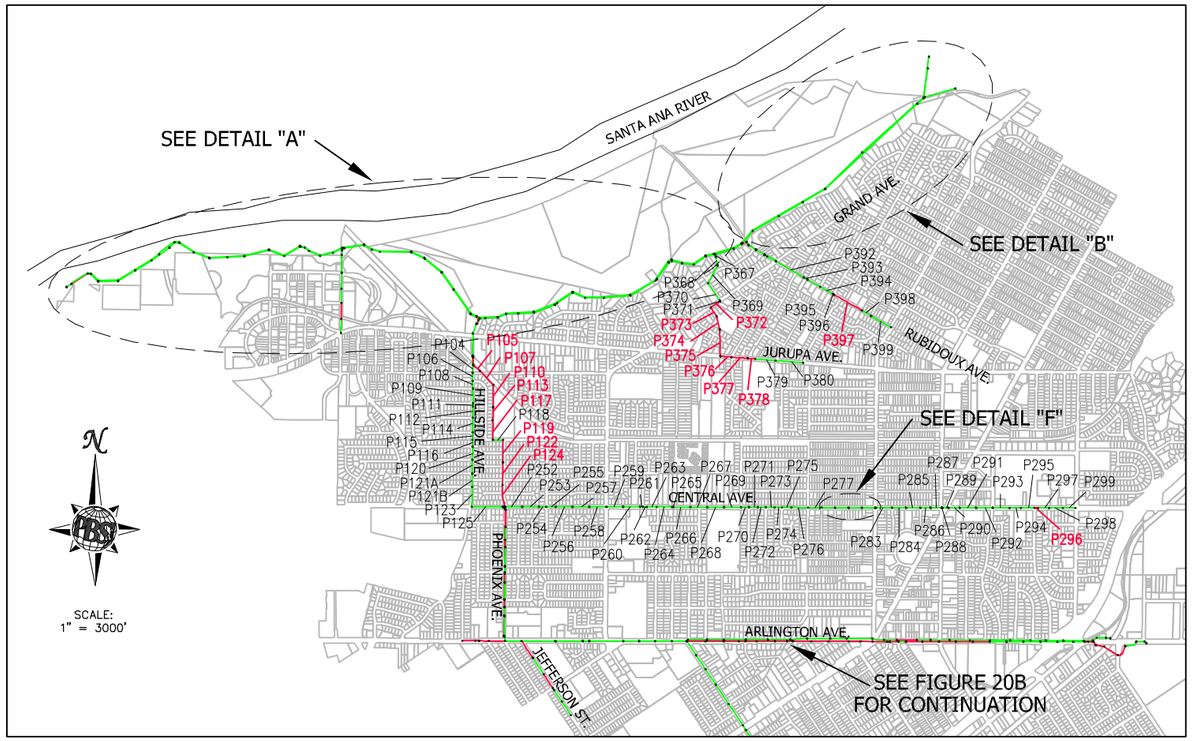
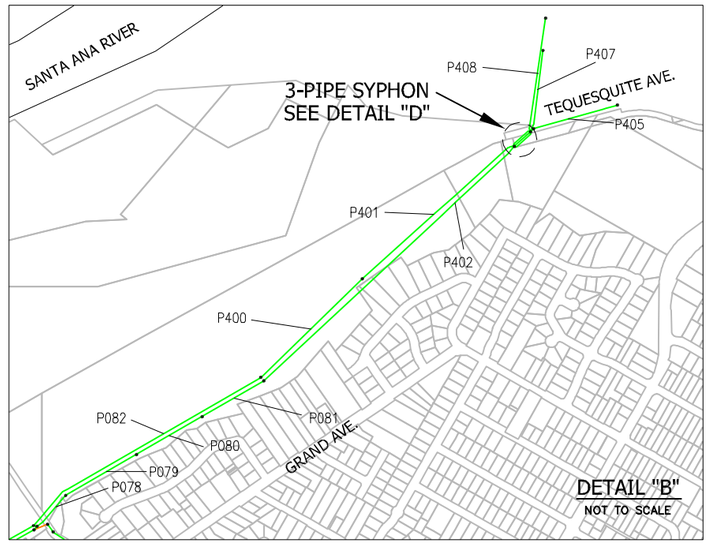
FIGURE 19B

EXISTING VOLUME DEFICIENCIES - PART 2

Y:\City of Riverside\Phoenix\DWG\Exhibits\PH-VolumeDeficientB.dwg, 9/28/2006 11:23:16 AM





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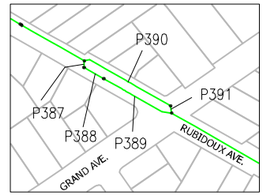

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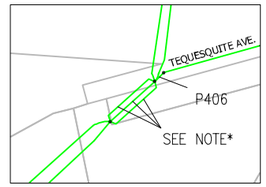

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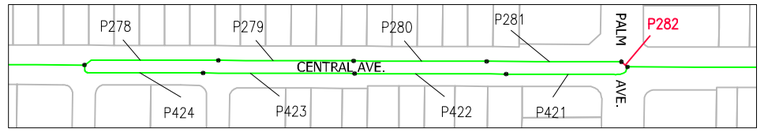

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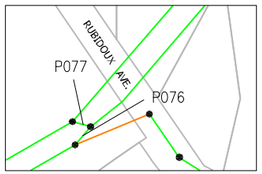

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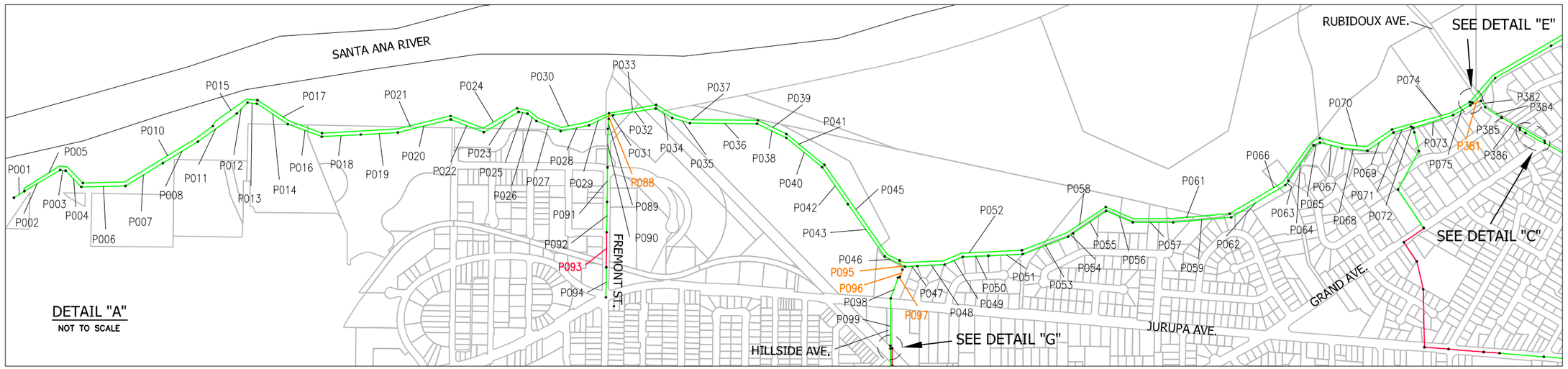

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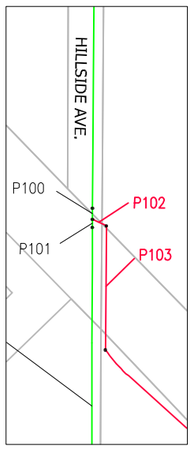

DETAIL "G"
NOT TO SCALE

LEGEND

- LESS THAN 2 FPS
- EXCEEDS 2 FPS
- EXCEEDS 10 FPS
- P001 PIPELINE NUMBER

NOTE* THIS 3-PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

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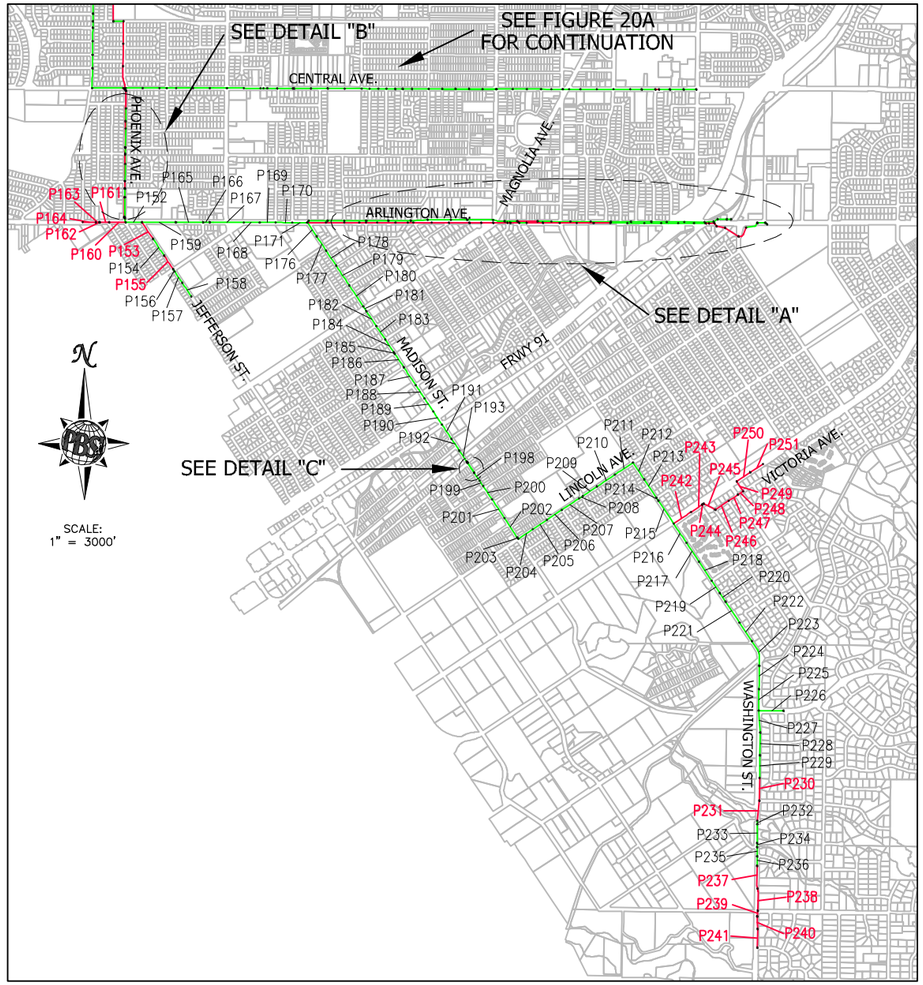
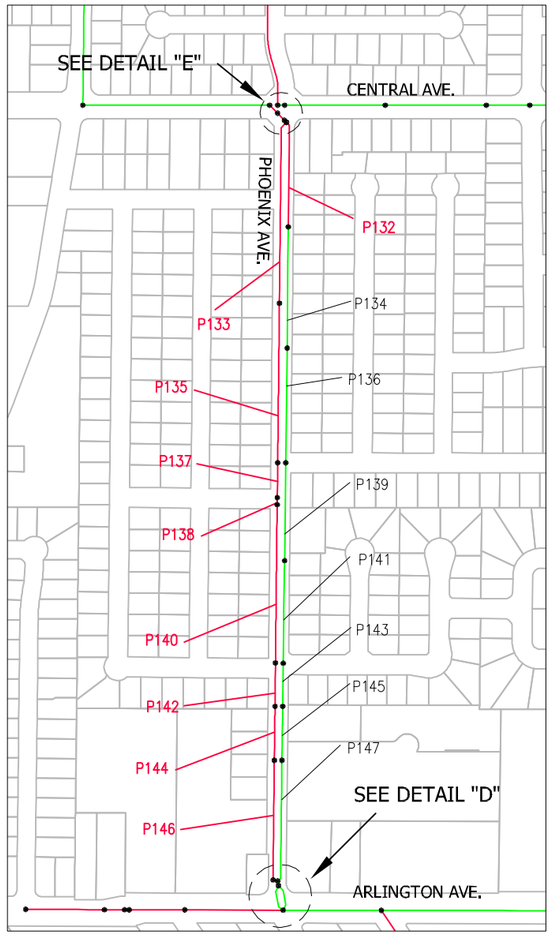
FIGURE 20A

EXISTING VELOCITY DEFICIENCIES - PART 1

Y:\City of Riverside\Phoenix\DWG\Exhibits\PH-VelocityDeficientA.dwg, 9/28/2006 11:19:34 AM





DETAIL "B"
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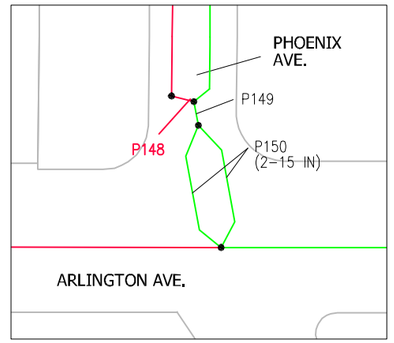
DETAIL "C"
NOT TO SCALE



DETAIL "D"
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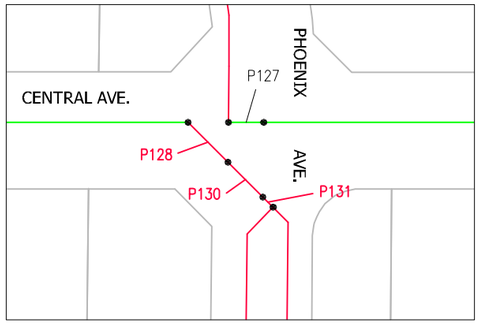
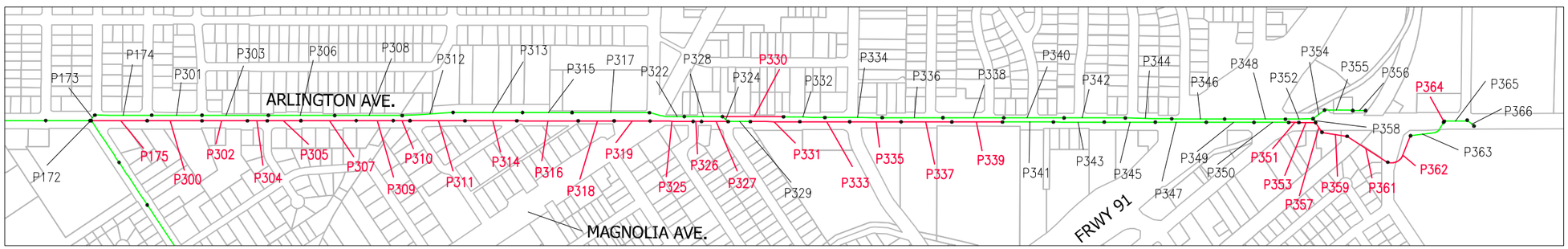


DETAIL "E"
NOT TO SCALE

LEGEND

	LESS THAN 2 FPS
	EXCEEDS 2 FPS
P001	PIPELINE NUMBER



DETAIL "A"
NOT TO SCALE

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FIGURE 20B

EXISTING VELOCITY DEFICIENCIES - PART 2

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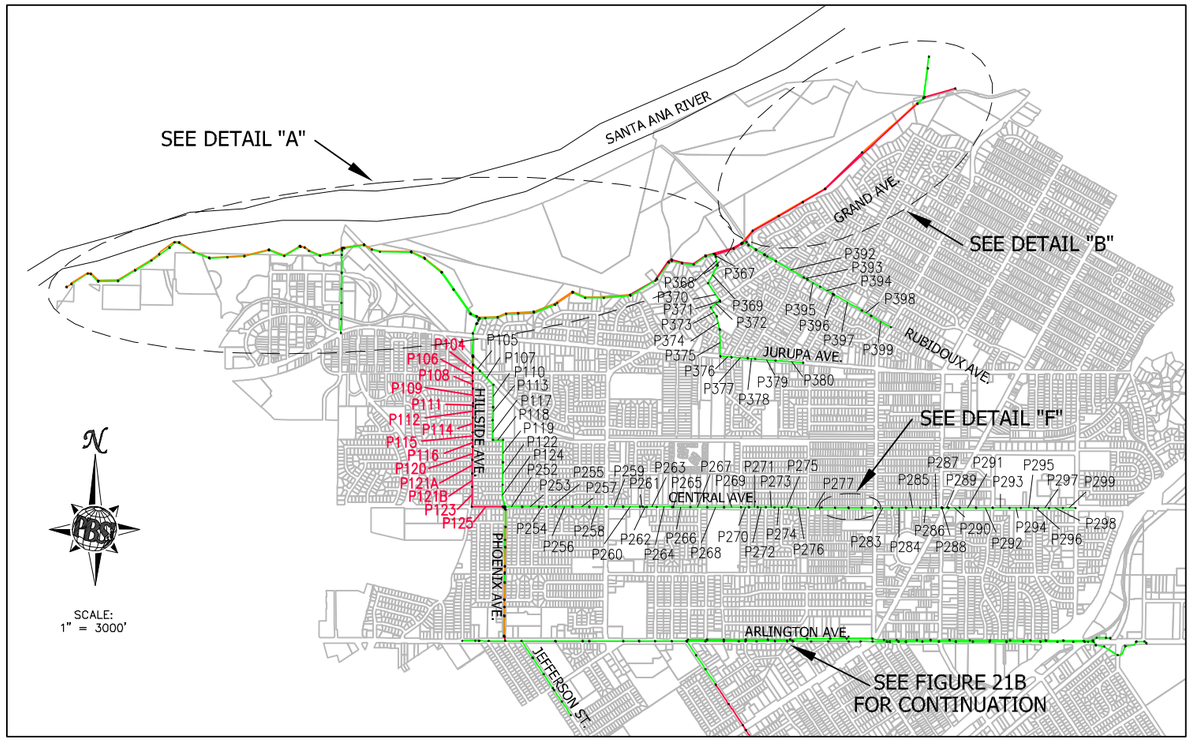

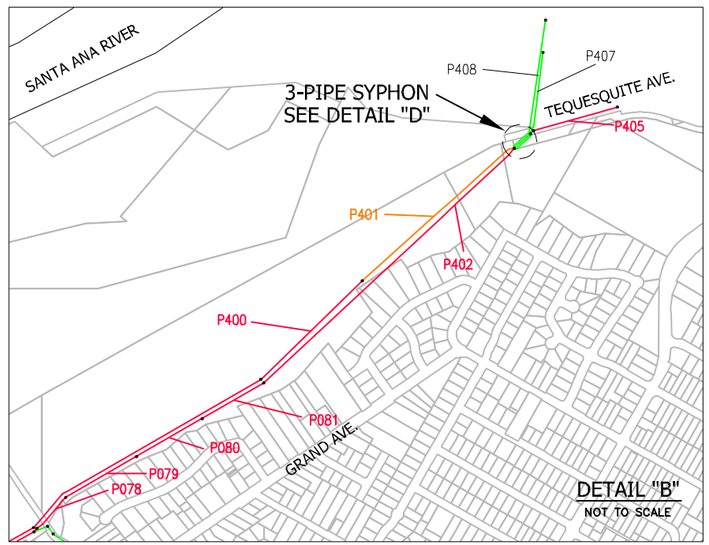

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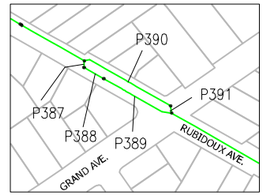

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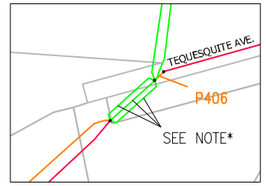
NOT TO SCALE



DETAIL "D"
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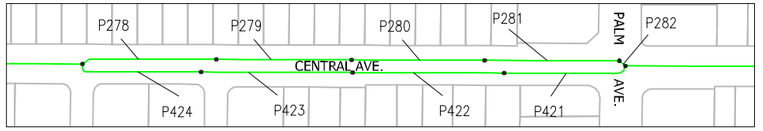

DETAIL "F"
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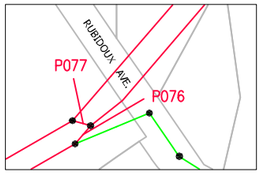

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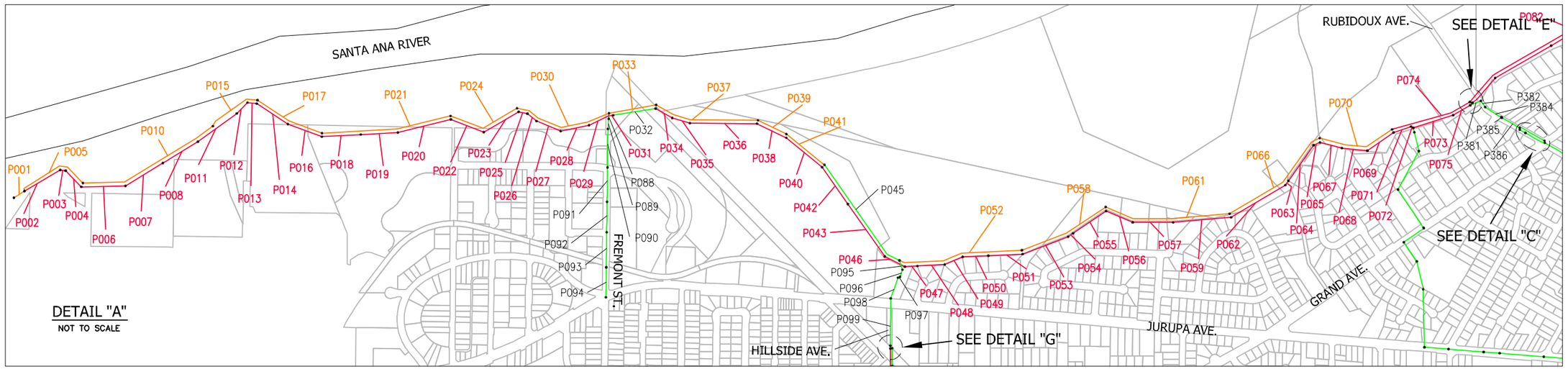

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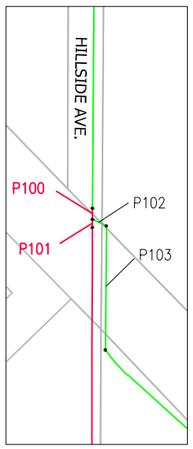

DETAIL "G"
NOT TO SCALE

LEGEND

- EXCEEDS 90% FULL
- > 75% < 90% FULL
- LESS THAN 75% FULL
- P001 PIPELINE NUMBER

NOTE* THIS 3-PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

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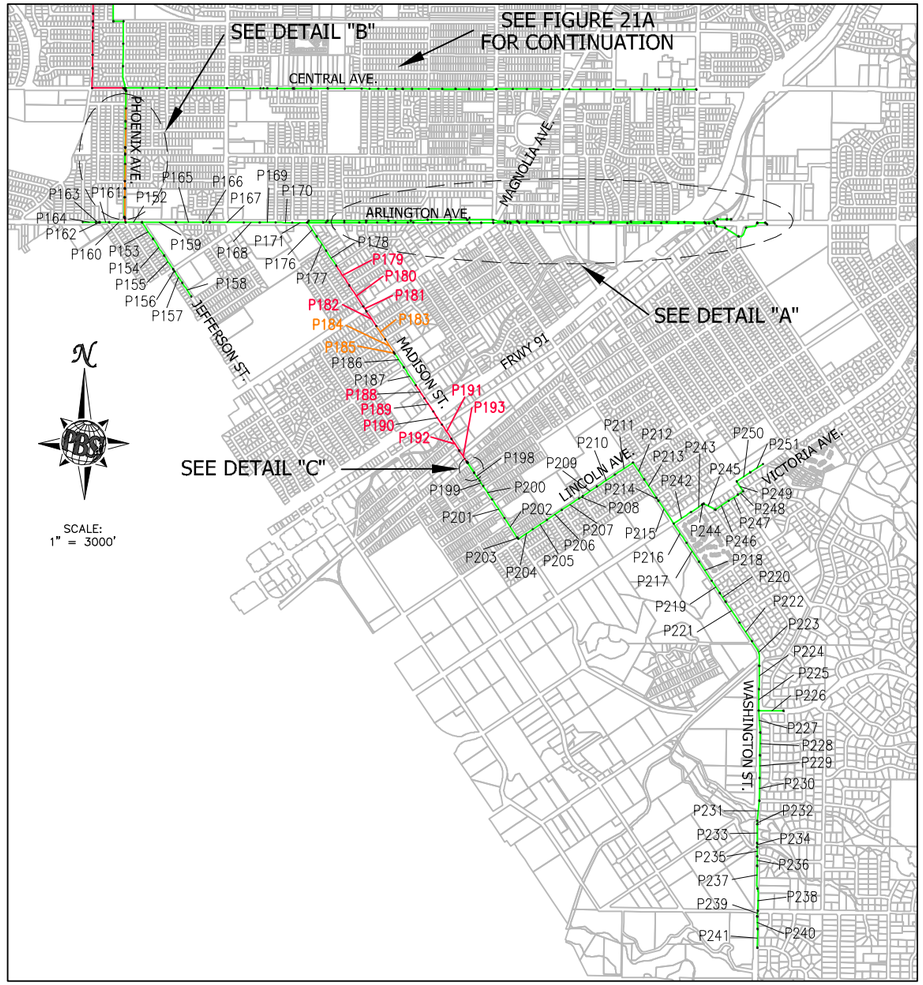
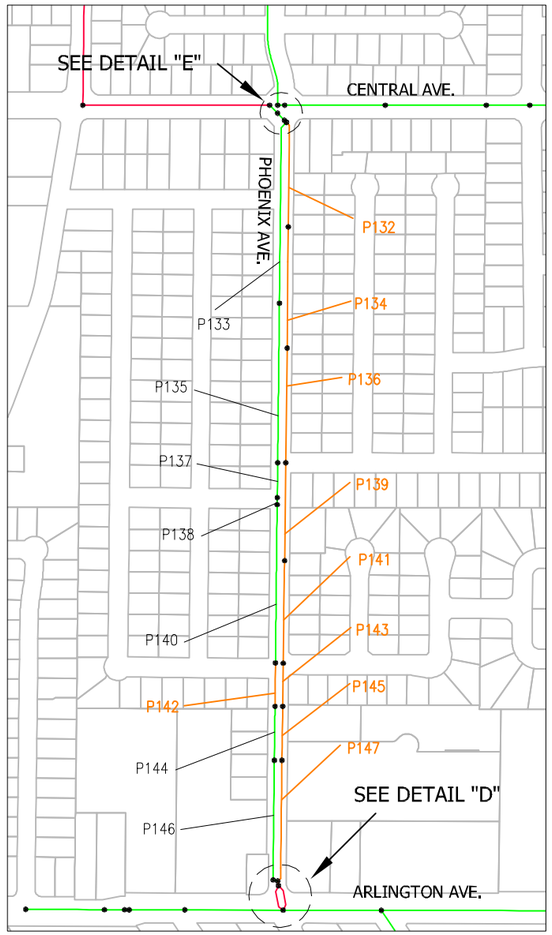
FIGURE 21A

ULTIMATE VOLUME DEFICIENCIES - PART 1

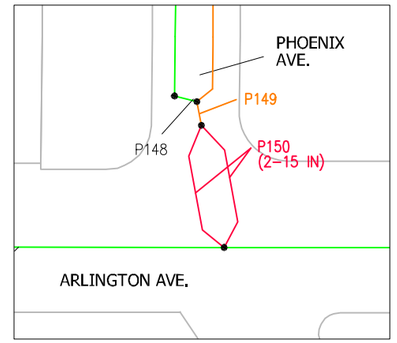
Y:\City of Riverside\Phoenix\DWG\Exhibits\PH-UltVolumeDefidentA.dwg, 9/28/2006 11:12:49 AM





DETAIL "B"
NOT TO SCALE

DETAIL "C"
NOT TO SCALE



DETAIL "D"
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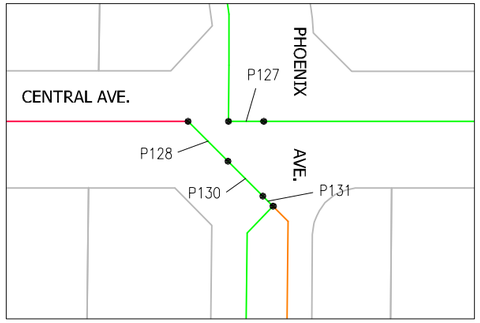

DETAIL "E"
NOT TO SCALE

LEGEND

- EXCEEDS 90% FULL
- > 75% < 90% FULL
- LESS THAN 75% FULL
- P001 PIPELINE NUMBER

DETAIL "A"
NOT TO SCALE

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FIGURE 21B

ULTIMATE VOLUME DEFICIENCIES - PART 2

Y:\City of Riverside\Phoenix\DWG\Exhibits\PH-UltVolumeDefidentB.dwg, 9/28/2006 11:17:21 AM

7.0 DEFICIENCIES AND SOLUTIONS

7.1 Deficient and Marginally Deficient Pipes

The City's design criterion for sewer lines allows pipes to flow at a ratio of 75% of "full" hydraulic capacity. Assuming that "full" capacity is the maximum hydraulic capacity of a pipe flowing under gravity (non-pressure) conditions, Manning's equation shows that maximum flow occurs when a pipe reaches a flow depth ratio of about 95% depth/diameter (d/D). For the purpose of this study, pipes flowing at greater than 90% capacity are considered "deficient", and pipes flowing at greater than 75% and less than 90% are considered "marginally deficient".

Pipe reaches which fail the "75% full" criterion for both existing and future flow conditions are shown in Table 7-2 and Figures 19A, 19B, 21A and 21B. It is seen that portions of the modeled trunk system are already flowing at greater than "75% full", and several reaches are computed to be over 100% full (surcharge conditions) in existing and future conditions. At ultimate conditions, numerous additional reaches are shown to surcharge or exceed the "75% full" criteria.

Pipe reaches that have flow velocity less than 2 feet per second and more than 10 feet per second under existing flow conditions are shown in Figures 20A and 20B.

7.2 Project Prioritization Methodology

The 75% full criterion is useful for analyzing deficient pipes and as a basis for sizing new facilities. However, the criterion is not necessarily the trigger point for replacement or augmentation of an existing sewer line. In most cases, a sewer entity would not implement a relief project until capacity problems are actually observed or known to be imminent.

A recommended system of project prioritization is the categorization of deficient sewer lines based on modeled % full results. The "A" priority projects are imminently needed and the "B" and "C" projects require further consideration for replacement. Priority classifications are described as follows:

Priority "A" – The pipes listed within this priority are currently flowing more than 90% full under maximum flow conditions. These pipes are grouped for replacement/rehabilitation in the period (2005-2010); preferably as soon as practically possible.

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P001	115	48	57.38%	74.13%	82.50%	C	54	60%	2016-2020
P002	384	24	64.99%	88.04%	99.56%	C	30	55%	2016-2020
P003	58	24	64.96%	87.97%	99.48%	C	30	55%	2016-2020
P004	206	24	64.92%	87.92%	99.42%	C	30	55%	2016-2020
P005	668	45	61.37%	78.37%	86.88%	C	51	62%	2016-2020
P006	398	24	64.86%	87.81%	99.29%	C	30	55%	2016-2020
P007	399	24	64.79%	87.69%	99.15%	C	30	55%	2016-2020
P008	376	24	64.74%	87.60%	99.03%	C	30	55%	2016-2020
P010	1354	45	61.04%	77.96%	86.42%	C	51	62%	2016-2020
P011	440	24	64.70%	87.51%	98.91%	C	30	55%	2016-2020
P012	144	24	64.67%	87.43%	98.82%	C	30	54%	2016-2020
P013	93	24	64.65%	87.40%	98.78%	C	30	54%	2016-2020
P014	342	24	64.70%	87.35%	98.67%	C	30	54%	2016-2020
P015	490	45	61.12%	78.06%	86.53%	C	51	62%	2016-2020
P016	329	24	64.59%	87.21%	98.52%	C	30	54%	2016-2020
P017	670	45	60.96%	77.85%	86.30%	C	51	62%	2016-2020
P018	356	24	64.56%	87.09%	98.36%	C	30	54%	2016-2020
P019	340	24	64.52%	86.97%	98.20%	C	30	54%	2016-2020
P020	502	24	64.48%	86.85%	98.04%	C	30	54%	2016-2020
P021	1196	45	61.11%	78.05%	86.52%	C	51	62%	2016-2020
P022	322	24	64.44%	86.86%	98.07%	C	30	54%	2016-2020
P023	370	24	64.41%	87.04%	98.35%	C	30	54%	2016-2020
P024	682	45	57.83%	73.87%	81.89%	C	51	59%	2016-2020
P025	88	24	64.39%	87.11%	98.47%	C	30	54%	2016-2020
P026	109	24	64.38%	87.14%	98.52%	C	30	54%	2016-2020
P027	236	24	64.36%	87.18%	98.59%	C	30	54%	2016-2020
P028	262	24	64.34%	87.22%	98.67%	C	30	54%	2016-2020
P029	199	24	64.33%	87.26%	98.73%	C	30	54%	2016-2020
P030	910	45	58.11%	74.23%	82.29%	C	51	59%	2016-2020
P031	44	24	64.32%	87.28%	98.76%	C	30	54%	2016-2020
P032	398	30	35.44%	48.13%	54.48%				
P033	436	45	54.10%	69.04%	76.52%	C	48	64%	2016-2020
P034	178	24	64.28%	87.37%	98.91%	C	30	55%	2016-2020
P035	166	24	64.27%	87.37%	98.91%	C	30	55%	2016-2020
P036	617	24	64.25%	87.36%	98.91%	C	30	55%	2016-2020
P037	964	45	55.30%	70.58%	78.22%	C	48	66%	2016-2020
P038	302	24	64.23%	87.35%	98.92%	C	30	55%	2016-2020
P039	287	45	58.98%	75.28%	83.43%	C	51	60%	2016-2020
P040	426	24	64.22%	87.35%	98.92%	C	30	55%	2016-2020
P041	447	45	59.76%	76.28%	84.54%	C	51	61%	2016-2020
P042	414	24	64.20%	87.34%	98.92%	C	30	55%	2016-2020
P043	586	24	64.19%	87.34%	98.92%	C	30	55%	2016-2020
P045	1131	45	49.12%	62.70%	69.49%				
P046	202	24	64.18%	87.34%	98.92%	C	30	55%	2016-2020
P047	113	24	64.18%	87.34%	98.93%	C	30	55%	2016-2020
P048	249	24	62.53%	85.69%	97.27%	C	30	54%	2016-2020
P049	180	24	62.52%	85.69%	97.27%	C	30	54%	2016-2020
P050	237	24	62.52%	85.68%	97.27%	C	30	54%	2016-2020
P051	313	24	62.52%	85.68%	97.27%	C	30	54%	2016-2020
P052	1148	39	58.98%	76.27%	84.92%	C	45	58%	2016-2020
P053	444	24	62.51%	85.68%	97.27%	C	30	54%	2016-2020
P054	54	24	62.51%	85.69%	97.28%	C	30	54%	2016-2020
P055	370	24	62.51%	85.73%	97.35%	C	33	42%	2016-2020
P056	268	24	62.51%	85.75%	97.38%	C	30	54%	2016-2020
P057	369	24	62.51%	85.86%	97.54%	C	30	54%	2016-2020
P058	870	39	59.04%	76.34%	84.99%	C	45	58%	2016-2020
P059	531	24	62.51%	86.22%	98.08%	C	30	54%	2016-2020
P061	1162	39	58.59%	75.75%	84.33%	C	45	58%	2016-2020
P062	575	24	60.85%	85.11%	97.25%	C	30	54%	2016-2020
P063	46	24	60.85%	85.44%	97.74%	C	30	54%	2016-2020
P064	403	24	60.85%	85.74%	98.18%	C	30	54%	2016-2020
P065	70	24	60.85%	85.97%	98.54%	C	30	54%	2016-2020
P066	1102	39	59.04%	76.33%	84.98%	C	45	58%	2016-2020
P067	210	24	60.85%	86.10%	98.73%	C	30	54%	2016-2020
P068	231	24	60.85%	86.31%	99.05%	C	30	55%	2016-2020
P069	290	24	60.85%	86.57%	99.44%	C	30	55%	2016-2020
P070	726	39	59.04%	76.33%	84.98%	C	45	58%	2016-2020
P071	170	24	60.85%	86.79%	99.76%	C	30	55%	2016-2020
P072	24	24	60.85%	86.87%	99.88%	C	30	55%	2016-2020
P073	383	24	54.15%	79.75%	92.55%	C	30	51%	2016-2020
P074	763	39	62.24%	80.46%	89.58%	C	48	51%	2016-2020
P075	181	24	54.15%	79.95%	92.86%	C	30	51%	2016-2020
P076	31	24	54.15%	80.02%	92.97%	C	30	51%	2016-2020
P077	15	15	96.15%	125.11%	139.59%	A	21	57%	2005-2010
P078	309	24	89.92%	112.15%	123.27%	A	33	53%	2005-2010

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P079	595	24	89.92%	112.23%	123.39%	A	30	68%	2005-2010
P080	550	24	89.92%	112.24%	123.39%	A	30	68%	2005-2010
P081	514	24	89.93%	112.24%	123.40%	A	30	68%	2005-2010
P082	1983	36	57.09%	79.23%	90.31%	C	42	60%	2016-2020
P088	52	10	5.88%	7.71%	8.63%				
P089	92	10	10.89%	14.28%	15.98%				
P090	353	15	13.18%	17.28%	19.33%				
P091	278	12	11.13%	14.58%	16.31%				
P092	278	12	11.96%	15.68%	17.53%				
P093	322	12	33.59%	44.03%	49.25%				
P094	275	12	12.99%	17.03%	19.05%				
P095	82	24	11.87%	14.51%	15.83%				
P096	68	24	13.08%	15.92%	17.34%				
P097	20	24	15.79%	19.21%	20.93%				
P098	201	24	28.07%	34.16%	37.21%				
P099	434	24	28.05%	34.13%	37.18%				
P100	14	27	74.47%	90.64%	98.73%	A*	33	58%	2005-2010
P101	11	24	96.23%	117.14%	130.42%	A	33	56%	2005-2010
P102	12	27	29.29%	30.53%	31.15%				
P103	161	27	29.70%	30.96%	31.59%				
P104	320	24	91.81%	118.72%	132.17%	A	33	56%	2005-2010
P105	183	27	30.44%	31.73%	32.37%				
P106	161	24	92.13%	119.13%	132.63%	A	33	57%	2005-2010
P107	384	27	30.65%	31.94%	32.58%				
P108	148	24	91.67%	118.53%	131.97%	A	33	56%	2005-2010
P109	290	24	90.73%	117.32%	130.61%	A	33	56%	2005-2010
P110	445	27	29.21%	30.42%	31.03%				
P111	64	24	97.18%	125.66%	139.90%	A	33	60%	2005-2010
P112	221	24	90.31%	116.78%	130.01%	A	33	56%	2005-2010
P113	252	27	28.51%	29.69%	30.28%				
P114	279	24	90.81%	117.42%	130.73%	A	33	56%	2005-2010
P115	150	24	92.28%	119.31%	132.83%	A	33	57%	2005-2010
P116	133	24	94.43%	122.09%	135.93%	A	33	58%	2005-2010
P117	392	27	27.06%	28.18%	28.74%				
P118	203	27	23.97%	24.96%	25.46%				
P119	445	27	30.01%	31.26%	31.88%				
P120	263	24	91.83%	118.74%	132.19%	A	33	56%	2005-2010
P121A	263	24	91.84%	118.74%	132.19%	A	33	56%	2005-2010
P121B	263	24	91.87%	118.76%	132.22%	A	33	56%	2005-2010
P122	445	27	29.61%	30.84%	31.45%				
P123	397	24	86.68%	112.04%	124.73%	A*	30	69%	2005-2010
P124	437	27	29.77%	31.01%	31.62%				
P125	615	24	143.27%	185.66%	206.33%	A	36	70%	2005-2010
P127	23	24	9.97%	10.38%	10.59%				
P128	34	27	42.92%	55.20%	61.35%				
P130	34	27	42.92%	55.21%	61.35%				
P131	10	27	57.57%	64.47%	67.92%				
P132	345	27	65.24%	73.46%	77.57%	C	30	59%	2016-2020
P133	604	21	4.67%	37.73%	54.26%				
P134	400	27	65.76%	75.19%	79.90%	C	30	60%	2016-2020
P135	526	21	3.81%	37.23%	53.95%				
P136	378	27	66.05%	76.72%	82.06%	C	30	62%	2016-2020
P137	115	21	3.57%	37.03%	53.76%				
P138	23	21	1.49%	28.61%	42.17%				
P139	323	27	65.62%	77.16%	82.94%	C	30	63%	2016-2020
P140	523	21	2.43%	44.58%	65.67%				
P141	338	27	65.91%	78.25%	84.43%	C	30	64%	2016-2020
P142	143	21	2.96%	53.63%	78.98%	C	24	55%	2016-2020
P143	143	27	67.18%	80.20%	86.71%	C	30	65%	2016-2020
P144	178	21	2.77%	50.05%	73.69%				
P145	178	27	65.29%	78.33%	84.86%	C	30	64%	2016-2020
P146	394	21	1.23%	21.99%	32.36%				
P147	398	27	63.64%	76.73%	83.28%	C	30	63%	2016-2020
P148	6	15	0.00%	12.45%	18.68%				
P149	16	27	51.83%	68.25%	76.45%	A*	30	58%	2005-2010
P150**	71	15	86.42%	129.62%	145.22%	A	2-18	71%	2005-2010
P152	324	21	37.59%	50.12%	56.39%				
P153	399	12	49.20%	51.03%	51.94%				
P154	393	12	43.10%	44.74%	45.56%				
P155	328	12	52.37%	54.38%	55.38%				
P156	50	12	24.63%	25.53%	25.97%				
P157	271	12	24.51%	25.40%	25.85%				
P158	322	12	24.68%	25.57%	26.02%				
P159	671	21	46.54%	64.01%	72.75%				
P160	324	12	11.20%	18.23%	21.74%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P161	184	12	9.99%	14.41%	16.62%				
P162	15	12	13.24%	17.24%	19.25%				
P163	67	12	14.95%	18.11%	19.69%				
P164	259	12	10.83%	11.34%	11.59%				
P165	541	21	46.39%	63.95%	72.74%				
P166	130	21	42.89%	59.13%	67.26%				
P167	673	21	27.26%	37.59%	42.76%				
P168	315	21	27.31%	37.65%	42.83%				
P169	314	21	28.27%	38.98%	44.33%				
P170	330	21	27.49%	37.91%	43.12%				
P171	291	21	26.30%	36.27%	41.26%				
P172	10	21	20.36%	27.59%	31.21%				
P173	49	15	15.32%	23.10%	26.99%				
P174	374	15	15.43%	23.27%	27.19%				
P175	367	12	0.71%	1.06%	1.24%				
P176	330	18	47.60%	64.49%	72.94%				
P177	335	18	45.72%	61.94%	70.05%				
P178	364	18	47.17%	63.91%	72.28%				
P179	462	18	63.52%	86.06%	97.33%	C	24	45%	2016-2020
P180	503	18	63.52%	86.06%	97.33%	C	24	45%	2016-2020
P181	114	18	63.52%	86.06%	97.33%	C	24	45%	2016-2020
P182	355	15	60.75%	83.04%	94.19%	C	18	58%	2016-2020
P183	316	15	52.15%	71.29%	80.86%	C	18	50%	2016-2020
P184	303	15	51.87%	70.91%	80.42%	C	18	49%	2016-2020
P185	34	15	52.57%	71.86%	81.51%	C	18	50%	2016-2020
P186	324	15	36.88%	50.42%	57.19%				
P187	425	15	40.41%	55.23%	62.65%				
P188	313	15	44.37%	61.28%	69.73%				
P189	313	15	35.74%	49.35%	56.16%				
P190	312	15	35.84%	49.49%	56.31%				
P191	338	15	73.95%	102.94%	117.45%	B	21	48%	2011-2015
P192	282	15	73.96%	102.95%	117.46%	B	21	48%	2011-2015
P193	263	15	73.97%	102.97%	117.47%	B	21	48%	2011-2015
P194	20	15	8.37%	11.08%	12.44%				
P195	21	15	27.68%	39.02%	44.69%				
P196	245	12	11.37%	15.12%	16.99%				
P197	241	15	32.55%	45.86%	52.51%				
P198	192	15	32.55%	45.86%	52.52%				
P199	130	15	14.92%	21.02%	24.07%				
P200	312	15	32.55%	45.86%	52.51%				
P201	446	15	22.86%	32.21%	36.89%				
P202	461	15	31.88%	44.91%	51.43%				
P203	34	15	25.35%	35.72%	40.91%				
P204	340	18	38.25%	53.90%	61.72%				
P205	337	18	37.12%	52.30%	59.89%				
P206	354	18	36.57%	51.53%	59.01%				
P207	411	24	17.10%	24.09%	27.59%				
P208	87	18	18.61%	26.23%	30.04%				
P209	337	18	18.52%	26.09%	29.88%				
P210	427	18	18.80%	26.49%	30.34%				
P211	429	18	18.81%	26.51%	30.36%				
P212	400	18	13.75%	19.77%	22.78%				
P213	431	18	14.26%	20.50%	23.62%				
P214	70	18	9.50%	14.20%	16.56%				
P215	545	18	9.41%	14.06%	16.39%				
P216	456	15	7.49%	12.10%	14.41%				
P217	450	15	7.48%	12.08%	14.39%				
P218	453	15	7.80%	12.60%	15.00%				
P219	290	15	6.83%	11.03%	13.14%				
P220	206	15	6.62%	10.70%	12.74%				
P221	500	15	9.20%	14.88%	17.71%				
P222	441	15	8.83%	14.27%	16.99%				
P223	529	12	9.14%	14.76%	17.58%				
P224	455	12	12.13%	19.60%	23.34%				
P225	428	12	12.90%	20.85%	24.83%				
P226	488	12	6.73%	8.49%	9.37%				
P227	434	12	6.40%	12.35%	15.33%				
P228	450	12	6.85%	13.22%	16.40%				
P229	450	12	9.49%	18.33%	22.74%				
P230	449	12	23.29%	44.94%	55.77%				
P231	400	12	22.42%	43.21%	53.61%				
P232	70	12	9.30%	17.93%	22.24%				
P233	70	12	4.06%	7.83%	9.71%				
P234	82	12	6.60%	12.73%	15.80%				
P235	175	12	6.45%	12.43%	15.43%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P236	193	12	6.45%	12.43%	15.42%				
P237	450	15	10.88%	20.97%	26.02%				
P238	444	15	10.81%	20.90%	25.95%				
P239	109	15	0.82%	8.56%	12.43%				
P240	250	15	0.81%	8.47%	12.31%				
P241	367	15	0.82%	0.96%	1.03%				
P242	227	15	0.18%	0.18%	0.18%				
P243	263	15	0.26%	0.26%	0.27%				
P244	39	15	0.26%	0.26%	0.26%				
P245	260	15	0.33%	0.33%	0.33%				
P246	318	15	0.52%	0.52%	0.52%				
P247	220	15	0.53%	0.53%	0.53%				
P248	123	15	0.52%	0.52%	0.53%				
P249	230	15	0.52%	0.52%	0.52%				
P250	323	15	0.52%	0.52%	0.52%				
P251	301	15	0.54%	0.54%	0.54%				
P252	332	15	27.77%	29.03%	29.65%				
P253	332	15	27.74%	29.00%	29.62%				
P254	144	15	55.06%	57.54%	58.79%				
P255	189	15	58.21%	60.84%	62.16%				
P256	332	15	58.09%	60.72%	62.03%				
P257	332	15	58.10%	60.72%	62.03%				
P258	338	15	57.49%	60.09%	61.39%				
P259	333	15	64.69%	67.61%	69.07%				
P260	333	15	64.31%	67.21%	68.67%				
P261	58	15	63.98%	66.87%	68.31%				
P262	75	15	60.07%	62.78%	64.13%				
P263	195	15	51.40%	53.72%	54.88%				
P264	308	15	58.22%	60.85%	62.17%				
P265	24	15	27.77%	29.02%	29.65%				
P266	337	15	43.62%	45.59%	46.58%				
P267	333	15	31.01%	32.41%	33.11%				
P268	333	15	30.99%	32.39%	33.09%				
P269	338	15	36.63%	38.29%	39.11%				
P270	156	15	27.20%	28.60%	29.29%				
P271	174	15	27.85%	29.28%	30.00%				
P272	158	15	37.54%	39.47%	40.43%				
P273	174	15	33.43%	35.15%	36.01%				
P274	149	15	38.78%	40.77%	41.77%				
P275	185	15	33.05%	34.75%	35.60%				
P276	331	15	35.59%	37.42%	38.33%				
P277	268	15	29.09%	30.58%	31.33%				
P278	265	12	23.39%	24.65%	25.28%				
P279	268	12	23.73%	25.00%	25.64%				
P280	264	12	13.80%	14.54%	14.91%				
P281	267	12	12.05%	12.70%	13.02%				
P282	12	12	22.92%	24.15%	24.77%				
P283	320	12	68.50%	72.02%	73.78%				
P284	277	12	67.74%	71.22%	72.96%				
P285	282	12	68.02%	71.52%	73.26%				
P286	205	12	69.22%	72.78%	74.56%				
P287	221	12	47.96%	51.02%	52.56%				
P288	12	12	30.26%	32.20%	33.17%				
P289	120	12	51.85%	55.17%	56.82%				
P290	223	12	30.73%	33.51%	34.89%				
P291	324	12	32.53%	35.46%	36.93%				
P292	330	12	32.68%	35.63%	37.11%				
P293	332	12	32.35%	35.27%	36.73%				
P294	224	12	32.45%	35.38%	36.85%				
P295	271	12	31.95%	34.83%	36.27%				
P296	72	12	19.46%	22.45%	23.94%				
P297	216	12	19.47%	22.46%	23.95%				
P298	272	12	19.16%	22.09%	23.56%				
P299	249	12	20.35%	23.47%	25.03%				
P300	360	12	0.74%	1.08%	1.25%				
P301	391	15	16.93%	25.53%	29.83%				
P302	299	12	0.71%	1.06%	1.24%				
P303	436	15	15.71%	23.68%	27.67%				
P304	131	12	0.70%	1.06%	1.23%				
P305	221	12	0.71%	1.06%	1.23%				
P306	437	15	15.27%	23.03%	26.91%				
P307	363	12	0.72%	1.08%	1.26%				
P308	444	15	16.17%	24.38%	28.49%				
P309	243	12	0.71%	1.07%	1.25%				
P310	111	12	0.71%	1.07%	1.24%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P311	361	12	1.20%	1.80%	2.10%				
P312	335	15	15.31%	23.08%	26.96%				
P313	457	15	21.35%	32.19%	37.61%				
P314	341	12	1.20%	1.79%	2.08%				
P315	326	15	20.81%	31.38%	36.66%				
P316	404	12	1.27%	1.88%	2.19%				
P317	509	15	23.76%	35.81%	41.84%				
P318	236	12	1.20%	1.78%	2.06%				
P319	236	12	1.22%	1.79%	2.08%				
P322	231	15	12.62%	19.03%	22.23%				
P324	50	8	10.17%	12.11%	13.08%				
P325	283	12	0.85%	1.25%	1.46%				
P326	55	12	0.80%	1.17%	1.36%				
P327	176	12	0.85%	1.25%	1.45%				
P328	252	15	17.97%	27.08%	31.64%				
P329	146	12	7.97%	9.71%	10.57%				
P330	401	15	31.42%	49.88%	59.12%				
P331	325	12	20.70%	25.20%	27.46%				
P332	272	15	21.11%	33.50%	39.69%				
P333	328	12	20.47%	24.88%	27.09%				
P334	378	15	21.58%	34.24%	40.57%				
P335	338	12	20.90%	25.36%	27.59%				
P336	399	15	21.29%	33.77%	40.02%				
P337	335	12	21.80%	26.39%	28.69%				
P338	401	15	21.38%	33.92%	40.19%				
P339	332	12	20.01%	24.17%	26.24%				
P340	396	15	16.24%	25.75%	30.52%				
P341	335	10	14.18%	17.11%	18.57%				
P342	403	15	16.40%	26.01%	30.81%				
P343	335	10	14.28%	17.18%	18.62%				
P344	305	15	16.46%	26.11%	30.94%				
P345	335	10	14.37%	17.24%	18.68%				
P346	348	15	16.29%	25.84%	30.61%				
P347	335	10	14.47%	17.34%	18.77%				
P348	400	15	16.35%	25.93%	30.72%				
P349	314	10	14.35%	17.13%	18.52%				
P350	229	10	20.53%	24.18%	26.01%				
P351	67	10	0.82%	1.01%	1.10%				
P352	182	15	9.00%	14.27%	16.91%				
P353	110	10	0.00%	0.00%	0.00%				
P354	94	8	24.85%	39.35%	46.60%				
P355	186	8	24.47%	38.74%	45.87%				
P356	83	12	8.52%	13.48%	15.97%				
P357	76	18	11.39%	18.06%	21.39%				
P358	31	18	1.22%	1.94%	2.30%				
P359	168	18	6.09%	9.66%	11.44%				
P361	317	18	6.04%	9.57%	11.33%				
P362	258	18	6.37%	10.09%	11.95%				
P363	253	18	5.12%	8.12%	9.61%				
P364	8	18	3.74%	5.92%	7.01%				
P365	158	12	12.89%	20.40%	24.16%				
P366	47	12	12.45%	19.71%	23.35%				
P367	42	12	9.40%	10.19%	10.58%				
P368	177	15	5.16%	5.60%	5.81%				
P369	401	15	5.16%	5.60%	5.81%				
P370	420	15	4.30%	4.60%	4.75%				
P371	7	15	24.01%	25.67%	26.50%				
P372	224	15	20.49%	21.91%	22.62%				
P373	212	15	20.40%	21.82%	22.53%				
P374	262	15	20.37%	21.78%	22.49%				
P375	532	15	20.34%	21.75%	22.46%				
P376	222	12	37.02%	39.59%	40.87%				
P377	325	12	29.41%	30.79%	31.49%				
P378	146	12	29.51%	30.90%	31.60%				
P379	406	12	19.14%	20.04%	20.49%				
P380	549	12	19.11%	20.01%	20.46%				
P381	11	12	3.64%	3.70%	3.73%				
P382	69	10	18.28%	18.55%	18.69%				
P384	175	10	21.85%	22.17%	22.34%				
P385	6	10	13.96%	14.17%	14.27%				
P386	189	10	40.13%	40.73%	41.03%				
P387	10	10	8.94%	9.07%	9.14%				
P388	60	10	18.92%	19.20%	19.34%				
P389	200	10	24.17%	24.52%	24.70%				
P390	256	10	13.19%	13.39%	13.50%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P391	13	10	15.83%	16.08%	16.20%				
P392	631	15	45.14%	45.87%	46.24%				
P393	87	15	34.93%	35.50%	35.78%				
P394	87	15	29.75%	30.23%	30.48%				
P395	286	15	42.73%	43.42%	43.77%				
P396	24	15	23.81%	24.23%	24.45%				
P397	798	15	43.38%	44.16%	44.55%				
P398	210	12	41.41%	42.15%	42.52%				
P399	451	12	41.56%	42.31%	42.68%				
P400	1028	33	58.92%	82.52%	94.33%	C	39	60%	2016-2020
P401	1273	33	54.89%	77.45%	88.74%	C	39	57%	2016-2020
P402	1906	24	68.42%	86.18%	95.07%	C	30	52%	2016-2020
P405	632	27	64.38%	88.02%	99.85%	C	33	58%	2016-2020
P406	33	27	54.38%	74.39%	84.39%	C	30	64%	2016-2020
P407	595	18	39.52%	46.39%	49.83%				
P408	831	36	21.56%	39.39%	48.31%				
P409	29	21							
P410	29	18							
P411	29	24							
P412	46	21							
P413	46	24							
P414	46	18							
P415	52	21							
P416	52	24							
P417	52	18							
P418	40	21							
P419	40	18							
P420	40	24							
P421	241	10	39.41%	41.39%	42.38%				
P422	300	10	43.25%	45.42%	46.50%				
P423	300	10	43.25%	45.42%	46.50%				
P424	237	10	44.04%	46.25%	47.36%				

* Placed under a different category due to geographical location.

** P150 is a two barrel pipe.

Priority “B” – The pipes listed in this priority are projected to be flowing more than 90% full in the future under estimated maximum flow conditions. A linear interpolation was done for anticipation of the mid-term flow in pipes between year 2005 and ultimate year (2020). The pipes that would be flowing more than 90% full in the year 2015 are placed under priority “B”. These pipes need evaluation as new development takes place in the tributary areas. Flow monitoring within the study area should be considered for observation of actual flows. The pipes under this priority are grouped for replacement/re-habilitation in the period (2011-2015).

Priority “C” – The pipes listed in this priority would be flowing more than 75% full in the future under maximum flow conditions. The pipes that are not part of priority “A” and “B” and will flow more than 75% full by the year 2020 are considered as priority “C”. These pipes need evaluation as new development takes place in the tributary areas. These may or may not be replaced or paralleled depending on actual observed flow conditions in the future. Flow monitoring within the study area should be considered when significant development occurs. The pipes under this priority are grouped for possible replacement/re-habilitation in the period (2016-2020).

7.3 Recommended Improvements

Table 7-3 lists project priority, project location, problem, solution and approximate cost for problem reaches. This table identifies immediate and future problems in the sewer lines and suggested solutions. The project cost is based on year 2005 indices.

Note that the first order of priority is field observation of all pipes where modeled results indicate surcharging conditions, to verify that flows are indeed exceeding pipe capacity.

7.4 Grouping of Projects

Proposed improvements under different priorities have been combined or grouped into projects to improve deficient and marginally deficient pipes based on the following criteria:

Pipes identified as marginally deficient in the near future (Priority “B”), and marginally deficient in the more distant future (Priority “C”) located geographically close to one another and requiring improvements, are grouped to reduce improvement costs.

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "A"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"A" (See Figures 22A, 22B and Table 7-2 for details of pipes)	Central Avenue	Pipes P125	Immediate Capacity Problem in reach M123 to M136 due to flat slope and smaller pipe size. Surcharging conditions.	Field verify surcharging conditions. Replace pipes with larger sizes pipe maintaining the same slope	$294,000
	Hillside Avenue	Pipes P100 to P101, P104, P106, P108 to P109, P111 to P112, P114 to P116, P120, P121A to P121B and P123	Immediate Capacity Problem in reaches M106 to M107, M107 to M108, M108 to M112, M112 to M121, M121 to M121A, M121A to M122, M122 to M123 due to flat slopes and small pipe sizes. Surcharging conditions.	Field verify surcharging conditions. Replace pipes with larger sizes pipe maintaining the same slope	$1,393,000
	Phoenix Avenue	Pipes P149-P150	Immediate Capacity Problem in reach M210 to M212 due to flat slopes and small pipe sizes. Surcharging conditions.	Field verify surcharging conditions. Replace pipes with larger sizes pipe maintaining the same slope	$71,000
	Santa Ana River Pipeline	Pipes P077 to P082	Immediate Capacity Problem in reaches M094 to M087, M058 to M060, M088 to M087 and M087 to M086 due to flat slopes and small pipe sizes. Surcharging conditions.	Field verify surcharging conditions. Replace pipes with larger sizes pipe maintaining the same slope	$828,000
				Total Cost for Priority "A" Projects (2005-2010 Replacement / Rehabilitation)	**$2,586,000**

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "B"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"B" (See Figures 23A, 23B and Table 7-2 for details of pipes)	Madison Street	Pipes P191 to P193	Future Capacity Problem in reach M246 to M249 due to smaller pipe sizes, flat slopes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining the same slope	$304,000
				Total Cost for Priority "B" Projects (2011-2015 Replacement / Rehabilitation)	**$304,000**

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "C"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"C" (See Figures 24A, 24B and Table 7-2 for details of pipes)	Madison Street	Pipes P179 to P185	Future Capacity Problem in reaches M235 to M242 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$716,000
	Phoenix Avenue	Pipes P132, P134, P136, P139, P141 to P143, P145, P147	Future Capacity Problem in reaches M140 to M141, M141 to M143, M143 to M144, M144 to M148, M148 to M149, M150 to M152, M149 to M151, M151 to M207, M207 to M210 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$1,100,000
	Santa Ana River Pipeline	Pipes P001 to P005, P006 to P008, P011 to P014, P016, P018 to P020, P022 to P023, P025 to P029, P031, P034 to P036, P038, P040, P042 to P043, P046 to P051, P053, P054, P055, P056 to P057, P059, P062, P063 to P065, P067 to P069, P071 to P073, P075, P076, P033, P037, P010, P015, P017, P021, P024, P030, P039, P041, P052, P058, P061, P070, P074, P082, P400 to P402, P405 to P406	Future Capacity Problem in the entire reach of two parallel pipelines along Santa Ana River between M001 to M426 due to flat slopes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$17,622,000
				Total Cost for Priority "C" Projects (2016-2020 Replacement / Rehabilitation)	**$19,438,000**

7.5 Construction Schedule

A summary of proposed construction prioritization and recommended scheduling is shown in Table 7-2. This table lists construction priorities and the year in which these activities are proposed. Also, the pipes included in priorities “B” and “C” will need re-evaluation before their replacement.

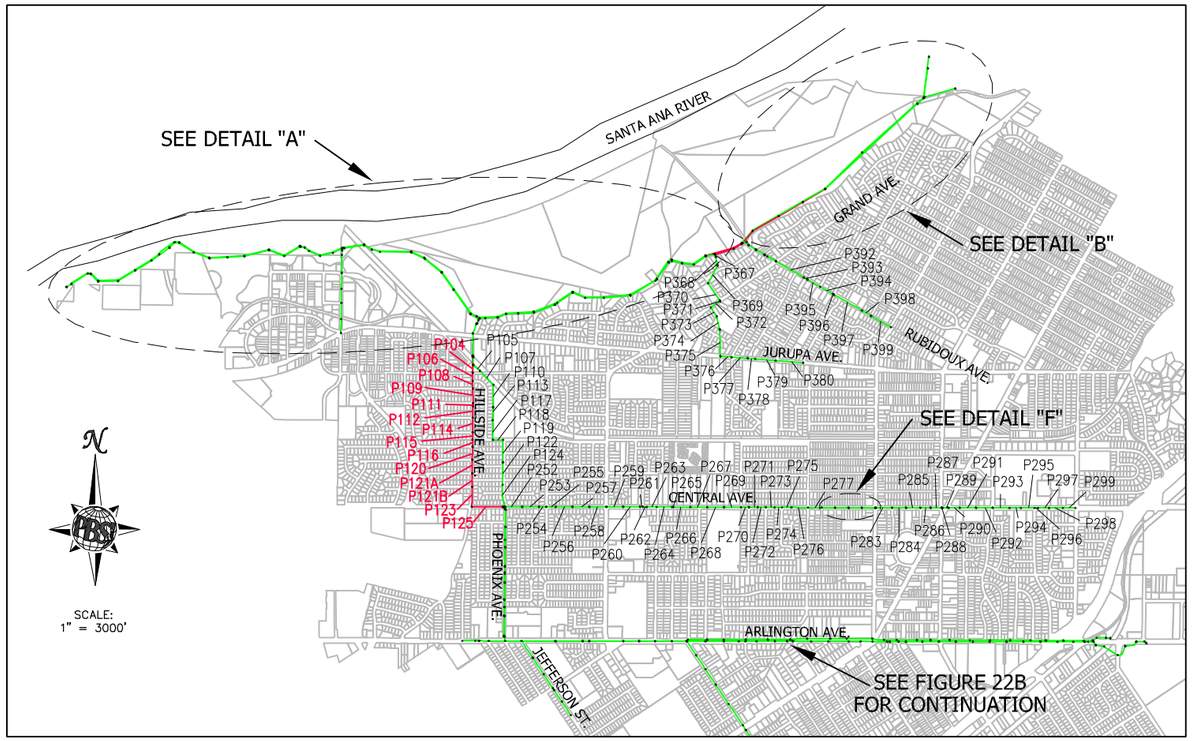
7.6 Cost Estimate

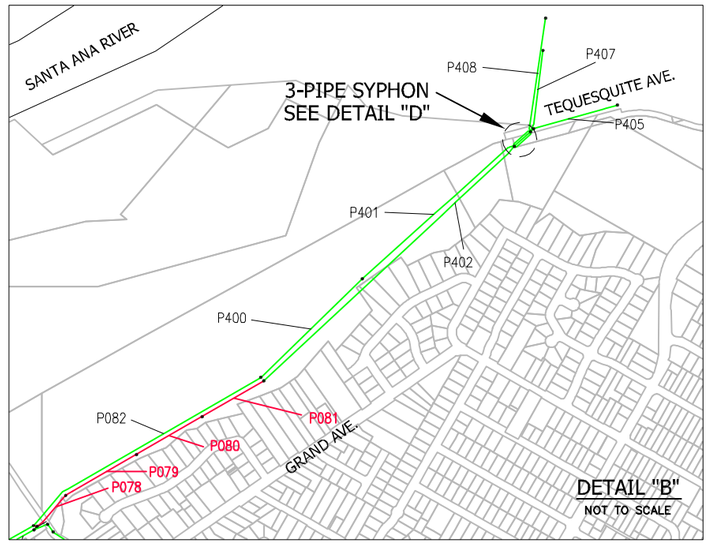
Unit costs of pipes are based on bid prices for similar projects and from the web site www.get-a-quote.net. The cost of construction includes labor, materials, excavation, backfill and all other items associated with pipe laying. To estimate total cost, cost of mobilization / demobilization (7%), traffic control (7%), bond (1%), contractor’s profit (15%) and construction contingency (25%) is added to the cost of construction. The cost of engineering, right of way acquisition, permits, soil conditions remediation and by-pass pumping is not included in the construction cost. For priorities “B” and “C”, the cost estimate is based on year 2005 prices and no escalation has been added to estimate future cost. Following is the summary of cost for the various priorities:

Priority “A” - $2.59 Million (2005 $’s) (See Figures 22A, 22B and Table 7-4 for details)

Priority “B” - $0.30 Million (2005 $’s) (See Figures 23A, 23B and Table 7-5 for details)

Priority “C” - $19.44 Million (2005 $’s) (See Figures 24A, 24B and Table 7-6 for details)





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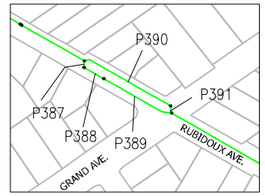

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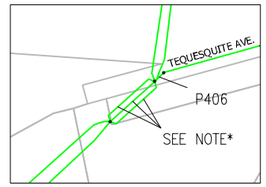

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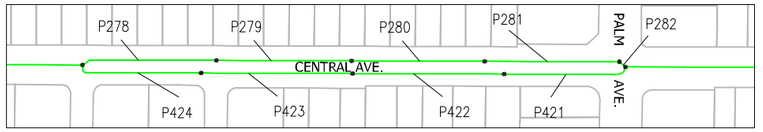

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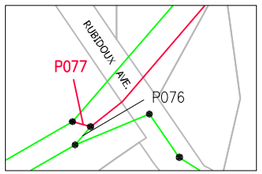

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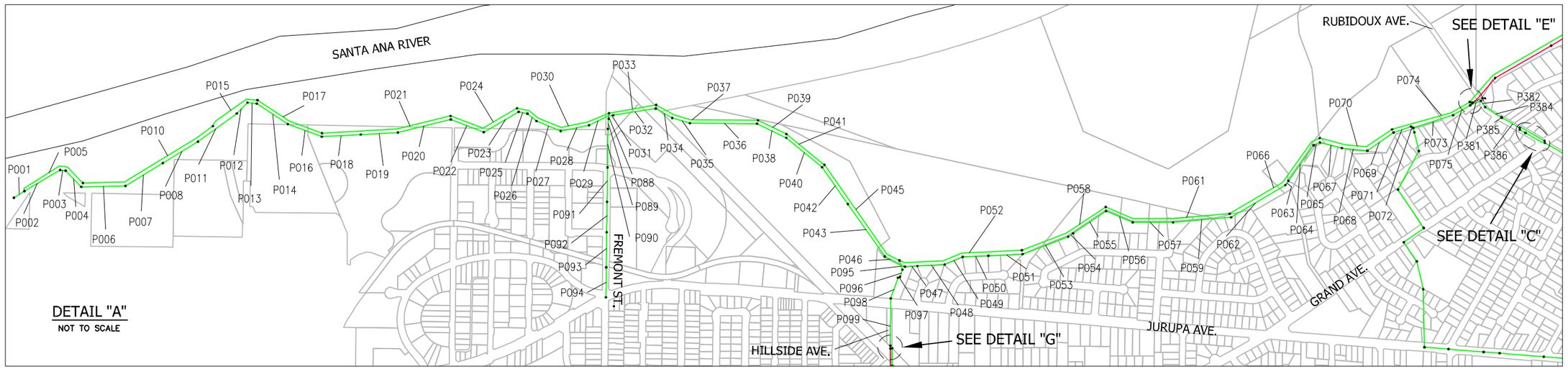

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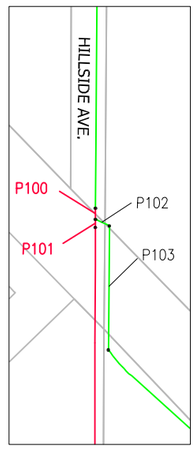

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LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2005 – 2010)
- P001 PIPELINE NUMBER

NOTE* THIS 3–PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

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Suite 200
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FIGURE 22A

PRIORITY "A" - PART 1

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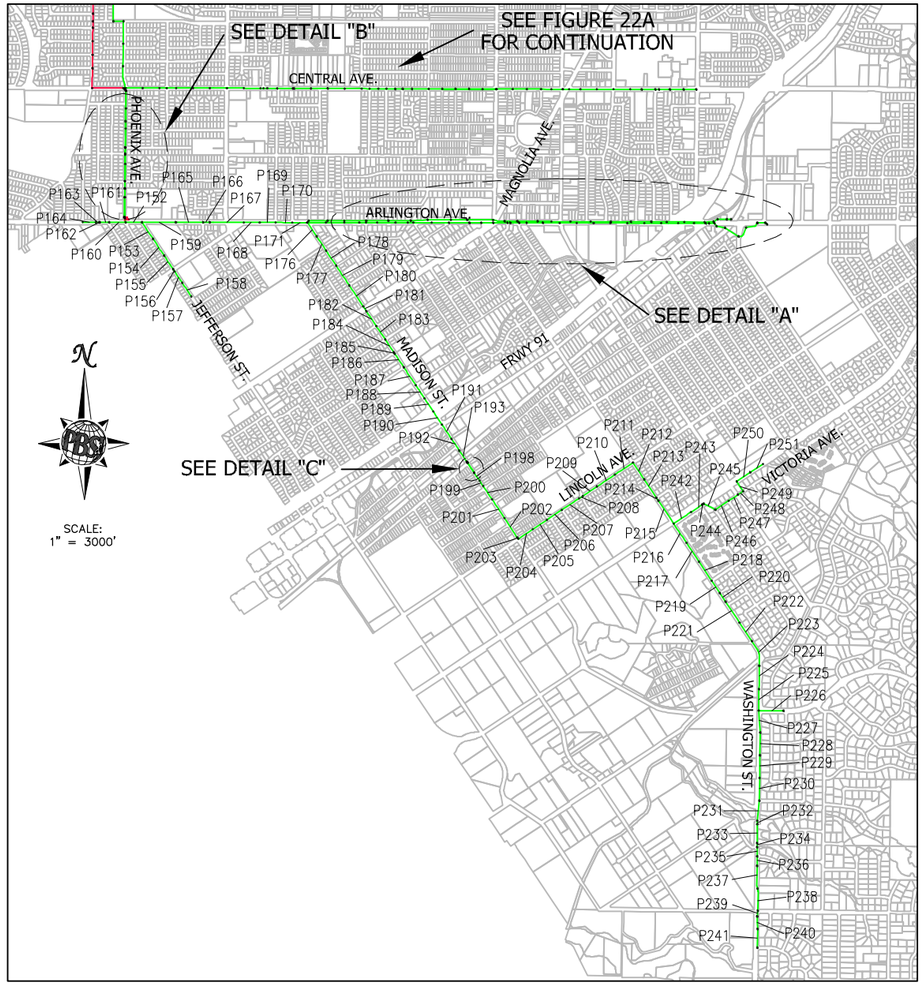

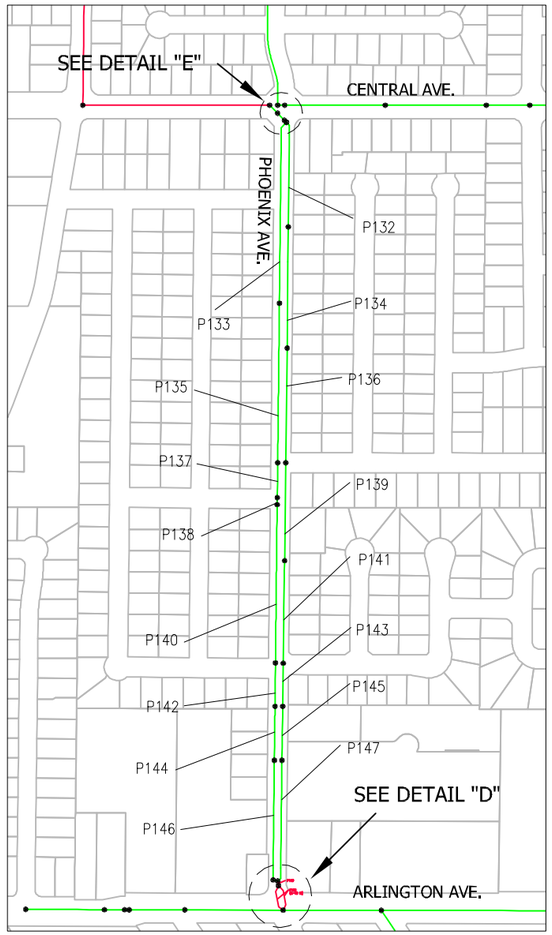

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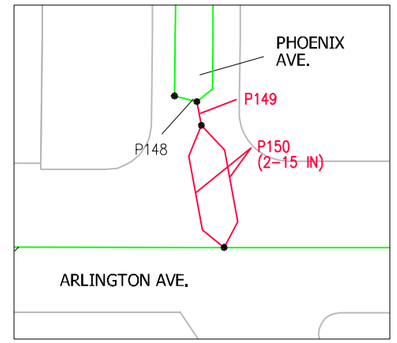

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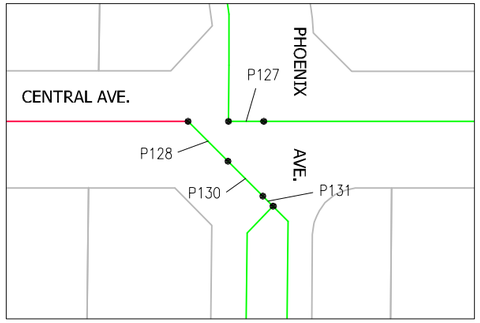

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LEGEND

	GRAVITY SEWER
	IMPROVEMENT SEWER (2005 – 2010)
P001	PIPELINE NUMBER

DETAIL "A"
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FIGURE 22B

PRIORITY "A" - PART 2

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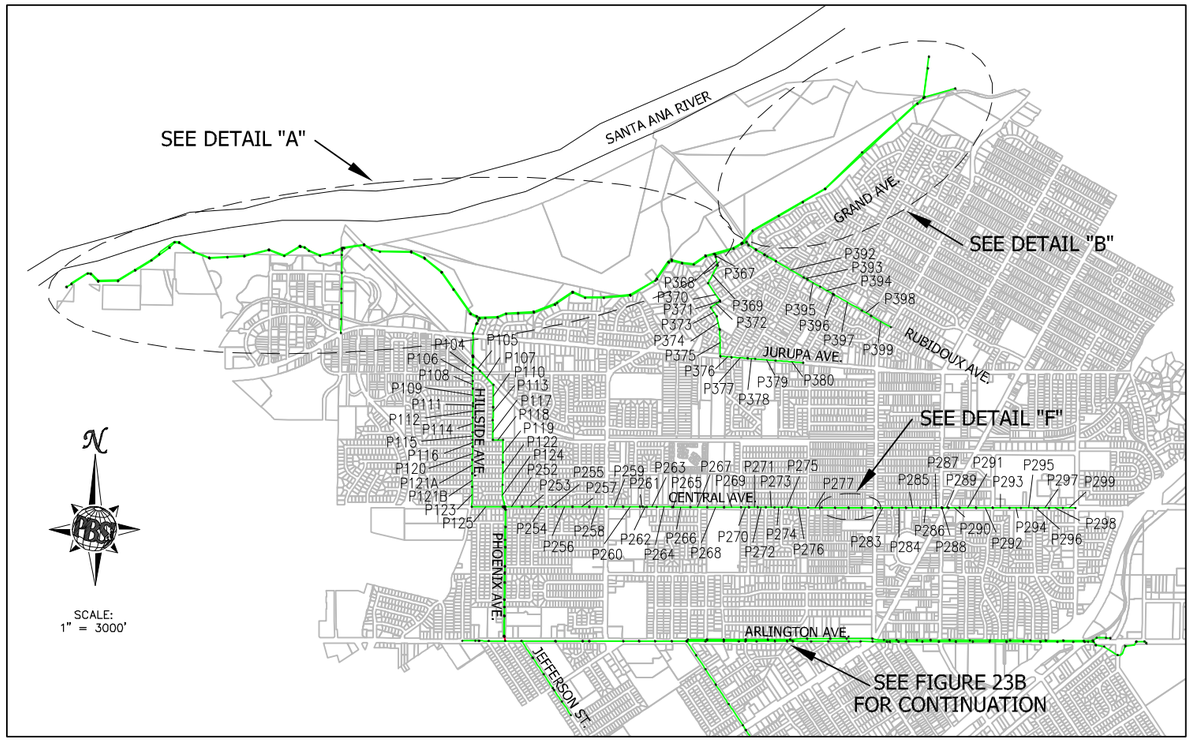

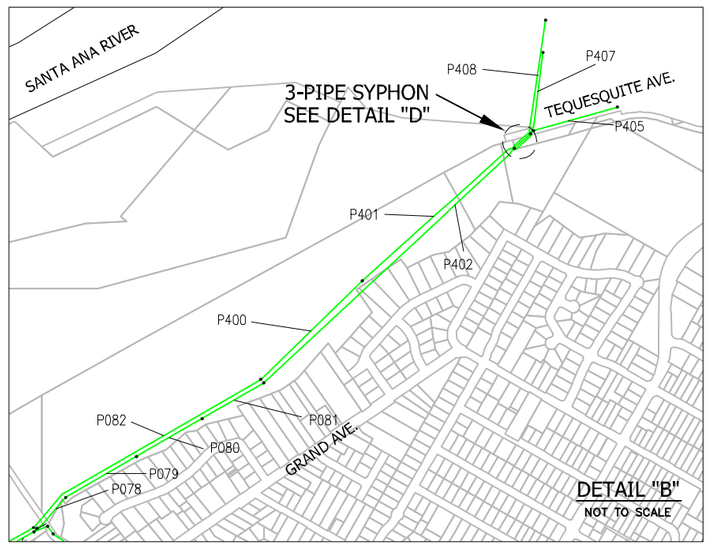

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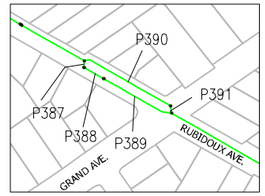

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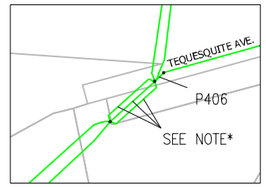

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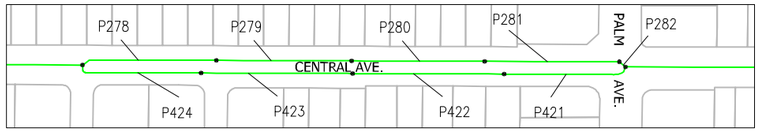

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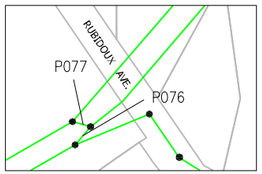

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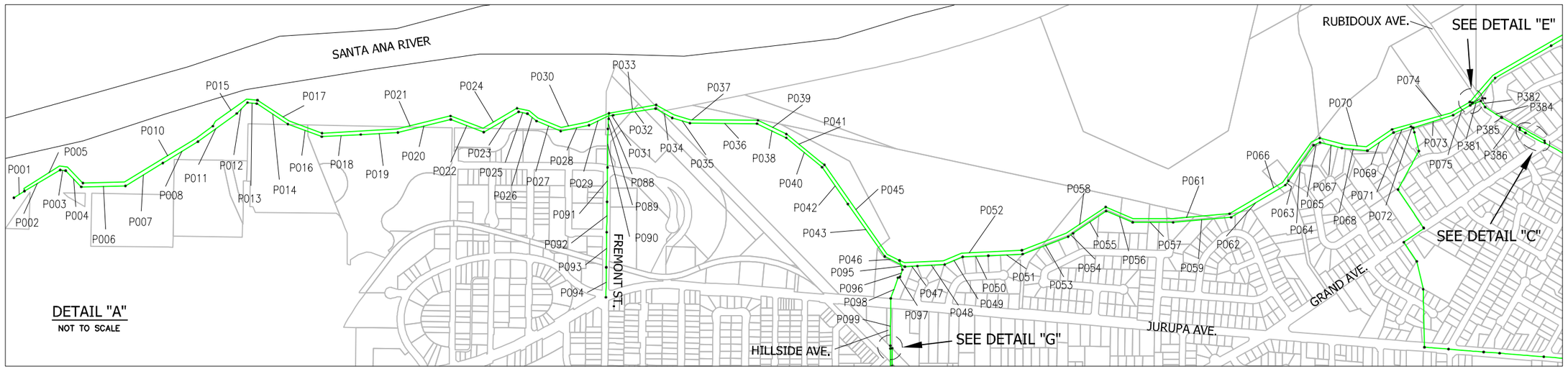

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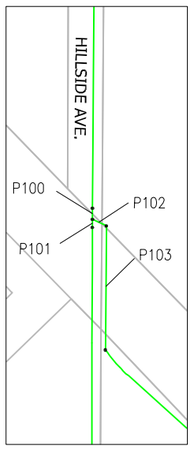

DETAIL "G"
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LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2011 – 2015)
- P001 PIPELINE NUMBER

NOTE* THIS 3–PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

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FIGURE 23A

PRIORITY "B" - PART 1

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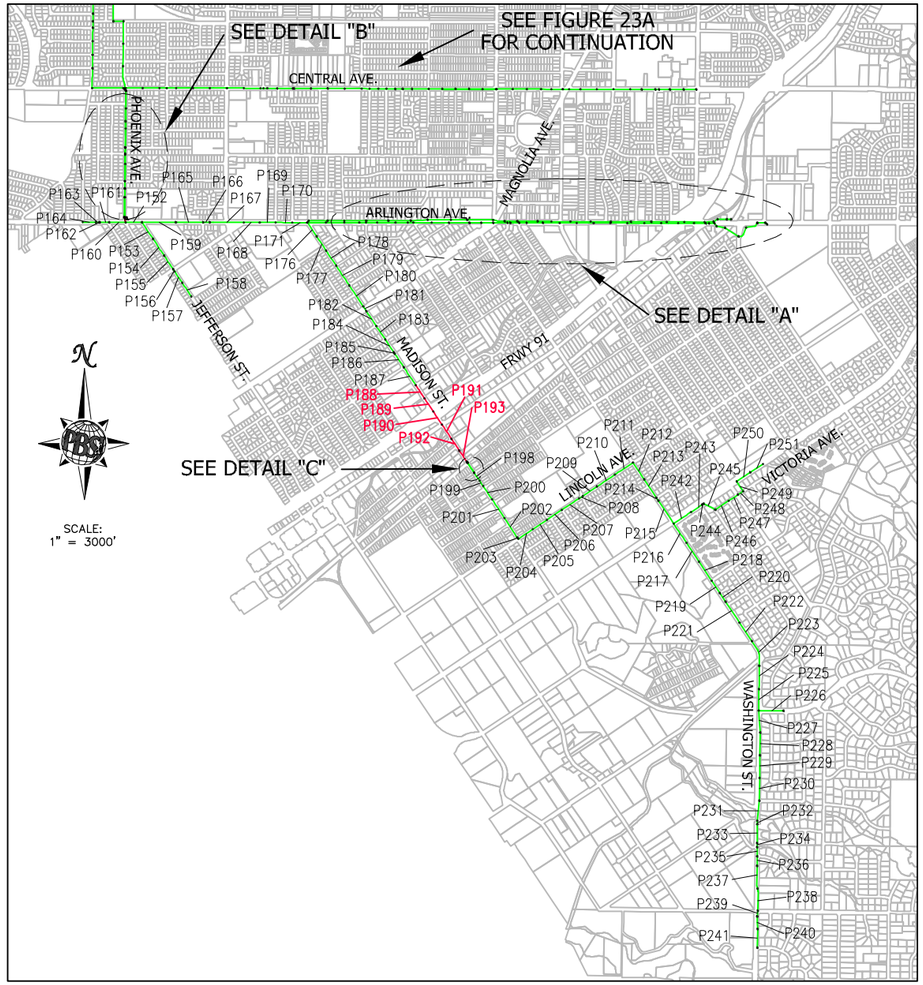

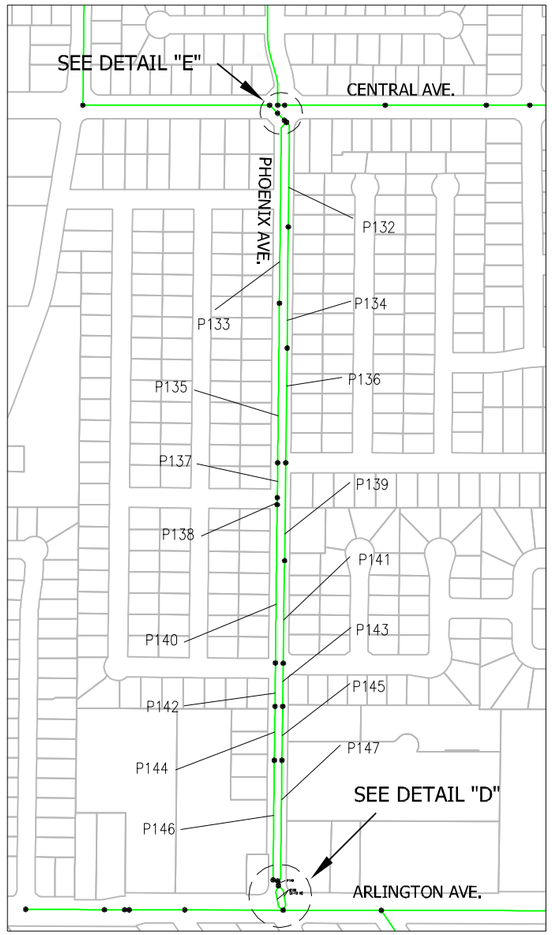

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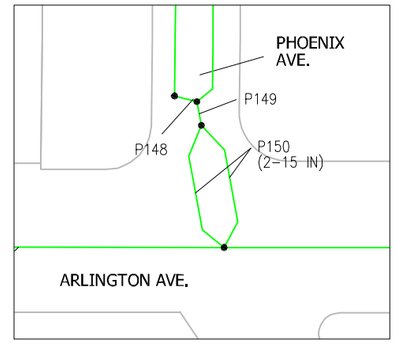

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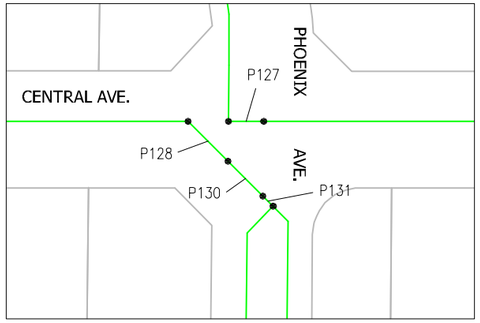

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LEGEND

GRAVITY SEWER

IMPROVEMENT SEWER (2011 – 2015)

P001 PIPELINE NUMBER

DETAIL "A"
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FIGURE 23B

PRIORITY "B" - PART 2

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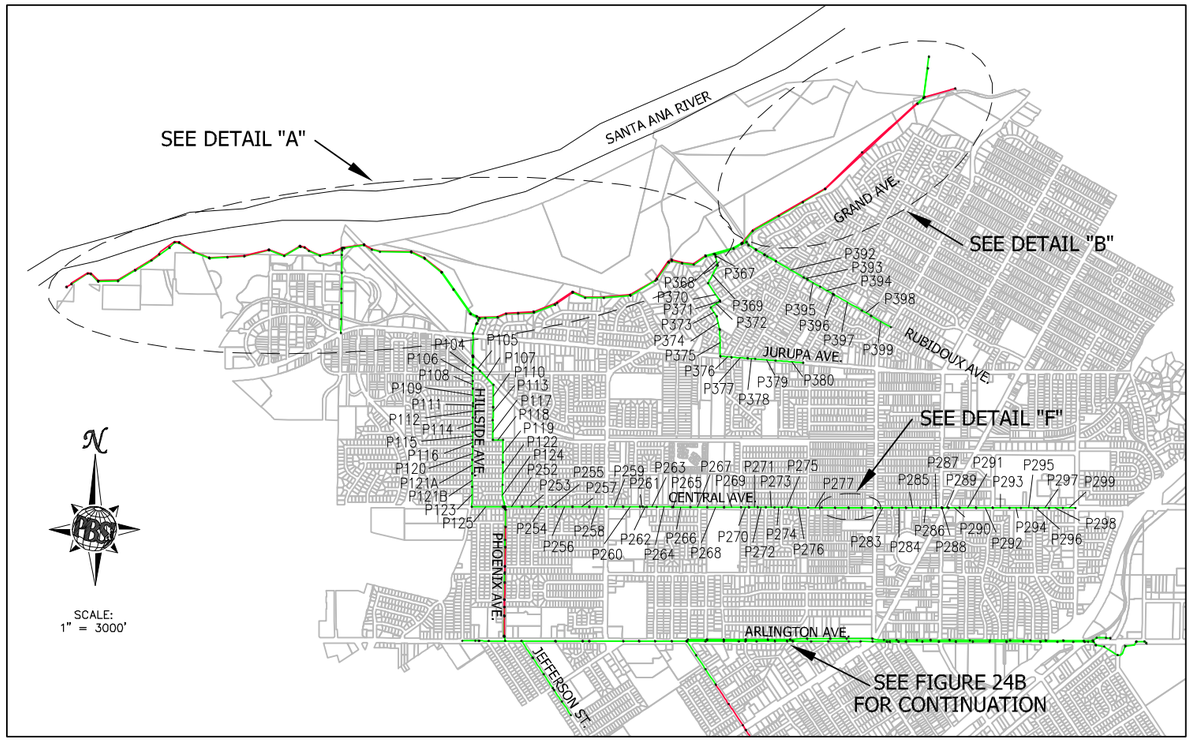

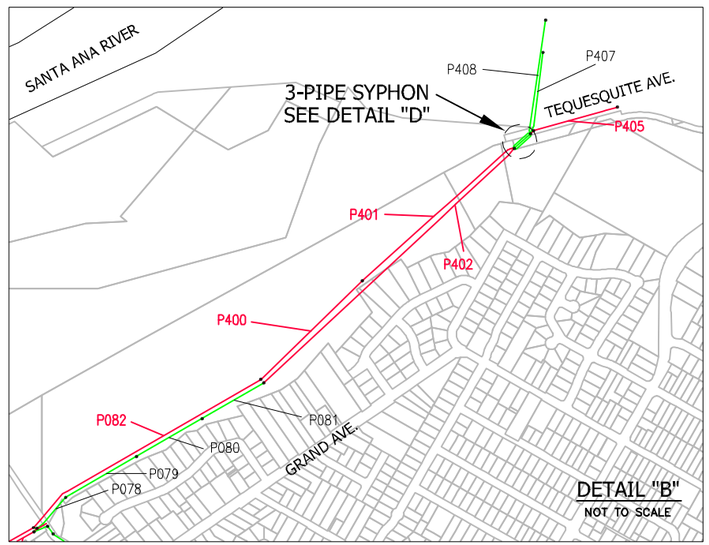

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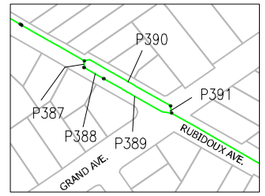

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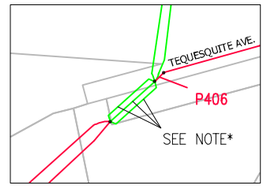

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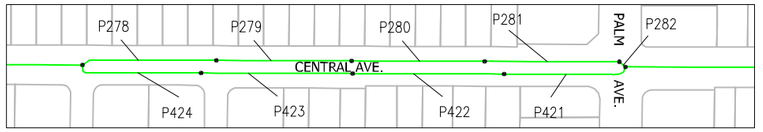

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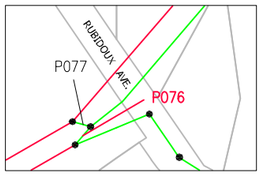

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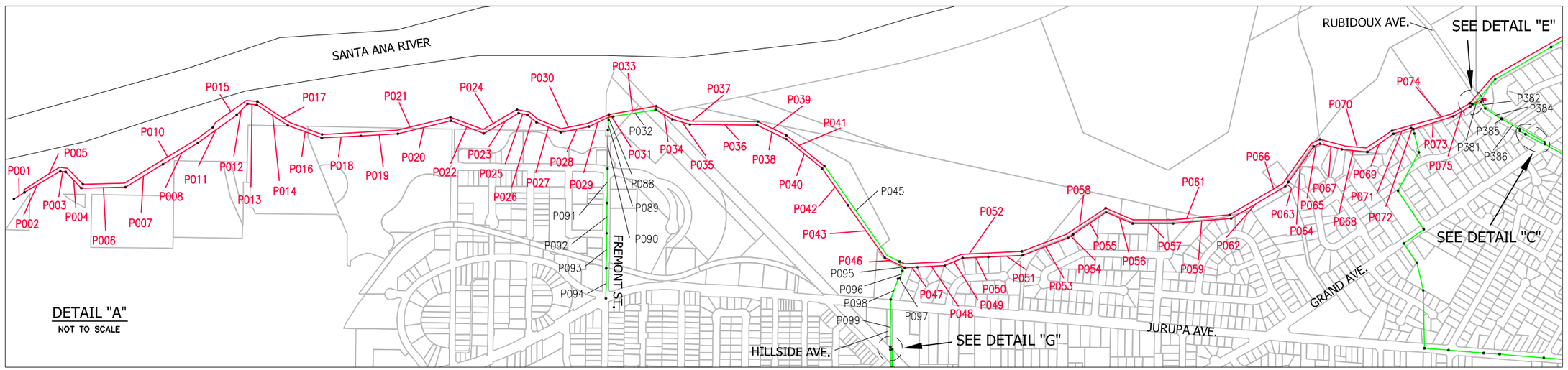

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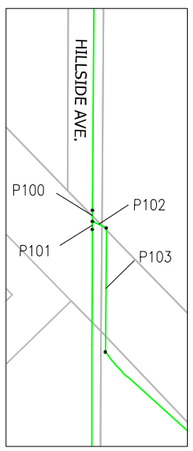

DETAIL "G"
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LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2016 – 2020)
- P001 PIPELINE NUMBER

NOTE* THIS 3–PIPE SYPHON CONSISTS OF PIPELINE NUMBERS P409 THROUGH P420.

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Planning
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Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358–1433
Fax:(951) 358–1434

DATE: 12/15/05 DWN BY: CD

CITY OF RIVERSIDE
PHOENIX SEWER STUDY

FIGURE 24A

PRIORITY "C" - PART 1

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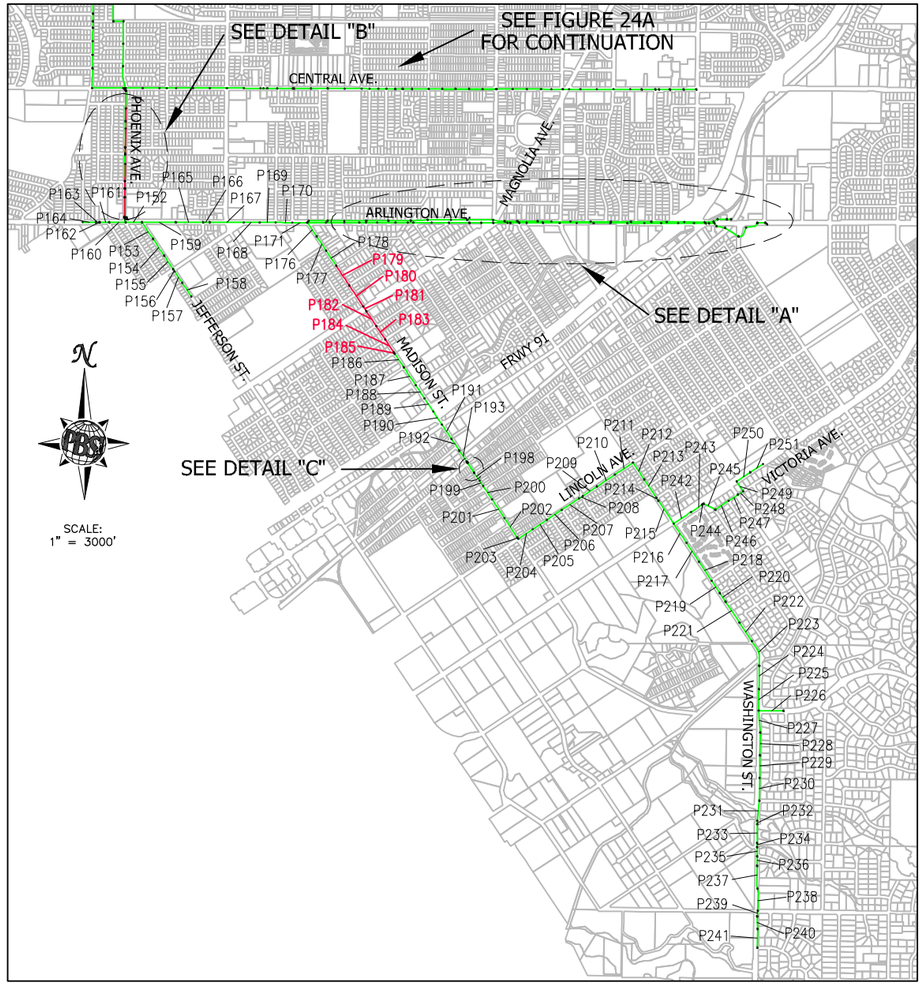

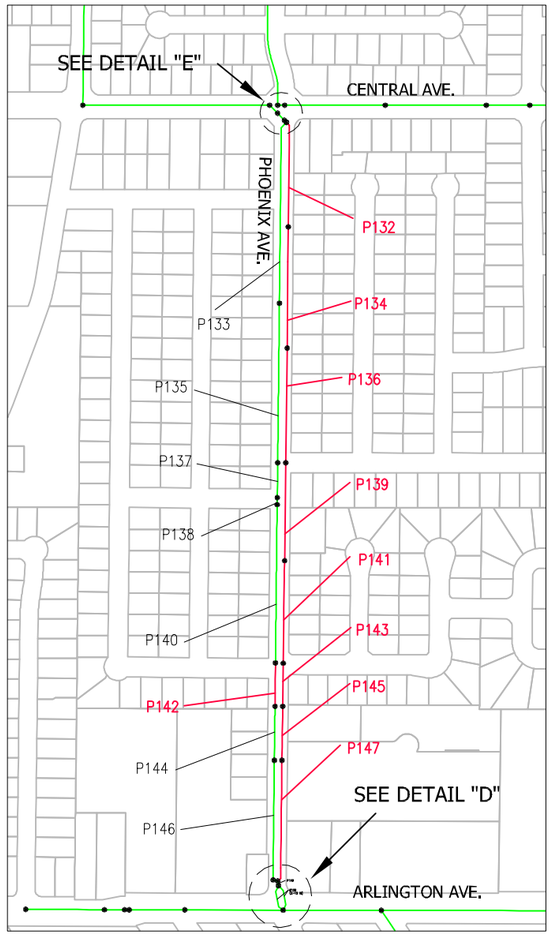

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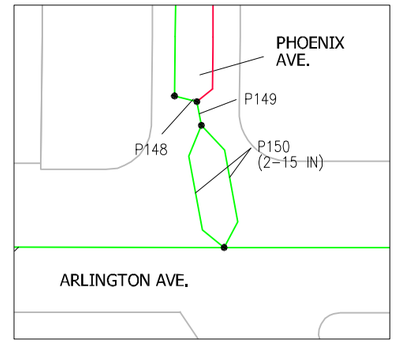

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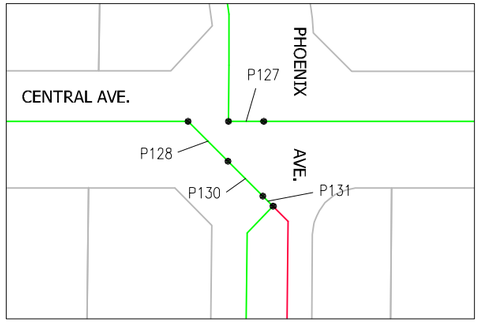

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LEGEND

GRAVITY SEWER

IMPROVEMENT SEWER (2016 – 2020)

P001 PIPELINE NUMBER

DETAIL "A"
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FIGURE 24B

PRIORITY "C" - PART 2

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Table 7-6
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Madison Street	Replace Pipes P179 to P181	18	24	LF	1079	$200	$215,800
	Replace Pipes P182 to P185	15	18	LF	1008	$145	$146,160
	Rehab / Replace Manhole			EA	8	$5,500	$44,000
	Reconnect Sewer Laterals			EA	21	$1,650	$34,650
						Total:	$440,610
Mobilization / Demobilization (7%)							$30,843
Traffic Control (7%)							$30,843
Bond (1%)							$4,406
Contractor's Profit(15%)							$66,092
Subtotal:							$572,793
Construction Contingency(25%)							$143,198
Total Construction Cost (Madison Street Sewer)							**$716,000**
Phoenix Avenue	Replace Pipes P132, P134, P136, P139, P141, P143, P145, P147	27	30	LF	2503	$220	$550,660
	Replace Pipes P142	21	24	LF	143	$200	$28,600
	Rehab / Replace Manhole			EA	10	$5,500	$55,000
	Reconnect Sewer Laterals			EA	26	$1,650	$42,900
						Total:	$677,160
Mobilization / Demobilization (7%)							$47,401
Traffic Control (7%)							$47,401
Bond (1%)							$6,772
Contractor's Profit(15%)							$101,574
Subtotal:							$880,308
Construction Contingency(25%)							$220,077
Total Construction Cost (Phoenix Avenue Sewer)							**$1,100,000**
Santa Ana River Pipeline	Replace Pipe P001	48	54	LF	115	$390	$44,850
	Replace Pipes P002, P003	24	30	LF	442	$220	$97,240
	Replace Pipes P004	24	27	LF	206	$205	$42,230

Table 7-6
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
	Replace Pipes P006-P008, P011-P014, P016, P018-P020, P022-P023, P025-P029, P031, P034-P036	24	30	LF	6310	$220	$1,388,200
	Replace Pipes P038, P040, P042-P043, P046-P051, P053, P054, P056-P057, P059, P062, P063-P065, P067-P069, P071-P073, P075, P076	24	30	LF	7300	$220	$1,606,000
	Replace Pipes P055	24	33	LF	370	$245	$90,650
	Replace Pipes P033, P037	45	48	LF	1400	$340	$476,000
	Replace Pipes P005, P010, P015, P017, P021, P024, P030, P039, P041	45	51	LF	6704	$360	$2,413,440
	Replace Pipes P052, P058, P061, P066, P070	39	45	LF	5008	$320	$1,602,560
	Replace Pipes P074	39	48	LF	763	$340	$259,420
	Replace Pipes P082	36	42	LF	1983	$300	$594,900
	Replace Pipes P400 to P401	33	39	LF	2301	$275	$632,775
	Replace Pipe P406	27	30	LF	33	$220	$7,260
	Replace Pipe P402	24	30	LF	1906	$220	$419,320
	Replace Pipe P405	27	33	LF	632	$245	$154,840
	Rehab / Replace Manhole			EA	78	$5,500	$429,000
	Reconnect Sewer Laterals			EA	355	$1,650	$585,750
						Total:	$10,844,435
Mobilization / Demobilization (7%)							$759,110
Traffic Control (7%)							$759,110
Bond (1%)							$108,444
Contractor's Profit(15%)							$1,626,665
Subtotal:							$14,097,766
Construction Contingency(25%)							$3,524,441
Total Construction Cost (Santa Ana River Pipeline Sewer)							**$17,622,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "C" PROJECTS							**$19,438,000**

City of Riverside
Phoenix Trunk Sewer Study

Appendices

Prepared By:

PBS&J
10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

August, 2006

Appendix A

Flow Data at Meter Locations (On CD)

Appendix B
City of Riverside, Criteria for Sewer Facility Design

CITY OF RIVERSIDE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

CRITERIA FOR SEWER FACILITY DESIGN

~~March 2000~~
Revised May 2004

Determination of Sewage Flows:

The sewer line shall be designed to flow 75% full during peak flows. Use a Manning's "n"=0.013.

Residential sewer flows are determined by using the following sources of information and criteria:

- Land use shown in the City's General Plan.
- Based on the Land Use determine the number of living units per acre.
- The capita per living unit can be determined from the latest census data for the study area. However, not less than an average 2.75 capita per living unit.
- Use 65 gallons per capita per day for average flows.
- Peak to average flow coefficient is to be determined from the attached graphs.

Peak flows for other types of development shall be determined using the following criteria:

- Industrial developments use: 0.012 cfs/acre
- Commercial developments use: 0.010 cfs/acre
- Offices: 30 gallons per capita per day (g/c/d)
- Schools: 30 g/c/d
- Laundromat: 580 gallons per machine per day

The Public Works Department must approve sewer flows for any other specific types of development.

Criteria for Sewage Pump Station Design:

Construction of a sewage pump station shall be considered the last resort for handling sewage flows from any development. An analysis of alternate gravity system alignments must be performed and submitted to the City for review. The analysis shall consider the economics of constructing and maintaining a pump station over a 20-year period versus obtaining right of way and constructing a gravity system.

If the analysis shows that a pump station is the most economical alternative the following criteria shall be used in its design.

Peak flows are determined by the criteria stated above in the Determination of Sewage Flows section.

Configuration of the components of the pump station shall be in such a way to permit easy access by maintenance equipment. Fencing shall be placed around the pump station components with gates provided at locations for access by maintenance personnel and equipment. The fencing is to be 6-feet in height and of materials and color permitted by the City's Planning Department. All metal parts are to be powder coated with the approved color.

All hatches and hardware shall be stainless steel.

The developer/contractor shall submit complete maintenance and spare parts information for all station components.

Force Main Design:

The force main shall be sized in such a way that the pumps will maintain a minimum flow velocity of 2 feet per second. The force main shall be no smaller than 4 inches in diameter and shall be made of ductile iron pipe. However, if the force main is small and located in a residential street, AWWA C900 PVC pipe may be used. The use of PVC pipe will require specific approval by the Public Works Department.

The force main shall have a continuous upward grade from the pump station to the outlet. No low or high points will be permitted between the pump station and outlet.

The force main shall outlet to a manhole connected to a gravity system. The outlet shall be at the flowline of the manhole and channeled as shown in City Standard Drawing No. 500. Within 30 feet of the manhole the force main shall have an elevation high enough to prevent sewage in the gravity system from flowing down the force main during the off cycle of the pumps.

The designer shall analyze bends in the force main for the need to use thrust blocks or restrained joints.

A force main cleaning station must be installed at approximately 500-foot intervals if the following conditions will exist in the completed system.

- Flows from the area served by the pump station are not enough to require the force main to be emptied every 4 hours.
- The force main is over 950 feet long.
- The difference in elevation between the force main at the valve vault and the outlet is greater than 25 feet.

Pump Design:

Pumps are to be sized to provide a minimum flow velocity of 2 feet per second in the force main.

Pumps shall be able to handle 4-inch solids.

Pump selection shall be based on the most efficient drive/pump/impeller combination for the force main system. The discharge flow velocity should be in the range of 10 to 14 feet per second. The designer shall graph the pipe system curve against the pump curve. If multiple pumps are used this graph shall show the curve for each pump. The minimum pump efficiency allowed is 60 percent.

Wet Well Design:

In stations that have 5 to 100 horsepower pumps the wet wells shall be sized to permit the pumps to cycle not less than 15 minutes between stops and starts. In addition the pumps must not run less than 10 minutes per cycle. Stations with pumps greater than 100 horsepower shall have a cycle time between pump stops and starts not be less than 20 minutes with a minimum run time of 15 minutes.

Pumps on and off elevations are to be shown on the plan. These elevations must be below the inlet elevation to the wet well. Flap gates on the wet well inlet are not permitted.

The wet well shall have a 6-foot minimum diameter and lined with PVC or City approved coating.

If the wet well is over 30 feet in depth there must be a "step off" landing designed in the well. The landing is a safety precaution to provide a location for maintenance personnel to step off the wet well access ladder.

All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

A wastewater recirculator or scum breaker shall be provided.

Valve Vault Design:

The vault shall be large enough to permit easy access by maintenance personnel. The bottom shall be a minimum 4-inch thick concrete slab. A 4-inch diameter PVC pipe shall be provided to drain the valve vault into the wet well.

All pipe and fittings from the pumps through the valve vault shall be made of ductile iron. Only flanged fittings shall be used. All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

Discharge and isolation valves shall be plug valves and not gate valves.

Controls and Electric Design:

A 480-volt three-phase power supply is required.

All conduits shall be schedule 80 PVC.

An emergency transfer switch shall be provided. Small stations will require a manual switch where large stations with emergency backup generators will require an automatic transfer switch. When a manual transfer switch is required a 100-amp plug and receptacle such as Killark 8581/21-407 and 8581/22-407 shall be provided. In addition, a minimum 30-foot long jumper cable shall be provided.

Lights shall be provided within the control panel to allow for night work.

The pump station shall have a communications link with the City's wastewater treatment plant. The equipment to provide this link shall be City approved.

An electric schematic diagram shall be provided on the pump station plans.

The wet well level measuring device shall be a Milltronics Hydroranger ultrasonic measuring device.

The station shall be controlled by a Modicon Quantum Programmable Logic Controller(PLC).

The station shall be equipped with a Motorola Moscad Radio Telemetry Unit(RTU).

This RTU shall be installed and completely functional prior to the acceptance by the City.

The Developer/contractor shall coordinate and pay for the integration of this RTU into the City's existing SCADA system.

Control system integration with the City's SCADA shall be performed by an integrator approved by the City.

Three phase 480 VAC power shall be the power source.

The power source for station controls shall be 120 VAC.

Two spare conduits shall be provided between the control panel and the wet well. This conduit shall same size of the largest conduit needed between the control panel and wet well.

One spare conduit shall be provided between the control panel and the valve vault. This conduit shall of the same size of the largest conduit needed between the control panel and valve vault.

The developer/contractor shall provide complete as built drawings of the electrical system. This shall include all wiring, general, and internal to the control panel

All wires must be individually tagged. They must be tagged at every termination and inside every junction box.

The developer/contractor shall provide a copy of the proposed PLC program for review prior to construction. A final fully annotated copy of the PLC program shall be provided, both in electronic format and in a hard copy printed format.

All panels shall be of the appropriate construction for the application. (minimum, NEMA 4X or 3R.

Pump Station Functional Requirements

Milltronics Hydroranger Ultrasonic Level Indicator/Controller

Shall provide analog level input to the Programmable Logic Controller (PLC)

Shall provide off & on starting of pumps in the event of PLC failure

Shall provide alternation of pumps in event of PLC failure

Shall provide ultrasonic failure Input to RTU

Float Switch

Shall provide an input to the RTU (high-high level)

Programmable Logic Controller (PLC)

Shall provide starting and stopping of the pumps in auto

Shall provide alternation of the pumps (after each cycle)

Recognize Milltronics failure and provide an input to the RTU

Shall recognize pump hand switch position and adjust the control logic

Shall provide all timing functions

Shall provide low level alarm output to RTU

Shall provide input to the RTU In event of seal failure of pumps (Each Pump)

Shall provide input to the RTU in event of Thermal overload

Shall call lag pump if required

Shall provide input to the RTU indicating pump failure and identifying the pump

Shall provide output to the RTU for high level alarm

A three-position selector switch shall interface with the PLC to provide for manual override of the automatic changing of lead and lag pumps, in case of pump failure (i.e.: P1-AUTO-P2)

Controls

A manual bypass shall be provided for water levels, PLC, Milltronics; etc. and shall directly energize the motor starters.

The auto function shall be controlled by the PLC or in the event of PLC failure, the Milltronics will start, stop, and alternate lead and lag pumps.

Radio Telemetry Unit (RTU)

Shall monitor only, not control

Transmit Dynamic Wet Well Level (Analog Output)

Indicate low level

Indicate high level

Indicate site entry

Indicate AC failure

Indicate individual pump failure

Indicate pump auto, pump not auto

Indicate pump run status

Indicate ultrasonic failure

Indicate Seal Failure

External Relays

(1) Intrinsically safe for the high, high level float

(2) For seal failure

(2) Motor starters

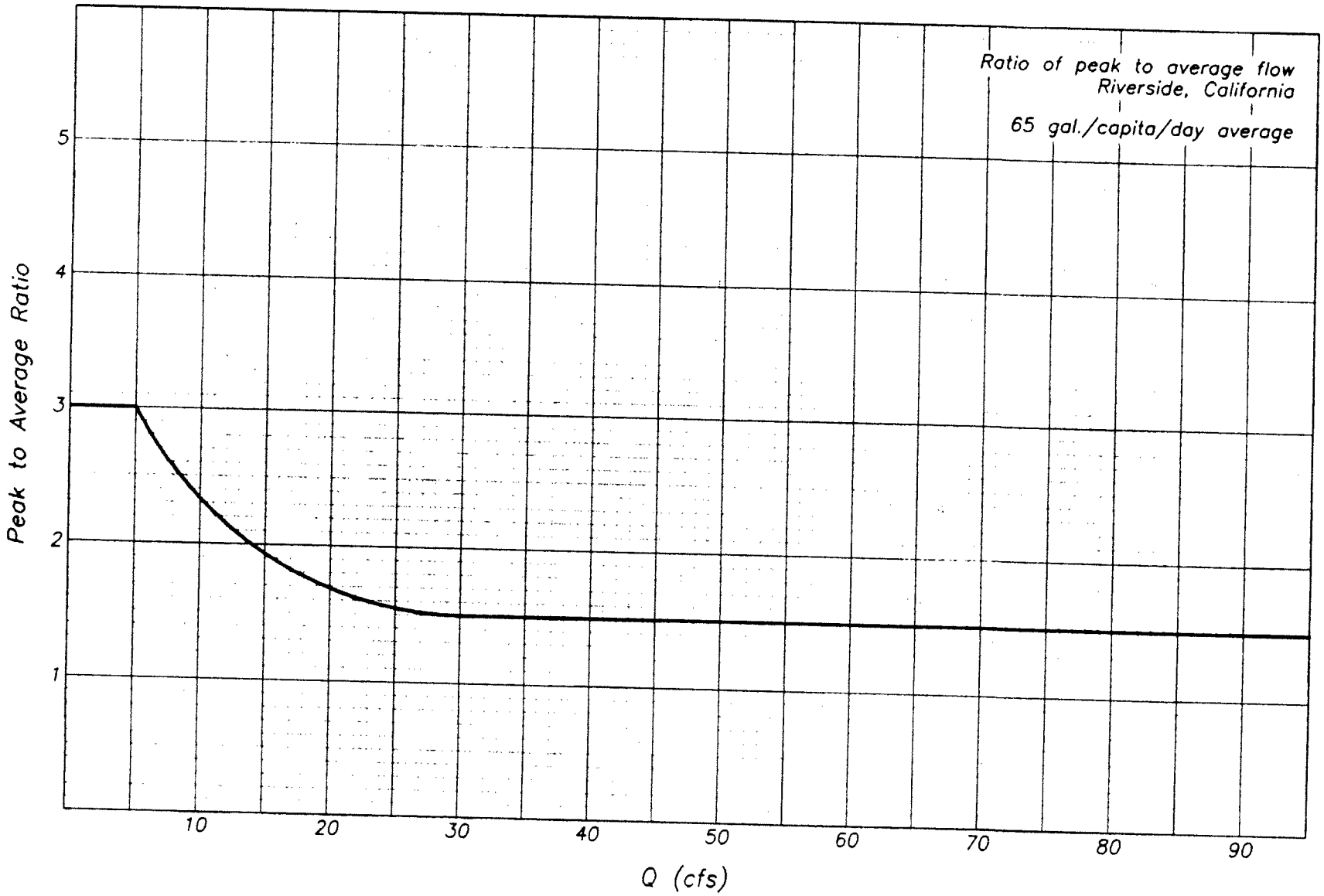
Criteria for Inverted Siphon Design:

Minimum flow velocity of 3 feet per second and maximum velocity of 7 feet per second within the siphon pipe(s) is required. A multiple pipe design should be incorporated with the upstream manhole designed to direct the anticipated average daily flow into one pipe and the anticipated peak flow into all pipes of the siphon. If the siphon will serve future development it may be necessary to design the siphon with more than two pipes in order to maintain the minimum flow velocity until the future development is constructed. Weirs shall be cast into the base of the manholes.

Minimum pipe size to be used in the siphon is 6-inch. Either Vitrified Clay Pipe or Ductile Iron Cement Mortar Lined Pipe (DIP) shall be used in the siphon. Type V cement shall be used for the lining of the DIP. Internal pressure of the siphon shall be considered in material selection.

The siphon shall not exceed 350 feet in length with manholes installed at each end. Flow shall be directed straight through these manholes. No side connections to the manholes will be permitted. The manhole diameter shall be determined by the number, size, and spacing of the siphon pipes plus 3 feet. The shelf elevation shall be above the water level during ultimate peak flows.

During ultimate peak flow the water surface elevation at the first sewer lateral connection upstream of the siphon must be within the sewer main.


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
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50
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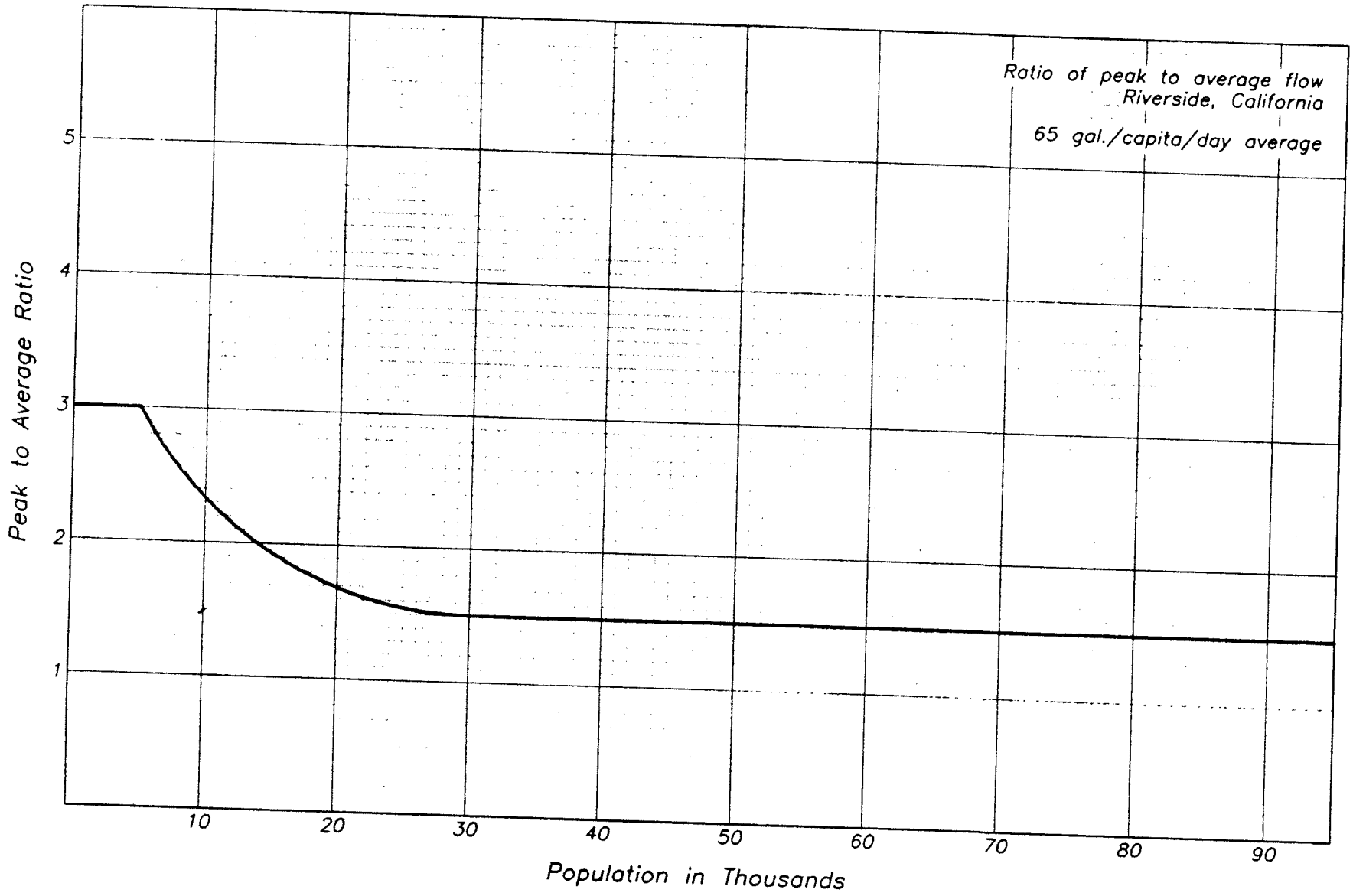
90
Q (cfs)


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
40
50
60
70
80
90
Population in Thousands

Appendix C
Study Sewer Lines

Table 7-4
Preliminary Construction Cost Estimate For Priority "A" Projects
(2005- 2010 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Central Avenue	Replace Pipe P125	24	36	LF	615	$260	$159,952
	Rehab / Replace Manhole			EA	2	$5,500	$11,000
	Reconnect Sewer Laterals			EA	6	$1,650	$9,900
						Total:	$180,852
Mobilization / Demobilization (7%)							$12,660
Traffic Control (7%)							$12,660
Bond (1%)							$1,809
Contractor's Profit(15%)							$27,128
Subtotal:							$235,108
Construction Contingency(25%)							$58,777
Total Construction Cost (Central Avenue Sewer)							**$294,000**
Hillside Avenue	Replace Pipe P100	27	33	LF	14	$245	$3,430
	Replace Pipes P123	24	30	LF	397	$220	$87,340
	Replace Pipes P101, P104, P106, P108-P109, P111-P112, P114-P116, P120, P121A, P121B	24	33	LF	2566	$245	$628,670
	Rehab / Replace Manhole			EA	16	$5,500	$88,000
	Reconnect Sewer Laterals			EA	30	$1,650	$49,500
						Total:	$856,940
Mobilization / Demobilization (7%)							$59,986
Traffic Control (7%)							$59,986
Bond (1%)							$8,569
Contractor's Profit(15%)							$128,541
Subtotal:							$1,114,022
Construction Contingency(25%)							$278,506
Total Construction Cost (Hillside Avenue Sewer)							**$1,393,000**
Phoenix Avenue	Replace Pipe P149	27	30	LF	16	$220	$3,520
	Replace Pipes P150	15	18	LF	142	$145	$20,590
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	2	$1,650	$3,300
						Total:	$43,910

Table 7-4
Preliminary Construction Cost Estimate For Priority "A" Projects
(2005- 2010 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Mobilization / Demobilization (7%)							$3,074
Traffic Control (7%)							$3,074
Bond (1%)							$439
Contractor's Profit(15%)							$6,587
Subtotal:							$57,083
Construction Contingency(25%)							$14,271
Total Construction Cost (Phoenix Avenue Sewer)							**$71,000**
Santa Ana River							
	Replace Pipe P077	15	21	LF	15	$170	$2,550
	Replace Pipes P078	24	33	LF	309	$245	$75,705
	Replace Pipes P079 to P081	24	30	LF	1659	$220	$364,980
	Rehab / Replace Manhole			EA	6	$5,500	$33,000
	Reconnect Sewer Laterals			EA	20	$1,650	$33,000
						Total:	$509,235
Mobilization / Demobilization (7%)							$35,646
Traffic Control (7%)							$35,646
Bond (1%)							$5,092
Contractor's Profit(15%)							$76,385
Subtotal:							$662,006
Construction Contingency(25%)							$165,501
Total Construction Cost (Santa Ana River Sewer)							**$828,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "A" PROJECTS							**$2,586,000**

Table 7-5
Preliminary Construction Cost Estimate For Priority "B" Projects
(2011- 2015 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Madison Street	Replace Pipes P191 to P193	15	21	LF	883	$170	$150,110
	Rehab / Replace Manhole			EA	4	$5,500	$22,000
	Reconnect Sewer Laterals			EA	9	$1,650	$14,850
						Total:	$186,960
Mobilization / Demobilization (7%)							$13,087
Traffic Control (7%)							$13,087
Bond (1%)							$1,870
Contractor's Profit(15%)							$28,044
Subtotal:							$243,048
Construction Contingency(25%)							$60,762
Total Construction Cost (Madison Street Sewer)							**$304,000**
TOTAL Construction COST FOR PRIORITY "B" PROJECTS							**$304,000**

Appendix E
NORTHSIDE TRUNK SEWER STUDY

City of Riverside
Northside Trunk Sewer Study

590110.30

Prepared By:

10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

September, 2006

NORTHSIDE TRUNK SEWER STUDY

City of Riverside

Client Representative	L.F.(Sandy) Caldwell, P.E.

PBS&J

Project Director	Gary H. Eikermann
Project Engineer	Barmeshwar Rai, P.E.
Technical Support	Charlene Drake Cristina Chavez

J.N. 590110.30

September, 2006

PBS&J 10370 Hemet Street, Suite 200, Riverside, CA 92503

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ES.3 Methodology *Ex-1*

ES.4 Project Priorities and Cost *Ex-2*

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Executive Summary

ES.1 Introduction

This report presents the results of the Northside Trunk Sewer System Capacity Study prepared by PBS&J for the City of Riverside. The report contains recommendations regarding system deficiencies as identified by hydraulic model XP-SWMM (XP Software, Version 9.1).

The City of Riverside is located in the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Interstate 215. The study area encompasses approximately 6,000 acres of mixed land use development and is generally bounded by Main Street to the North, Santa Ana River to the West, Spruce Street to the South and Pope Kirlos Avenue to the East. The study area is a developed community, comprised of single family residential, multi family residential, commercial and light industrial areas within the City limit with some vacant parcels within the County of Riverside that will be developed in the future. The portion of study area west of I-215 can be considered a mature community, comprised of residential, commercial and light industrial development. The portion of study area east of I-215 is primarily a Business Park / Light Industrial area. The vacant parcels east of I-215 and proposed Spring Mountain Ranch and Springbrook Estates developments would be major wastewater contributors to the sewer system.

ES.2 Existing Sewer System

The existing trunk sewer system within the study area is comprised of approximately 10 miles of gravity sewer mains. The gravity sewer main lines range in sizes from 8-inch to 36-inch in diameter and there are 176 manholes. These sewer lines are essentially VCP and the manholes are typically brick lined. The City of Riverside owns, maintains and operates the sewer system.

ES.3 Methodology

For determination of current wastewater flows, flow monitoring was performed at three (3) strategic locations. These meter locations were chosen to observe actual flow characteristics for various sub areas with a distinct land use pattern within the study area. The flow monitoring was accomplished over a two-week period. The flow results were carefully evaluated for accuracy and some adjustments were made based on depth of flow at meter locations. The readings of only one week were used for meters 1 and 2.

A theoretical estimate of wastewater flow from vacant areas was made based on factors from the City of Riverside “Criteria for Sewer Facility Design”. Residential wastewater flow was determined by using future

projected population, whereas commercial and industrial flow was determined based on acreage and City estimated flow coefficients.

The Computer Model Simulation Analysis involved evaluation of available capacity in the existing collection system under present and future development conditions. The results of the model runs were used to identify system deficiencies on a priority basis, and a phased facility improvement plan was developed to accommodate the projected growth within the study area.

ES.4 Project Priorities and Cost

Deficient and marginally deficient pipes were identified from the results of model runs and were prioritized for replacement/rehabilitation purposes. The pipes that are currently flowing more than 90% full under modeled existing maximum flow conditions and needing near term (2005-2010) replacement/rehabilitation are grouped under priority “A”. None of the pipes were found to flow more than 90% full under existing flow conditions, so there are no pipes under category “A”. The pipes that would flow more than 90% full in year 2015 under anticipated maximum future flow conditions are classified as priority “B”. The pipelines that are not included in priorities “B” and are anticipated to flow more than 75% full under future flow conditions are categorized as priority “C”. Some adjustment of priorities and combining of improvements was done for continuity and efficiency of improvements.

The time phased improvements for various priorities are listed in Table 7-2. The approximate cost of recommended improvements is summarized in Tables 7-6-B and 7-6-C.

Deficiencies predicted under ultimate flow conditions in year 2005 (Priority “B”) include 6,800 linear feet of inadequate sewer lines. The estimated capital cost to remedy these identified deficiencies (in year 2005 $) is approximately $1,759,000. The total length of pipelines under Priority “C” would be approximately 9,800 feet and the cost of Priority “C” remedial projects would be approximately $2,788,000. However, it is probable that the majority of Priority “C” improvements will not need to be actually implemented. Only those where surcharging (within manhole) and other problems are deemed imminent should be considered for improvement. Periodic flow monitoring is recommended to verify anticipated deficiencies and need for improvements. It is recommended that field observations of all pipes should be done where modeled results indicate surcharging conditions. The priorities are summarized in the table Ex-1:

Table Ex-1
Summary of Priorities

Priority	Approximate Pipeline Length (feet)	Location	Replacement Year	Total Project Cost (Year 2005 $)
"B"	6,800	Columbia Avenue, La Cadena Drive, Marlborough Avenue and Palmyrita Avenue	2011-2015	$1,759,000
"C"	14,000	Columbia Avenue, Fairmount Boulevard, Fairmount Trunk, Marlborough Avenue and Strong Street	2016-2020	$2,788,000

1.0 INTRODUCTION

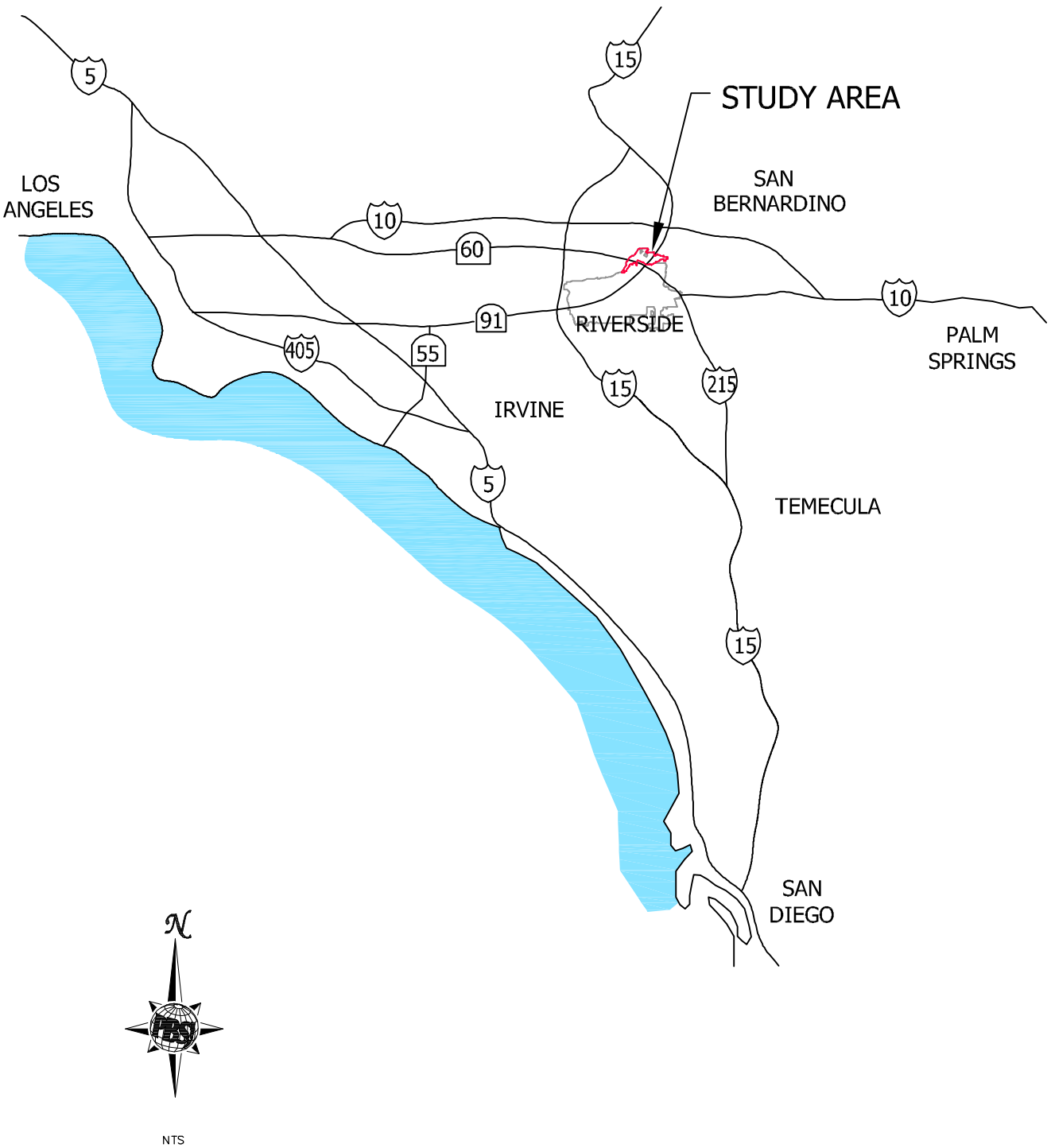
1.1 Background

The City of Riverside (City) retained PBS&J to prepare a Trunk Sewer System Study for the northern portion of the City. The sewer system has been designated as Northside Trunk Sewer System. The study is necessitated by the fact that the City desires to evaluate the capacity of the existing sewer system and identify needed improvements.

1.2 Study Area

The City of Riverside is located in the northwest corner of the County of Riverside at the intersection of three major freeways; Route 91, Route 60 and Route 215. Founded in 1870, the City is known for its citrus industry, world famous Mission Inn and other historical monuments. Figure-1 is a Vicinity Map depicting the City's location and its accessibility. Figure 2 shows the study area. The study area shown in Figure 2 encompasses approximately 6,000 acres and is generally bounded by Main Street to the North, Santa Ana River to the West, Spruce Street to the South and Pope Kirlos Avenue to the East. The southern portion of the study area also includes Fiarmount Park Golf Course Area west of Fairmount Boulevard. The areas not falling within City's jurisdiction but likely to contribute to the existing sewer system in the future have also been included in this study. For purpose of this study, the area has been divided into 26 tributary sub-areas, where downstream sub-areas intercept sewage flow from upstream sub-areas. To obtain actual observed flow information for this study, sewage flow meters were placed at three (3) strategic locations to monitor cumulative flows contributed from the tributary sub-areas.

The I-215 freeway divides the study area into two distinct parts. The study area west of I-215 is considered to be a mature community comprised of single family residential, multi-family residential, commercial and light industrial development. The study area east of I-215 is primarily a Business Park / Light Industrial area. The vacant parcels east of I-215 and designated as Light Industrial and Industrial Business Park would be the major contributors to increases in sewage flow within the study area. Another significant flow contribution would be from the



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CITY OF RIVERSIDE NORTHSIDE SEWER STUDY	FIGURE 1
VICINITY MAP	

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Suite 200
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Fax:(951) 358-1434

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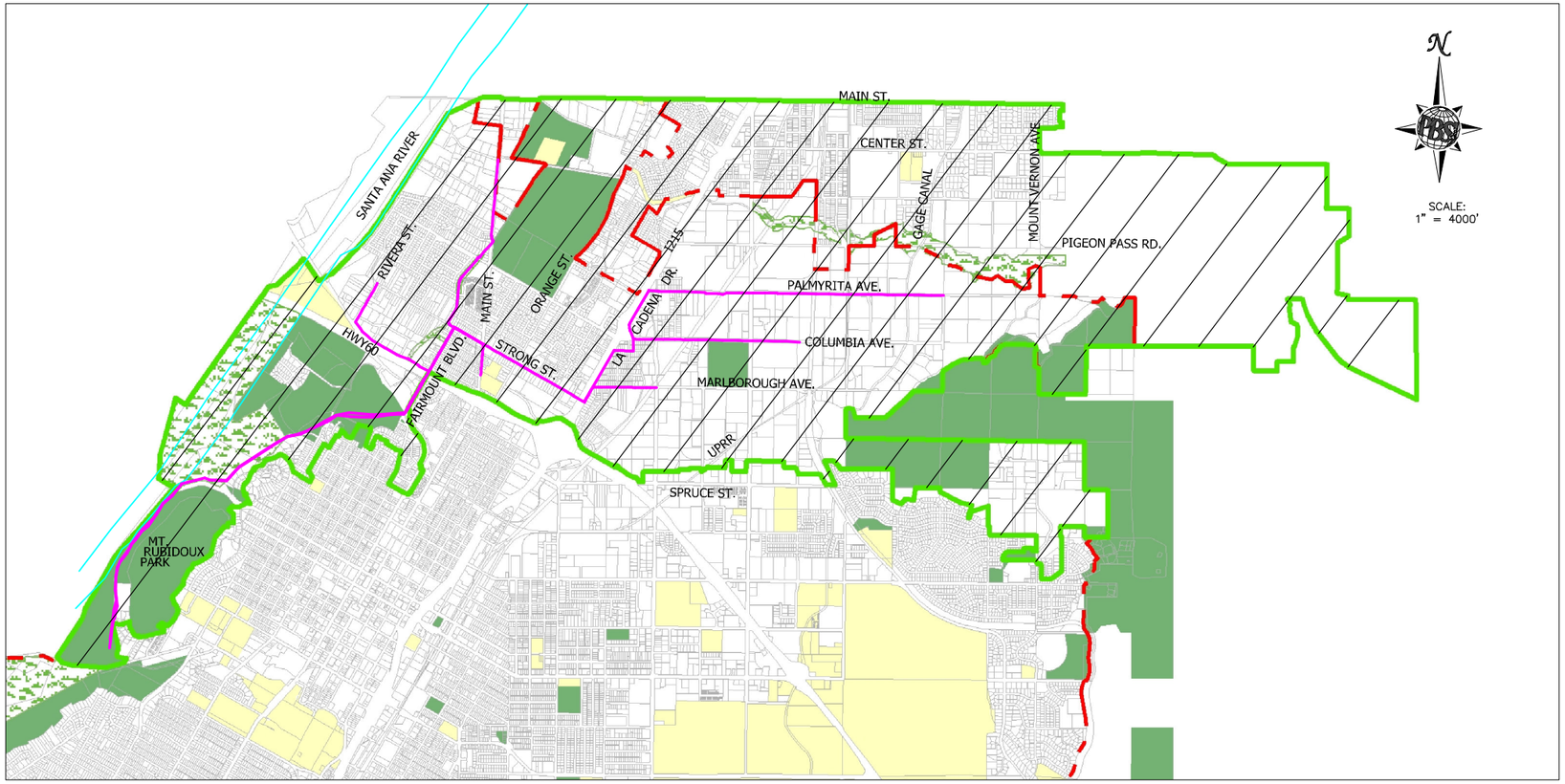

LEGEND

- STUDY AREA
- STUDY SEWER
- CITY LIMITS

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10370 Hemet Street
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Tel:(951) 358-1433
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FIGURE 2

STUDY AREA

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proposed Spring Mountain Ranch and Springbrook Estates developments.

1.3 Objective

The objective of this Sewer System Capacity Study is to provide a comprehensive evaluation of the capacity of the sewer system within the study area, identify deficiencies in the current system, and evaluate alternatives to enhance the conveyance capacity to accommodate ultimate wastewater flows anticipated to be generated in the study area.

1.4 Scope and Study Approach

Specific work tasks undertaken for this study are summarized as follows:

- Kickoff Meeting

  An initial meeting was held between PBS&J and the City to discuss the project scope, communication protocol, explanation of methodology and scheduling of flow monitoring. Field data and other digital files to be provided by the City were also discussed.

- Progress Meetings

  Informal Project Progress Meetings were held to discuss on-going issues and the progress of the study.

- Flow Monitoring and Hydrograph Development

  Downstream Services Inc. installed, maintained, and collected flow data from three (3) monitoring stations throughout the study area. They submitted the collected raw data in electronic/hard copy format to PBS&J. PBS&J then processed and reviewed this information and created a hydraulic database. The City provided a copy of City's General Plan for estimation of current and future flows. Other information including as-built plans of wastewater facilities were provided by the City as and when requested by PBS&J.

- Model Development

  Model development included input data collection, conversion of data and calibration. The City's GIS staff made available

data pertaining to roads, sewers, land use, buildings and other utilities in ArcView format on a CD. As-built plans for study sewer lines were reviewed. Data available from GIS system and as-built plans were placed in a database system (MS Excel) as a pre-processor for XP-SWMM model development. Calibration of model was done after construction of the model and additional data input.

- Draft Report

  Based on the model simulations and the City's criteria for Sewer Facility Design, a Draft Report was prepared that summarized the existing and future capacity situations. Where deficiencies were identified, alternatives were developed for needed sewer improvements, along with probable costs. The draft report was prepared for review by the City.

- Final Report

  Draft Report review comments from the City were incorporated into the Final Report along with any additional information or research, in order to reflect a final level of study completion. The Final Report includes data and information assembled, system deficiencies identified, alternatives evaluated, capital improvement recommendations to remediate anticipated deficiencies, prioritization of improvements, and approximate costs.

The comprehensive evaluation of the sewage collection system to accomplish the above-summarized scope of work features the following multi-step approach:

- Review of as built plans provided by the City to determine system configuration, inverts, pipe sizes and slopes
- Use of detailed database provided by the City in Arcview format
- Creation of computer hydraulic model using existing sewer system to study project area
- Identification of flow monitoring station locations
- Identification of tributary areas contributing sewage flow to meter locations or combinations
- Installation of flow meters and monitoring of flows at the selected locations on continuous basis for two-week period
- Review of current land use in study area per GIS information from the City and determination of existing land use, population and vacant land
- Assessment of ultimate land use and projected population
- Review and evaluation of metered data from flow monitoring stations

- Development of flow coefficients and representative diurnal flow patterns based on typical curves for various land uses and observed flows from monitored sub areas which are dominated by a specific land use
- Modeling of sewer system, deficiency identification, and model simulation of remedial alternatives using above-mentioned information as input data
- Evaluation of alternatives, optimization, cost comparison
- Prioritization of recommended improvements, including identification of critical pipelines which need immediate attention
- Draft Report and recommendations including phased improvements and costs
- Review of Draft Report by the City, comments and discussion
- Final Report

2.0 LAND USE

2.1 Existing Land Use

Land use is the basis for estimating sewage flow from the majority of the study area. The land use pattern for this study was developed from the GIS information provided by the City. Figure 3A shows land use within the study area based on the City's "Land Use" GIS layer. For the purpose of this study, land uses in the study area have been broadly classified into four categories: Single Family Residential (SFR), Multi Family Residential (MFR), Commercial and Industrial. The areas classified as Industrial Business Park are categorized under Industrial land use. Table 2-1 summarizes the land use areas within the study area that would generate wastewater flow.

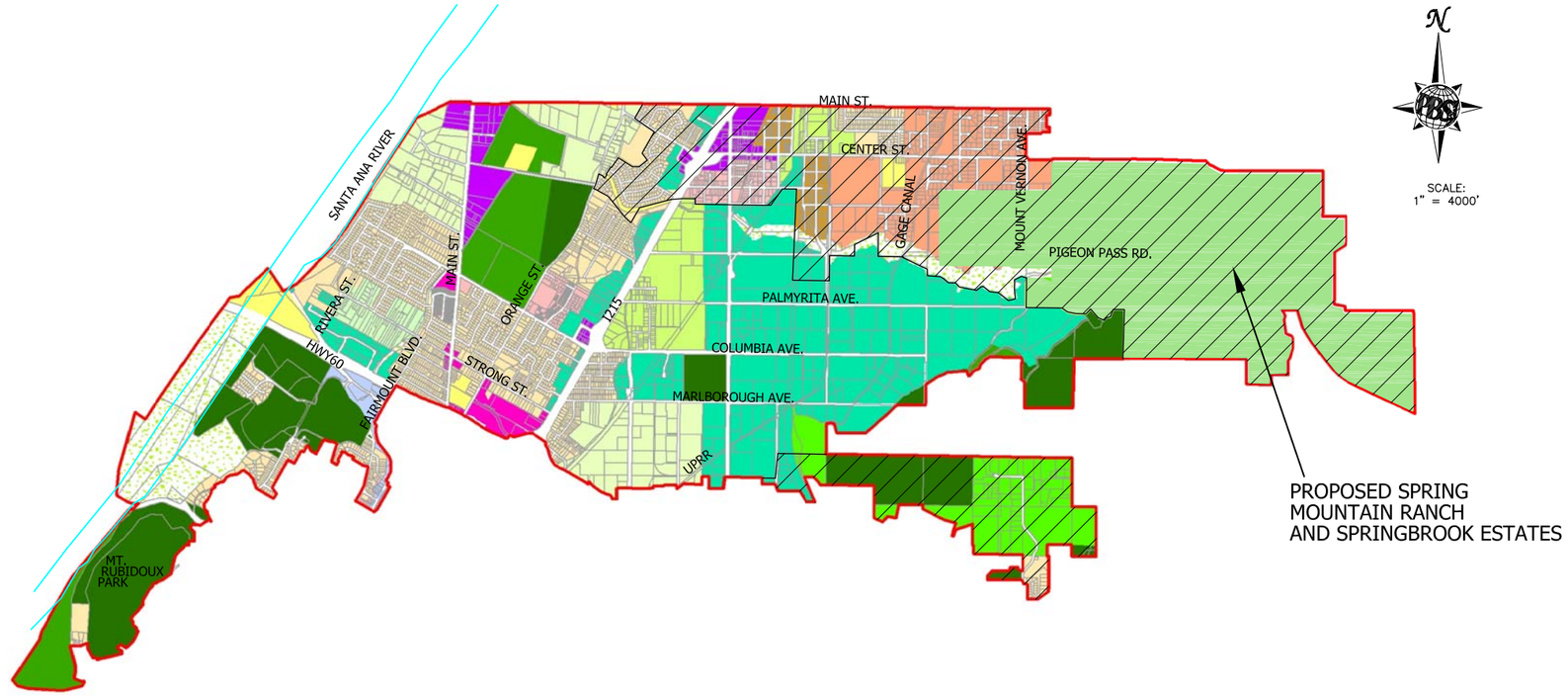
2.2 Future Land Use

The study area on west side of I-215 is primarily a mature community. The portion of study area on east side of I-215 has vacant parcels that would be developed in the future. This area is designated to be developed as Single Family Residential (SFR), Commercial and Industrial Business Park (IBP) / Light Industrial. The vacant parcels are shown in Figure 3B. It is assumed that the majority of vacant lots within the study area would be fully developed by year 2020.

Table 2-1
Land Use that would produce Wastewater Flow within the Study Area (Acres)

Category	Existing (Year 2005)	Future (Year 2020)	Change
Single-Family Residential (SFR)	700	2,250	1,550 (220 %)
Multi-Family Residential (MFR)	72	157	85 (118 %)
Commercial	108	213	105 (97 %)
Industrial /IBP	738	1,512	774 (105 %)

The areas that are marked as open space public facilities are not included in Table 2-1 because of zero wastewater flow generation.



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LEGEND

- Commercial – Business and Office
- Commercial – Service
- Downtown Specific Plan
- Industrial – Business Park
- Industrial – General
- Industrial – Light
- Natural Open Space
- Parks – Other Recreation
- Parks – Public
- Public Facilities and Open Space*
- Residential – Estate
- Residential – Hillside
- Residential – Low Density
- Residential – Medium Density
- Residential – Medium–High Density
- Residential – Semi–Rural
- County Area**
- Area Which May be Served by City
- Sewer Basin Boundary

*Includes schools and other public use facilities
**Assumed to be Low Density Residential

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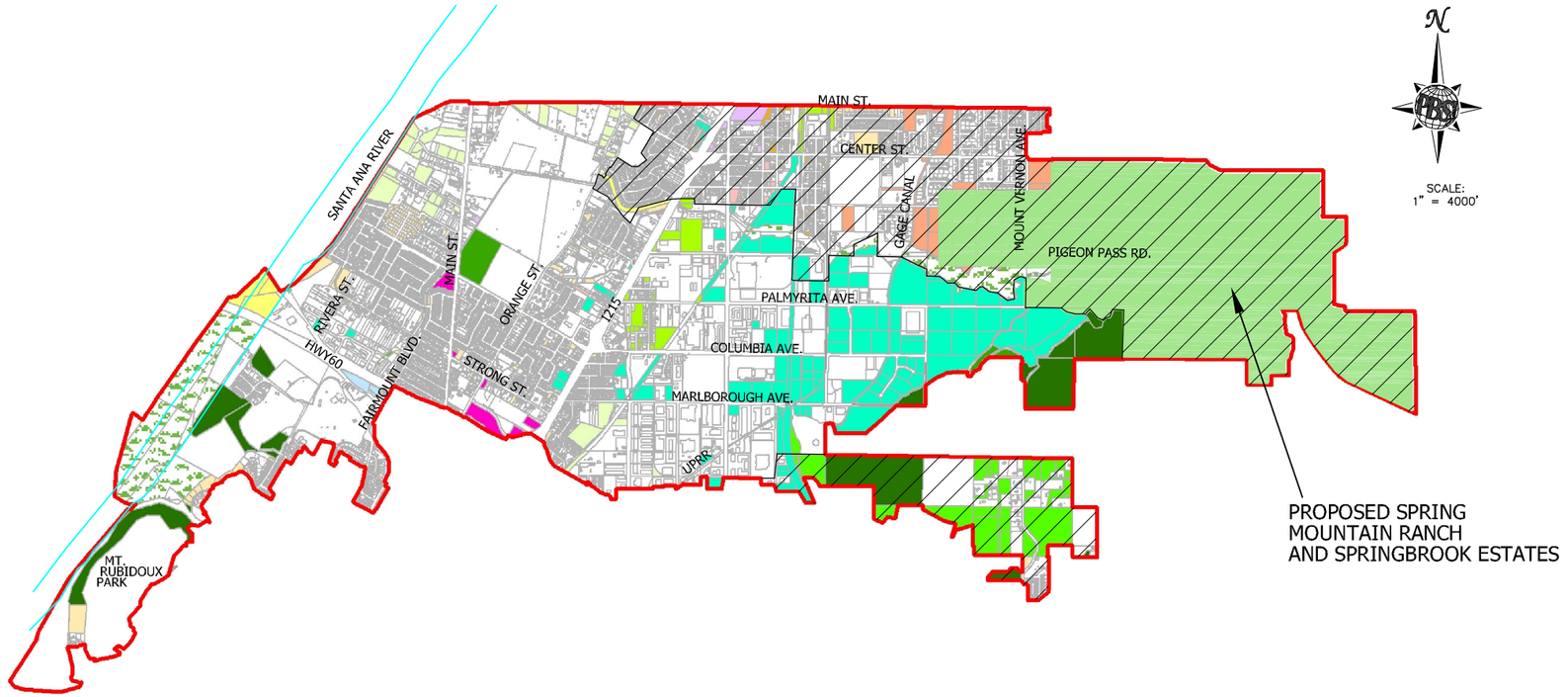
FIGURE 3A

ZONED LAND USE



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LEGEND

- Commercial – Business and Office
- Commercial – Service
- Downtown Specific Plan
- Industrial – Business Park
- Industrial – General
- Industrial – Light
- Natural Open Space
- Parks – Other Recreation
- Parks – Public
- Public Facilities and Open Space*
- Residential – Estate
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- Area Which May be Served by City
- Sewer Basin Boundary

*Includes schools and other public use facilities
**Assumed to be Low Density Residential

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FIGURE 3B

ZONED LAND USE (VACANT PARCELS)

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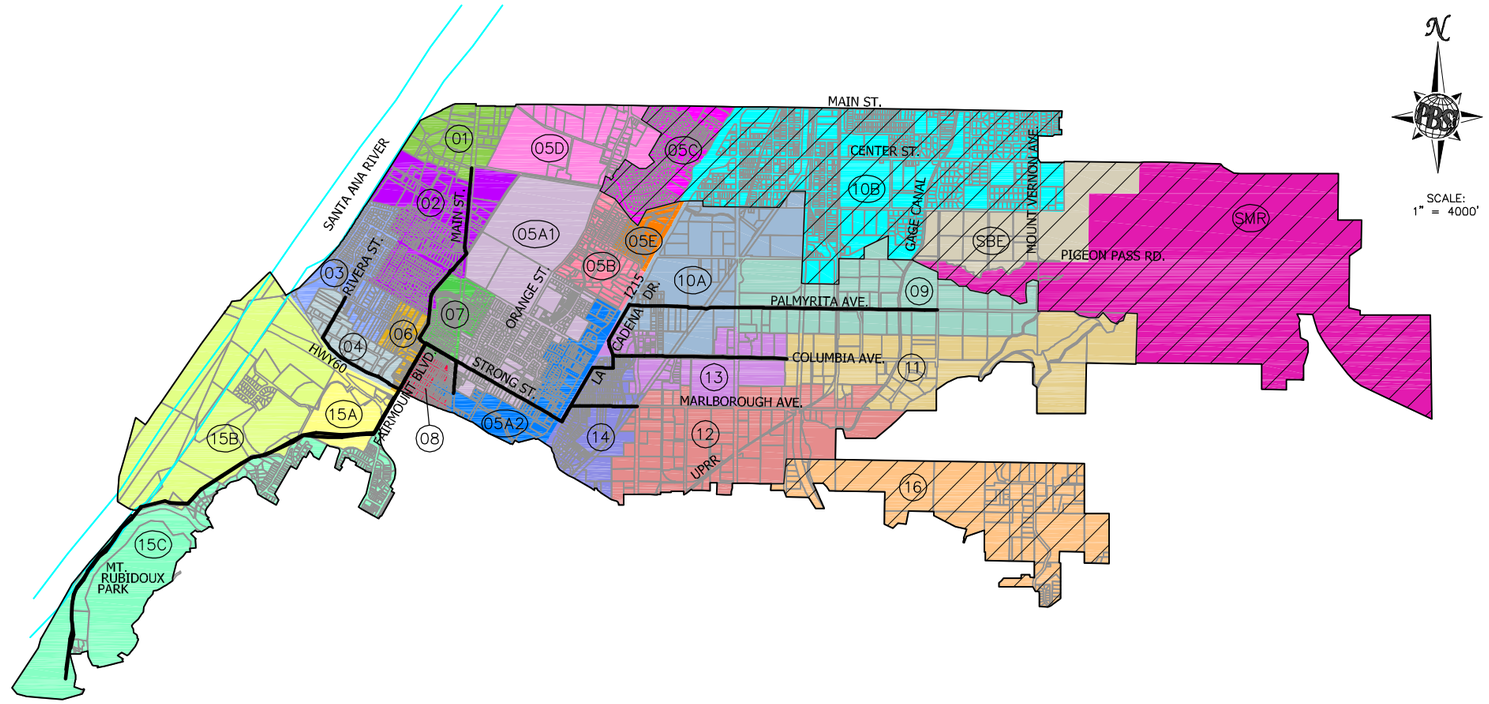
3.0 EXISTING SEWER SYSTEM

3.1 System Overview

As previously described, the Northside Trunk Sewer Study covers approximately 6,000 acres, which has been divided into 26 tributary sub-areas (See Figure 4). Each sub-area can be considered as a sewer sub-basin where wastewater flow from it is intercepted by a sewer trunk line. The wastewater flow generated from a sub-area can be measured at a meter location or can be reasonably assessed based on land use plan of that sub-area. The location of meters can be seen on Figure-5. The modeled gravity conveyance system is approximately 53,000 linear feet (10 miles) of gravity sewer system, with pipe sizes varying from 8 inches to 36 inches in diameter (See Figure 6). Most of the gravity sewer lines within the system are vitrified clay pipe (VCP).

3.2 Collection System

The wastewater generated within the study area flows in the southerly or westerly direction depending on general topography. The major trunk lines are along Palmyrita Avenue, Columbia Avenue, Marlborough Avenue, La Cadena Drive, Strong Street, Main Street, Rivera Street, Fairgrounds Street, Fairmount Boulevard and Rubidoux Mountain Sewer Easement. The trunk line in Palmyrita Avenue accepts sewage flow from Industrial Areas north of Columbia Avenue. The trunk line in Columbia Avenue picks up flow from the area between Palmyrita Avenue and Marlborough Avenue. The trunk line in Marlborough Avenue picks up wastewater flow from the area north of Spruce Street and south of Columbia Avenue. The trunk line in La Cadena Drive accepts flows from Palmyrita Avenue, Columbia Avenue and Marlborough Avenue sewer lines. The trunk line in Main Street conveys wastewater flow from residential and commercial areas west of I-215. The trunk line in Strong Street picks up flow from La Cadena and Main Street sewer lines. The trunk line in Rivera Street collects wastewater flow from the residential area north of Hwy 60. This sewage flow is pumped to the Fairmount trunk sewer line through a small lift station located at Fairgrounds Street. The trunk sewer lines in Fairmount Boulevard pick up flow from the Northside Study area as well as Spruce Study Area. Pipe sizes, lengths, and number of manholes have been tabulated for major segments of the modeled trunk system (See Appendix “C”).



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LEGEND

- SUB AREA 01
- SUB AREA 02
- SUB AREA 03
- SUB AREA 04
- SUB AREA 05A1
- SUB AREA 05A2
- SUB AREA 05B
- SUB AREA 05C
- SUB AREA 05D
- SUB AREA 05E
- SUB AREA 06
- SUB AREA 07
- SUB AREA 08
- SUB AREA 09
- SUB AREA 10A
- SUB AREA 10B
- SUB AREA 11
- SUB AREA 12
- SUB AREA 13
- SUB AREA 14
- SUB AREA 15A
- SUB AREA 15B
- SUB AREA 15C
- SUB AREA 16
- SPRINGBROOK ESTATES (SBE) SUB AREA
- SPRING MOUNTAIN RANCH (SMR) SUB AREA
- COUNTY AREA THAT MAY BE SERVED BY CITY

LEGEND

STUDY SEWER

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FIGURE 4

TRIBUTARY AREAS

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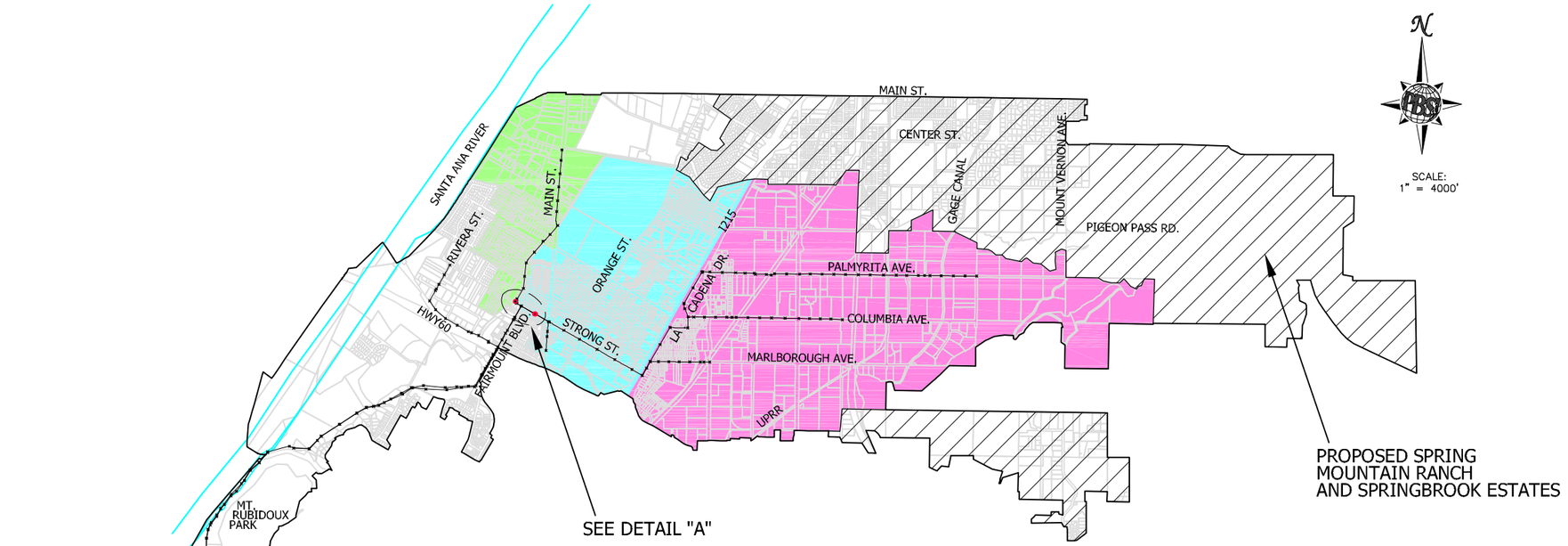

LEGEND

- STUDY MAIN AND MANHOLES
- FLOW METER 1
- FLOW METER 2
- FLOW METER 3
- FLOW METER LOCATION

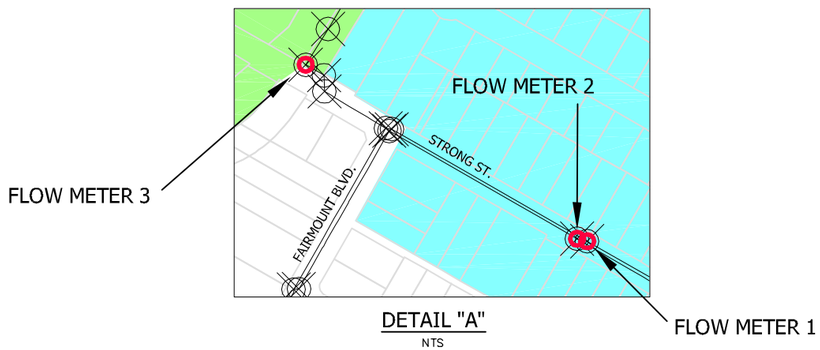

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FIGURE 5

FLOW MONITORING LOCATIONS

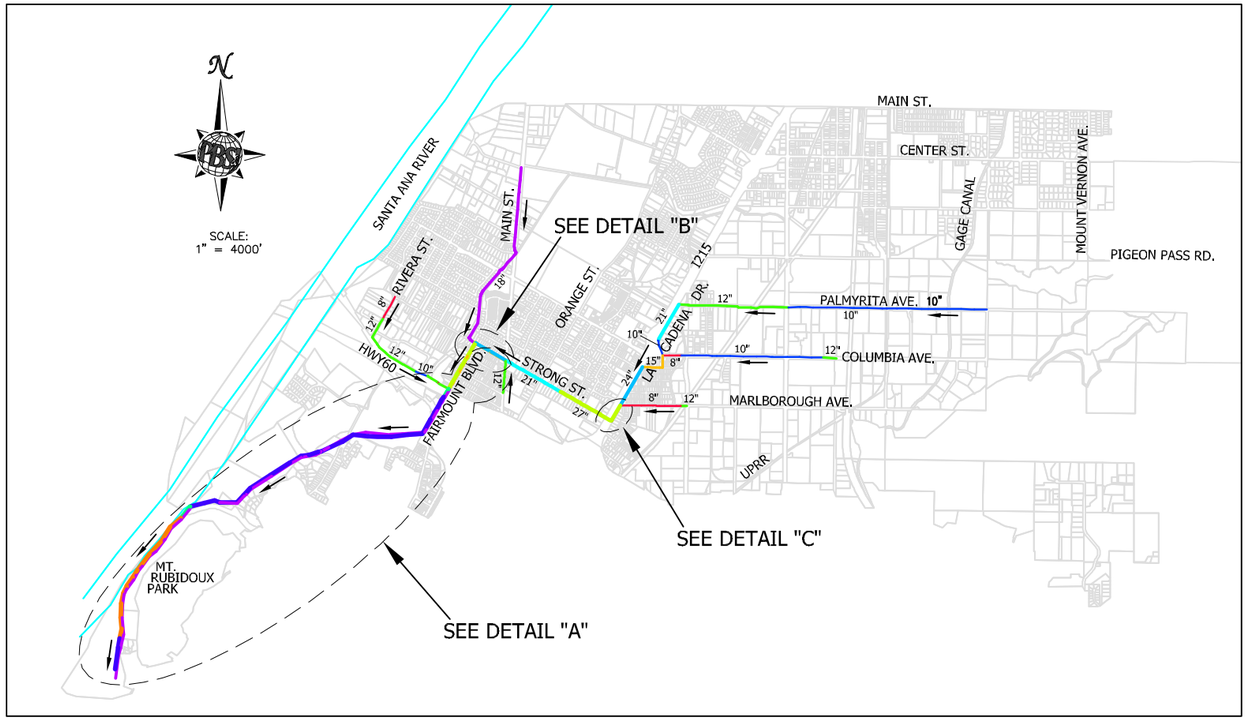
3.3 System Description

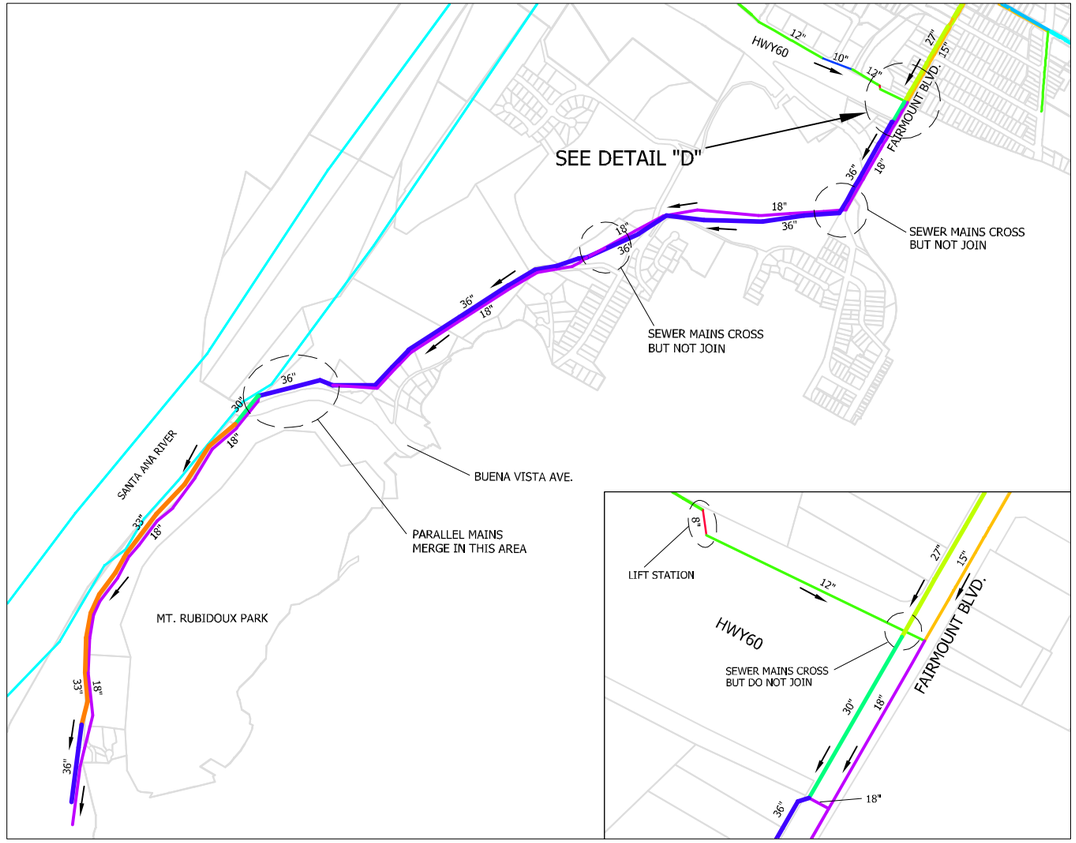
The existing trunk sewer system, which is the subject of this evaluation, is shown on Figure-6. The sewer collection system was constructed over a period of time (50 plus years) to accommodate increasing sewage flow during the development within the City. The GIS data and as-built plans provided by the City were studied to ascertain characteristics of the system. The existing sewer manholes and sewer lines can be seen in Figure-7 and Figure-8 respectively. The pipelines in the system are prefixed with letter "P" (for pipe) and the manholes are prefixed with letter "M" (for manhole) to match the Hydraulic Model. The sewer system is briefly described as follows:

- *Palmyrita Avenue Sewer Line:* The sewer line along Palmyrita Avenue begins at manhole M036P, located at the intersection of Palmyrita Avenue and Michigan Avenue. A 10-inch diameter line picks up flow from industrial development along Palmyrita Avenue. The line between manholes M036P and M036 is 10-inch and between manhole M036 and M025, 12-inch. The line between manholes M025 and M024 is 12-inch. It crosses the railroad on the west side of Iowa Avenue. At manhole M024 the line joins the trunk sewer line along La Cadena Drive.

- *Columbia Avenue Sewer Line*: The sewer line in Columbia Avenue begins at manhole M052 located between Iowa Avenue and Northgate Street. The flow is in a westerly direction. The size of the line between manholes M052 and M039 is 10-inch and between manholes M039 and M019, 8-inch. The line collects wastewater flow from the industrial area and office complexes located along Columbia Avenue. It crosses the railroad on the east side of Chicago Avenue. At manhole M019, it joins the trunk sewer line along La Cadena Drive.

- *Marlborough Avenue Sewer Line*: A 12-inch sewer line along Marlborough Avenue begins at manhole M105 located at the intersection of Chicago Avenue and Marlborough Avenue. The flow is in a westerly direction. The size of the line is 12-inch between manholes M105 and M104 and 8-inch between manholes M104 and M098. The sewer line crosses the railroad west of Chicago Avenue. It picks up wastewater flow from the light industrial development along Chicago Avenue and single family residences along La Cadena Drive.





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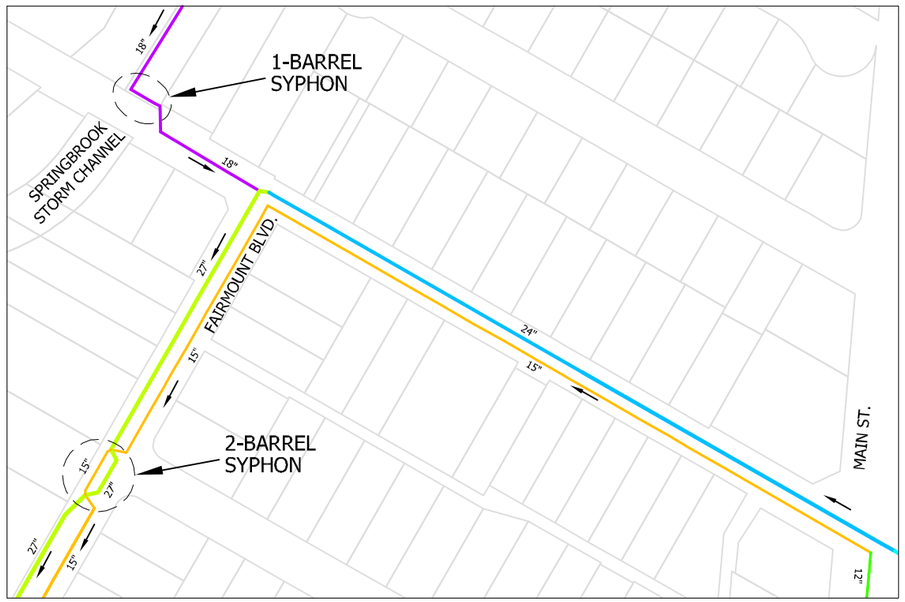

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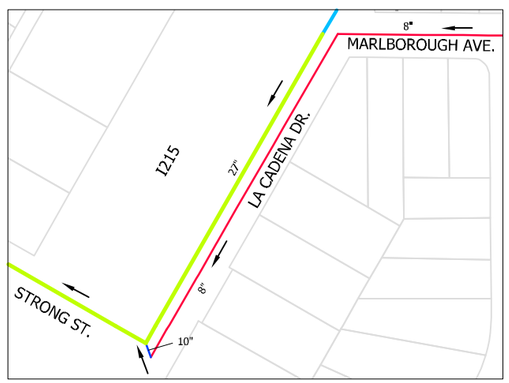

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- 8" DIAMETER PIPE
- 10" DIAMETER PIPE
- 12" DIAMETER PIPE
- 15" DIAMETER PIPE
- 18" DIAMETER PIPE
- 21" DIAMETER PIPE
- 24" DIAMETER PIPE
- 27" DIAMETER PIPE
- 30" DIAMETER PIPE
- 33" DIAMETER PIPE
- 36" DIAMETER PIPE

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Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

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FIGURE 6

SYSTEM PIPE DIAMETERS

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- *La Cadena Drive Sewer Line*: The sewer line along La Cadena Drive begins at manhole M025 located at the intersection of Palmyrita Avenue and La Cadena Drive. A 21-inch line collects wastewater flows from Palmyrita Avenue sewer line and the industrial areas north of Palmyrita Avenue. The flow is in a southwesterly direction, parallel to I-215. The size of the line between manholes M025 and M022 is 21-inch and between manholes M022 and M018, 10-inch. At manhole M019 the line collects flow from Columbia Avenue sewer line. In the reach M018 to M017A the size of the line is 15-inch and the flow is in a westerly direction. The size of the line between manholes M017A and M017 is 21-inch. At manhole M017, a 24-inch line continues to manhole M015. The size of the line between manholes M015 and M014 is 27-inch. The wastewater flow from Marlborough sewer line is intercepted by this line at manhole M014. A parallel sewer line in La Cadena Drive begins at manhole M098 and continues in the southwesterly direction. The size of the line between manholes M098 and M096 is 8-inch and between manholes M096 and M014, 10-inch. The trunk sewer line in La Cadena Drive collects all wastewater flows from study sub-areas east of Fwy. 215. The sewer line joins the trunk line in Strong Street at manhole M014.

- *Strong Street Sewer Line:* The sewer line along Strong Street begins at manhole M014, located at the intersection of Strong Street and La Cadena Drive. This trunk line picks up flow from all study sub-areas located east of Fwy. 215. The size of the line between manhole M014 and M011 is 27-inch and between manholes M011 and M008, 21-inch. A 24-inch line continues west of manhole M008 to manhole M006. Another line runs parallel to the trunk line in the reach between manholes M091 and M089. The size of this line is 15-inch. On the west side of Fairmount Boulevard there is an 18-inch sewer siphon along Strong Street that crosses under the storm drain channel. The sewer line along Strong Street joins the trunk sewer line along Fairmount Boulevard at manhole M005.

- *Main Street Sewer Line:* The sewer line along Main Street has two segments; one on the north of Strong Street and the other on the south. The north segment begins at manhole M069 located at the intersection of Main Street and Garner Road. At this location, an 18-inch sewer line continues along Main Street in a southeasterly direction to manhole M063 located at the intersection of Main Street and Witt Avenue. At this location, the line continues

through a sewer easement in a southwesterly direction to manhole M055 where it joins the siphon in Strong Street.

The southern segment of Main Street sewer line begins at manhole M094 located at the intersection of Main Street and Shamrock Avenue. A 12-inch line continues in a northwesterly direction along Main Street to manhole M091 located at the intersection of Main Street and Strong Street.

- *Rivera Street Sewer Line:* The sewer line begins at manhole M082 located at the intersection of Strong Street and Rivera Street. An 8-inch sewer line continues in a southerly direction to manhole M080. Then a 12-inch line continues to manhole M077 located north of Market Street. This line picks up wastewater flow from residential area north of Market Street and east of Santa Ana River. It joins Fairgrounds Street line at M077.

- *Fairgrounds Street Sewer Line:* The sewer line along Fairgrounds Street begins at manhole M077 located at the intersection of Rivera Street and Market Street. A 12-inch line continues in an easterly direction to manhole M073. Then a 10-inch line continues to manhole M071. The line between manholes M070 and M071 is 12-inch. A small lift station is located at manhole M070. From this location wastewater is lifted to manhole M095 through an 8-inch force main line. The flow between manholes M075 and M084 is through a 12-inch gravity sewer line.

- *Fairmount Boulevard Sewer Line:* The sewer line in Fairmount Boulevard is comprised of two parallel trunk lines and a siphon. A 27-inch sewer line continues in a southerly direction from manhole M005 and joins the siphon at manhole M004. A parallel 15-inch trunk sewer line also continues in a southerly direction and joins the siphon at manhole M004. The siphon is comprised of two parallel conduits (27-inch and 15-inch). These conduits cross under a single barrel box culvert storm drain. At manhole M003 the two trunk sewer lines join and continue in a southerly direction towards Hwy 60. These two sewer lines in Fairmount Boulevard pick up cumulative wastewater flow from the study area north of Hwy 60.

- *Fairmount Trunk (South of Hwy 60 up to Tequesquite Avenue) Sewer Line:* This sewer consists of two parallel trunk sewer lines. A 36-inch sewer line continues in a southerly direction from manhole M001 to manhole M182

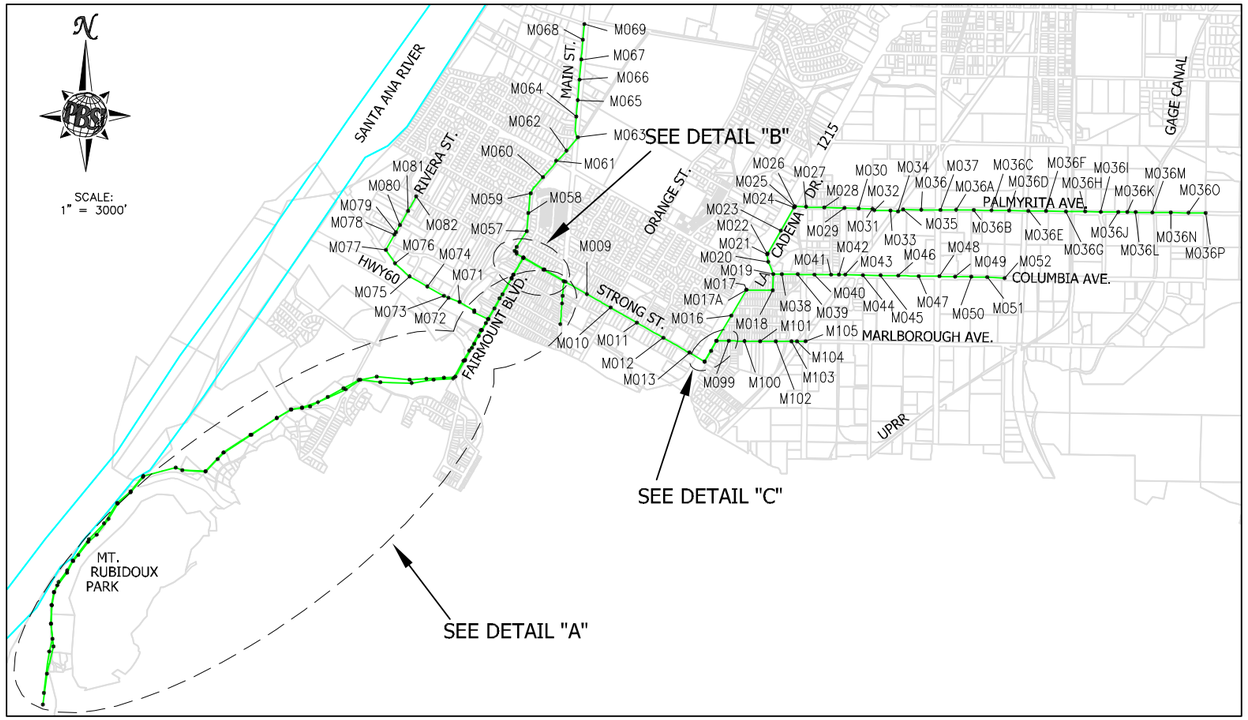
located at Buena Vista Avenue. From this location, a 30-inch line continues to manhole M183 where parallel sewer lines converge. A single 36-inch line continues to manhole M185 where the flow splits into two parallel lines 30-inch and 15-inch in size. At manhole M190 the larger trunk line changes to 33-inch and continues to the end of study area at manhole M220. The trunk line picks up the most of wastewater flows from Spruce Street Sewer Study area at manhole M153. The smaller trunk sewer line is 18-inch diameter in its entire reach. It picks up a small portion of the flow from Spruce Street Sewer Study Area at manhole M145.

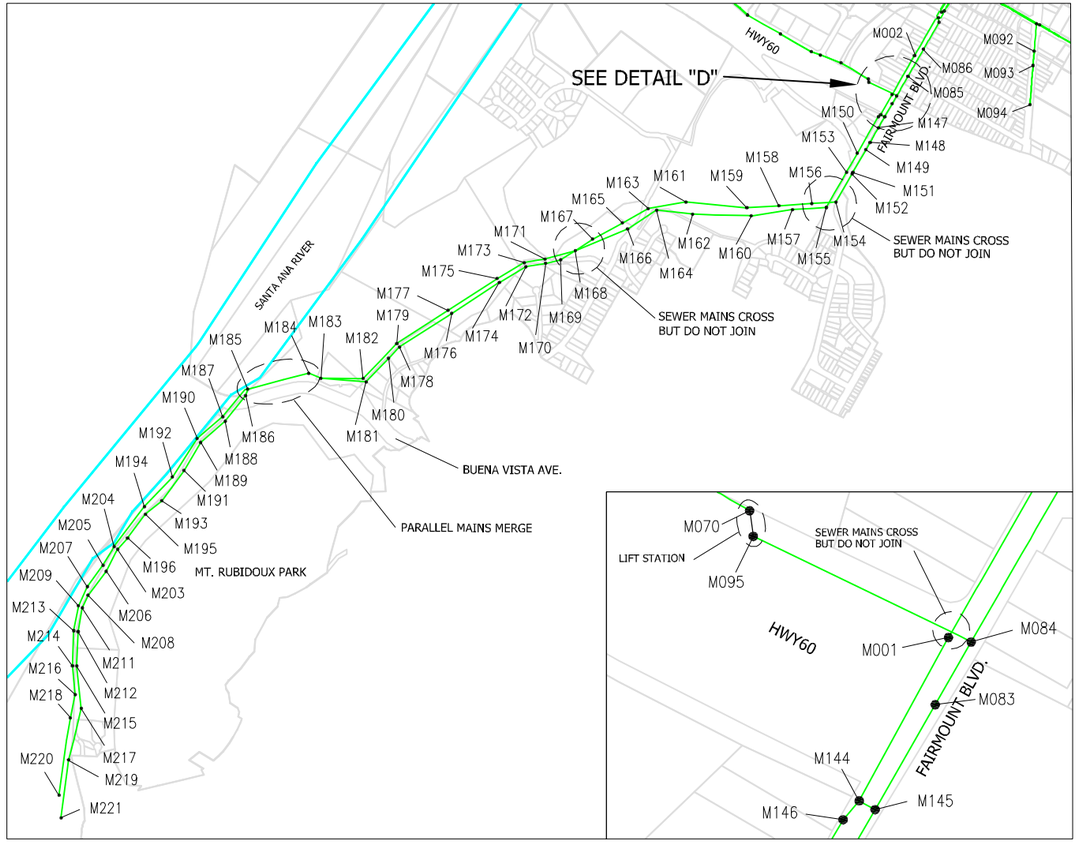
3.4 Tributary Areas

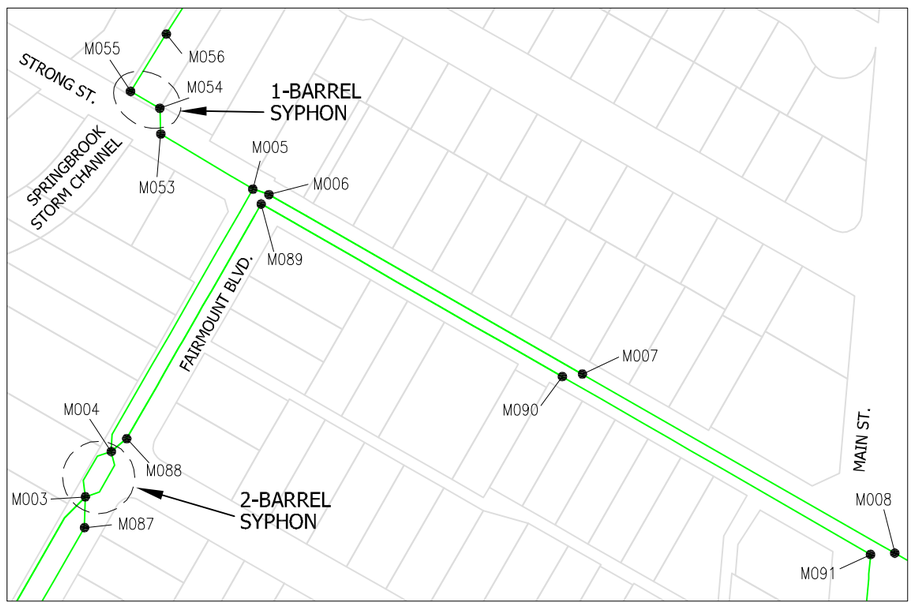
The study area is divided into 26 sub-areas, each area having a land use or flow pattern distinctive from the other. These sub-areas are tributary to a particular meter location either individually or collectively. Because of their strategic locations, meters upstream to a cumulative meter can be subtracted out to reduce the cumulative effect. See Figure 4 for details of tributary sub-areas and Figure 5 for meter locations. The following is the listing of tributary sub-areas and their contribution to a particular meter location.

1. Sub-areas 9, 10A, 11, 12, 13, and 14 are tributary to meter No. 1, located on Strong Street east of Fairmount Boulevard.
2. Sub-areas 5A1, 5A2 and 5E are tributary to meter No. 2 located on Strong Street east of Fairmount Boulevard.
3. Sub-areas 1, 2 and 5D are tributary to meter no. 3 located at the sewer easement north of Strong Street.

Within each sub-area there is generally a distinct mixture of land use that generates a unique quantity and diurnal pattern of wastewater flows. For identification of land use patterns, data provided by the City of Riverside in GIS Arcview format was used. Table 3-1 summarizes the sub-areas and land uses within the sub-areas that are currently contributing to the existing sewer system.







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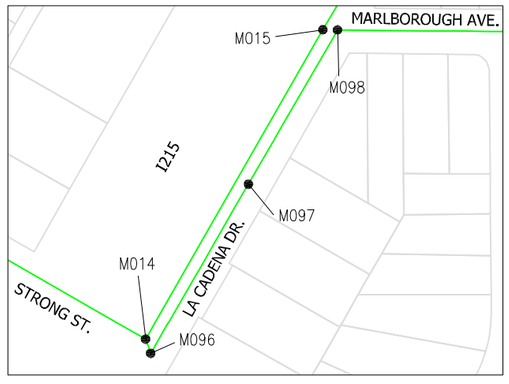

DETAIL "C"
NTS

DETAIL "D"
NTS

DETAIL "A"
NTS

LEGEND

———	GRAVITY SEWER
M001	MANHOLE NUMBER

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 01/04/06 | DWN BY: CD

CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 7

EXISTING MANHOLES

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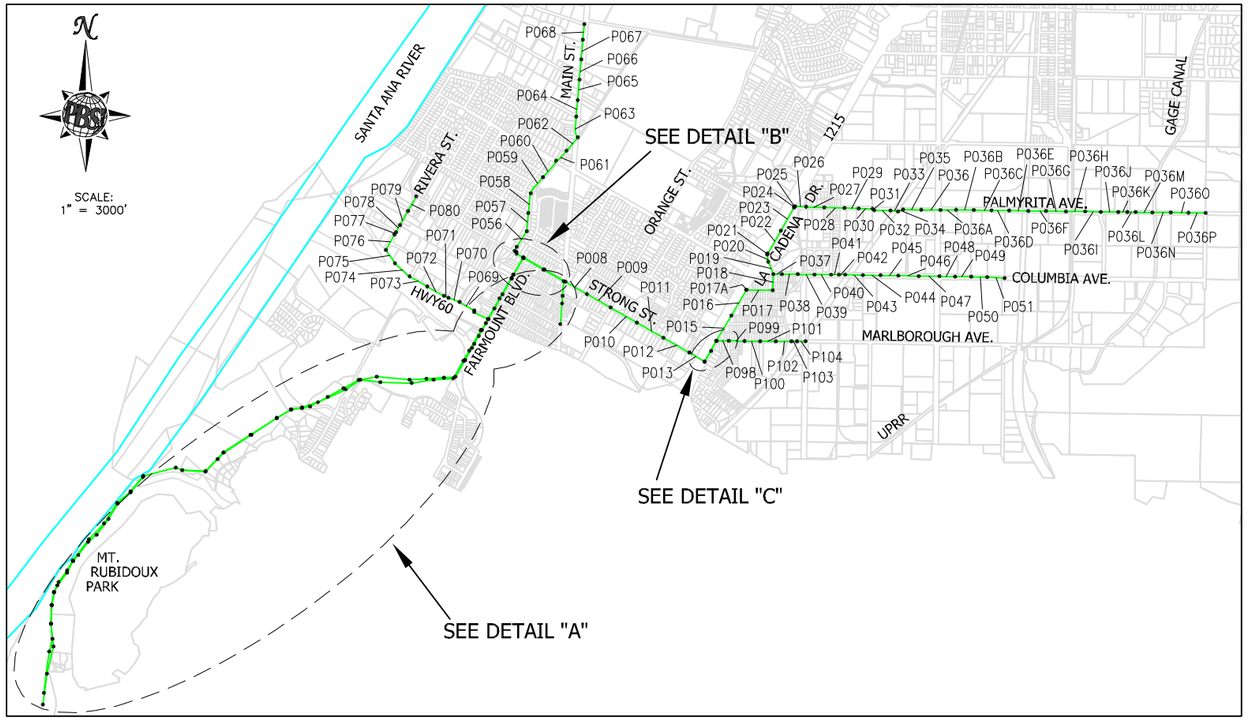
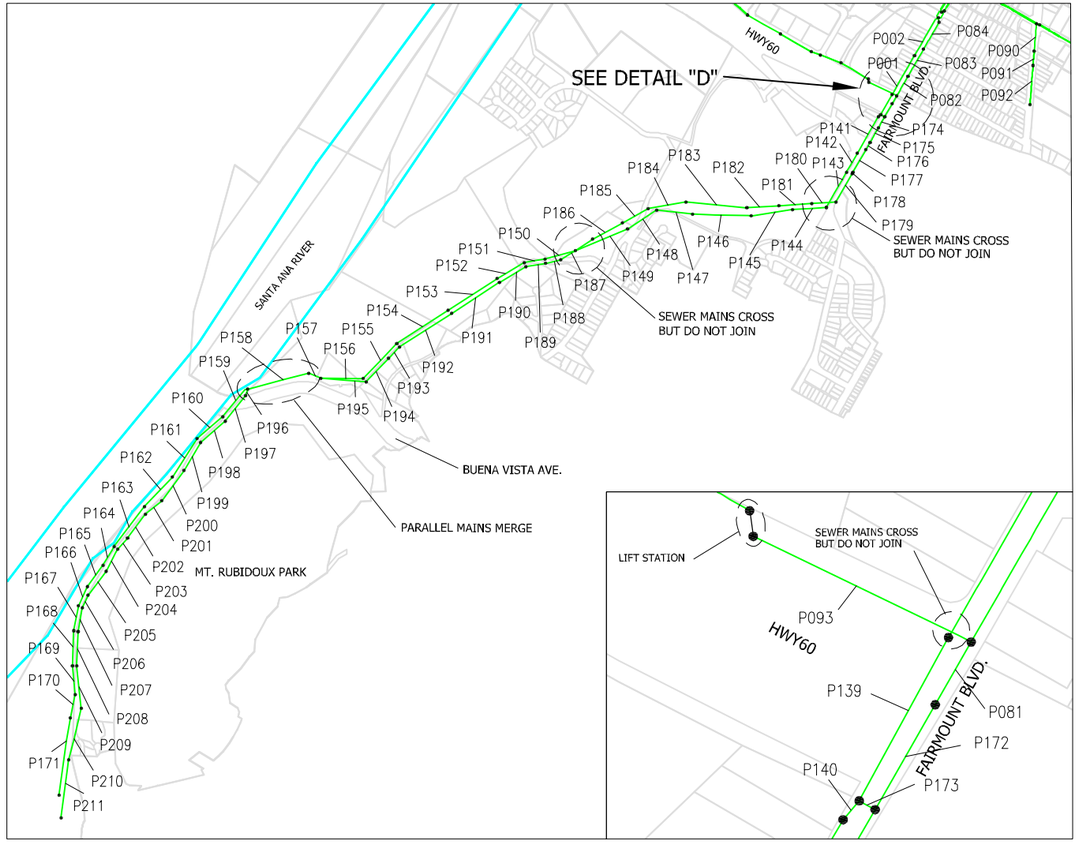
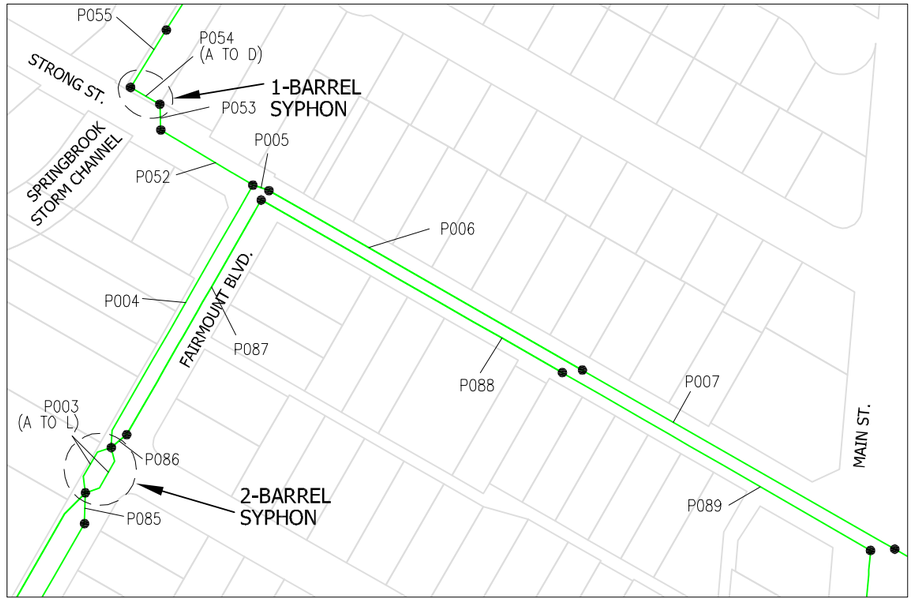




DETAIL "A"
NTS

DETAIL "D"
NTS



DETAIL "B"
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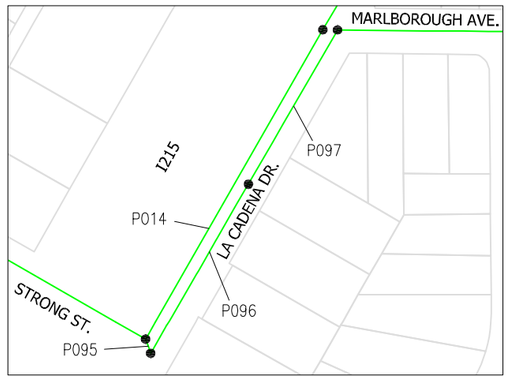

DETAIL "C"
NTS

LEGEND

———	GRAVITY SEWER
P001	PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 01/04/06 | DWN BY: CD

CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 8

EXISTING PIPES

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Table 3-1

Developed Tributary Areas and Current Wastewater Generating Land Use

Sub Area	SFR (Acres)	MFR (Acres)	Commercial (Acres)	Industrial (Acres)	School (Acres)	Total (Acres)
1	-	-	29	17	-	46
2	80	-	29	35	-	144
3	78	-	-	-	-	78
4	1	-	-	44	-	45
5A1	40	-	-	16	9	65
5A2	98	28	10	-	-	136
5D	-	-	-	36	-	36
5E	12	-	-	10	-	22
6	34	-	-	-	-	34
7	35	12	2	-	-	49
8	25	-	-	-	-	25
9	-	-	-	110	-	110
10A	-	-	-	139	-	139
12	-	-	-	201	-	201
13	-	-	-	77	-	77
14	55	-	-	34	-	89
15A	-	-	4	-	-	4
15B	15	-	6	-	-	21
15C	124	-	6	-	-	130

SFR – Single Family Residential
MFR – Multi Family Residential

4.0 DETERMINATION OF SEWER FLOWS

4.1 Flow Monitoring

Flow Monitoring was conducted at three (3) sites in order to accomplish the following: (See Figure 5 for locations of Flow Monitoring Stations).

- Establish current flow levels.
- Verify or adjust flow coefficients.
- Establish characteristic flow patterns (Diurnal Curves) for the model (See Figures 12-14).
- Confirm peak to average flow relationships.
- Help prioritize recommend improvements.

Meter locations were chosen to observe actual flow characteristics for the various sub-areas and to provide a continuous record of measured flows over a period of time (two weeks for this study). Meter locations were also chosen in such a manner that current flow quantities along the Fairmount Boulevard Trunk Sewer could be quantitatively determined. The following is an amplification of the logic for placement of each flow meter.

- Meter No. 1; location on Strong Street east of Fairmount Boulevard – This location was chosen because it carries all the flow generated from the industrial area east of I-215. The flow pattern at this location reflects a diurnal pattern of mixed land uses consisting of light industrial, industrial business park and residential development.

- Meter No. 2; location on Strong Street east of Fairmount Boulevard – This location was chosen to observe flow generated from the residential area west of I-215. This meter intercepts most of the flow generated from the residential development (medium to high density) and the diurnal curve can be used for calibration of residential flow.

- Meter No. 3; location in sewer easement north of Strong Street – This location was chosen to measure the flow from residential areas (low to medium density) that are not contributory to flow at meter location 2.

4.2 Results of Flow Monitoring

Measurement of sewage flows is an imprecise science, as the in-line equipment is placed in a harsh environment and is subject to solids interference, turbulence and other problems, which can impede the accuracy. Installed equipments must be frequently inspected, calibrated, and maintained, and monitoring results interpreted, evaluated for reasonableness, and sometimes adjusted. In this particular application, metered flow information was generally good. However, some flows at specific meter locations did not display consistent values. Graphical results at each site were carefully reviewed for consistency and reasonableness, using the following general guidelines.

- Where the magnitude or daily pattern varies significantly from one non-holiday weekday to the next, the data is likely to be flawed.
- Where the base (low) flows are rising during the flow monitoring period, the data is suspect.
- Where the algebraic sum of flows from meters in series are significantly out of sync, the data from one or more meters may be faulty.
- Where minimum (nighttime) flows are abnormally high or algebraically inconsistent, the data is suspect.
- Where the measured depth data and velocity data are inconsistent, the data is suspect.

Metered flows displaying one or more of the above flaws were purged or adjusted based on reasonable assumptions.

At each meter location the flow-monitoring device measures depth of flow and velocity. Upon reviewing the report submitted by Downstream Services, and from discussions with their staff, it was determined the data (depth or velocity) that is more consistent should be used for determination of flow. By using depth of flow readings and inputting pipe characteristics from record drawings (slope, size and roughness “n” values), sewage flow can be calculated using Manning’s equation. The raw flow data have been included in Appendix “A”.

The flow data at each meter site, adjusted based on the depth measurement, are shown in Figures 9 through 11. The following relevant observations were made from evaluation of the measured flows:

- Flows from the study area east of I-215 are atypical because of the majority of study area being light industrial / commercial. These areas produce less flow than estimated

from the land use pattern because some of the parcels are being used for storage purposes only.

- Weekend hydrographs show generally lower flows and smaller peaks than weekday patterns, for the commercial / industrial area, usually due to closure of offices during the weekends.

- At meter location 1, the velocity and depth of flow readings are consistent for the period October 5-9, 2004. The flow during this monitoring period has been used for estimation of the maximum flow and calibration of the model.

- Flow measured at meter location 2 is higher than the anticipated theoretical flow from the land use. This is most likely attributable to a higher than anticipated resident population or "overcrowding" in this particular area. The diurnal flow patterns derived from meter no. 2 reveal a consistent high flow during night - time hours. This can be explained by the general nocturnal habits of people living in high-density residential areas. The people living in these areas usually work in multiple shifts and use the wastewater facilities in inconsistent ways. The flow pattern is similar to Kansas Street area of Spruce Street Sewer Capacity Study. The flow for the period September 30 – October10, 2004 shows a relatively consistent flow pattern which has been used for estimation of maximum flow and calibration of the model.

5.0 ESTIMATED ULTIMATE FLOW

5.1 Methodology

Future wastewater flows in the study area are estimated by applying unit (per acre or per capita) flow factors to the projected "ultimate" land use acreage or population in each sub area. As discussed in Section 2, ultimate land uses within the study area are estimated based on the City's current General Plan (which governs future development/redevelopment) and input from City staff. The major contributor to the projected wastewater flow in the future would be undeveloped industrial business park area in the eastern portion of I-215, proposed Spring Mountain Ranch (SMR) residential development and Springbrooks Estates Development. For purposes of this study it has been assumed that these areas will be developed by the year 2020.

5.2 Flow Coefficients

A review of commonly used flow coefficients (or unit factors) was performed to arrive at preliminary criteria, which is an appropriate starting point for the study.

Flow coefficients are commonly expressed in terms of cubic feet per second (cfs) of average dry weather flow (ADWF) per acre of a specific land use type. For population based estimates, flows are expressed in gallons per capita per day (gpcd). Peak flow generation rates can be estimated by applying peaking factors to the average flow, with factors often based on observed peak-to-average ratios from previous studies. However peaking factors and diurnal flow patterns vary greatly from one setting to another. Peaks for various uses differ not only in magnitude, but also in time of the day. The diurnal patterns are thus a composite picture of inflows that are not simultaneous, but rather staggered throughout the day. Also, peaks are attenuated by lag times and in-pipe storage as the flows move downstream. Notwithstanding the above, diurnal peaking factors are also estimated for each land use type to estimate peak generation rates.

For preliminary estimation of wastewater flow, the document "Criteria for Sewer Facility Design, Public Works Department, City of Riverside" was used. (See Appendix "B"). The document states the following general guideline for estimation of wastewater flows:

Flows from Residential Developments:

- Land use shown in the City's General Plan.
- No. of dwelling units per acre within a certain land use.
- Persons per living unit determined from the latest census data for the study area. However, it should not be less than an average of 2.75 persons per living unit.
- Average wastewater flow based on 65 gallons per capita per day.
- Peak to average flows to be determined from the graphs.

Flows from non-residential developments:

- Industrial Developments – Peak flow; 0.012 cfs per acre.
- Commercial Developments – Peak flow 0.01 cfs per acre.
- Offices – 30 gallons per capita (employee on site) per day peak flow.
- Schools – 30 gallons per capita per day.
- Laundromat – 580 gallons per machine per day peak flow.

5.3 Representative Diurnal Hydrographs

The study area is comprised of a variety of unique land uses. For the purpose of defining characteristic diurnal patterns, flow from each sub-basin was analyzed and percentage of flow contribution from each land use type was estimated. Although only a few of the tributary sub areas flowing to the meter locations are comprised of a single land use category, several are dominated by one or two categories, and are thus selected as being representative of the diurnal flow patterns for those land uses. The diurnal patterns were established at each meter location and the model was calibrated for mixed land use. In addition flow from Spruce Street Sewer Capacity Study (June, 2002) was used to determine flow pattern at manhole M153. The following diurnal patterns were used for the modeled peak flow evaluation.

- Flow at meter location 1: Mixed Land Use Pattern (Residential, Commercial and Light Industrial)
- Flow at meter location 2: Mixed Residential (SFR and MFR)
- Flow at meter location 3: Residential

These representative diurnal hydrographs are shown in Figures 12-14. The flow patterns are used in the model to estimate, for each land use type, the percentage of Average Dry Weather Flow (ADWF) contributed at specific times throughout the day.

Figure 9

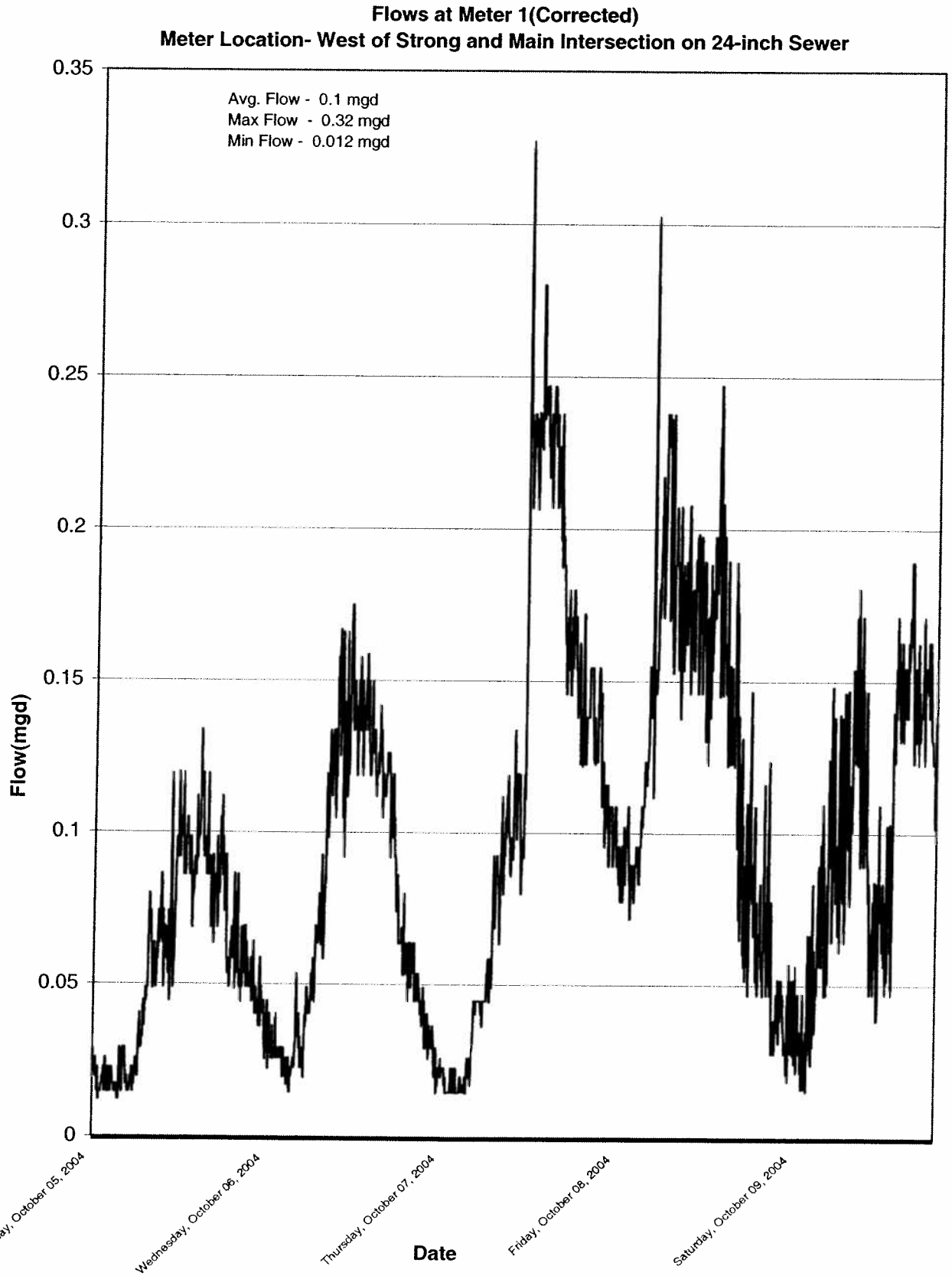

Flows at Meter 1(Corrected)
Meter Location- West of Strong and Main Intersection on 24-inch Sewer
Avg. Flow - 0.1 mgd
Max Flow - 0.32 mgd
Min Flow - 0.012 mgd
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Flow(mgd)
Tuesday, October 05, 2004
Wednesday, October 06, 2004
Thursday, October 07, 2004
Friday, October 08, 2004
Saturday, October 09, 2004
Date

Figure 10

Flows at Meter 2 (Corrected)
Meter Location - West of Strong and Main Intersection on 15-inch Sewer

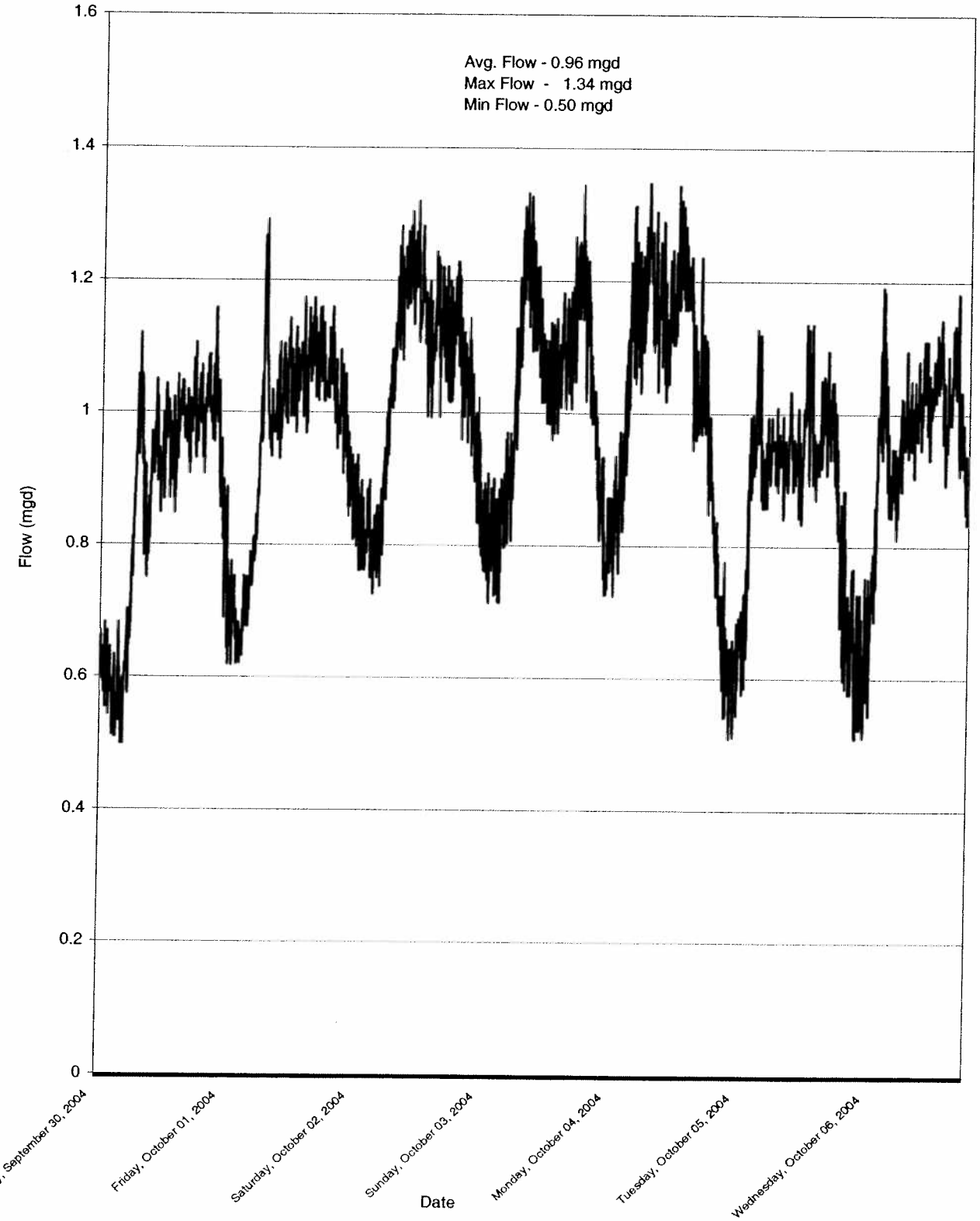


Figure 11

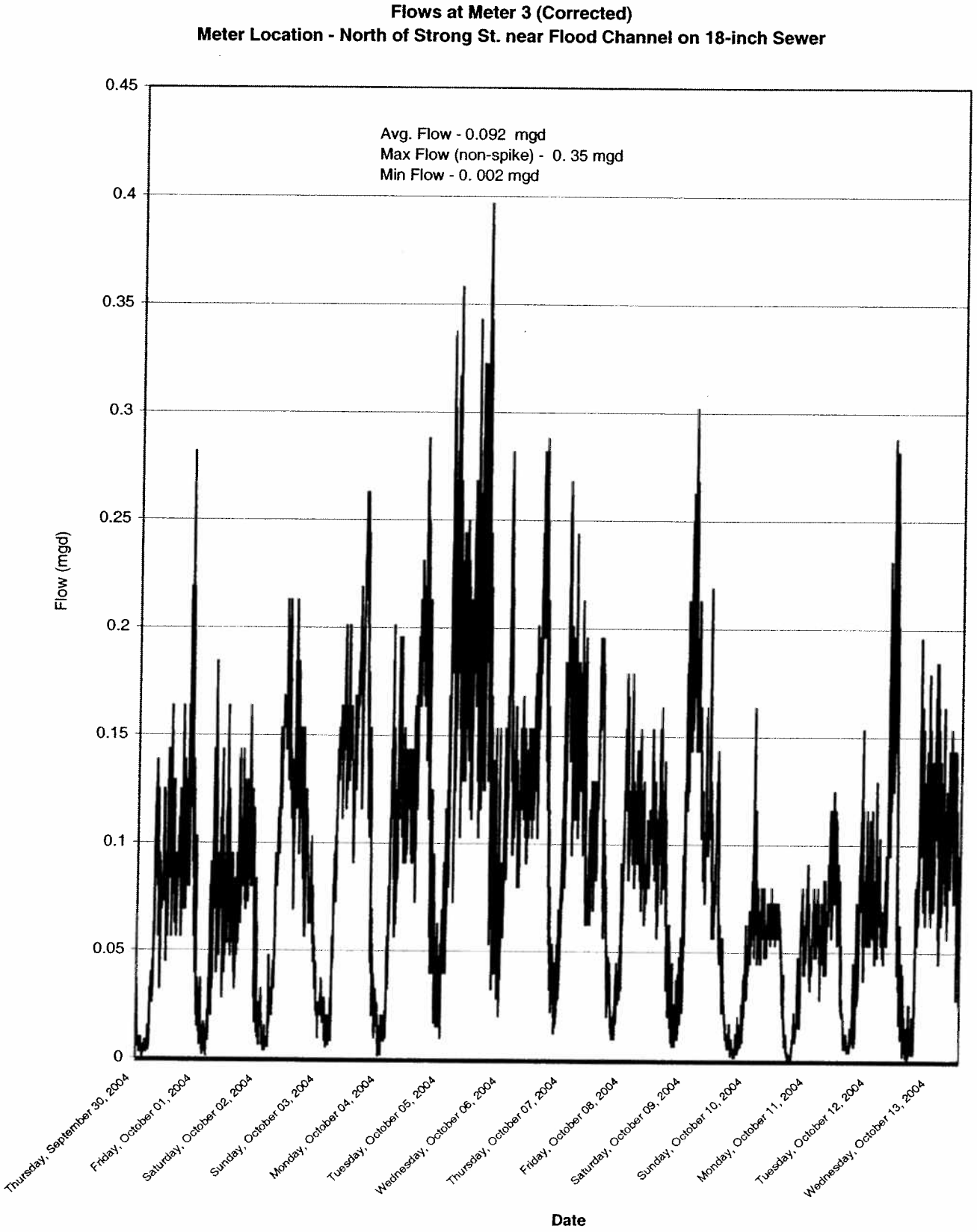

Flows at Meter 3 (Corrected)
Meter Location - North of Strong St. near Flood Channel on 18-inch Sewer
Avg. Flow - 0.092 mgd
Max Flow (non-spike) - 0. 35 mgd
Min Flow - 0. 002 mgd
Flow (mgd)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Thursday, September 30, 2004
Friday, October 01, 2004
Saturday, October 02, 2004
Sunday, October 03, 2004
Monday, October 04, 2004
Tuesday, October 05, 2004
Wednesday, October 06, 2004
Thursday, October 07, 2004
Friday, October 08, 2004
Saturday, October 09, 2004
Sunday, October 10, 2004
Monday, October 11, 2004
Tuesday, October 12, 2004
Wednesday, October 13, 2004
Date

Figure 12

Representative Diurnal Curve for Mixed Land Use (Residential and Industrial)
Meter Location 1

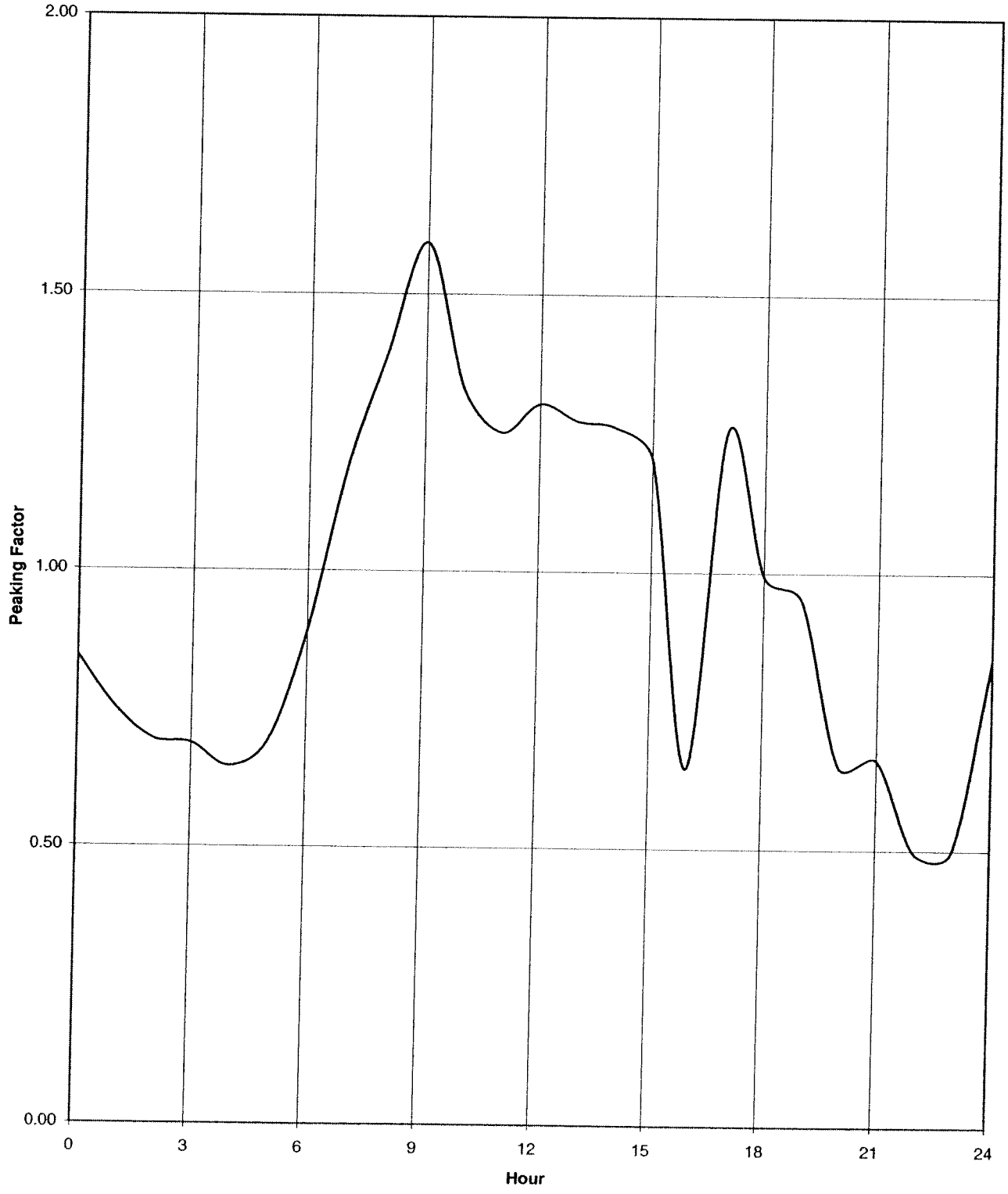


Figure 13

Representative Diurnal Curve for Residential (SFR and MFR), at Meter Location 2

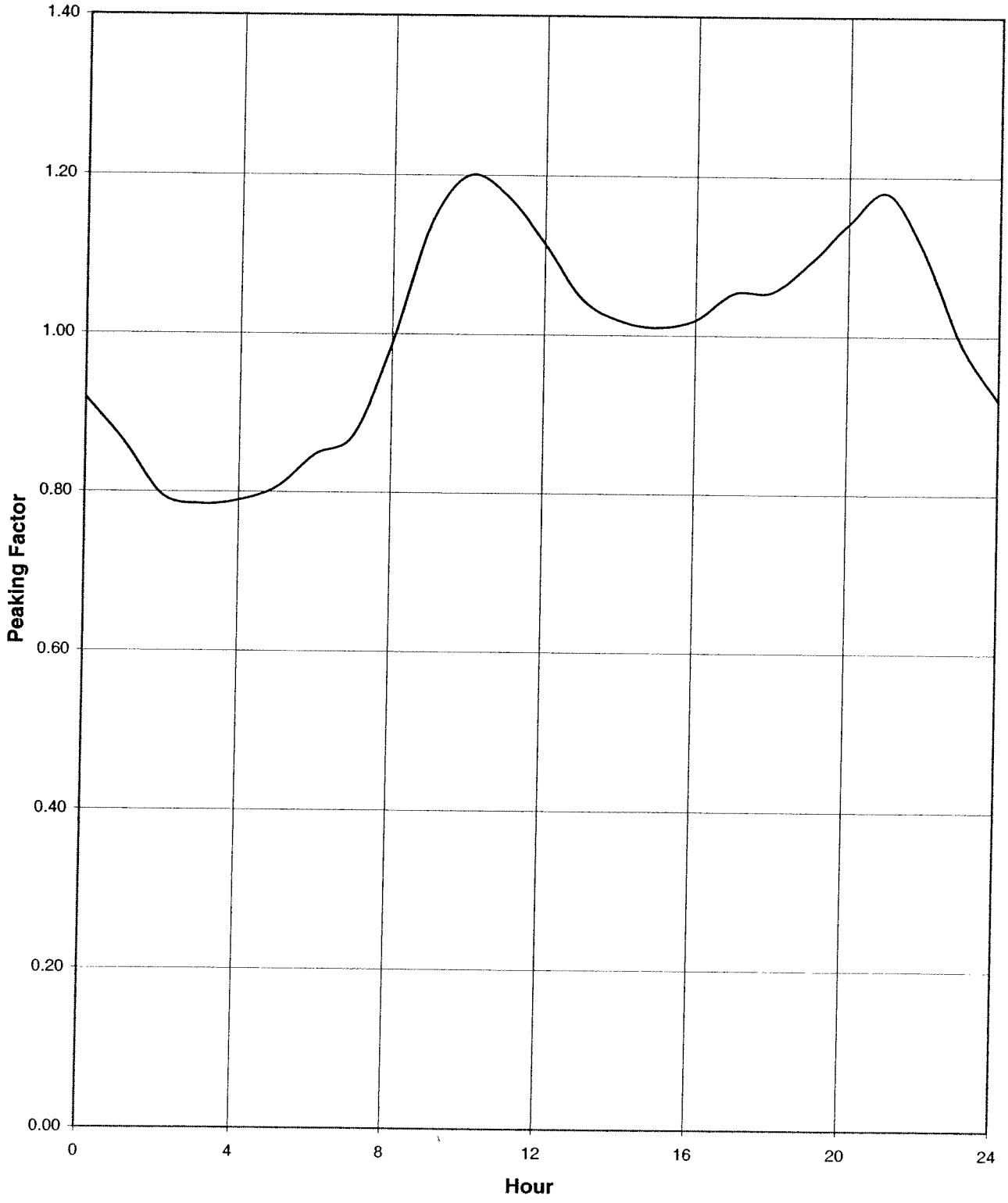
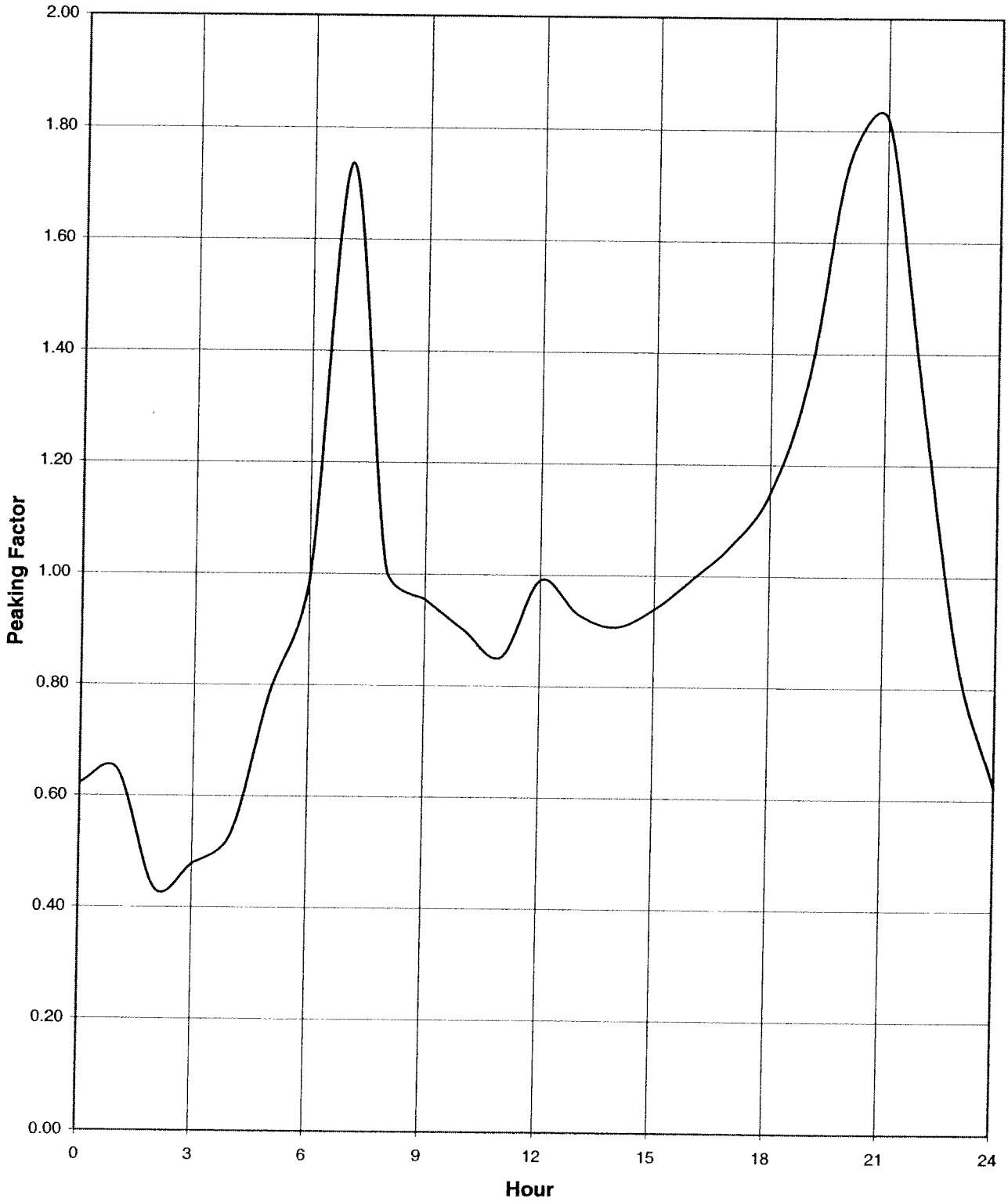


Figure 14

Representative Diurnal Curve for Land Use (Residential), at Meter Location 3



6.0 COMPUTER MODEL SIMULATION ANALYSIS

6.1 Methodology

Capacity analysis involved the evaluation of the available capacity in the existing collection system under present and future development conditions. Based on results of the analysis, phased facility improvements were identified to allow for projected growth within the service area.

This section describes the analytical methodology and hydraulic model development and summarizes the results of the analyses.

The principal tool utilized in the capacity analysis was a hydraulic model that simulates flow conditions using demand and piping characteristic input data. With this input information, the model is able to compute and output depth of flow, rate of flow, and velocity of flow, in selected pipes and manholes during different times of the day. The model selected for use in this study is XP-SWMM (XP Software, Version 9.12). This modeling software belongs to a class of software referred to as “dynamic wave models”. These types of models provide an accurate simulation of hydraulic flow conditions over an extended period of time.

Data required to create the model include information describing the physical wastewater collection system, such as pipe diameters and reach lengths, manhole invert elevations, and estimated pipe roughness coefficients. Additionally, data describing the sewage loading at selected manholes expressed as a varying flow rate over time (i.e. a diurnal curve), must be provided. Model output consists of a variety of hydraulic parameters, most importantly peak flow velocity and discharge rates.

Calibration of the model consisted of simulating existing sewer flow conditions and comparing the modeled flows with the recorded flows at the meter locations. The assumed diurnal curves that serve as input to the model were iteratively adjusted until the simulated and recorded sewage flow hydrographs achieved reasonable agreement.

Simulations of future sewage flow conditions were performed by developing input data sets that included sewage generation projections for the assumed ultimate development conditions. Pipe reaches in which simulated peak flows exceeded a specified trigger criteria, were identified as potential improvement reaches. Improvements required to provide adequate capacity for projected flows were then determined through an iterative modeling process. The process consists of simulating flow conditions after increasing the diameter of downstream portions of the identified

reaches. In subsequent iterations, additional lengths of pipe were increased in diameter until the projected peak flow could be conveyed through the reach without exceeding the specified design flow criteria.

6.2 Limitations of Modeling

The hydraulic model, which was utilized as the primary planning tool for the sewer capacity analysis, provides an accurate simulation of actual flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation, however, is directly related to the accuracy of the model input data, including physical parameters and sewage loading projections. For example, in a case where roots had entered the pipeline, thereby causing a restriction of flow, the model would be unable to predict the reduction in flow through this obstruction. Consequently, a general understanding of the data sources is critical in interpreting the modeling results.

The physical parameters of the model, including the pipe diameter, slope, and roughness coefficients were based principally on City's GIS database information. Where this data appeared to be inaccurate, construction drawings were reviewed and the input data corrected.

Network connectivity refers to the flow path followed by sewage within the sewer system. The connectivity is a function of the relative slope of each sewer pipe and the relative invert elevations of the incoming and outgoing sewer pipes at manholes. For example, a manhole may have two or more sewer pipes, which could convey flow away from the manhole. If the invert (bottom) of one of these pipes is lower than the other, the downstream flow path at this manhole would follow the lower pipe.

Sewage loading projections were based on calibrated flow rates. As previously described, flow rates used for calibration were based on actual monitored flows at key points in the trunk system over a 2-week period in October 2004. This period included the two weekends.

Since a degree of uncertainty exists in both the physical data and the sewage loading projections used as model inputs, reaches identified by model simulations as near or at capacity should be subject to additional engineering evaluation prior to implementing improvements. Such evaluation may include field inspection, video monitoring and flow metering.

The results of model runs for existing and ultimate conditions are summarized in Table 7-1.

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Year 2020 Estimated Peak Flow (cfs)	Year 2020 Estimated % Full
P001	2.25	0.2400	15.15	3.090	20%	11.086	73%
P002	2.25	0.1764	12.99	3.183	24%	11.087	85%
P003A	2.25	0.4878	Siphon	2.574		10.981	
P003B	2.25	-41.4266	Siphon	2.569		10.984	
P003C	2.25	-20.7000	Siphon	2.574		10.984	
P003D	2.25	0.0000	Siphon	2.490		10.984	
P003E	2.25	41.4013	Siphon	2.502		10.985	
P003F	2.25	0.9569	Siphon	1.788		10.994	
P003G	1.25	0.9569	Siphon	1.142		1.358	
P003H	1.25	41.4013	Siphon	1.164		1.358	
P003I	1.25	0.0000	Siphon	1.181		1.358	
P003J	1.25	-20.7000	Siphon	1.199		1.358	
P003K	1.25	-41.4266	Siphon	1.207		1.358	
P003L	1.25	0.4878	Siphon	1.279		1.358	
P004	2.25	0.2837	16.48	0.851	5%	8.563	52%
P005	2.25	0.4054	19.70	0.528	3%	7.285	37%
P006	2.00	0.4419	15.01	0.442	3%	7.150	48%
P007	2.00	0.4424	15.02	0.443	3%	7.149	48%
P008	1.75	1.1616	17.04	0.443	3%	7.149	42%
P009	1.75	4.1142	32.08	0.443	1%	7.150	22%
P010	1.75	2.2855	23.91	0.443	2%	7.150	30%
P011	2.25	0.3283	17.73	0.443	2%	7.150	40%
P012	2.25	0.3288	17.74	0.444	3%	7.151	40%
P013	2.25	0.5684	23.32	0.445	2%	7.151	31%
P014	2.25	0.5348	22.62	0.222	1%	5.895	26%
P015	2.00	0.4812	15.67	0.223	1%	5.895	38%
P016	2.00	0.4822	15.68	0.223	1%	5.896	38%
P017	1.25	0.3459	3.79	0.223	6%	5.896	21" 156%
P017A	1.75	1.0204	15.97	0.223	1%	5.896	37%
P018	1.25	0.3473	3.79	0.223	6%	5.896	21" 155%
P019	0.83	0.6178	1.71	0.147	9%	3.967	18" 231%
P020	0.83	0.6207	1.72	0.147	9%	3.967	18" 231%
P021	0.83	~~1.0000~~ 0.62	1.74 ~~2.18~~	0.147	8% ~~7%~~	3.967	18" ~~182%~~ 228%
P022	1.75	0.5486	11.71	0.147	1%	3.967	34%
P023	1.75	0.5465	11.69	0.147	1%	6.397	~~55%~~
P024	0.83	0.0870	0.64	0.147	23%	6.397	27" ~~996%~~
P025	1.25	0.1960	2.85	0.147	5%	3.516	18" ~~123%~~
P026	1.25 ~~1.00~~	~~1.0800~~ 0.35	3.85 ~~3.69~~	0.110	3%	3.340	~~91%~~ 87%
P027	1.00	1.0800	3.69	0.110	3%	3.336	90%
P028	1.00	~~1.2000~~ 1.08	3.74 3.89	0.110	3%	3.333	~~86%~~ 89%
P029	1.00	1.2186	3.92	0.110	3%	3.984	18" 102%
P030	1.00	~~1.1978~~ 1.21	3.96 3.88	0.110	3%	3.984	18" 103%
P031	1.00	~~1.2400~~ 1.17	3.95	0.110	3%	3.984	18" 101%
P032	1.00	0.8400	3.25	0.110	3%	3.984	18" 122%
P033	1.00	0.8400	3.25	0.110	3%	3.985	18" 123%
P034	1.00	1.3400	4.11	0.110	3%	3.985	97%
P035	1.00	~~1.3056~~ 1.04	3.67 4.06	0.110	3%	3.986	18" ~~98%~~ 109%
P036	1.00	1.3134	4.07	0.110	3%	3.988	98%
P036A	0.83	2.1005	3.16	0.056	2%	2.552	81%
P036B	0.83	2.2000	3.23	0.056	2%	2.558	79%
P036C	0.83	2.5600	3.49	0.056	2%	2.580	74%
P036D	0.83	2.5600	3.49	0.056	2%	2.600	75%
P036E	0.83	1.9227	3.02	0.056	2%	2.599	86%
P036F	0.83	3.1457	3.86	0.056	1%	2.601	67%
P036G	0.83	2.6010	3.51	0.056	2%	2.601	74%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Year 2020 Estimated Peak Flow (cfs)	Year 2020 Estimated % Full
P036H	0.83	3.0000	3.77	0.056	1%	2.601	69%
P036I	0.83	3.0007	3.77	0.056	1%	2.602	69%
P036J	0.83	2.9677	3.75	0.056	2%	2.602	69%
P036K	0.83	2.9506	3.74	0.057	2%	2.603	70%
P036L	0.83	2.9203	3.72	0.057	2%	2.603	70%
P036M	0.83	3.0000	3.77	0.057	1%	2.603	69%
P036N	0.83	2.6393	3.54	0.057	2%	2.603	74%
P036O	0.83	2.6393	3.54	0.057	2%	2.604	74%
P036P	0.83	2.6342	3.54	0.057	2%	2.605	74%
P037	0.67	0.4000	0.76	0.041	5%	2.065	272%
P038	0.67	0.4000	0.76	0.041	5%	2.065	272%
P039	0.83	1.2849	2.45	0.041	2%	2.196	90%
P040	0.83	1.3050	2.49	0.041	2%	2.196	88%
P041	0.83	2.1999	3.20	0.041	1%	2.196	69%
P042	0.83	2.0498	3.12	0.041	1%	2.099	67%
P043	0.83	1.5029	2.67	0.041	2%	2.101	79%
P044	0.83	1.2971	2.48	0.041	2%	2.108	85%
P045	0.83	1.2657	2.45	0.041	2%	2.128	87%
P046	0.83	1.5366	2.70	0.041	2%	2.174	80%
P047	0.83	1.2000	2.39	0.041	2%	2.215	93%
P048	0.83	1.9600	3.05	0.042	1%	2.093	69%
P049	0.83	1.9700	3.06	0.049	2%	2.093	68%
P050	0.83	1.9371	3.03	0.040	1%	2.096	69%
P051	~~0.83~~	0.3984	1.38	0.040	3%	2.096	~~152%~~
P052	1.50	0.1047	3.39	0.541	16%	2.180	64%
P053	1.50	0.3863	6.51	0.541	8%	2.180	33%
P054A	1.50	5.0000	Siphon	0.541		2.180	
P054B	1.50	-70.6666	Siphon	0.541		2.180	
P054C	1.50	0.3647	Siphon	0.541		2.180	
P054D	1.50	80.0000	Siphon	0.541		2.180	
P055	1.50	0.1247	3.70	0.530	14%	2.166	59%
P056	1.50	0.1178	3.60	0.531	15%	2.167	60%
P057	1.50	0.1201	3.63	0.531	15%	2.168	60%
P058	1.50	0.2250	4.97	0.267	5%	1.452	29%
P059	1.50	0.2250	4.97	0.269	5%	1.452	29%
P060	1.50	0.2222	4.94	0.269	5%	1.453	29%
P061	1.50	0.2234	4.95	0.269	5%	1.453	29%
P062	1.50	0.2244	4.96	0.269	5%	1.454	29%
P063	1.50	0.2201	4.92	0.269	5%	1.455	30%
P064	1.50	0.2188	4.90	0.269	5%	1.455	30%
P065	1.50	0.2198	4.91	0.269	5%	1.456	30%
P066	1.50	0.2202	4.92	0.270	5%	1.457	30%
P067	1.50	0.2202	4.92	0.270	5%	1.459	30%
P068	1.50	0.2188	4.90	0.271	6%	1.460	30%
P069	1.00	0.3555	2.12	0.068	3%	0.107	5%
P070	0.83	0.9928	2.17	0.068	3%	0.107	5%
P071	0.83	1.3006	2.48	0.068	3%	0.107	4%
P072	1.00	0.3490	2.10	0.068	3%	0.107	5%
P073	1.00	0.3282	2.03	0.068	3%	0.107	5%
P074	1.00	0.3483	2.09	0.068	3%	0.107	5%
P075	1.00	0.3512	2.10	0.068	3%	0.107	5%
P076	1.00	0.3486	2.10	0.068	3%	0.107	5%
P077	1.00	0.3507	2.10	0.069	3%	0.107	5%
P078	1.00	0.0523	0.81	0.069	8%	0.107	13%
P079	0.67	0.3477	0.71	0.069	10%	0.108	15%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Year 2020 Estimated Peak Flow (cfs)	Year 2020 Estimated % Full
P080	0.67	0.3490	0.71	0.069	10%	0.108	15%
P081	1.25	0.4198	4.17	0.262	6%	0.388	9%
P082	1.25	0.0781	1.80	0.025	1%	0.125	7%
P083	1.50	0.2034	4.73	0.026	1%	0.126	3%
P084	1.25	0.3252	3.67	0.026	1%	0.127	3%
P085	1.25	3.5714	12.17	0.000	0%	0.000	0%
P086	1.25	5.3571	14.90	2.068	14%	2.722	18%
P087	1.25	0.2003	2.88	2.068	72%	2.722	94%
P088	1.25	0.2010	2.89	2.069	72%	2.723	94%
P089	1.25	0.2002	2.88	2.070	72%	2.725	95%
P090	1.00	1.0000	3.55	0.613	17%	1.020	29%
P091	1.00	2.1527	5.21	0.613	12%	1.020	20%
P092	1.00	0.4386	2.35	0.613	26%	1.021	43%
P093	1.00	0.0744	0.97	0.228	24%	0.293	30%
P095	0.83	0.5896	1.67	0.232	14%	1.257	75%
P096	0.67	0.4000	0.76	0.232	31%	1.257	18" 166%
P097	0.67	0.4000	0.76	0.233	31%	1.257	18" 166%
P098	0.67	0.4000	0.76	0.207	27%	1.136	18" 150%
P099	0.67	1.0000	1.20	0.208	17%	1.137	95%
P100	0.67	1.6871	1.56	0.208	13%	1.140	73%
P101	0.67	1.3613	1.40	0.208	15%	1.170	84%
P102	0.67	1.8871	1.65	0.209	13%	1.175	71%
P103	0.67	1.9091	1.66	0.209	13%	1.176	71%
P104	1.00	0.9907	3.53	0.209	6%	1.176	33%
P139	2.50	0.4357	27.05	3.072	11%	11.086	41%
P140	3.00	0.8270	60.64	3.251	5%	11.344	19%
P141	3.00	0.1823	28.47	3.244	11%	11.343	40%
P142	3.00	0.2380	32.53	3.234	10%	11.335	35%
P143	3.00	0.2156	30.97	9.844	32%	19.928	64%
P144	3.00	0.2260	31.70	9.841	31%	19.927	63%
P145	3.00	0.2273	31.79	9.837	31%	19.927	63%
P146	3.00	0.2268	31.76	9.830	31%	19.927	63%
P147	3.00	0.2277	31.82	9.825	31%	19.926	63%
P148	3.00	0.2271	31.78	9.823	31%	19.926	63%
P149	3.00	0.2268	31.76	9.820	31%	19.925	63%
P150	3.00	0.2275	31.81	9.817	31%	19.925	63%
P151	3.00	0.2279	31.83	9.815	31%	19.925	63%
P152	3.00	0.2271	31.78	9.829	31%	19.940	63%
P153	3.00	0.2262	31.72	9.827	31%	19.940	63%
P154	3.00	0.2271	31.78	9.823	31%	19.939	63%
P155	3.00	0.2266	31.74	9.820	31%	19.938	63%
P156	3.00	0.1629	26.92	9.818	36%	19.938	74%
P157	3.00	0.4996	47.14	10.127	21%	20.303	43%
P158	3.00	0.2464	33.10	10.126	31%	20.303	61%
P159	2.50	0.6132	32.09	7.625	24%	15.488	48%
P160	2.50	0.6115	32.05	7.624	24%	15.488	48%
P161	2.75	0.3653	31.95	7.624	24%	15.488	48%
P162	2.75	0.3679	32.06	7.624	24%	15.488	48%
P163	2.75	0.3685	32.09	7.623	24%	15.488	48%
P164	2.75	0.3679	32.06	7.623	24%	15.488	48%
P165	2.75	0.3677	32.05	7.623	24%	15.488	48%
P166	2.75	0.3679	32.06	7.623	24%	15.488	48%
P167	2.75	0.3691	32.11	7.623	24%	15.488	48%
P168	2.75	0.3632	31.86	7.623	24%	15.488	49%
P169	2.75	0.3732	32.29	7.622	24%	15.488	48%

Table 7-1
Sewer Analysis Results (Existing and Future Conditions)

Name	Diameter, ft	Slope (%)	Theoretical "Full" Flow (cfs)	Existing Estimated Peak Flow (cfs)	Existing Estimated % Full	Year 2020 Estimated Peak Flow (cfs)	Year 2020 Estimated % Full
P170	2.75	0.3624	31.82	7.622	24%	15.488	49%
P171	2.75	0.2300	25.35	7.621	30%	15.488	61%
P172	1.50	0.2445	5.18	0.262	5%	0.388	7%
P173	1.50	0.2217	4.93	0.228	5%	0.299	6%
P174	1.50	0.2860	5.60	0.294	5%	0.370	7%
P175	1.50	0.0951	3.23	0.294	9%	0.370	11%
P176	1.50	0.3737	6.41	0.294	5%	0.370	6%
P177	1.50	0.1304	3.78	0.294	8%	0.370	10%
P178	1.50	0.3784	6.45	0.294	5%	0.370	6%
P179	1.50	0.2036	4.73	0.294	6%	0.370	8%
P180	1.50	0.2028	4.72	0.293	6%	0.369	8%
P181	1.50	0.3143	5.87	0.295	5%	0.371	6%
P182	1.50	0.2929	5.67	0.295	5%	0.371	7%
P183	1.50	0.3005	5.74	0.295	5%	0.371	6%
P184	1.50	0.3004	5.74	0.295	5%	0.371	6%
P185	1.50	0.3001	5.74	0.295	5%	0.371	6%
P186	1.50	0.2996	5.74	0.358	6%	0.434	8%
P187	1.50	0.3000	5.74	0.358	6%	0.434	8%
P188	1.50	0.2950	5.69	0.358	6%	0.434	8%
P189	1.50	0.3013	5.75	0.358	6%	0.434	8%
P190	1.50	0.2967	5.71	0.36	6%	0.434	8%
P191	1.50	0.2950	5.69	0.36	6%	0.434	8%
P192	1.50	0.3049	5.79	0.36	6%	0.433	7%
P193	1.50	0.2999	5.74	0.36	6%	0.433	8%
P194	1.50	0.2999	5.74	0.36	6%	0.433	8%
P195	1.50	0.3439	6.14	0.36	6%	0.433	7%
P196	1.50	0.2921	5.66	2.50	44%	4.815	85%
P197	1.50	0.3000	5.74	2.50	44%	4.815	84%
P198	1.50	0.3010	5.75	2.50	43%	4.815	84%
P199	1.50	0.5198	7.55	2.50	33%	4.815	64%
P200	1.50	0.5210	7.56	2.50	33%	4.815	64%
P201	1.50	0.2984	5.72	2.50	44%	4.815	84%
P202	1.50	0.3004	5.74	2.50	44%	4.815	84%
P203	1.50	0.3354	6.07	2.50	41%	4.815	79%
P204	1.50	0.3174	5.90	2.50	42%	4.815	82%
P205	1.50	0.3018	5.76	2.50	43%	4.815	84%
P206	1.50	0.2993	5.73	2.50	44%	4.81	84%
P207	1.50	0.2988	5.73	2.50	44%	4.81	84%
P208	1.50	0.3010	5.75	2.50	43%	4.81	84%
P209	1.50	0.6407	8.39	2.50	30%	4.81	57%
P210	1.50	0.2993	5.73	2.50	44%	4.81	84%
P211	1.50	0.2994	5.73	2.50	44%	4.81	84%

7.0 DEFICIENCIES AND SOLUTIONS

7.1 Deficient and Marginally Deficient Pipes

The Computer model simulations of the City's wastewater system have evaluated pipe reaches in terms of both volume and velocity criteria.

The City's design criterion for sewer lines allows pipes to flow at a ratio of 75% of "full" hydraulic capacity. Assuming that "full" capacity is the maximum hydraulic capacity of a pipe flowing under gravity (non-pressure) conditions, Manning's equation shows that maximum flow occurs when a pipe reaches a flow depth ratio of about 95% depth/diameter (d/D). For the purpose of this study, pipes flowing at 90% or greater capacity are considered "deficient", and pipes flowing at greater than 75% and less than 90% are considered "marginally deficient".

Pipe reaches which fail the "75% full" volume criterion for both existing and future flow conditions are shown in Table 7-2 and Figures 15 and 17. It is seen that under existing flow conditions none of the pipes in the system flow greater than 90% full. At ultimate conditions (year 2020) some of the reaches flow greater than 90% full and some greater than 75% full.

A velocity more than 10 feet per second is considered to be the threshold for scouring. The pipes having a maximum velocity of more than 10 feet per second are considered "deficient" in velocity, due to the potential erosion of the interiors of pipe walls over time. A velocity less than 2 feet per second is not considered self- cleansing and pipe reaches that have a maximum flow velocity less than 2 feet per second under existing flow conditions are also considered "deficient" in velocity. These pipes are shown in Figure 16.

7.2 Project Prioritization Methodology

The 75% full criterion is useful for analyzing deficient pipes and as a basis for sizing new facilities. However, the criterion is not necessarily the trigger point for replacement or augmentation of an existing sewer line. In most cases, a sewer entity would not implement a relief project until capacity problems are actually observed or known to be imminent.

A recommended system of project prioritization is the categorization of deficient sewer lines based on modeled % full results. The "A" priority projects are imminently needed and the "B" and "C" projects require further consideration for replacement. Priority classifications are described as follows:

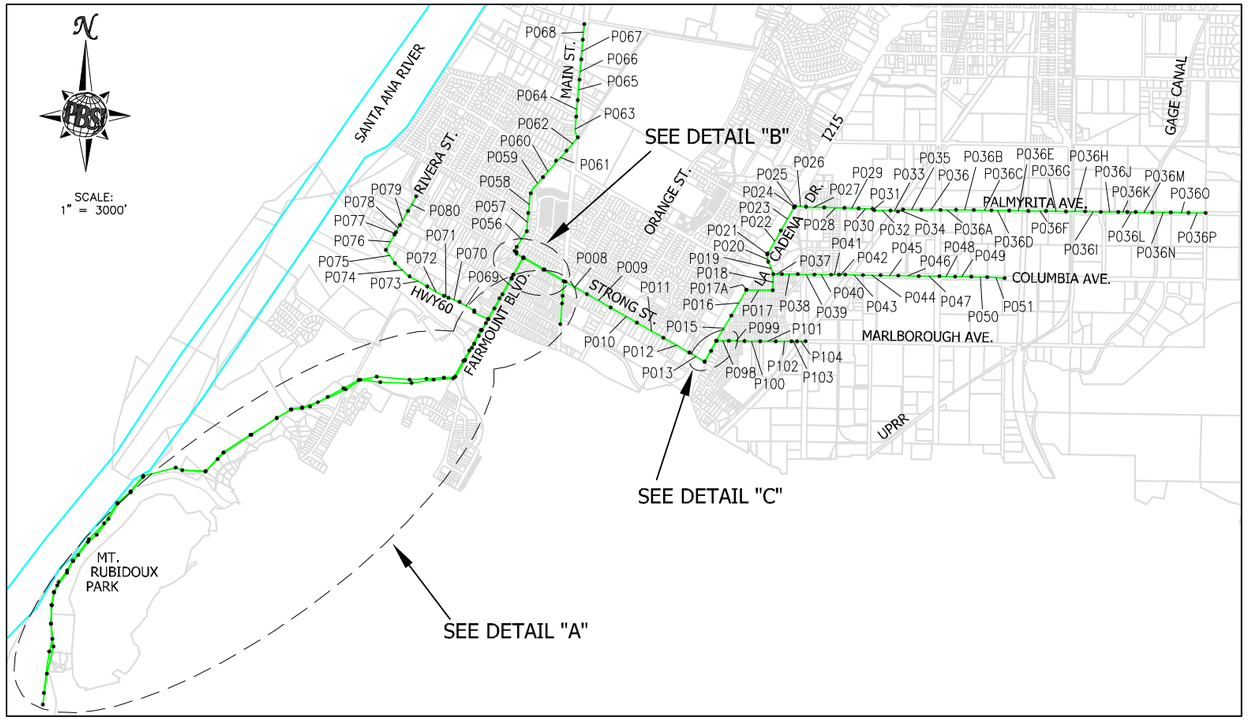
Priority "A" – The pipes listed within this priority are currently flowing more than 90% full under the maximum flow condition. Modeled results indicate that there are no pipes that are currently flowing more than 90% full.

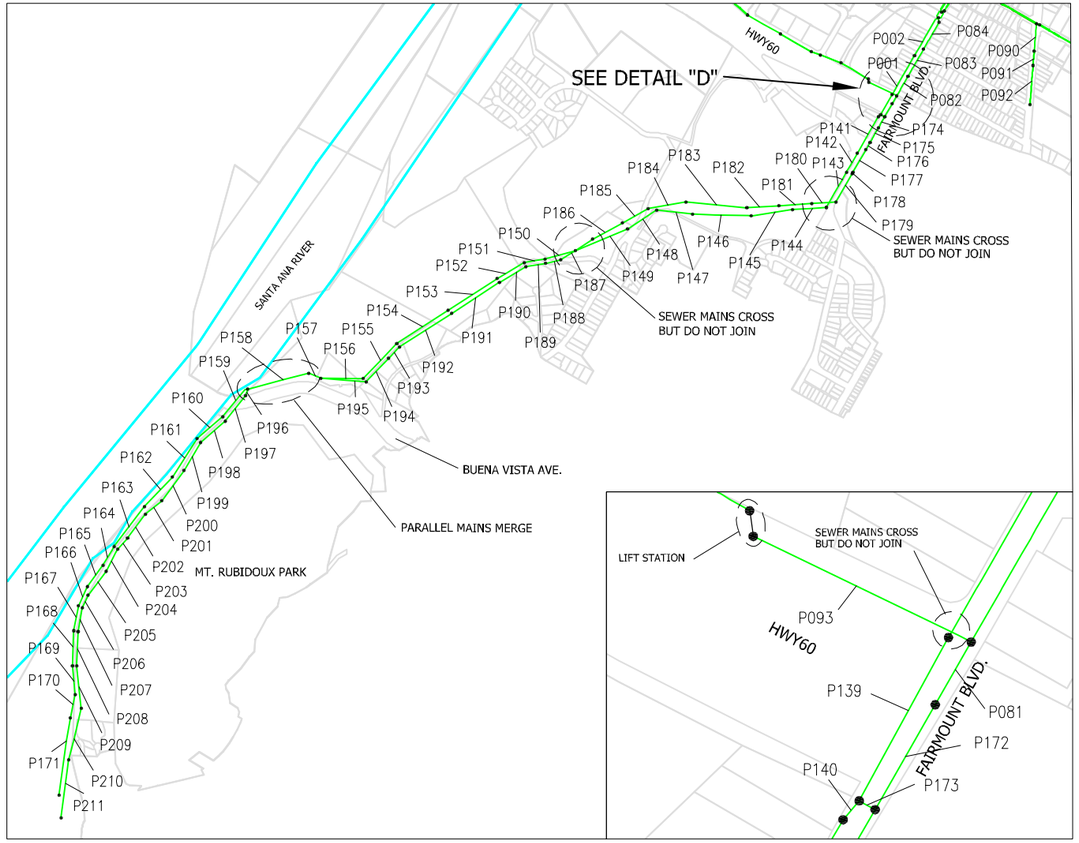
Priority "B" – The pipes listed in this priority are projected to be flowing more than 90% full in the future under estimated maximum flow conditions. A linear interpolation was done for anticipation of the mid-term flow in pipes between year 2005 and ultimate year (2020). The pipes that would be flowing more than 90% full in the year 2015 are placed under priority "B". These pipes need evaluation as new development takes place in the tributary areas. Flow monitoring within the study area should be considered for observation of actual flows. The pipes under this priority are grouped for replacement/re-habilitation in the period (2011-2015).

Priority "C" – The pipes listed in this priority would be flowing more than 75% full in the future under estimated maximum flow conditions. The pipes that are not part of priority "A" and "B" and will flow more than 75% full by the year 2020 are considered as priority "C". These pipes need evaluation as new development takes place in the tributary areas. These may or may not be replaced or paralleled depending on actual observed flow conditions in the future. Flow monitoring within the study area should be considered when significant development occurs. The pipes under this priority are grouped for possible replacement/re-habilitation in the period (2016-2020).

7.3 Recommended Improvements

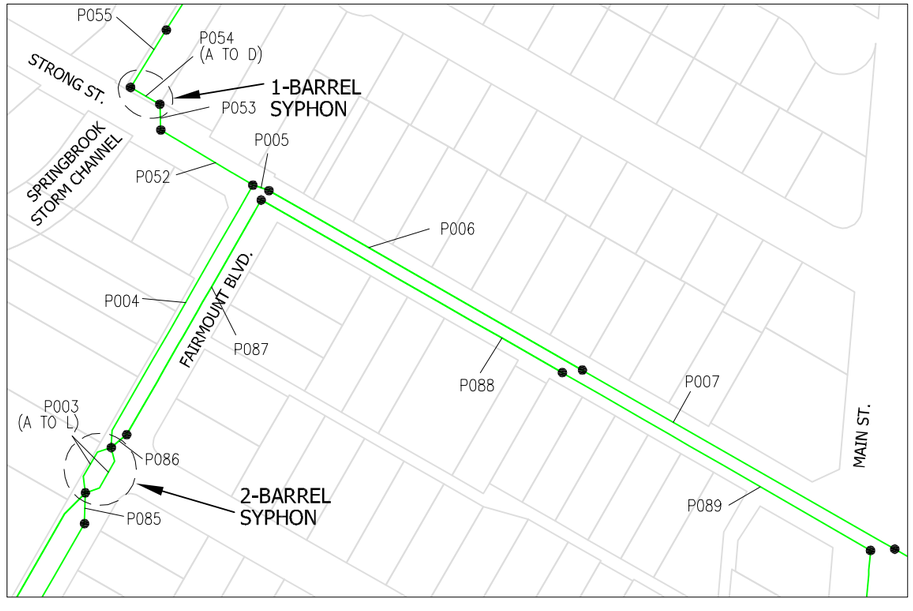
Table 7.3 lists project priority, project location, problem, solution and approximate cost for problem reaches. This table identifies future problems in the sewer lines and suggested solutions. The project cost is based on year 2005 indices.



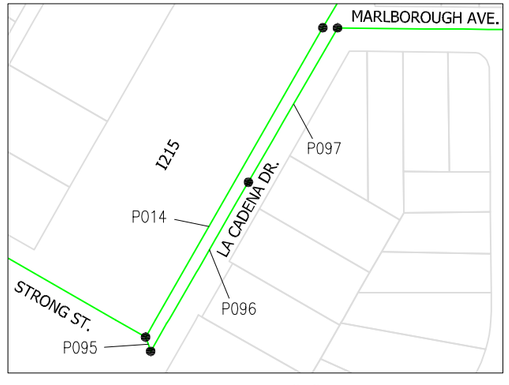


DETAIL "A"
NTS

DETAIL "D"
NTS



DETAIL "B"
NTS



DETAIL "C"
NTS

LEGEND

GRAVITY SEWER

P001 PIPE SEGMENT NUMBER

NO PIPE IS DEFICIENT IN CAPACITY
UNDER EXISTING FLOW CONDITIONS

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

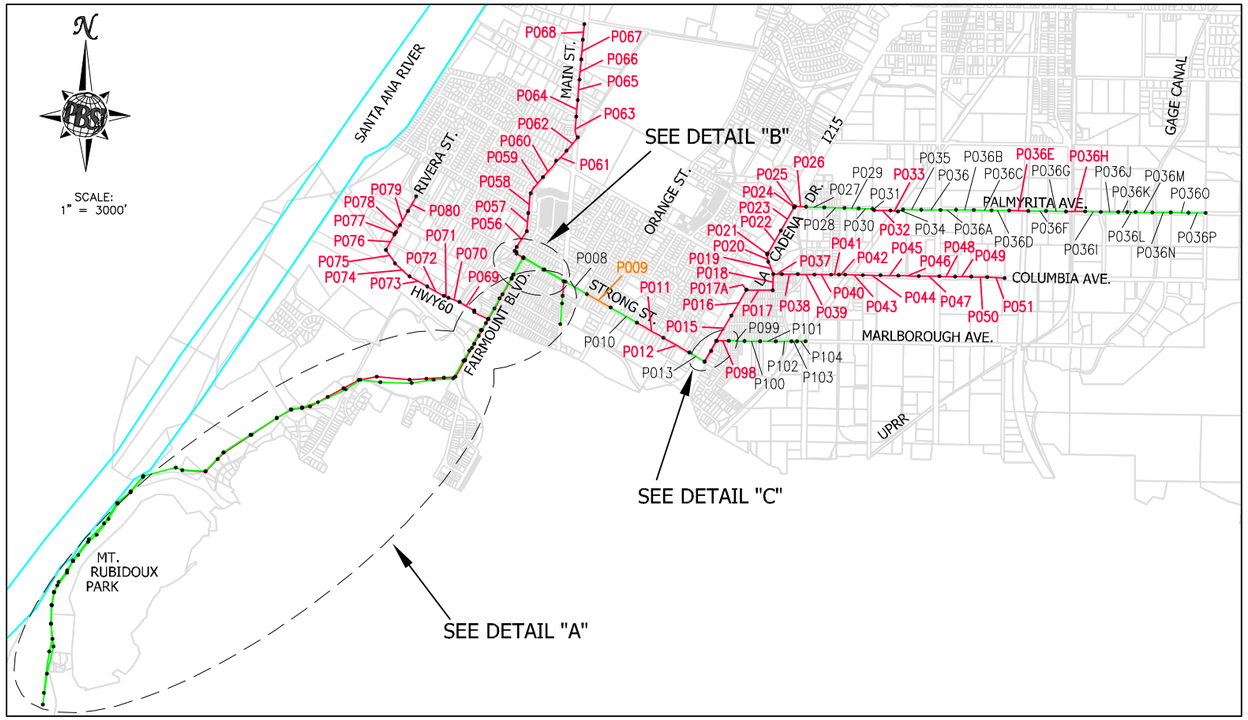
DATE: 01/04/06 | DWN BY: CD

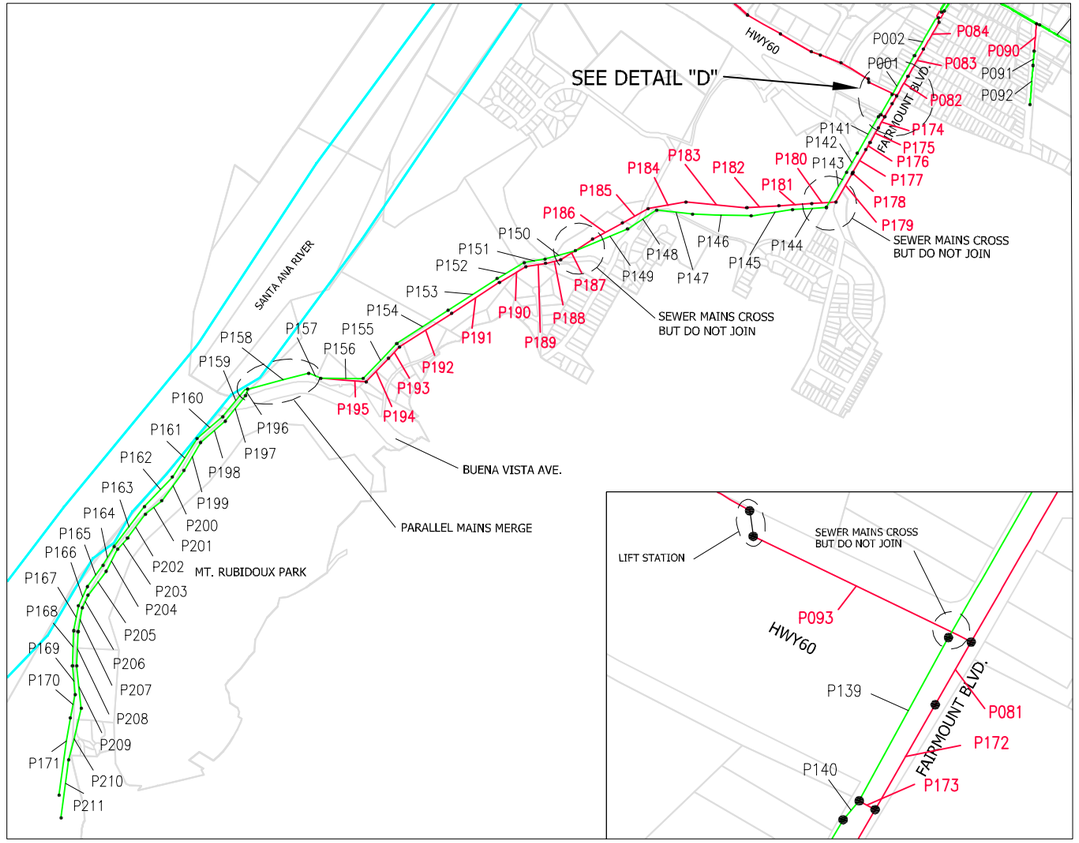
CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 15

EXISTING VOLUME DEFICIENCIES

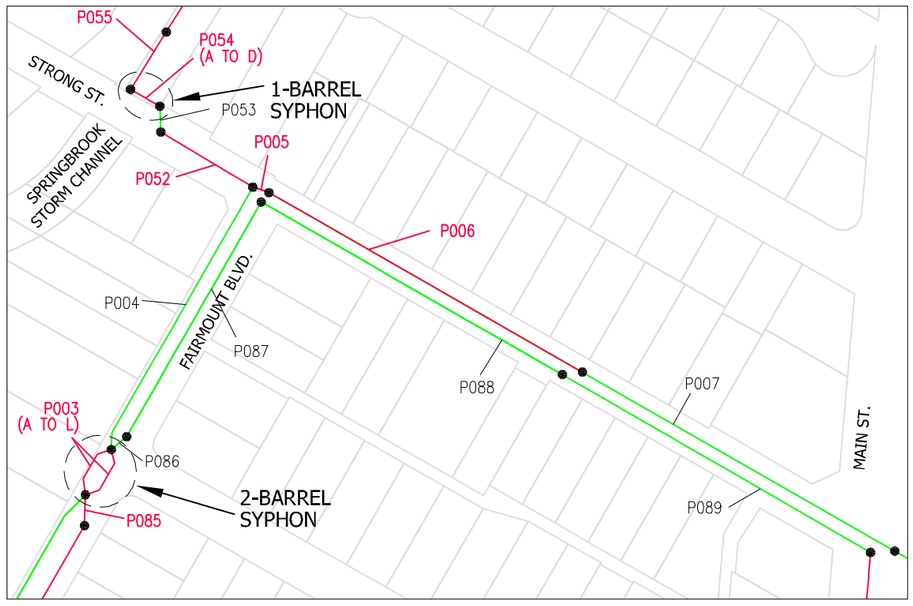
Y:\City of Riverside\Northside\DWG\Exhibits\NS-VolumeDeficient.dwg, 9/28/2006 9:23:34 AM



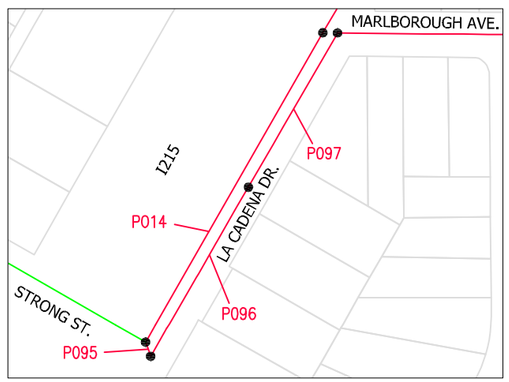


DETAIL "A"
NTS

DETAIL "D"
NTS



DETAIL "B"
NTS



DETAIL "C"
NTS

LEGEND

- GRAVITY SEWER
- VELOCITY > 10 FPS
- VELOCITY < 2 FPS
- P001 PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

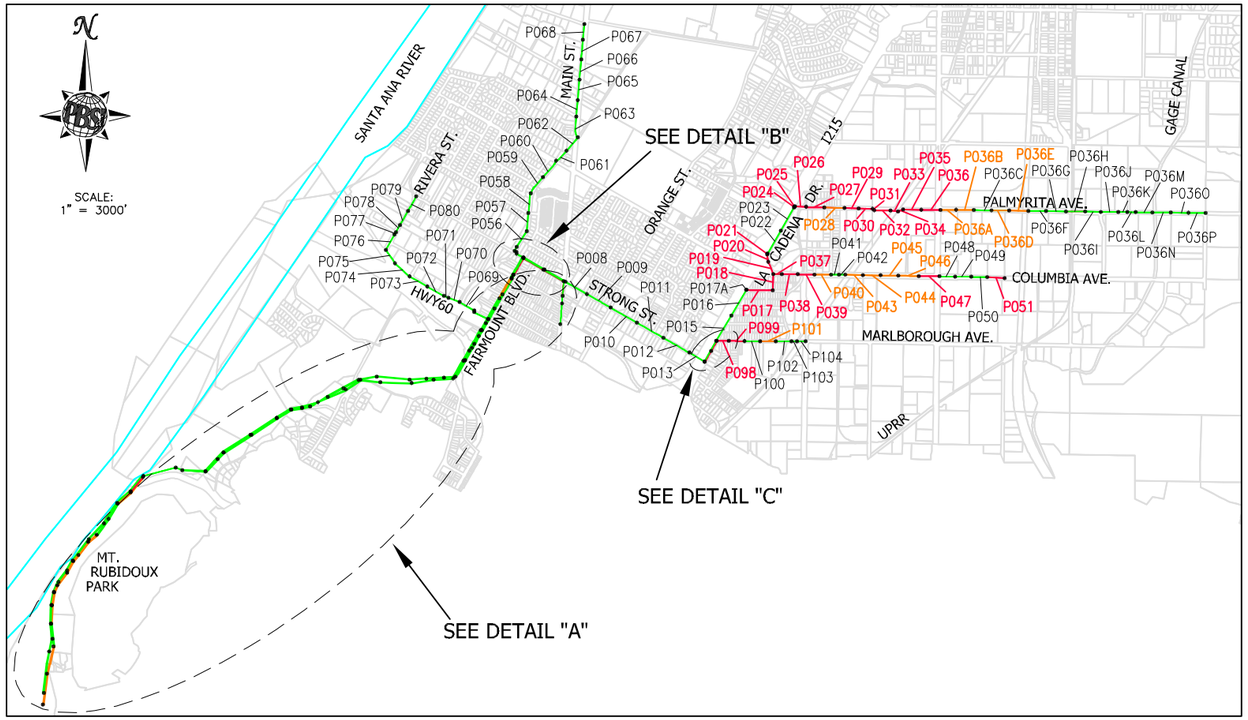
DATE: 01/04/06 | DWN BY: CD

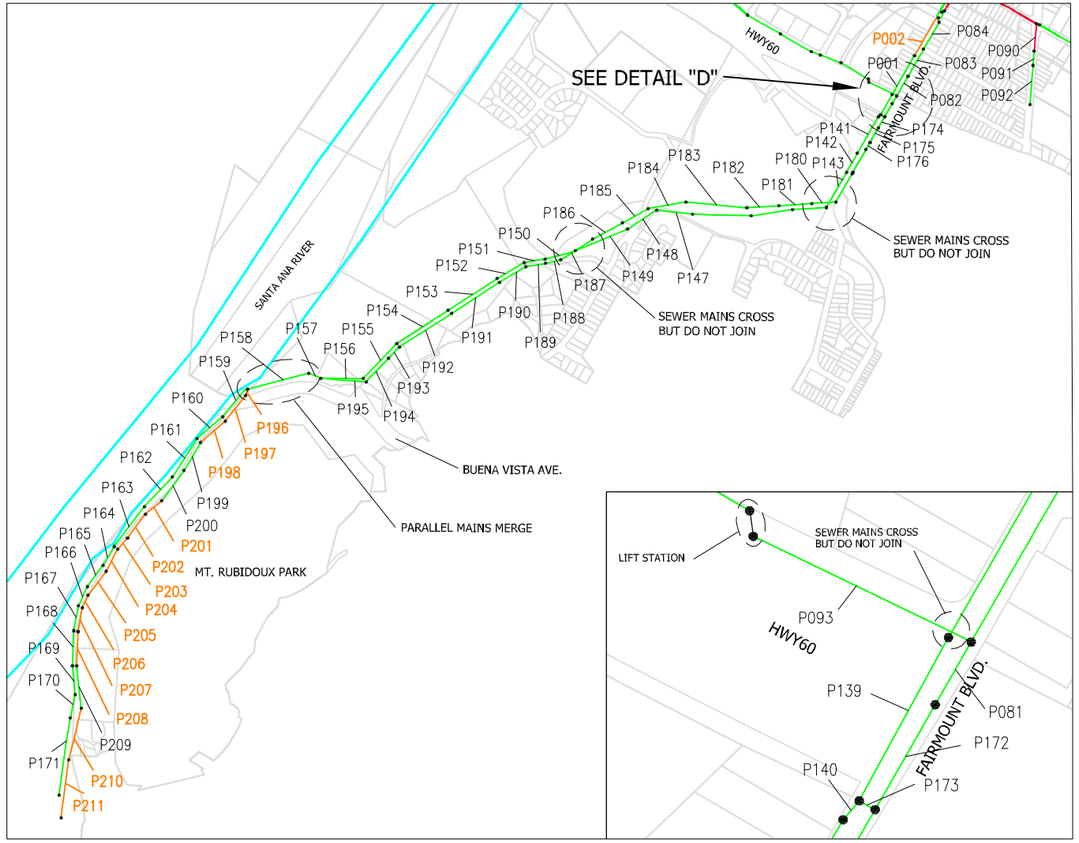
CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 16

EXISTING VELOCITY DEFICIENCIES

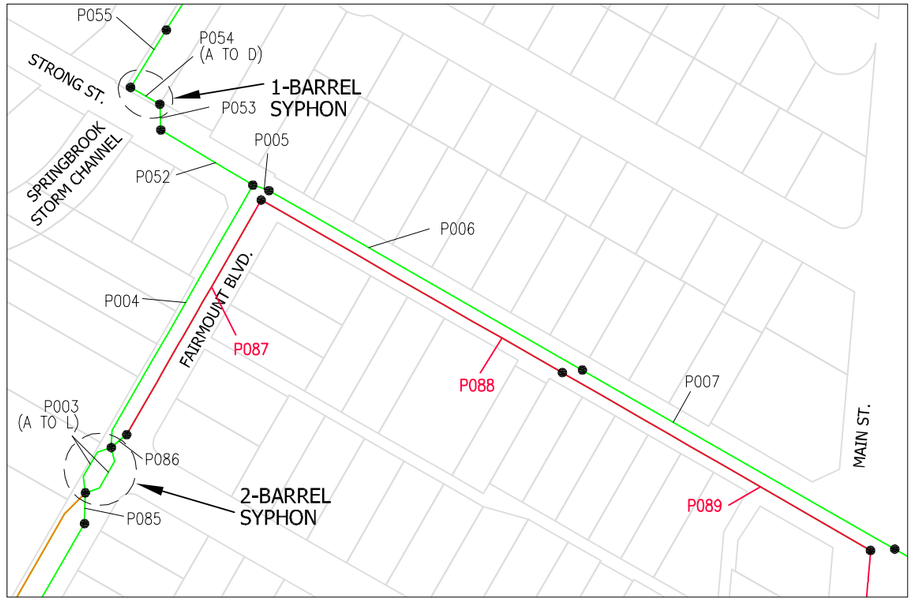
Y:\City of Riverside\Northside\DWG\Exhibits\NS-VelocityDeficient.dwg, 9/28/2006 9:22:12 AM



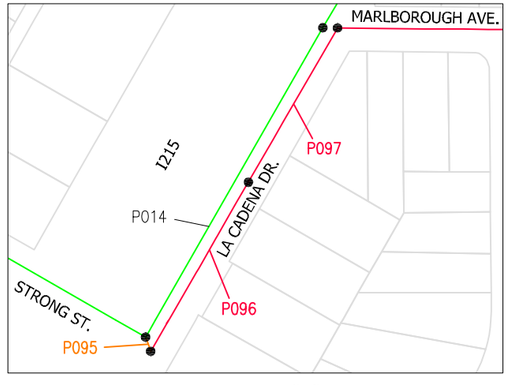


DETAIL "A"
NTS

DETAIL "D"
NTS



DETAIL "B"
NTS



DETAIL "C"
NTS

LEGEND

- VOLUME ≤ 75 % FULL
- VOLUME > 75 < 90 % FULL
- VOLUME ≥ 90 % FULL
- P001 PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 01/04/06 | DWN BY: CD

CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 17

ULTIMATE VOLUME DEFICIENCIES

Y:\City of Riverside\Northside\DWG\Exhibits\NS-UltVolumeDeficient.dwg, 9/28/2006 9:21:00 AM

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (Inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (Inch)	New % Full (Year 2020)	Approximate Replacement Period
P001	473	27	20.39%	55.56%	73.16%				
P002	465	27	24.50%	65.04%	85.32%	C	30	64%	2016-2020
P003A	6	27							
P003B	7	27							
P003C	10	27							
P003D	25	27							
P003E	13	27							
P003F	6	27							
P003G	6	15							
P003H	13	15							
P003I	25	15							
P003J	10	15							
P003K	7	15							
P003L	6	15							
P004	391	27	5.16%	36.37%	51.97%				
P005	15	27	2.68%	25.55%	36.99%				
P006	473	24	2.95%	32.72%	47.62%				
P007	475	24	2.95%	32.71%	47.59%				
P008	495	21	2.60%	28.83%	41.95%				
P009	534	21	1.38%	15.32%	22.29%				
P010	606	21	1.85%	20.55%	29.91%				
P011	600	27	2.50%	27.72%	40.34%				
P012	590	27	2.51%	27.71%	40.31%				
P013	373	27	1.91%	21.08%	30.66%				
P014	466	27	0.98%	17.70%	26.06%				
P015	584	24	1.42%	25.55%	37.62%				
P016	585	24	1.42%	25.53%	37.59%				
P017	520	15	5.89%	105.73%	155.67%	B	21	63%	2011-2015
P017A	7	21	1.40%	25.07%	36.91%				
P018	331	15	5.89%	105.52%	155.36%	B	21	63%	2011-2015
P019	256	10	8.55%	157.12%	231.42%	B	18	48%	2011-2015
P020	147	10	8.54%	156.89%	231.09%	B	18	48%	2011-2015
P021	18	10	6.73%	123.61%	182.07%	B	15	62%	2011-2015
P022	525	21	1.25%	23.00%	33.87%				
P023	527	21	1.26%	36.89%	54.72%				
P024	23	10	22.86%	671.27%	995.57%	B	30	53%	2011-2015
P025	7	15	5.15%	83.92%	123.31%	B	24	35%	2011-2015
P026	219	12	2.97%	61.36%	90.56%	B**	18	31%	2011-2015
P027	367	12	2.97%	61.29%	90.46%	B**	15	50%	2011-2015
P028	396	12	2.82%	58.09%	85.73%	B**	15	47%	2011-2015
P029	279	12	2.80%	68.72%	101.69%	B**	15	56%	2011-2015
P030	276	12	2.83%	69.32%	102.57%	B**	15	57%	2011-2015
P031	37	12	2.78%	68.13%	100.81%	B**	15	56%	2011-2015
P032	326	12	3.37%	82.78%	122.49%	B**	18	41%	2011-2015
P033	129	12	3.37%	82.78%	122.50%	B**	18	41%	2011-2015
P034	97	12	2.67%	65.55%	97.00%	B**	15	53%	2011-2015
P035	360	12	2.71%	66.43%	98.30%	B**	15	54%	2011-2015
P036	381	12	2.70%	66.26%	98.04%	B**	15	54%	2011-2015
P036A	315	10	1.78%	54.46%	80.80%	B**	12	50%	2011-2015
P036B	350	10	1.74%	53.34%	79.15%	B**	12	49%	2011-2015
P036C	350	10	1.61%	49.87%	74.01%				
P036D	350	10	1.62%	50.26%	74.58%				
P036E	375	10	1.86%	57.97%	86.03%	B**	12	53%	2011-2015
P036F	350	10	1.46%	45.34%	67.29%				
P036G	396	10	1.60%	49.87%	74.01%				
P036H	381	10	1.50%	46.44%	68.92%				
P036I	309	10	1.50%	46.45%	68.93%				
P036J	341	10	1.51%	46.72%	69.33%				
P036K	182	10	1.51%	46.86%	69.54%				
P036L	163	10	1.52%	47.10%	69.90%				
P036M	341	10	1.50%	46.48%	68.97%				
P036N	341	10	1.60%	49.56%	73.55%				
P036O	341	10	1.60%	49.57%	73.57%				
P036P	339	10	1.61%	49.64%	73.66%				

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P037	169	8	5.38%	183.29%	272.28%	B	15	51%	2011-2015
P038	315	8	5.38%	183.29%	272.27%	B*	15	51%	2011-2015
P039	319	10	1.69%	60.39%	89.76%	C	12	55%	2016-2020
P040	330	10	1.66%	59.35%	88.21%	C	12	54%	2016-2020
P041	159	10	1.29%	46.17%	68.61%				
P042	121	10	1.33%	45.29%	67.28%				
P043	350	10	1.55%	52.95%	78.66%	C	12	48%	2016-2020
P044	350	10	1.67%	57.18%	84.94%	C	12	52%	2016-2020
P045	350	10	1.69%	58.42%	86.80%	C	12	53%	2016-2020
P046	410	10	1.53%	54.17%	80.50%	C	12	49%	2016-2020
P047	402	10	1.74%	62.44%	92.79%	C	12	57%	2016-2020
P048	315	10	1.37%	46.19%	68.61%	C	12	42%	2016-2020
P049	319	10	1.61%	46.17%	68.45%				
P050	315	10	1.31%	46.51%	69.12%				
P051	351	10	2.89%	102.54%	152.39%	C*	15	52%	2016-2020
P052	162	18	15.95%	48.16%	64.27%				
P053	36	18	8.31%	25.08%	33.47%				
P054A	2	18							
P054B	8	18							
P054C	30	18							
P054D	8	18							
P055	88	18	14.33%	43.81%	58.55%				
P056	365	18	14.76%	45.08%	60.25%				
P057	358	18	14.63%	44.67%	59.69%				
P058	400	18	5.37%	21.26%	29.21%				
P059	400	18	5.40%	21.28%	29.22%				
P060	414	18	5.44%	21.42%	29.41%				
P061	291	18	5.43%	21.37%	29.34%				
P062	343	18	5.42%	21.33%	29.29%				
P063	423	18	5.48%	21.55%	29.59%				
P064	320	18	5.50%	21.63%	29.69%				
P065	410	18	5.48%	21.59%	29.64%				
P066	395	18	5.49%	21.59%	29.64%				
P067	395	18	5.50%	21.61%	29.66%				
P068	315	18	5.52%	21.70%	29.79%				
P069	301	12	3.22%	4.44%	5.05%				
P070	243	10	3.14%	4.33%	4.92%				
P071	132	10	2.75%	3.78%	4.30%				
P072	375	12	3.26%	4.49%	5.10%				
P073	375	12	3.36%	4.63%	5.26%				
P074	365	12	3.27%	4.50%	5.12%				
P075	336	12	3.26%	4.48%	5.10%				
P076	350	12	3.27%	4.50%	5.12%				
P077	60	12	3.26%	4.50%	5.11%				
P078	153	12	8.46%	11.65%	13.25%				
P079	325	8	9.71%	13.38%	15.21%				
P080	321	8	9.73%	13.39%	15.23%				
P081	95	15	6.28%	8.29%	9.29%				
P082	333	15	1.41%	5.12%	6.97%				
P083	329	18	0.54%	1.96%	2.67%				
P084	357	15	0.70%	2.53%	3.45%				
P085	13	15	0.00%	0.00%	0.00%				
P086	13	15	13.88%	16.80%	18.26%				
P087	400	15	71.77%	86.89%	94.46%	C	18	58%	2016-2020
P088	458	15	71.67%	86.76%	94.32%	C	18	58%	2016-2020
P089	465	15	71.85%	87.01%	94.60%	C	18	58%	2016-2020
P090	284	12	17.26%	24.92%	28.75%				
P091	131	12	11.76%	16.98%	19.59%				
P092	415	12	26.07%	37.64%	43.43%				
P093	309	12	23.52%	27.99%	30.23%				
P095	8	10	13.88%	54.70%	75.11%	B*	12	46%	2011-2015
P096	235	8	30.64%	120.69%	165.73%	B	12	56%	2011-2015
P097	235	8	30.69%	120.72%	165.75%	B	12	56%	2011-2015
P098	238	8	27.36%	109.00%	149.82%	B	12	51%	2011-2015

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P099	310	8	17.32%	68.99%	94.84%	C	10	53%	2016-2020
P100	310	8	13.37%	53.25%	73.20%				
P101	310	8	14.89%	60.74%	83.68%	C	10	46%	2016-2020
P102	310	8	12.66%	51.77%	71.33%				
P103	110	8	12.60%	51.51%	70.97%				
P104	171	12	5.91%	24.16%	33.29%				
P139	246	30	11.36%	31.11%	40.98%				
P140	16	36	5.36%	14.26%	18.71%				
P141	466	36	11.39%	30.36%	39.84%				
P142	218	36	9.94%	26.54%	34.84%				
P143	403	36	31.79%	53.50%	64.36%				
P144	389	36	31.04%	52.25%	62.86%				
P145	440	36	30.94%	52.10%	62.68%				
P146	617	36	30.96%	52.15%	62.75%				
P147	400	36	30.88%	52.04%	62.62%				
P148	348	36	30.91%	52.11%	62.71%				
P149	604	36	30.92%	52.13%	62.74%				
P150	334	36	30.86%	52.04%	62.64%				
P151	219	36	30.84%	52.01%	62.59%				
P152	326	36	30.93%	52.14%	62.75%				
P153	619	36	30.98%	52.24%	62.87%				
P154	638	36	30.91%	52.13%	62.74%				
P155	512	36	30.94%	52.19%	62.82%				
P156	460	36	36.48%	61.54%	74.07%				
P157	140	36	21.48%	35.88%	43.07%				
P158	666	36	30.59%	51.08%	61.33%				
P159	393	30	23.76%	40.09%	48.26%				
P160	357	30	23.79%	40.15%	48.33%				
P161	479	33	23.86%	40.27%	48.47%				
P162	432	33	23.78%	40.13%	48.31%				
P163	526	33	23.76%	40.09%	48.26%				
P164	228	33	23.77%	40.12%	48.30%				
P165	283	33	23.78%	40.14%	48.32%				
P166	217	33	23.77%	40.13%	48.30%				
P167	263	33	23.74%	40.06%	48.23%				
P168	369	33	23.93%	40.38%	48.61%				
P169	300	33	23.60%	39.84%	47.96%				
P170	257	33	23.95%	40.43%	48.67%				
P171	826	33	30.07%	50.75%	61.10%				
P172	160	18	5.05%	6.67%	7.48%				
P173	9	18	4.63%	5.58%	6.06%				
P174	133	18	5.25%	6.15%	6.60%				
P175	179	18	9.09%	10.66%	11.45%				
P176	88	18	4.59%	5.38%	5.78%				
P177	276	18	7.77%	9.11%	9.78%				
P178	19	18	4.56%	5.34%	5.74%				
P179	368	18	6.21%	7.28%	7.82%				
P180	222	18	6.22%	7.29%	7.83%				
P181	350	18	5.03%	5.89%	6.32%				
P182	338	18	5.21%	6.10%	6.55%				
P183	649	18	5.14%	6.02%	6.46%				
P184	366	18	5.14%	6.02%	6.46%				
P185	340	18	5.14%	6.02%	6.46%				
P186	357	18	6.25%	7.13%	7.57%				
P187	400	18	6.24%	7.12%	7.56%				
P188	159	18	6.29%	7.18%	7.62%				
P189	216	18	6.23%	7.10%	7.54%				
P190	330	18	6.27%	7.16%	7.60%				
P191	600	18	6.29%	7.18%	7.62%				
P192	656	18	6.19%	7.06%	7.49%				
P193	170	18	6.23%	7.11%	7.55%				
P194	343	18	6.23%	7.11%	7.55%				
P195	462	18	5.82%	6.64%	7.05%				
P196	21	18	44.15%	71.40%	85.02%	C	21	56%	2016-2020

Table 7-2
Proposed Construction Prioritization and Schedule

Pipe Name	Pipe Length (ft)	Existing Pipe Size (inch)	Existing Estimated % Full (Year 2005)	Year 2015 Estimated % Full	Future Estimated % Full (Year 2020)	Priority	New Diameter (inch)	New % Full (Year 2020)	Approximate Replacement Period
P197	391	18	43.56%	70.45%	83.90%	C	21	56%	2016-2020
P198	342	18	43.48%	70.33%	83.75%	C	21	55%	2016-2020
P199	350	18	33.09%	53.52%	63.74%				
P200	394	18	33.05%	53.46%	63.67%				
P201	218	18	43.66%	70.63%	84.12%	C	21	56%	2016-2020
P202	320	18	43.52%	70.39%	83.84%	C	21	56%	2016-2020
P203	161	18	41.18%	66.62%	79.34%	C	21	53%	2016-2020
P204	227	18	42.33%	68.48%	81.56%	C	21	54%	2016-2020
P205	315	18	43.41%	70.24%	83.65%	C	21	55%	2016-2020
P206	150	18	43.59%	70.52%	83.99%	C	21	56%	2016-2020
P207	261	18	43.62%	70.58%	84.06%	C	21	56%	2016-2020
P208	365	18	43.46%	70.31%	83.75%	C	21	55%	2016-2020
P209	451	18	29.78%	48.20%	57.41%				
P210	555	18	43.57%	70.52%	83.99%	C	21	56%	2016-2020
P211	618	18	43.55%	70.50%	83.98%	C	21	56%	2016-2020

* Placed under a different category due to geographical location.
** The proposed development affecting these pipelines is expected in the near future. So, these pipelines are placed under category "B".

7.4 Grouping of Projects

Proposed improvements under different priorities have been combined or grouped into projects to improve deficient and marginally deficient pipes based on following criteria:

Pipes identified as marginally deficient in near future (Priority "B"), and marginally deficient in more distant future (Priority "C") located geographically close to one another and requiring improvements, are grouped to reduce improvement costs.

It is anticipated that the proposed development of Spring Mountain Ranch and Springbrook Estates will be in the near future. This will increase flow in the pipes along Palmyrita Avenue, La Cadena Drive and downstream. Thus pipelines under priority "C" along this segment are placed in priority "B".

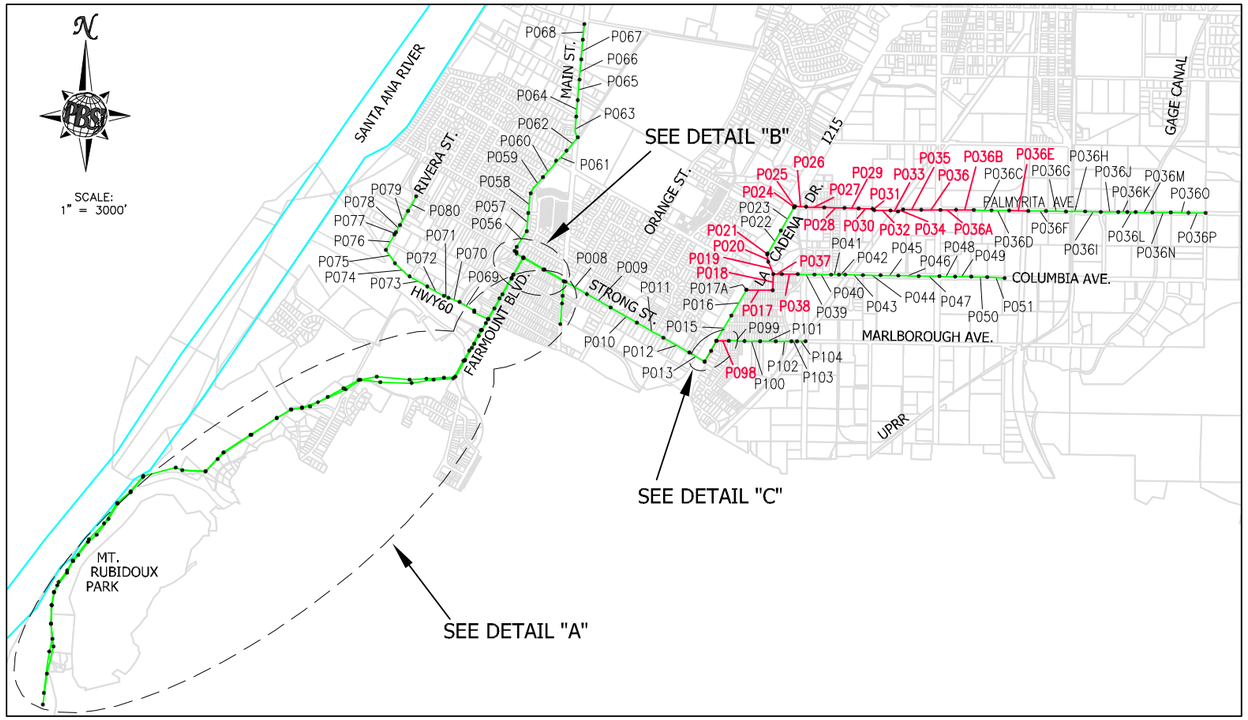
7.5 Construction Schedule

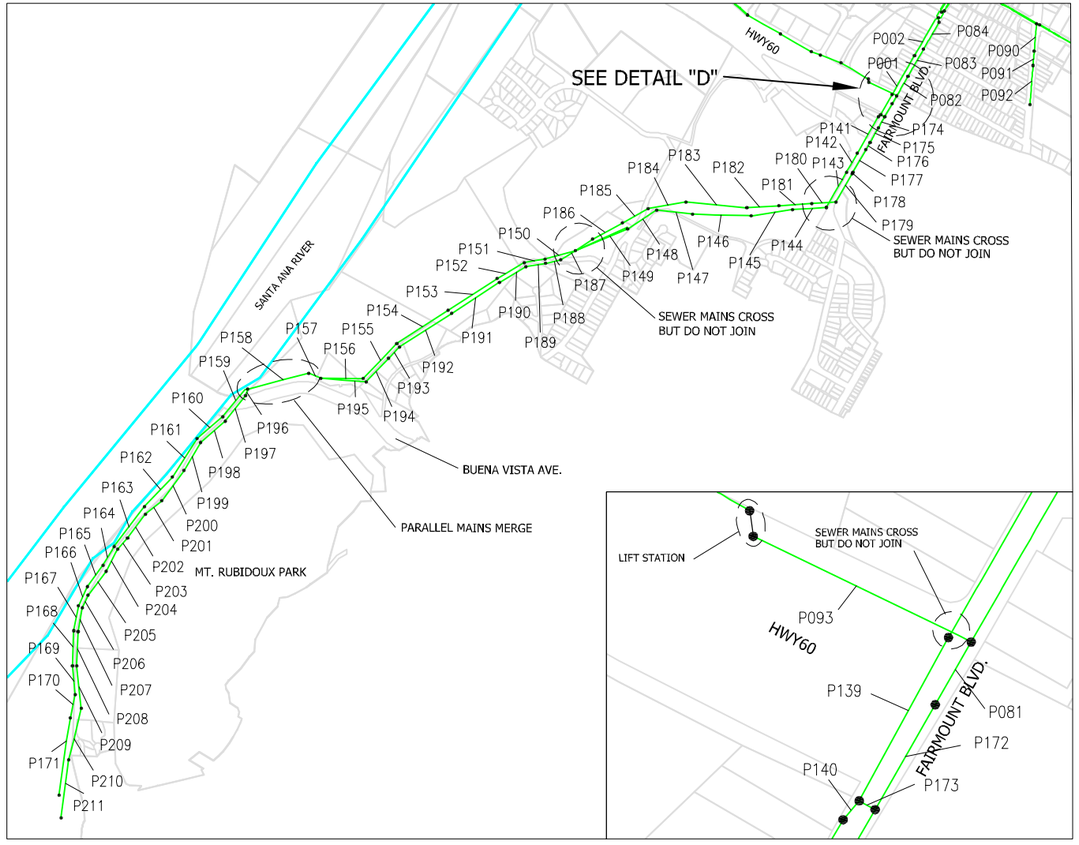
A summary of proposed construction prioritization and recommended scheduling is shown in Table 7-2. This table lists construction priorities and the year in which these activities are proposed. As previously discussed, the pipes included in priorities "B" and "C" will need re-evaluation before their replacement.

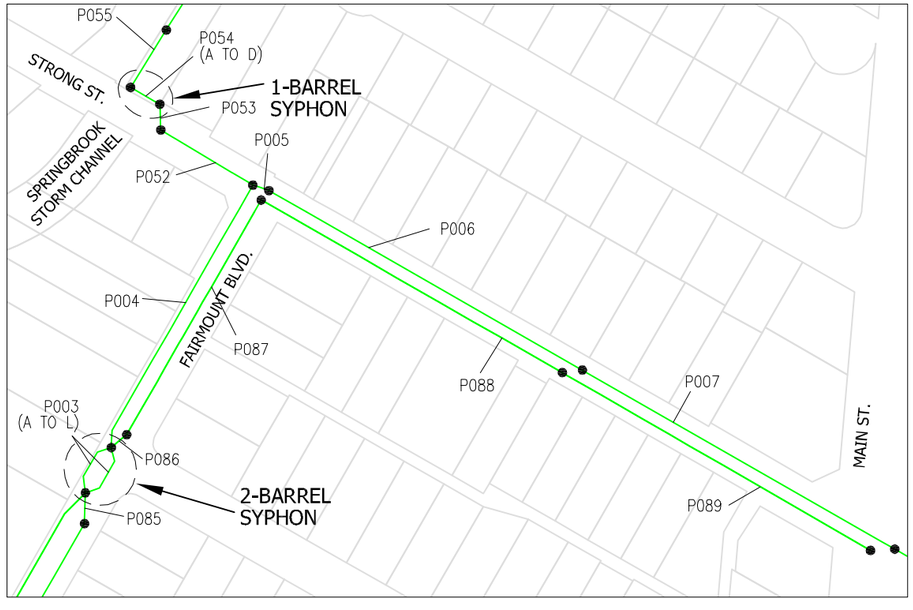
7.6 Cost Estimate

Unit costs of pipes are based on bid prices for similar projects and from the web site www.get-a-quote.net. The cost of construction includes labor, materials, excavation, backfill and all other items associated with pipe laying. To estimate total cost, cost of mobilization / demobilization (7%), traffic control (7%), bond (1%), contractor's profit (15%) and construction contingency (25%) is added to the cost of construction. The cost of engineering, right of way acquisition, permits, soil conditions remediation and by-pass pumping is not included in the construction cost. For priorities "B" and "C", the cost estimate is based on year 2005 indices and no escalation has been added to estimate future cost. Following is the summary of cost for the various priorities:

- Priority "B" - $1,759,000 (2005 $) (See Figure 18 and Table 7-6-B for details)
- Priority "C" - $ 2,788,000 (2005 $) (See Figure 19 and Table 7-6-C for details)

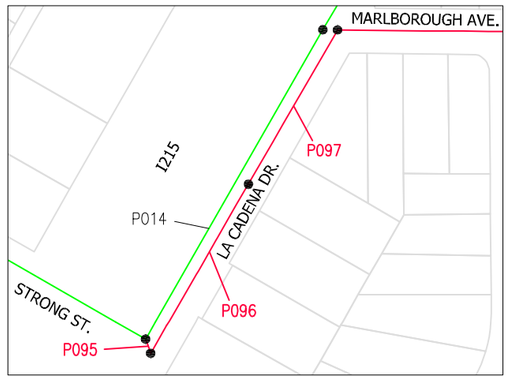






DETAIL "A"
NTS

DETAIL "B"
NTS



DETAIL "C"
NTS

DETAIL "D"
NTS

LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2011 - 2015)
- P001 PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

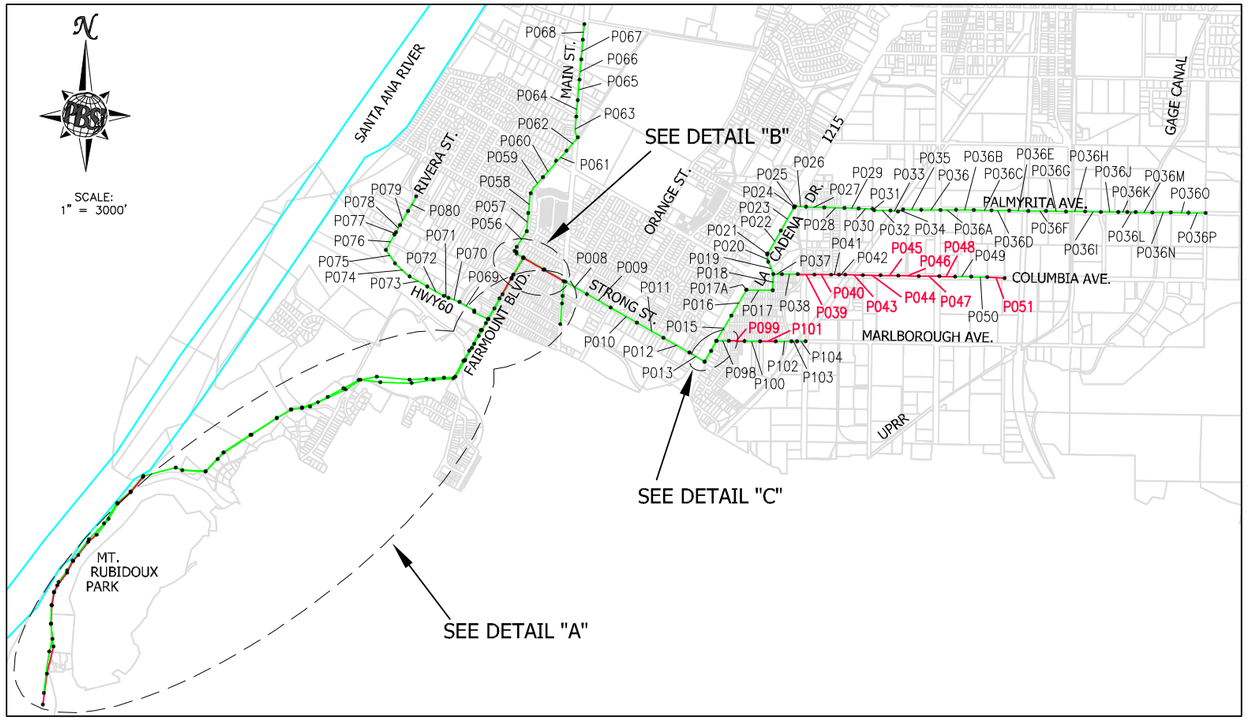
DATE: 01/04/06 | DWN BY: CD

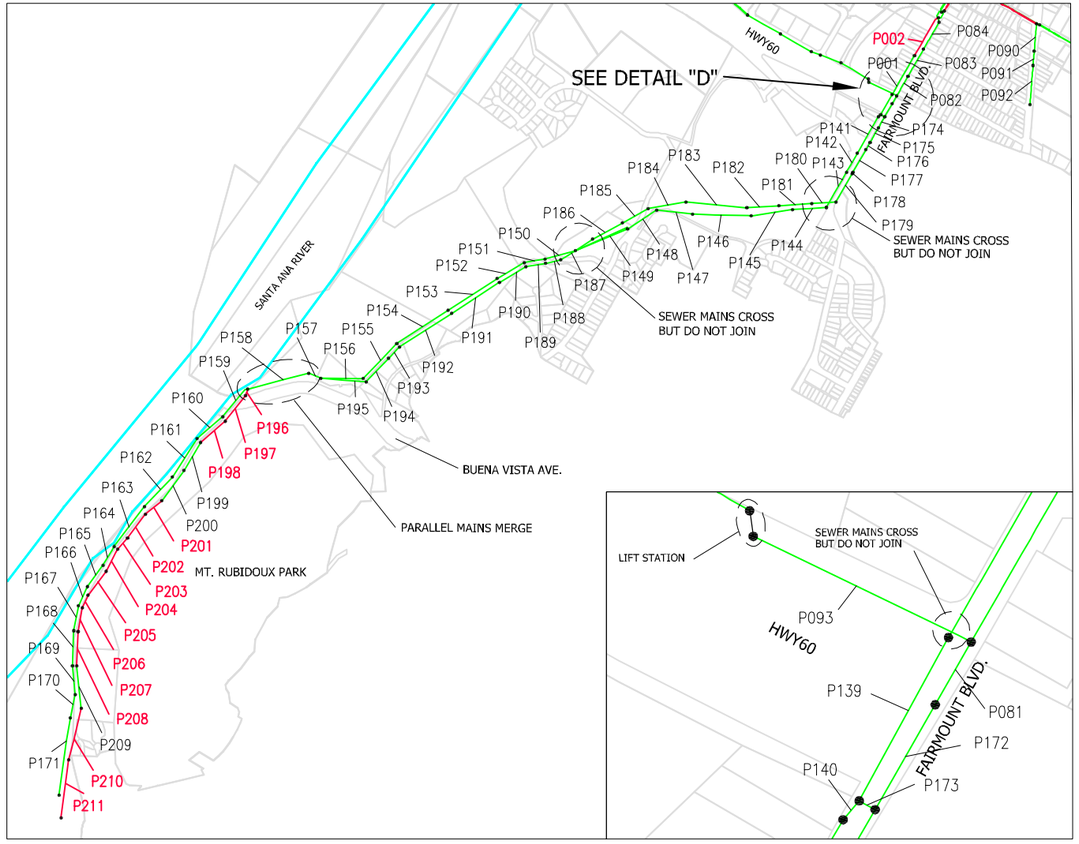
CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

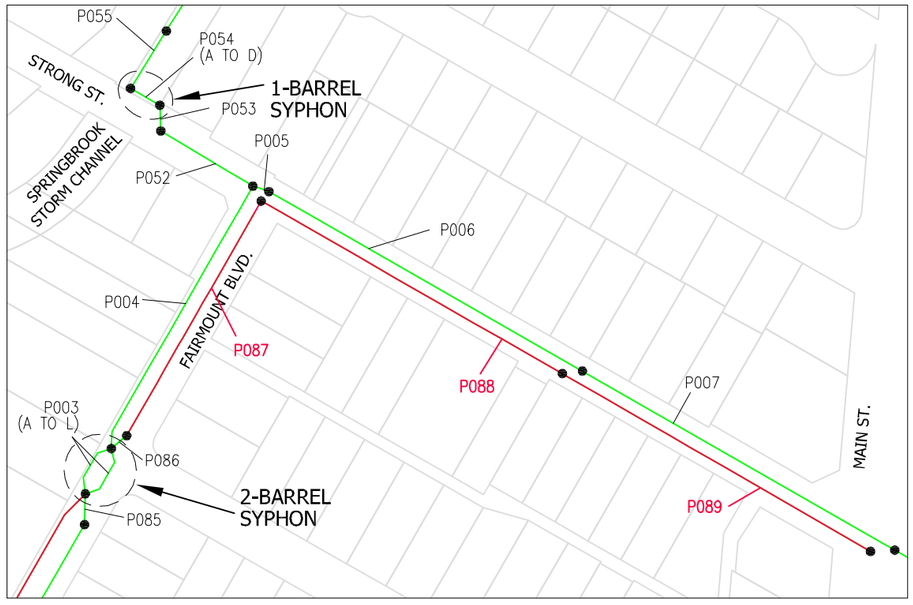
FIGURE 18

PRIORITY "B"

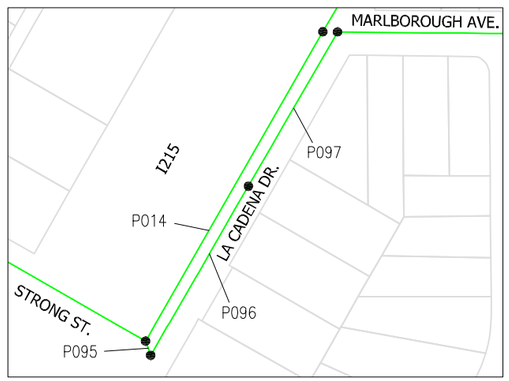
Y:\City of Riverside\Northside\DWG\Exhibits\NS-PriorityB.dwg, 9/28/2006 9:14:16 AM







DETAIL "B"
NTS



DETAIL "C"
NTS

DETAIL "D"
NTS

DETAIL "A"
NTS

LEGEND

- GRAVITY SEWER
- IMPROVEMENT SEWER (2016 - 2020)
- P001 PIPE SEGMENT NUMBER

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

DATE: 01/04/06 | DWN BY: CD

CITY OF RIVERSIDE
NORTHSIDE SEWER STUDY

FIGURE 19

PRIORITY "C"

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Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "B"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"B" (See Figure 18 and Table 7-2 for details of pipes)	Columbia Avenue	Pipes P037 to P038	Future Capacity Problem in reaches M019 to M038 and M038 to M039 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining the same slope.	$131,000
	La Cadena Drive	Pipes P017 to P018, P019 to P021, P024, P095 to P097	Future Capacity Problem in reaches M017A to M018, M019 to M022, M024 to M025, M014 to M096 and M096 to M098 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining the same slope.	$565,000
	Marlborough Avenue	Pipes P098	Future Capacity Problem in reach M098 to M099 due to flat slope and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria. Replace pipes with larger size pipes maintaining the same slope.	$66,000
	Palmyrita Avenue	Pipes P025 to P036, P036A, P036B, P036E, P036H	Future Capacity Problem in reach M025 to M037H due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor flow in future to verify that it will exceed 90% criteria or needed as part of another project. Replace pipes with larger size pipes maintaining the same slope.	$997,000
				Total Construction Cost for Priority "B" Projects (2011-2015 Replacement / Rehabilitation)	**$1,759,000**

Table 7-3
Summary of Improvement Plans for Problem Areas
Priority "C"

Priority	Location	Pipes	Problem	Solution	Approx. Cost (2005 $'s)
"C" (See Figure 19 and Table 7-2 for details of pipes)	Columbia Avenue	Pipes P039 to P040, P043 to P048, P051	Future Capacity Problem in reaches M039 to M041, M043 to M049 and M051 to M052 due to smaller pipe sizes, flat slopes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$746,000
	Fairmount Boulevard	Pipes P002 and P087	Future Capacity Problem in reaches M002 to M003 and M088 to M089 due to flat slopes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$311,000
	Fairmount Trunk	Pipes P196 to P198, P201 to P208 and P210 to P211	Future Capacity Problem in reaches M186 to M189, M193 to M215 and M217 to M219 due to flat slopes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$1,319,000
	Marlborough Avenue	Pipes P099, P101	Future Capacity Problem in reaches M099 to M100 and M101 to M102 due to flat slopes, smaller pipe sizes and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$144,000
	Strong Street	Pipes P088 to P089	Future Capacity Problem in reach M089 to M091 due to flat slope and increased flow in the system.	Monitor in future to verify that flows exceed 75% criteria. Replace with larger size pipes maintaining same slopes if surcharging appears imminent or if part of another needed project.	$268,000
				Total Construction Cost for Priority "C" Projects (2016-2020 Replacement / Rehabilitation)	**$2,788,000**

Table 7-6-B
Preliminary Construction Cost Estimate For Priority "B" Projects
(2011- 2015 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Columbia Avenue	Replace Pipe P037	8	15	LF	169	$115	$19,435
	Replace Pipe P038	8	15	LF	315	$115	$36,225
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	5	$1,650	$8,250
						Total:	$80,410
Mobilization / Demobilization (7%)							$5,629
Traffic Control (7%)							$5,629
Bond (1%)							$804
Contractor's Profit(15%)							$12,062
Subtotal:							$104,533
Construction Contingency (25%)							$26,133
Total Construction Cost (Columbia Avenue Sewer)							**$131,000**
La Cadena Drive	Replace Pipe P017 - P018	15	21	LF	851	$170	$144,670
	Replace Pipe P019 - P020	10	18	LF	403	$145	$58,435
	Replace Pipe P021	10	15	LF	18	$115	$2,070
	Replace Pipe P024	10	30	LF	23	$220	$5,060
	Replace Pipe P095	10	12	LF	8	$110	$880
	Replace Pipe P096 - P097	8	12	LF	470	$110	$51,700
	Rehab / Replace Manhole			EA	10	$5,500	$55,000
	Reconnect Sewer Laterals			EA	18	$1,650	$29,700
						Total:	$347,515
Mobilization / Demobilization (7%)							$24,326
Traffic Control (7%)							$24,326
Bond (1%)							$3,475
Contractor's Profit(15%)							$52,127
Subtotal:							$451,770
Construction Contingency(25%)							$112,942
Total Construction Cost (La Cadena Drive Sewer)							**$565,000**
Marlborough Avenue	Replace Pipe P098	8	12	LF	238	$110	$26,180
	Rehab / Replace Manhole			EA	2	$5,500	$11,000

Table 7-6-B
Preliminary Construction Cost Estimate For Priority "B" Projects
(2011- 2015 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
	Reconnect Sewer Laterals			EA	2	$1,650	$3,300
						Total:	$40,480
Mobilization / Demobilization (7%)							$2,834
Traffic Control (7%)							$2,834
Bond (1%)							$405
Contractor's Profit(15%)							$6,072
Subtotal:							$52,624
Construction Contingency(25%)							$13,156
Total Construction Cost (Marlborough Avenue Sewer)							**$66,000**
Palmyrita Avenue	Replace Pipe P025	15	24	LF	7	$200	$1,400
	Replace Pipe P026	12	18	LF	219	$145	$31,755
	Replace Pipe P027 - P031	12	15	LF	1355	$115	$155,825
	Replace Pipe P032 - P033	12	18	LF	455	$145	$65,975
	Replace Pipe P034 - P036	12	15	LF	838	$115	$96,370
	Replace Pipe P036A, P036B, P036E	10	12	LF	1040	$110	$114,400
	Rehab / Replace Manhole			EA	14	$5,500	$77,000
	Reconnect Sewer Laterals			EA	43	$1,650	$70,950
						Total:	$613,675
Mobilization / Demobilization (7%)							$42,957
Traffic Control (7%)							$42,957
Bond (1%)							$6,137
Contractor's Profit(15%)							$92,051
Subtotal:							$797,778
Construction Contingency(25%)							$199,444
Total Construction Cost (Palmyrita Avenue Sewer)							**$997,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "B" PROJECTS							**$1,759,000**

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Columbia Avenue	Replace Pipe P039 - P040	10	12	LF	649	$110	$71,390
	Replace Pipe P043 - P048	10	12	LF	2177	$110	$239,470
	Replace Pipe P051	10	15	LF	351	$115	$40,365
	Rehab / Replace Manhole			EA	10	$5,500	$55,000
	Reconnect Sewer Laterals			EA	32	$1,650	$52,800
						Total:	$459,025
Mobilization / Demobilization (7%)							$32,132
Traffic Control (7%)							$32,132
Bond (1%)							$4,590
Contractor's Profit(15%)							$68,854
Subtotal:							$596,733
Construction Contingency(25%)							$149,183
Total Construction Cost (Columbia Avenue Sewer)							**$746,000**
Fairmount Boulevard	Replace Pipe P002	27	30	LF	465	$220	$102,300
	Replace Pipe P087	15	18	LF	400	$145	$58,000
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	9	$1,650	$14,850
						Total:	$191,650
Mobilization / Demobilization (7%)							$13,416
Traffic Control (7%)							$13,416
Bond (1%)							$1,917
Contractor's Profit(15%)							$28,748
Subtotal:							$249,145
Construction Contingency(25%)							$62,286
Total Construction Cost (Fairmount Boulevard Sewer)							**$311,000**
Fairmount Trunk	Replace Pipe P196 - P198, P201 - P208, P210 - P211	18	21	LF	3944	$170	$670,480
	Rehab / Replace Manhole			EA	14	$5,500	$77,000
	Reconnect Sewer Laterals			EA	39	$1,650	$64,350

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
						Total:	$811,830
Mobilization / Demobilization (7%)							$56,828
Traffic Control (7%)							$56,828
Bond (1%)							$8,118
Contractor's Profit(15%)							$121,775
Subtotal:							$1,055,379
Construction Contingency(25%)							$263,845
Total Construction Cost (Fairmount Trunk Sewer)							**$1,319,000**
Marlborough Avenue	Replace Pipe P099, P101	8	10	LF	620	$100	$62,000
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	6	$1,650	$9,900
						Total:	$88,400
Mobilization / Demobilization (7%)							$6,188
Traffic Control (7%)							$6,188
Bond (1%)							$884
Contractor's Profit(15%)							$13,260
Subtotal:							$114,920
Construction Contingency(25%)							$28,730
Total Construction Cost (Marlborough Avenue Sewer)							**$144,000**
Strong Street	Replace Pipe P088 - P089	15	18	LF	923	$145	$133,835
	Rehab / Replace Manhole			EA	3	$5,500	$16,500
	Reconnect Sewer Laterals			EA	9	$1,650	$14,850
						Total:	$165,185
Mobilization / Demobilization (7%)							$11,563
Traffic Control (7%)							$11,563
Bond (1%)							$1,652
Contractor's Profit(15%)							$24,778

Table 7-6-C
Preliminary Construction Cost Estimate For Priority "C" Projects
(2016- 2020 Replacement / Rehabilitation)

Location	Description	Existing Diameter (inch)	New Diameter (inch)	Unit	Quantity	Unit Cost	Approx Total Cost(2005 $'s)
Subtotal:							$214,741
Construction Contingency(25%)							$53,685
Total Construction Cost (Strong Street Sewer)							**$268,000**
TOTAL CONSTRUCTION COST FOR PRIORITY "C" PROJECTS							**$2,788,000**

City of Riverside
Northside Trunk Sewer Study

Appendices

Prepared By:

10370 Hemet Street, Suite 200
Riverside, CA 92503
(951) 358-1433

September, 2006

Appendix A

Flow Data at Meter Locations (On CD)

Appendix B

City of Riverside, Criteria for Sewer Facility Design

CITY OF RIVERSIDE
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

CRITERIA FOR SEWER FACILITY DESIGN

~~March 2000~~
Revised May 2004

Determination of Sewage Flows:

The sewer line shall be designed to flow 75% full during peak flows. Use a Manning's "n"=0.013.

Residential sewer flows are determined by using the following sources of information and criteria:

- Land use shown in the City's General Plan.
- Based on the Land Use determine the number of living units per acre.
- The capita per living unit can be determined from the latest census data for the study area. However, not less than an average 2.75 capita per living unit.
- Use 65 gallons per capita per day for average flows.
- Peak to average flow coefficient is to be determined from the attached graphs.

Peak flows for other types of development shall be determined using the following criteria:

- Industrial developments use: 0.012 cfs/acre
- Commercial developments use: 0.010 cfs/acre
- Offices: 30 gallons per capita per day (g/c/d)
- Schools: 30 g/c/d
- Laundromat: 580 gallons per machine per day

The Public Works Department must approve sewer flows for any other specific types of development.

Criteria for Sewage Pump Station Design:

Construction of a sewage pump station shall be considered the last resort for handling sewage flows from any development. An analysis of alternate gravity system alignments must be performed and submitted to the City for review. The analysis shall consider the economics of constructing and maintaining a pump station over a 20-year period versus obtaining right of way and constructing a gravity system.

If the analysis shows that a pump station is the most economical alternative the following criteria shall be used in its design.

Peak flows are determined by the criteria stated above in the Determination of Sewage Flows section.

Configuration of the components of the pump station shall be in such a way to permit easy access by maintenance equipment. Fencing shall be placed around the pump station components with gates provided at locations for access by maintenance personnel and equipment. The fencing is to be 6-feet in height and of materials and color permitted by the City's Planning Department. All metal parts are to be powder coated with the approved color.

All hatches and hardware shall be stainless steel.

The developer/contractor shall submit complete maintenance and spare parts information for all station components.

Force Main Design:

The force main shall be sized in such a way that the pumps will maintain a minimum flow velocity of 2 feet per second. The force main shall be no smaller than 4 inches in diameter and shall be made of ductile iron pipe. However, if the force main is small and located in a residential street, AWWA C900 PVC pipe may be used. The use of PVC pipe will require specific approval by the Public Works Department.

The force main shall have a continuous upward grade from the pump station to the outlet. No low or high points will be permitted between the pump station and outlet.

The force main shall outlet to a manhole connected to a gravity system. The outlet shall be at the flowline of the manhole and channeled as shown in City Standard Drawing No. 500. Within 30 feet of the manhole the force main shall have an elevation high enough to prevent sewage in the gravity system from flowing down the force main during the off cycle of the pumps.

The designer shall analyze bends in the force main for the need to use thrust blocks or restrained joints.

A force main cleaning station must be installed at approximately 500-foot intervals if the following conditions will exist in the completed system.

- Flows from the area served by the pump station are not enough to require the force main to be emptied every 4 hours.
- The force main is over 950 feet long.
- The difference in elevation between the force main at the valve vault and the outlet is greater than 25 feet.

Pump Design:

Pumps are to be sized to provide a minimum flow velocity of 2 feet per second in the force main.

Pumps shall be able to handle 4-inch solids.

Pump selection shall be based on the most efficient drive/pump/impeller combination for the force main system. The discharge flow velocity should be in the range of 10 to 14 feet per second. The designer shall graph the pipe system curve against the pump curve. If multiple pumps are used this graph shall show the curve for each pump. The minimum pump efficiency allowed is 60 percent.

Wet Well Design:

In stations that have 5 to 100 horsepower pumps the wet wells shall be sized to permit the pumps to cycle not less than 15 minutes between stops and starts. In addition the pumps must not run less than 10 minutes per cycle. Stations with pumps greater than 100 horsepower shall have a cycle time between pump stops and starts not be less than 20 minutes with a minimum run time of 15 minutes.

Pumps on and off elevations are to be shown on the plan. These elevations must be below the inlet elevation to the wet well. Flap gates on the wet well inlet are not permitted.

The wet well shall have a 6-foot minimum diameter and lined with PVC or City approved coating.

If the wet well is over 30 feet in depth there must be a "step off" landing designed in the well. The landing is a safety precaution to provide a location for maintenance personnel to step off the wet well access ladder.

All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

A wastewater recirculator or scum breaker shall be provided.

Valve Vault Design:

The vault shall be large enough to permit easy access by maintenance personnel. The bottom shall be a minimum 4-inch thick concrete slab. A 4-inch diameter PVC pipe shall be provided to drain the valve vault into the wet well.

All pipe and fittings from the pumps through the valve vault shall be made of ductile iron. Only flanged fittings shall be used. All nuts, bolts, and washers shall be made of 304 or 316 stainless steel.

Discharge and isolation valves shall be plug valves and not gate valves.

Controls and Electric Design:

A 480-volt three-phase power supply is required.

All conduits shall be schedule 80 PVC.

An emergency transfer switch shall be provided. Small stations will require a manual switch where large stations with emergency backup generators will require an automatic transfer switch. When a manual transfer switch is required a 100-amp plug and receptacle such as Killark 8581/21-407 and 8581/22-407 shall be provided. In addition, a minimum 30-foot long jumper cable shall be provided.

Lights shall be provided within the control panel to allow for night work.

The pump station shall have a communications link with the City's wastewater treatment plant. The equipment to provide this link shall be City approved.

An electric schematic diagram shall be provided on the pump station plans.

The wet well level measuring device shall be a Milltronics Hydroranger ultrasonic measuring device.

The station shall be controlled by a Modicon Quantum Programmable Logic Controller(PLC).

The station shall be equipped with a Motorola Moscad Radio Telemetry Unit(RTU).

This RTU shall be installed and completely functional prior to the acceptance by the City.

The Developer/contractor shall coordinate and pay for the integration of this RTU into the City's existing SCADA system.

Control system integration with the City's SCADA shall be performed by an integrator approved by the City.

Three phase 480 VAC power shall be the power source.

The power source for station controls shall be 120 VAC.

Two spare conduits shall be provided between the control panel and the wet well. This conduit shall same size of the largest conduit needed between the control panel and wet well.

One spare conduit shall be provided between the control panel and the valve vault. This conduit shall of the same size of the largest conduit needed between the control panel and valve vault.

The developer/contractor shall provide complete as built drawings of the electrical system. This shall include all wiring, general, and internal to the control panel

All wires must be individually tagged. They must be tagged at every termination and inside every junction box.

The developer/contractor shall provide a copy of the proposed PLC program for review prior to construction. A final fully annotated copy of the PLC program shall be provided, both in electronic format and in a hard copy printed format.

All panels shall be of the appropriate construction for the application. (minimum, NEMA 4X or 3R.

Pump Station Functional Requirements

Milltronics Hydroranger Ultrasonic Level Indicator/Controller

Shall provide analog level input to the Programmable Logic Controller (PLC)

Shall provide off & on starting of pumps in the event of PLC failure

Shall provide alternation of pumps in event of PLC failure

Shall provide ultrasonic failure Input to RTU

Float Switch

Shall provide an input to the RTU (high-high level)

Programmable Logic Controller (PLC)

Shall provide starting and stopping of the pumps in auto

Shall provide alternation of the pumps (after each cycle)

Recognize Milltronics failure and provide an input to the RTU

Shall recognize pump hand switch position and adjust the control logic

Shall provide all timing functions

Shall provide low level alarm output to RTU

Shall provide input to the RTU In event of seal failure of pumps (Each Pump)

Shall provide input to the RTU in event of Thermal overload

Shall call lag pump if required

Shall provide input to the RTU indicating pump failure and identifying the pump

Shall provide output to the RTU for high level alarm

A three-position selector switch shall interface with the PLC to provide for manual override of the automatic changing of lead and lag pumps, in case of pump failure (i.e.: P1-AUTO-P2)

Controls

A manual bypass shall be provided for water levels, PLC, Milltronics; etc. and shall directly energize the motor starters.

The auto function shall be controlled by the PLC or in the event of PLC failure, the Milltronics will start, stop, and alternate lead and lag pumps.

Radio Telemetry Unit (RTU)

Shall monitor only, not control

Transmit Dynamic Wet Well Level (Analog Output)

Indicate low level

Indicate high level

Indicate site entry

Indicate AC failure

Indicate individual pump failure

Indicate pump auto, pump not auto

Indicate pump run status

Indicate ultrasonic failure

Indicate Seal Failure

External Relays

(1) Intrinsically safe for the high, high level float

(2) For seal failure

(2) Motor starters

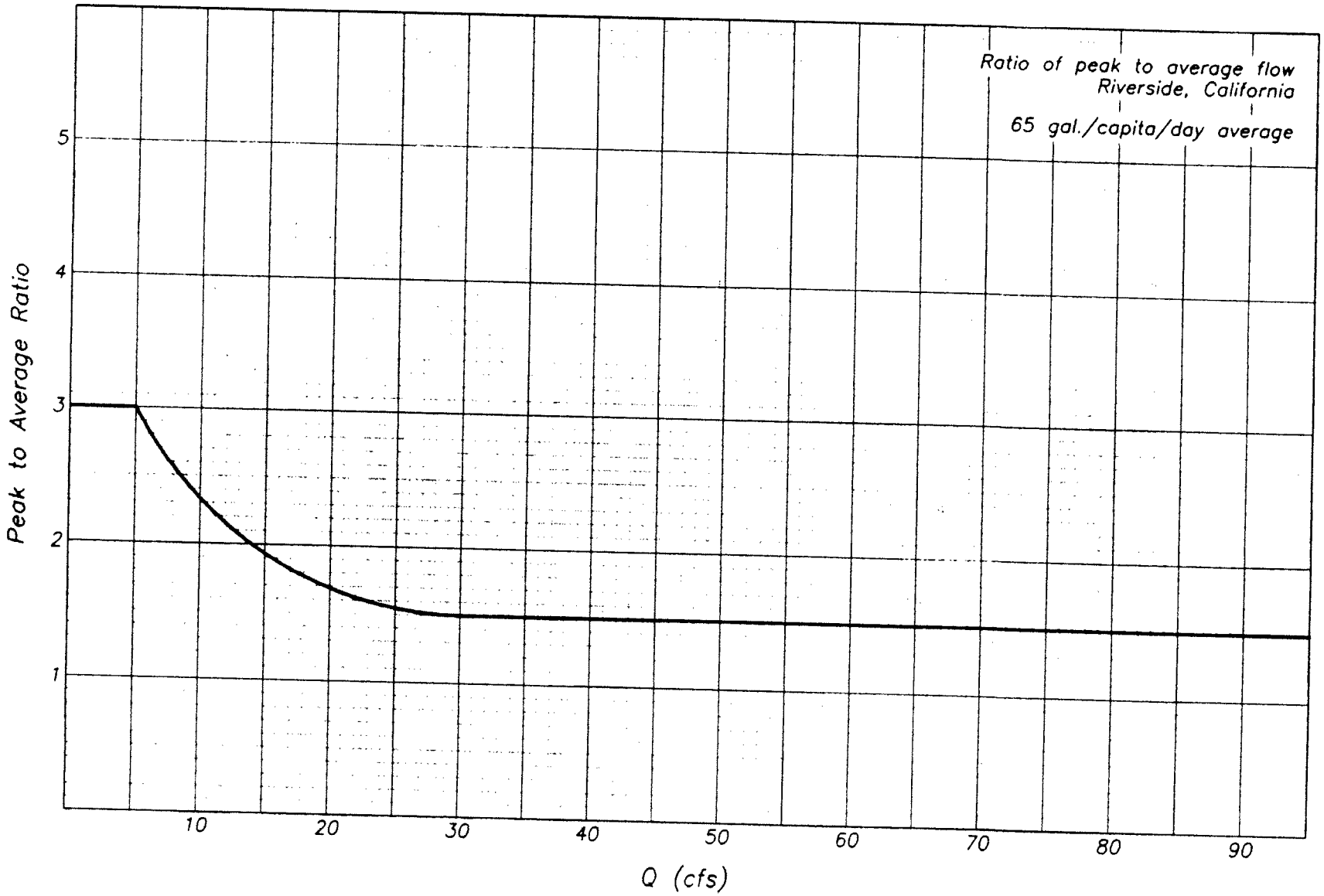
Criteria for Inverted Siphon Design:

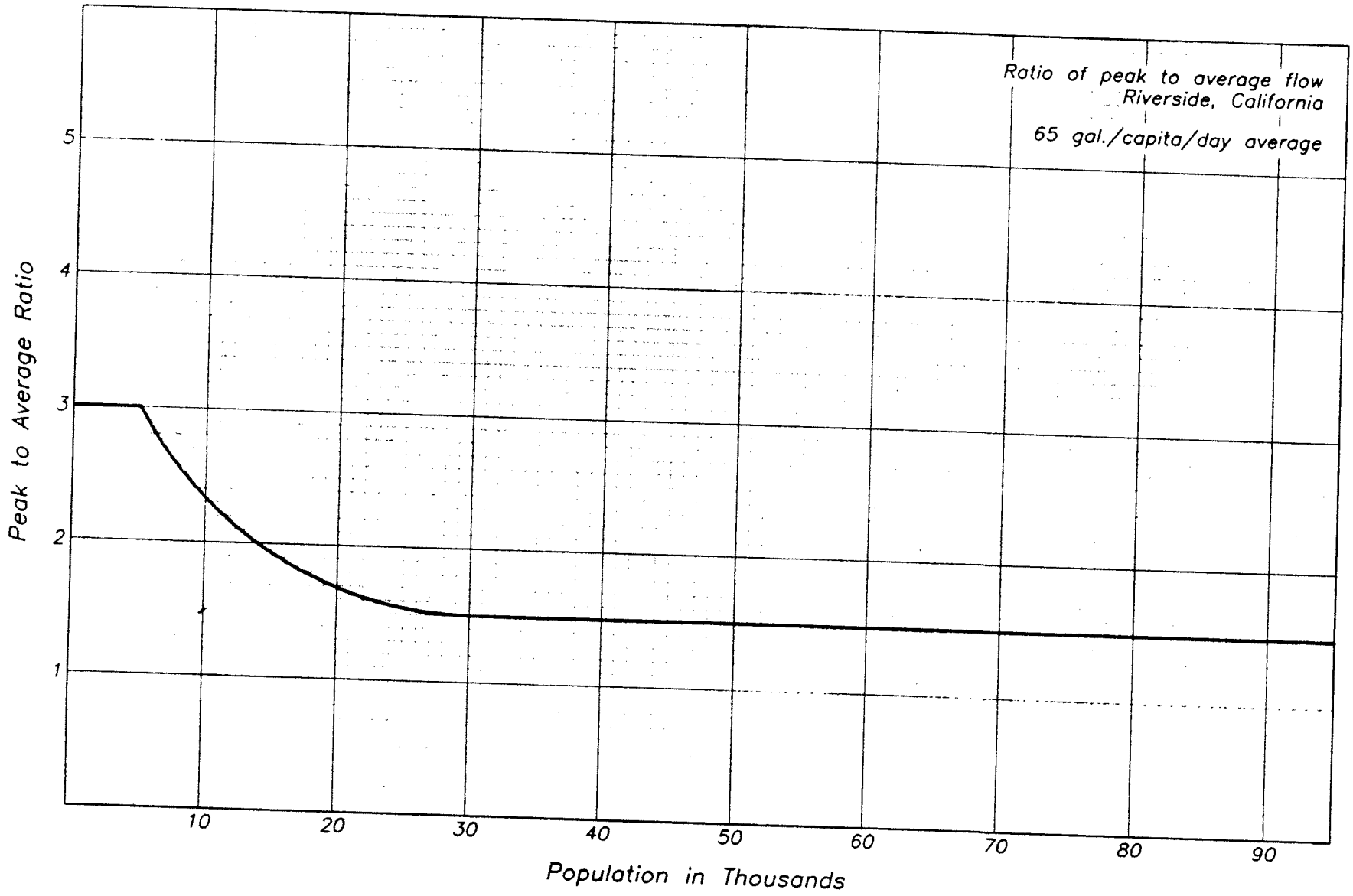
Minimum flow velocity of 3 feet per second and maximum velocity of 7 feet per second within the siphon pipe(s) is required. A multiple pipe design should be incorporated with the upstream manhole designed to direct the anticipated average daily flow into one pipe and the anticipated peak flow into all pipes of the siphon. If the siphon will serve future development it may be necessary to design the siphon with more than two pipes in order to maintain the minimum flow velocity until the future development is constructed. Weirs shall be cast into the base of the manholes.

Minimum pipe size to be used in the siphon is 6-inch. Either Vitrified Clay Pipe or Ductile Iron Cement Mortar Lined Pipe (DIP) shall be used in the siphon. Type V cement shall be used for the lining of the DIP. Internal pressure of the siphon shall be considered in material selection.

The siphon shall not exceed 350 feet in length with manholes installed at each end. Flow shall be directed straight through these manholes. No side connections to the manholes will be permitted. The manhole diameter shall be determined by the number, size, and spacing of the siphon pipes plus 3 feet. The shelf elevation shall be above the water level during ultimate peak flows.

During ultimate peak flow the water surface elevation at the first sewer lateral connection upstream of the siphon must be within the sewer main.


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
40
50
60
70
80
90
Q (cfs)


Ratio of peak to average flow
Riverside, California
65 gal./capita/day average
Peak to Average Ratio
5
4
3
2
1
10
20
30
40
50
60
70
80
90
Population in Thousands

Appendix C
Study Sewer Lines

City of Riverside
Northside Trunk Sewer System: Study Sewer Lines

Location	Pipe Diameter	Length	Number of Manholes
	(inch)	(feet)	
Palmyrita Avenue	12	2,866	11
	15	8	2
Columbia Avenue	8	484	2
	10	4,090	14
Marlborough Avenue	8	1,588	6
	12	171	2
La Cadena Drive	8	479	1
	10	451	3
	15	829	2
	21	1,075	4
	24	1,169	2
	27	466	1
Main Street	12	830	4
	18	4,917	15
Strong Street	15	922	1
	18	246	2
	21	1,635	3
	24	948	1
	27	1,578	4
Fairgrounds Street	15	1,512	2
	27	1,396	6
Rivera Street	8	646	3
	12	563	2
Fairmount Boulevard	15	1,512	7
	27	1,396	4
Fairmount Trunk (South of Hwy 60 to Tequesquite Avenue)	18	10,400	39
	30	995	2
	33	4,180	10
	36	5,970	21
Total of Study Sewer Lines		**53,322**	**176**

Appendix F
INFILTRATION AND INFLOW STUDY

City of Riverside
Infiltration and Inflow Study

Prepared For:

Sandy Caldwell, P.E.

Principal Engineer
5950 Acorn Street
Riverside, California 92504

Prepared By:

10370 Hemet Street, Suite 200
Riverside CA, 92503
(951) 358-1433

May, 2005

INFILTRATION AND INFLOW (I & I) STUDY

City of Riverside

Client Representative Sandy Caldwell, P.E.

PBS&J

Project Manager Mark Iverson, P.E.

Technical Advisory Louis Atwell, P. E.

Project Engineer Barmeshwar Rai, P.E.

Technical Support Cristina Chavez

May, 2005

10370 Hemet Street Suite 200, Riverside, CA 92503 Ph: (951) 358-1433

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A Flow Data from Downstream Services Inc. (CD included)
B Rainfall Data from CIMIS Web Site

Executive Summary

ES.1 Introduction

This report presents the results of the Inflow & Infiltration (I&I) Study prepared by PBS&J for the City of Riverside (City). The report contains recommendations on I&I into the City's sewer systems based on sewer flow data collected by Downstream Services, Inc.

The City of Riverside is located in the northwestern portion of the County of Riverside at the intersection of three major freeways: Route 91, Route 60 and Route 215. The study area encompasses approximately 78 square miles and includes five drainage basins: Northside, Spruce, Tequesquite, Phoenix and Arlanza. The study area is essentially a fully developed matured community with pockets of vacant lands to be developed in the future.

The City is currently experiencing higher levels of wastewater flow into its sewer system during rain events. For this reason, an I&I study was undertaken to evaluate the extent of I&I into the sewer system.

ES.2 Existing Sewer System

The existing sewer system within the City is comprised of approximately 800 miles of sewer lines ranging from 4-inches to 51-inches in diameter. There are approximately 16,500 manholes in the sewer system. These sewer lines are essentially VCP except for force main lines that are either cement mortar lined steel pipes or techite pipes. The manholes are typically brick-lined. The City of Riverside owns and operates the sewer system.

ES.3 Methodology

For determination of current wastewater flows, flow monitoring was performed at nine (9) strategic locations. These meter locations were chosen to observe actual flow characteristics for various drainage basins with a distinct land use pattern. The flow monitoring was performed over a two-month period (from January 8, 2005 to February 28, 2005), which contains four (4) significant rain events. The flow data were carefully evaluated for their accuracy and some adjustments were made considering depth of flow measurement was more reliable than flow velocity measurement. All readings at meter no. 6 (Jurupa) were discarded for inconsistencies.

Rainfall data was taken from the California Irrigation Management Information System (CIMIS) website for the months of January and February. For this period, four (4) significant rain events were identified. For each monitoring station, graphs were plotted for Dry and Wet Week flows versus rainfall intensity.

ES.4 Conclusions and Recommendations

This study concludes high inflow and infiltration for storm events I and IV (see below). It was evident that during peak (high intensity) rainfall periods, high inflows were measured as shown in the meter graphs. In some cases, infiltration would lag by hours following the rainfall event. High intensity rain events were the cause of I&I. Rainfall events II and III, which were milder in intensity, did not trigger any significant I&I. Based on the flow and rainfall data, a rough quantitative estimate of infiltration and inflow at RWQCP is as follows:

Storm event I (Saturday January 8th through Friday January 14th)
Total Rainfall (inches) – 3.73
Peak Intensity (inches/hour) – 0.65
Inflow – approximately 4.8 MG
Infiltration – approximately 2.7 MG

Storm Event IV (Friday February 18th through Monday February 28th)
Total Rainfall (inches) – 4.21
Peak Intensity (inches/hour) – 0.29
Inflow – approximately 3.3 MG
Infiltration – approximately 2.3 MG

These quantities are indicative only and need to be reconfirmed with further investigations and studies.

PBS&J recommends that further investigations be performed to "pinpoint" areas of I&I. This can be accomplished by strategically placing flow meters upstream of the meters in this report. The future meters could be located in upstream sub-basins. In addition, physical manhole inspections, smoke tests and CCTV inspections are also methods of determining I&I. Smoke tests would identify the problem areas, such as Storm Drain Connectors and/or manhole lid openings, while manhole and CCTV inspection would determine the condition and extent of damage within the sewer system.

Section 1
Introduction

1.1 GENERAL

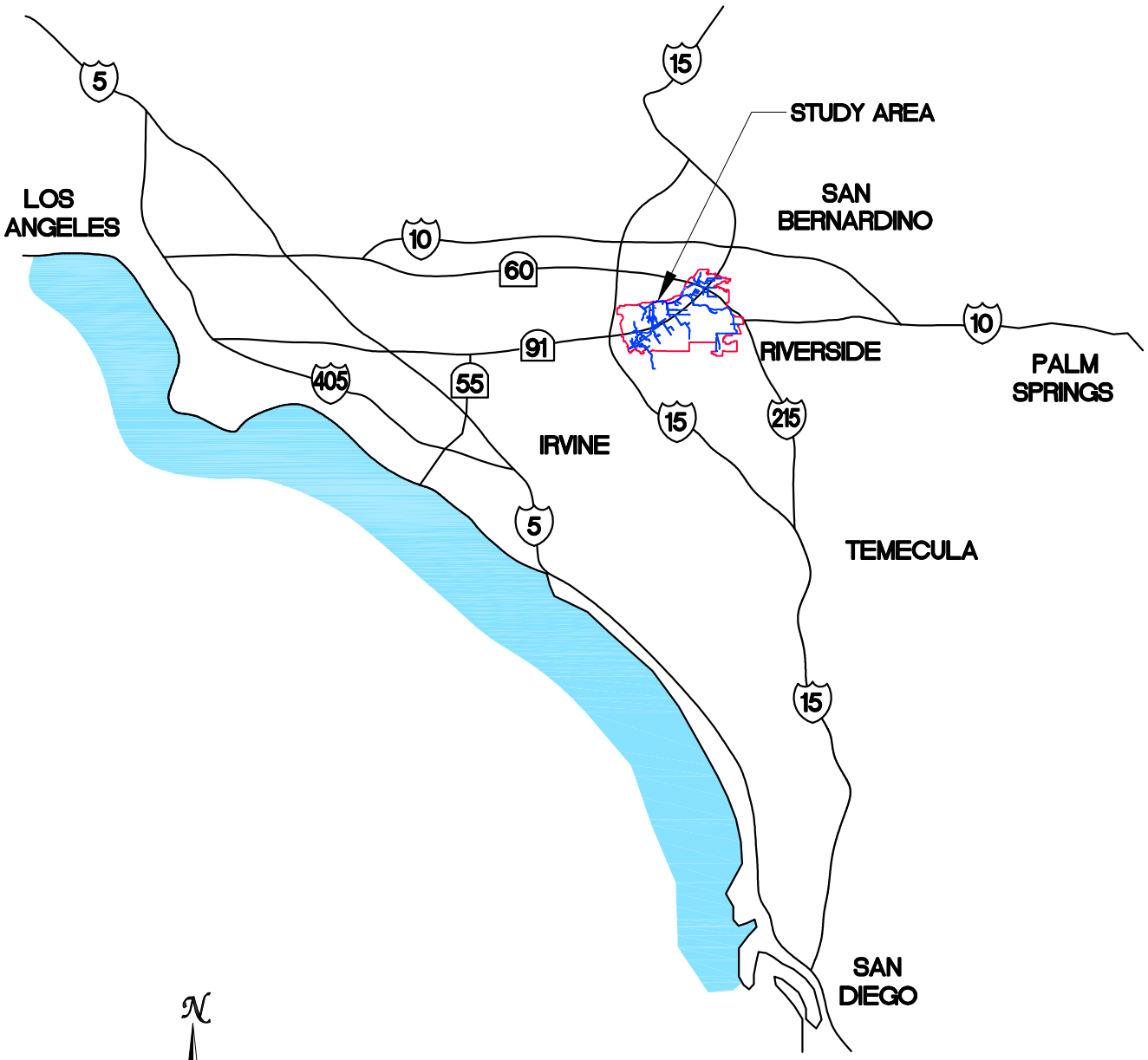
The City of Riverside (City) is located in the northwest portion of the County of Riverside at the intersection of three major freeways: 60, 91 and 215. The sewer system of the City is spread over an area of 78 square miles and treated at the Riverside Water Quality Control Plant (RWQCP) located at the intersection of Van Buren Boulevard and Jurupa Avenue. Figure –1 is the vicinity map showing City's location and accessibility.

In the recent years, excessive sewage flows have been recorded at RWQCP during rain events. This prompted the City to initiate an Infiltration and Inflow (I&I) study for the sewer system. The purpose of this report is to evaluate whether I&I of storm water takes place into the City's sewer system. The report summarizes findings of flow monitoring done for a long period of time (more than 2 months) at various strategic locations of the sewer system. The information gathered is critical in assessing the condition of the collection system and is used to plan future projects to help reduce I&I. This, in turn, should reduce sewage overflows and the possibility of fines that could be imposed by the Santa Ana Regional Water Quality Control Board (RWQCB). This evaluation will also be part of the new EPA requirements for Capacity, Management, Operation and Maintenance (CMOM), which would soon be implemented.

1.2 SCOPE

The following is an outline of the scope of work covered in this evaluation of the City's I&I Study:

- Evaluate Flow Meter Locations: Evaluate the City's collection system using the GIS information received from the City and recommend locations for flow meters. A minimum of one meter would be installed for each of the City's five (5) major drainage basins. Also, the meters would be installed at locations where I&I conditions are expected. A total of nine (9) meter locations have been selected.



Engineering
Planning
Surveying
Construction Services

PBS&J

10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358-1433
Fax:(951) 358-1434

CITY OF RIVERSIDE
INFLOW AND INFILTRATION STUDY

FIGURE
1

VICINITY MAP

- Develop a Flow Monitoring Plan: Develop a flow monitoring plan to include the duration of the study, the routine data collection and the collection of data during and after rainfall events. The meters will be installed for a period of 30 to 90 days. The actual duration of the meter installations will depend on rainfall conditions and durations. A minimum of three significant rainfall events are needed to ensure validity of the data. The meters will be installed for a minimum period of 30 days.
- Installation of Meters: Arrange the services of a subcontractor to install flow meters at the selected locations. Schedule and coordinate the installation of the meters.
- Coordinate Data Collection: Coordinate the retrieval of the flow data from the instruments. The data will be retrieved weekly during non-rainy periods and immediately following significant rainfall events. Collect flow data from the subcontractor in an electronic format and store it.
- Evaluate and Analyze Flow Data: For evaluation, data will be organized and assessed for validity. Analyses will be performed to determine whether I&I occur from each of the five major drainage basins and from the sub-basins within these basins.
- Prepare Report: Prepare a report of the findings of I&I study. It will include flow data, summary of findings, recommendations of additional flow monitoring, tables, figures and maps. It will also include recommendations for the scope of work for follow-up studies that would be specific to individual drainage basins of the City.

Section 2
Meter Locations

2.0 GENERAL

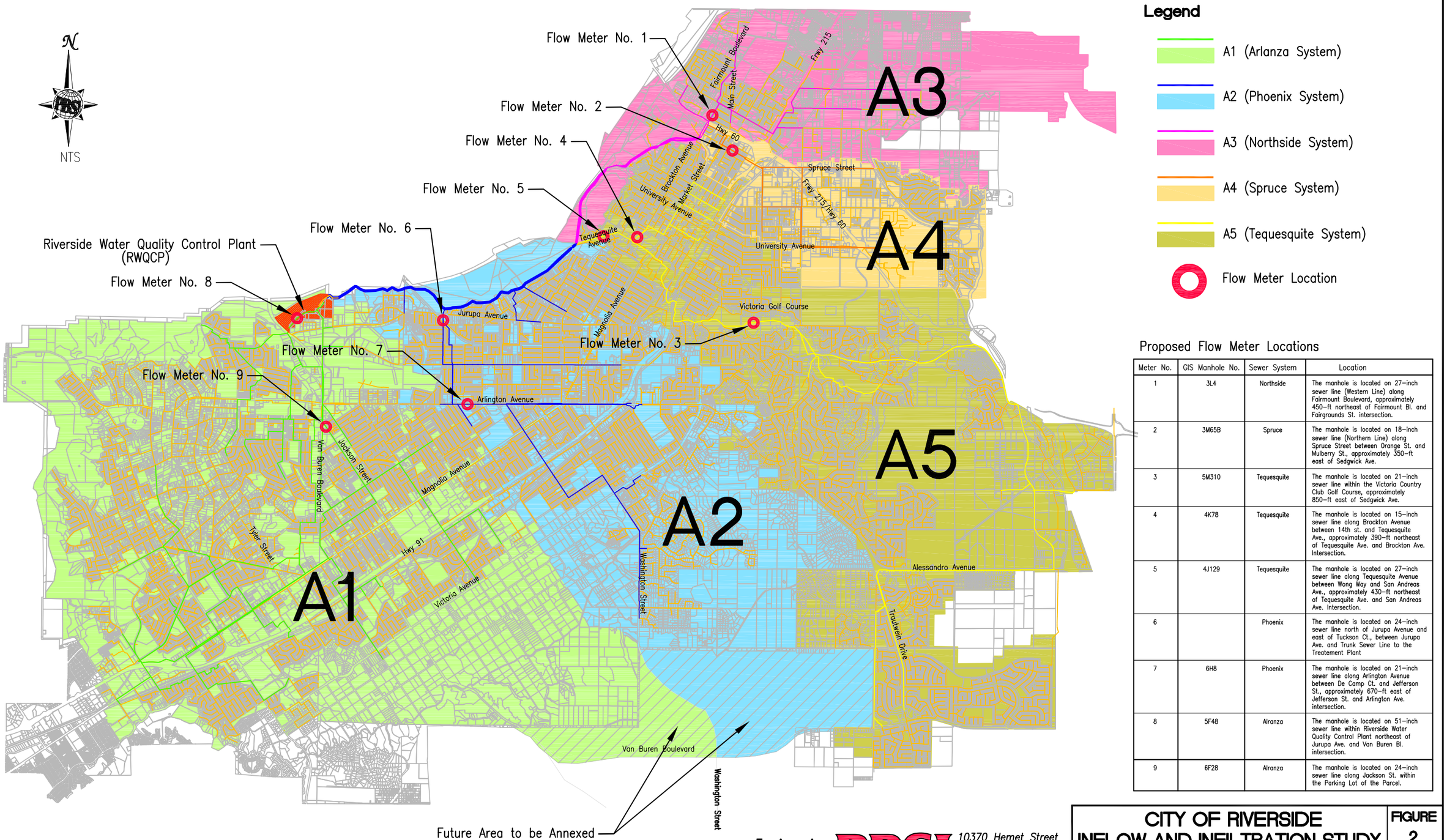
Flow Monitoring was conducted at nine (9) locations to accomplish the following:

- Determine current flow quantities.
- Determine average dry weather flow.
- Determine flow during rain events.
- Determine fluctuation of flow in the system per intensity of rain.
- Determine flow patterns following the rain events.

The location of each flow monitoring station can be seen in Figure –2. The locations of flow monitoring stations and logic behind selection of their locations is explained in the following sub-sections.

2.1 METER NO. 1 (FAIRMOUNT BOULEVARD)

The flow monitoring manhole is located on a 27-inch sewer line (Western Trunk Line) along Fairmount Boulevard, approximately 450-ft northeast of the intersection of Fairmount Boulevard and Fairgrounds Street. The sewer line at this location picks up almost the entire flow coming out of the Northside Drainage Basin. The Northside Drainage Basin comprises of mixed land uses: the area west of Fwy. 215 is primarily residential and the area east of Fwy. 215 is primarily commercial. Most of the future developments would take place in the northeastern portion of the drainage basin. The sewer system, west of the Fwy. 215 is older than the eastern sewer system. The flow monitoring station would measure almost total sewage flow generated from the Northside drainage basin.



Proposed Flow Meter Locations

Meter No.	GIS Manhole No.	Sewer System	Location
1	3L4	Northside	The manhole is located on 27–inch sewer line (Western Line) along Fairmount Boulevard, approximately 450–ft northeast of Fairmount Bl. and Fairgrounds St. intersection.
2	3M65B	Spruce	The manhole is located on 18–inch sewer line (Northern Line) along Spruce Street between Orange St. and Mulberry St., approximately 350–ft east of Sedgwick Ave.
3	5M310	Tequesquite	The manhole is located on 21–inch sewer line within the Victoria Country Club Golf Course, approximately 850–ft east of Sedgwick Ave.
4	4K78	Tequesquite	The manhole is located on 15–inch sewer line along Brockton Avenue between 14th st. and Tequesquite Ave., approximately 390–ft northeast of Tequesquite Ave. and Brockton Ave. Intersection.
5	4J129	Tequesquite	The manhole is located on 27–inch sewer line along Tequesquite Avenue between Wong Way and San Andreas Ave., approximately 430–ft northeast of Tequesquite Ave. and San Andreas Ave. Intersection.
6		Phoenix	The manhole is located on 24–inch sewer line north of Jurupa Avenue and east of Tuckson Ct., between Jurupa Ave. and Trunk Sewer Line to the Treatement Plant
7	6H8	Phoenix	The manhole is located on 21–inch sewer line along Arlington Avenue between De Camp Ct. and Jefferson St., approximately 670–ft east of Jefferson St. and Arlington Ave. intersection.
8	5F48	Alranza	The manhole is located on 51–inch sewer line within Riverside Water Quality Control Plant northeast of Jurupa Ave. and Van Buren Bl. intersection.
9	6F28	Alranza	The manhole is located on 24–inch sewer line along Jackson St. within the Parking Lot of the Parcel.

Engineering
Planning
Surveying
Construction Services
PBS&J
10370 Hemet Street
Suite 200
Riverside, CA 92503
Tel:(951) 358–1433
Fax:(951) 358–1434

CITY OF RIVERSIDE
INFLOW AND INFILTRATION STUDY

FIGURE 2

METER LOCATION AND SEWER BASINS

2.2 METER NO. 2 (SPRUCE STREET)

The monitoring manhole is located on an 18-inch sewer line (Northern Line) along Spruce Street between Orange Street and Mulberry Street, approximately 350-ft east of Sedgwick Avenue. The sewer line picks up a majority of the wastewater flow coming from the Spruce Drainage Basin. One of the major contributors of the sewage flow is the University Of Riverside (UCR), which has experienced rapid growth in the recent years. The sewer system within the UCR campus is owned and operated by it.

2.3 METER NO. 3 (VICTORIA COUNTRY CLUB)

The monitoring manhole is located on a 21-inch sewer line within the Victoria Country Club Golf Course, approximately 850-ft east of Sedgwick Avenue. The wastewater flow from the Canyon Crest and Orange Crest areas of the City can be measured at this location. Within the country club, the sewer line is installed in a non-paved sewer right of way for a long stretch that makes it vulnerable for I&I.

2.4 METER NO. 4 (BROCKTON AVENUE)

The manhole is located on a 15-inch sewer line along Brockton Avenue between 14th Street and Tequesquite Avenue, approximately 390-ft northeast of the intersection of Tequesquite Avenue and Brockton Avenue. The sewer line at this location picks up flow from the downtown area of the City and residential developments east of Hwy. 91. The sewer system upstream of this location is perhaps the oldest sewer system within the City. The wastewater flow from the downtown commercial and office developments can be measured at this location.

2.5 METER NO. 5 (TEQUESQUITE AVENUE)

The manhole is located on a 27-inch sewer line along Tequesquite Avenue between Wong Way and San Andreas Avenue, approximately 430-ft northeast of the intersection of Tequesquite Avenue and San Andreas Avenue.

Total wastewater from Tequesquite Drainage Basin can be measured at this location.

2.6 METER NO. 6 (JURUPA AVENUE)

The manhole is located on a 24-inch sewer line north of Jurupa Avenue and east of Tuckson Ct., between Jurupa Avenue and the Trunk Sewer Line to the Treatment Plant. The flow monitor at this location will measure most of the sewage flow generated from the Phoenix Drainage Basin. Also, the sewer line near this location is installed in a non-paved sewer right of way, which is susceptible to I&I.

2.7 METER NO. 7 (ARLINGTON AVENUE)

The manhole is located on a 21-inch sewer line along Arlington Avenue between De Camp Ct. and Jefferson Street, approximately 670-ft east of the intersection of Jefferson Street and Arlington Avenue. The sewer line at this location picks up most of the residential flow generated from the southeastern portion of the Phoenix Drainage Basin. The combination of flow data at this location and meter number six (6) can be used to analyze wastewater flow characteristics of the Phoenix Drainage Basin.

2.8 METER NO. 8 (RWQCP)

The manhole is located on a 51-inch sewer line within the RWQCP, northeast of the intersection of Jurupa Avenue and Van Buren Boulevard. The wastewater flow generated from the Arlanza Drainage Basin can be measured at this location. Also, this flow can be compared to the daily flow data entering RWQCP from the Arlanza Trunk Sewer.

2.9 METER NO. 9 (JACKSON STREET)

The manhole is located on a 24-inch sewer line along Jackson Street, within the parking lot of the parcel near the intersection of Van Buren Boulevard and Jackson Street. The wastewater flow from the eastern portion of the Arlanza Drainage Basin (East of Van Buren Boulevard) can be measured at this location.

Section 3
Description of Drainage Basins

3.0 GENERAL

The general topography of the City follows the Santa Ana River, which flows at the western edge of the City in the southerly direction. In general, the northern and western portions of the City are higher in elevation and general surface flow is either in southerly or westerly direction. Based on the general topography and existing layout of the sewer system, the City has been divided into five (5) drainage basins. See Figure –2 for details of drainage basins. The drainage basins are described in the following sub-sections:

3.1 NORTHSIDE DRAINAGE BASIN

The Northside Drainage Basin, located in the northern portion of the City covers approximately 6,000 acres. It is generally bounded by Main Street to the North, Santa Ana River to the west, Spruce Street to the south and Pope Kirlos Avenue to the east. The eastern portion of the drainage basin (east of Fwy. 215) is primarily a business park / light industrial area and has scope for future development activities. The western portion is a mature community. Total sewage flow from the drainage basin can be measured at the meter location 1. In the future, significant sewage flow would be generated from the proposed Spring Mountain Ranch and Springbrooks Developments proposed in the eastern portion of the drainage basin. PBS&J has performed a trunk sewer study for Northside Drainage Basin for dry weather flow conditions. According to this study, the existing sewer system is efficient for current flows but the system would need rehabilitation / replacement of sewer segments to accommodate the future flows.

3.2 SPRUCE DRAINAGE BASIN

The drainage basin covers around 2,500 acres and is located north of the Riverside Downtown

neighborhood. It is generally bounded by Spruce Street to the north, University Avenue to the south, Fairmont Boulevard to the west and Watkins Drive to the east. PBS&J has performed trunk sewer capacity study for this drainage basin. According to this study, the Spruce Sewer System has current and future deficiencies. UCR is one of the major sewage contributors to the Spruce Sewer System. The drainage basin is a mature community comprised of residential, commercial, light industrial and educational facilities.

3.3 TEQUESQUITE DRAINAGE BASIN

The drainage basin encompasses around 13,000 acres in area and includes Downtown, Canyon Crest and Orangecrest neighborhoods of the City. It is generally bounded by UCR to the north, Van Buren Boulevard to the south, Tequesquite Avenue to the west and Fwy. 215 to the east. PBS&J has performed a trunk sewer capacity study for this drainage basin. According to this study, the Tequesquite Sewer System has current and future deficiencies. The area designated as an Industrial Business Park in the Sycamore Canyon neighborhood would be one of the major wastewater contributors to the Tequesquite Sewer System. The drainage basin is a mature community and comprises of residential, commercial, light industrial and educational facilities. The area marked as Sycamore Canyon Park is a reserved area. The sewer lines in the downtown area are quite old and may have I&I problems in addition to capacity deficiencies as identified in the Sewer Capacity Study.

3.4 PHOENIX DRAINAGE BASIN

The Phoenix Drainage Basin is located in the middle portion of the City and it covers approximately 11,000 acres. It is generally bounded by the Santa Ana River to the north, Woodcrest neighborhood of the County of Riverside to the south, Jefferson Street to the west and Alessandro Avenue to the east. PBS&J is currently performing a trunk sewer capacity study for this drainage basin that would determine current and future deficiencies for dry weather conditions. The drainage basin is a mature community comprised of residential, commercial, light industrial and educational facilities. The sewage flow from this drainage basin dumps into

the trunk sewer line that runs parallel to Santa Ana River.

3.5 ARLANZA DRAINAGE BASIN

The drainage basin encompasses around 20,000 acres and includes a southern portion of the City. It is generally bounded by the Santa Ana River to the north, Home Gardens neighborhood of the County of Riverside to the south, City of Norco to the west and Jefferson Street to the east. PBS&J is currently performing a trunk sewer capacity study for this drainage basin that would determine current and future deficiencies. The drainage basin is a mature community comprised of residential, commercial, light industrial and educational facilities. It can distinctly be divided into two portions: the area west of Tyler Street contributing to the pump station at Pierce Street and the area east of Tyler Street contributing to the RWQCP by gravity. The sewer system comprises of new and old (approximately 50 years) sewer lines. The wastewater flow from the western portion of the drainage basin is pumped through a force main line to the gravity sewer system and eventually it flows to RWQCP.

Section 4

Data Evaluation Procedures

4.0 GENERAL

Flow data for wastewater was collected and provided by Downstream Services, Inc from nine (9) metering locations. The data for each station was evaluated. The data was collected for the period of January 7, 2005 through February 28, 2005.

Two types of meters were installed, a Marsh-McBirney FloDar meter with a non-intrusive ultrasonic level and radar velocity sensors to measure depth, velocity and flow and an ISCO 2150 Area Velocity meter using a pressure transducer to measure depth and a Doppler to measure velocity. The Marsh-McBirney FloDar meter was installed at stations 2, 5 and 8; while the ISCO 2150 Area Velocity meter was installed at stations 1, 3, 4, 6, 7 and 9.

4.1 RAINFALL DATA

CIMIS, the California Irrigation Management Information System (http://www.cimis.water.ca.gov/cimis/data.jsp) is the source of information used for this study for the rainfall data. The rainfall data used for this study was for the months of January and February. The rainfall data can be seen in Appendix B. There were a total of four (4) storm events during the study period that were evaluated. The rainfall data for these four (4) storm events is summarized in the Table 4-1.

Table 4-1

City of Riverside, Station 44, CIMIS Rainfall Data for Jan/Feb 2005

Storm Event	Dates	Days	Total Rainfall (in)	Average Rainfall for Storm Event (in/hr)	Peak Intensity (in/hr)
I	1/8 to 1/14	7	3.73	0.02	0.65
II	1/26 to 2/01	7	0.23	0.001	0.09
III	2/9 to 2/15	7	0.88	0.01	0.16
IV	2/18 to 2/28	11	4.21	0.02	0.29

The storm events are described in more details in the following sub-sections.

4.1.1 STORM EVENT I

The Storm Event I began on January 8, 2005 and continued until January 14, 2005 for a period of 7 days. The intensity of rainfall gradually increased and the peak intensity (0.65 inch per hour) was recorded on January 09, 2005 at 17.00 hours. After that, the rainfall intensity decreased rapidly and finally diminished on January 12, 2005. The average rainfall for this storm event was 0.02 inch per hour and the total rainfall was 3.73 inch.

4.1.2 STORM EVENT II

The Storm Event II began on January 26, 2005 and continued until February 01, 2005 for a period of 7 days. The intensity of rainfall was mild in nature and the peak intensity (0.09 inch per hour) was recorded on January 28, 2005 at 16:00 hours. This was a minor storm event with scanty or negligible rainfall. The average rainfall for this storm event was 0.001 inch per hour and the total rainfall was 0.23 inch.

4.1.3 STORM EVENT III

The Storm Event III began on February 09, 2005 and continued until February 15, 2005 for a period of 7 days. The intensity of rainfall was mild in nature and the peak intensity (0.16 inch per hour) was recorded on February 11, 2005 at 12:00 hours. This storm event was a mild one with majority of rainfall falling on February 11, 2005. For the rest of the storm period, a scanty or negligible rainfall was recorded. The average rainfall for this storm event was 0.01 inch per hour and the total rainfall was 0.88 inch.

4.1.4 STORM EVENT IV

The Storm Event IV began on February 18, 2005 and continued until February 28, 2005

for a period of 11 days. The intensity of rainfall was mild to heavy in nature and the peak intensity (0.29 inch per hour) was recorded on February 19, 2005 at 13:00 hours. This storm event was spread over a longer period of time. It began with a mild intensity on February 18, 2005 and peaked on February 19, 2005. This continued until February 23, 2005 with two intermediate peaks on February 21, 2005 at 4:00 hours (0.20 inch per hour) and on February 23, 2005 at 3:00 hours (0.13 inch per hour). For the rest of the storm period, a scanty or negligible rainfall was recorded. The average rainfall for this storm event was 0.02 inch per hour and the total rainfall was 4.21 inch.

4.2 METER DATA COLLECTION / EVALUATION

4.2.1 METER NO. 1 (FAIRMOUNT)

At Station 1 (Fairmount), the sensor was positioned in the 27" VCP inflow pipe. Acquiring data at this location was difficult because debris would build up during low-flow conditions. For this reason, data for some of the dates were lost and the data collected from the hardware had to be salvaged and re-calculated for velocity and flow considering depth was reliable. This data was evaluated and a graph plotted to make a better representation of the storm events. A 30-period moving average was used to plot graphs for the Wet and Dry Week Periods. A figure for the flow data for the entire period is shown in Figure 5.1.1.

4.2.2 METER NO. 2 (SPRUCE)

At Station 2 (Spruce), the meter was installed at the inflow 18" VCP. This meter has a consistent depth of flow, velocity and flow data. The data collected at this station was converted to a 30-period moving average and used for plotting graphs. A figure for the flow data for the entire period is shown in Figure 5.2.1.

4.2.3 METER NO. 3 (GOLF COURSE)

At Station 3 (Golf Course), the meter was installed in the 27" inflow VCP pipe. The readings at this station are generally consistent and accurate. Data was used to calculate a 30-

period moving average for both the wet and dry-week periods. During rain events, some inconsistent spikes were experienced at this location for a small period of time. However, data was used to create graphs for a 30-period moving average for both wet and dry week periods. A figure for the flow data for the entire period is shown in Figure 5.3.1.

4.2.4 METER NO. 4 (BROCKTON)

At Station 4 (Brockton), the meter was installed at the 15" inflow VCP pipe. At this location, a major problem was encountered during flow monitoring. Flow surcharge caused the hardware to be dislodged on February 17th, and the damaged equipment could not be replaced until February 25th. For this reason, data is missing for this period so only two storm events were plotted using a 30-period moving average. A figure for the flow data for the entire period is shown in Figure 5.4.1.

4.2.5 METER NO. 5 (TEQUESQUITE)

At Station 5 (Tequesquite), the meter was installed at the inflow 27" VCP pipe. The data was analyzed using the 30-period moving average for both the Wet week and Dry Week Periods. Graphs for all four storm events were plotted. A figure for the flow data for the entire period is shown in Figure 5.5.1.

4.2.6 METER NO. 6 (JURUPA)

At Station 6 (Jurupa), the meter was installed in the 24" VCP line. The total flow quantity of both influent lines, 24" VCP and 27" VCP, were metered. The data at this location was analyzed for the influent flow of the 27" line. This station had debris and large objects flowing into the system that interfered with the readings. In mid January, the mounting ring became dislodged due to a mass of debris flowing into the pipeline. This caused a lot of the data at this station to be considered as erroneous and only one storm event in mid-February was plotted. A 30-period moving average was taken for the data that was salvaged. A figure for the flow data for the entire period is shown in Figure 5.6.1.

4.2.7 METER NO. 7 (ARLINGTON)

At Station 7 (Arlington), the meter was installed at the 21" VCP inflow pipe. Hydraulic conditions at this site were generally good, with moderately fast flow velocities. Brief accounts of surcharging were present. Data was used for a 30-period moving average for a graphical representation of all four storm events.

A figure for the flow data for the entire period is shown in Figure 5.7.1.

4.2.8 METER N0. 8 (RWQCP)

At Station 8 (RWQCP), the meter was installed in the 51" inflow pipe. Flow conditions monitored showed consistent flow, with moderate-to-fast velocity indications. The data of the entire period was used for a 30-period moving average and plotted for three storm events. Due to insufficient amount of data for February 18th through the 24th, representation of the fourth storm event was not done. A figure for the flow data for the entire period is shown in Figure 5.8.1.

4.2.9 METER NO. 9 (JACKSON)

At Station 9 (Jackson), the meter was installed in the 24" inflow pipe. All four storm events were plotted using data for a 30-period moving average. One problem with the collection of data was encountered for this station during the last two days of February, when zero readings were recorded by the meters for depth and flow. This period was ignored for graphical representation. A figure for the flow data for the entire period is shown in Figure 5.9.1.

Section 5
Flow Monitoring Findings

5.0 GENERAL

The analysis of data was performed and graphs plotted for the data collected. The total amount of wastewater flow at RWQCP is the sum of flows at meters 1, 2, 5, 6, 8 and 9. The details of I&I flow at the RWQCP are tabulated in table 5-1. The analysis of flow data for each metering station is described in detail in the following sub-sections.

Table 5-1

Total I&I at Riverside Water Quality Control Plant (RWQCP)

Storm Event I (From Saturday January 8th through Friday January 14th)					
Estimation of Inflow:					
Meter No.	**Location**	**Approximate Wet Day Flow (On Jan. 9) (MG)**	**Approximate Dry Day Flow (On Jan. 16) (MG)**	**Difference (MG)**	**Variation %**
1	Fairmount Boulevard	0.8	0.3	0.5	145%
2	Spruce Street	2.6	2.4	0.2	8%
5	Tequesquite Avenue	8.5	7.7	0.9	11%
6	Jurupa Avenue	3.9	2.5	1.4	57%
8	RWQCP	10.1	8.9	1.3	14%
9	Jackson Street	2.9	2.3	0.6	24%
	Total:	**28.78**	**24.01**	**4.77**	**20%**
Estimation of Infiltration:					
Meter No.	**Location**	**Approximate Wet Day Flow (On Jan. 12) (MG)**	**Approximate Dry Day Flow (On Jan. 19) (MG)**	**Difference (MG)**	**Variation %**
1	Fairmount Boulevard	0.5	0.3	0.1	38%
2	Spruce Street	3.1	2.9	0.2	6%
5	Tequesquite Avenue	8.5	8.1	0.4	5%
6*	Jurupa Avenue				

8	RWQCP	9.6	7.9	1.7	21%
9	Jackson Street	2.5	2.2	0.3	14%
	Total:	**24.13**	**21.41**	**2.72**	**13%**
Storm Event IV (From Friday February 18th through Monday February 28th)					
Estimation of Inflow:					
Meter No.	**Location**	**Approximate Wet Day Flow (On Feb. 20) (MG)**	**Approximate Dry Day Flow (On Feb. 6) (MG)**	**Difference (MG)**	**Variation %**
1	Fairmount Boulevard	0.9	0.3	0.70	209%
2	Spruce Street	2.7	2.5	0.2	9%
5	Tequesquite Avenue	6.6	6.5	0.2	2%
6**	Jurupa Avenue	3.9	3.8	0.1	2%
8	RWQCP	11.2	9.4	1.8	19%
9	Jackson Street	2.6	2.3	0.4	16%
	Total:	**28.04**	**24.79**	**3.25**	**13%**
Estimation of Infiltration:					
Meter No.	**Location**	**Approximate Wet Day Flow (On Feb. 12) (MG)**	**Approximate Dry Day Flow (On Jan. 20) (MG)**	**Difference (MG)**	**Variation %**
1	Fairmount Boulevard	0.3	0.3	0.02	6%
2	Spruce Street	3.1	2.9	0.3	9%
5	Tequesquite Avenue	8.0	7.1	0.9	12%
6**	Jurupa Avenue	3.9	3.8	0.03	1%
8	RWQCP	8.4	7.7	0.6	8%
9	Jackson Street	2.7	2.2	0.4	20%
	Total:	**26.32**	**24.07**	**2.25**	**9%**

Notes:

* Data was not available for these dates and could not be included in this calculation

** In case of missing data for Storm Event IV, corresponding flow data for similar rainfall intensity was used for Storm Event I.

5.1 METER NO. 1 (FAIRMOUNT)

The flow from the Northside Drainage Basin is measured at this location. Due to debris accumulation at low flows, the collection of data for this station was not consistent for the entire period of January 7th through February 28th. Meter malfunction was the cause of invalid velocity data. However, reliable readings that were considered useful were of the water level in the manhole (depth) for the period of the first storm event. This is why data was plotted on a graph for only the first storm event in January, from Saturday January 8th through Friday January 14th. The representation given on this graph shows several inflow spikes immediately following the wettest day, January 9th, for two 12-hour period cycles. The infiltration subsided by the end of the first storm period. The graph for the infiltration and inflow at this meter location can be seen in Figure –5.1.2 to Figure –5.1.5.

5.2 METER NO. 2 (SPRUCE)

At this location, the flow from Spruce Drainage Basin is measured. Four significant storm events were monitored for the whole two-month period. Graphs for all four storm events were plotted. Rain-induced inflow can be seen on the graphs. Storm events I and IV showed evidence of some inflow conditions for three 24-hour period cycles. This was seen with wet flows increasing for three consecutive cycles and being higher than dry flows for that week. This was followed by gradually decreasing infiltration for the rest of the week. Graphs plotted for storm events II and III show comparable flows for both dry and wet periods and do not show any evidence of infiltration or inflow. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.2.2 to Figure –5.2.5.

5.3 METER NO. 3 (GOLF COURSE)

Wastewater flows from Orangecrest and Canyon Crest neighborhoods of the City can be measured at this location. Surcharging was seen during some rain events at this location, causing

the water level to reach the top of the manhole at some instances. Storm event I shows high wet flows following the one-day peak rainfall event on January 9th. Inflow spikes were evident for 24-hour period cycles. Storm events II and III present steady flows for the one week period, so no conclusion of I&I was derived for these rain events. Storm event IV shows high wet flows for five out of eleven days plotted. This was due to four high rainfall days at the beginning of the period that might have caused inflow spikes followed by diminishing flows. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.3.2 to Figure –5.3.5.

5.4 METER NO. 4 (BROCKTON)

Wastewater flows from the downtown areas of the City can be measured at this location. Only two storm events were analyzed of this location: Storm I and II. This was because of inconsistencies in the data for storm events III and IV. Manning's formula was used to determine velocities and flows for the measured depths, assuming they were reliable. When zero readings were attained for some of the depths, no data was recovered and excluded from graphs. For the first storm event, I&I was evident following a peak rainfall day. The second graph does not provide reliable I&I information because the data is inconsistent. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.4.2 to Figure –5.4.4.

5.5 METER NO. 5 (TEQUESQUITE)

The total flow from Tequesquite Drainage Basin can be measured at this location. Significant inflow spikes were recorded during storm events I and IV for this station. This was primarily evident during storm event I. Infiltration evidence was seen for Storm I for a 24-hour period and diminishing after that. However, storm IV showed infiltration readings that were sporadic with dry periods being sometimes higher than wet periods for flow. This may have been caused by flawed meter readings that caused inconsistent data. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.5.2 to Figure –5.5.5.

5.6 METER NO. 6 (JURUPA)

Most of the wastewater flows from the Phoenix Drainage Basin can be measured at this location. Despite efforts to salvage a lot of the raw data collected for this station, it was difficult to draw conclusive information for the presence of inflow and infiltration from graphs. Only one storm event for the month of February was plotted and used to analyze flow data. Peaks representing high periods of the flow following high rainfall were attained from the plot, but only four consecutive days were representative for this occurrence. It was difficult to determine the presence of infiltration in one graph alone. In conclusion, data for this station was determined invalid and was not considered for this sewer study. The graph for the infiltration and inflow at this meter location can be seen in Figure –5.6.3 to Figure –5.6.5.

5.7 METER NO. 7 (ARLINGTON)

The wastewater flow from part of the Phoenix Drainage Basin can be measured at this location. Hydraulic conditions were reliable for the collection of raw data for this station. All four storm events were analyzed and plotted. Storm event I contains a peak rainfall day on the second day, for a 24-hour period, followed by high wet flows indicating inflow. A small quantity of infiltration can be seen on the graph; but nothing comparable to other stations. Storm events II and III demonstrated steady flows throughout the one week period. No indication of I&I was present for storm events II and III. Storm IV presents a cycle of events, with three peak rainfall days at the beginning of the period, followed by peak wet flows as well. Inflow was present throughout this period, with indications of high wet flows for five consecutive days. Very minimal infiltration was seen after five days. There were ambiguous dry flows being higher than wet flows that might have been caused by a brief period of surcharging in the system. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.7.2 to Figure –5.7.5.

5.8 METER NO. 8 (RWQCP)

Total wastewater flow from Arlanza Basin can be measured at this location. Collection of data for this station was made for the entire period, except for one week. This was due to failure of the meter's data logger for February 17th through February 24th. It was replaced on February 25th. The flow data for the first three storm events were plotted. The graph for storm event I show indication of inflow spikes, followed by mild infiltration that diminishes at the end of the storm period. Little or no indication of I&I was witnessed during storm events II and III. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.8.2 to Figure –5.8.4.

5.9 METER NO. 9 (JACKSON)

At this meter location, part of the wastewater flow from the Arlanza Basin can be measured. Flows for all four storm events were measured at this station. Storm event I contains a significant period of high rainfall for the first three days of the week, with the wettest day having a period of an 8-hour rainfall. High inflow indication followed this trend, with a diminishing wet flow occurrence after three subsequent days. Storm events II and III showed mild rainfall events, so no I&I was seen on the graphs. Storm event IV showed a series of high rainfall for the first five days. Significant wet period flows can be seen for this storm event followed by prolonged low diminishing flows. The graphs for the infiltration and inflow at this meter location can be seen in Figure –5.9.2 to Figure –5.9.5.

Section 6
Conclusion / Recommendations

6.0 GENERAL

This study concludes high inflow and infiltration for storm events I and IV. It was evident that during peak (high intensity) rainfall periods, high inflows were measured as shown in the meter graphs. In some cases, infiltration would lag inflow by hours following the rainfall event. High intensity rain events were the cause of I&I. Rainfall events II and III, which were milder in intensity, and did not trigger any significant I&I. Based on the flow and rainfall data, an approximate quantitative estimate of infiltration and inflow at RWQCP is as follows:

Storm event I (Saturday January 8th through Friday January 14th)
Total Rainfall (inches) – 3.73
Peak Intensity (inches/hour) – 0.65
Inflow – Approximately 4.8 MG
Infiltration – Approximately 2.7 MG

Storm Event IV (Friday February 18th through Monday February 28th)
Total Rainfall (inches) – 4.21
Peak Intensity (inches/hour) – 0.29
Inflow – Approximately 3.3 MG
Infiltration – Approximately 2.3 MG

These quantities are indicative only and need to be reconfirmed with further investigations and studies.

PBS&J recommends that further investigations be performed to “pinpoint” areas of I&I. This can be accomplished by strategically placing flow meters upstream of the meters in this report. The future meters could be located in upstream sub-basins. In addition, physical manhole inspections, smoke tests and CCTV inspections are also some of the recommendations that can help in the determination of I&I. Smoke tests would identify the problem areas, such as Storm Drain Connectors and/or manhole lid openings, while manhole and CCTV inspection would determine the condition and extent of damage of the sewer system.

Station 1

FAIRMOUNT

Figure 5.1.1
Flow at Meter 1- Fairmount
(1/7/05 to 2/28/05)

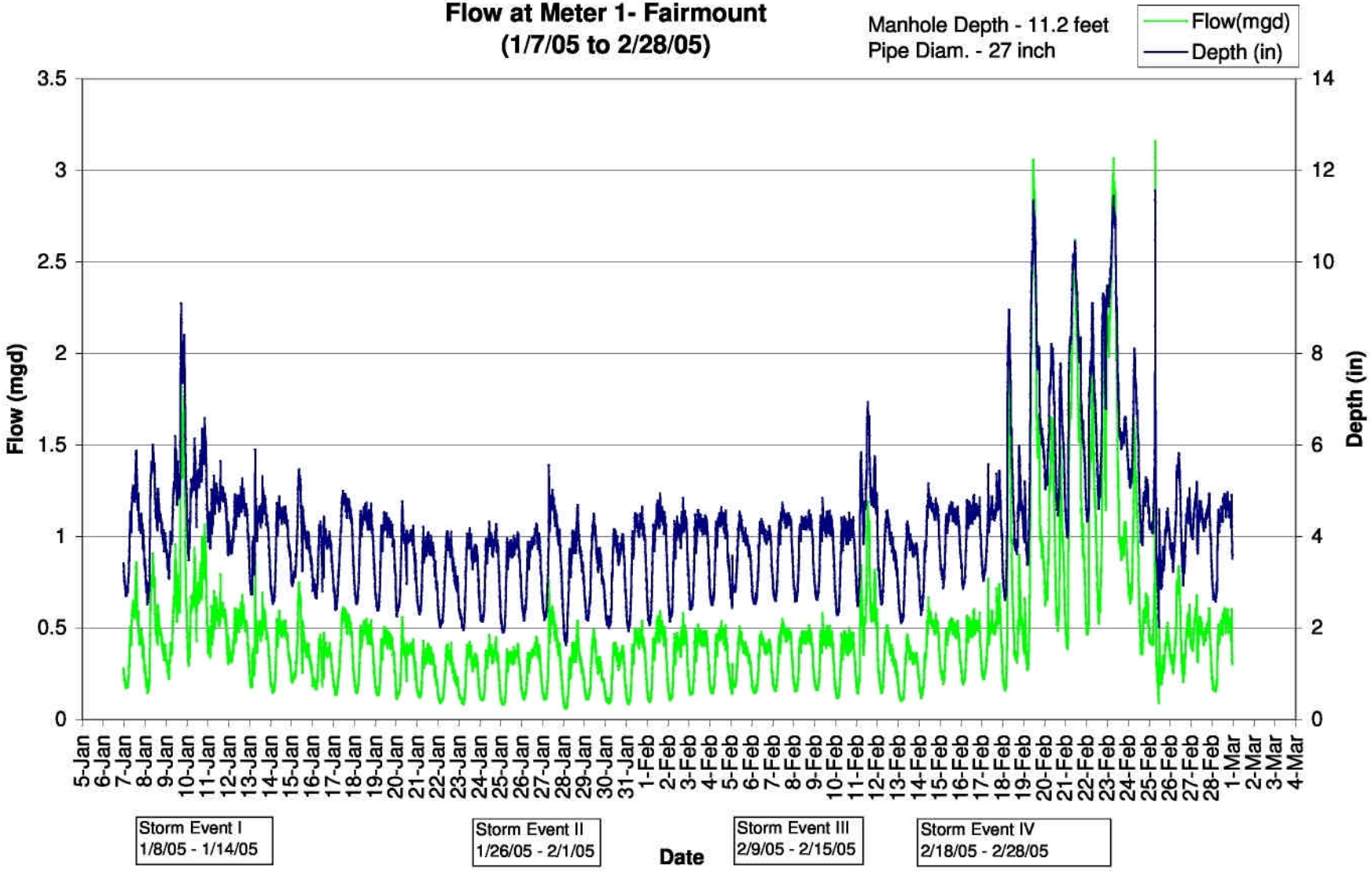
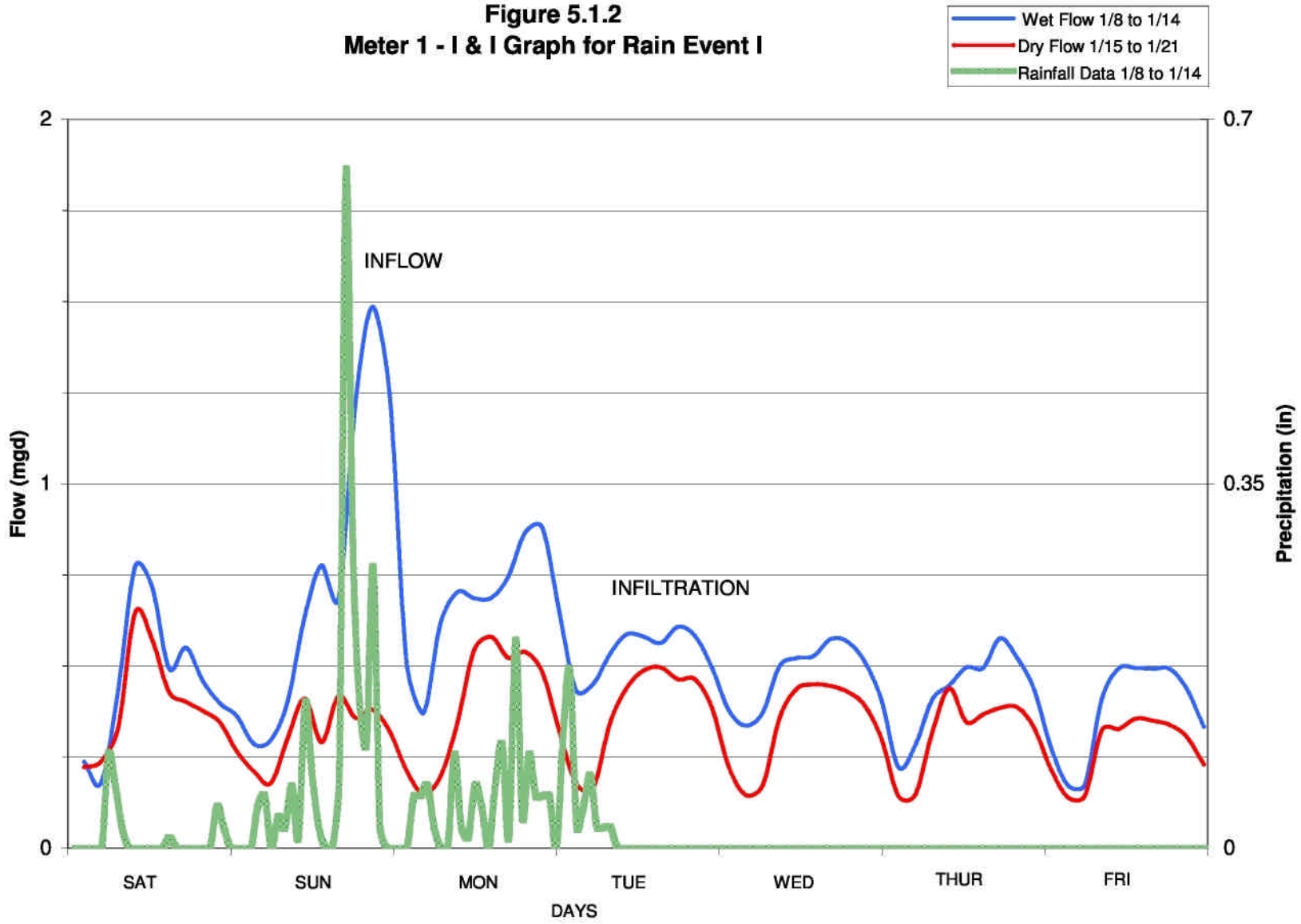


Figure 5.1.2
Meter 1 - I & I Graph for Rain Event I



Station 2

SPRUCE

Figure 5.2.1
Flow at Meter 2 - Spruce
(1/7/05 to 2/28/05)

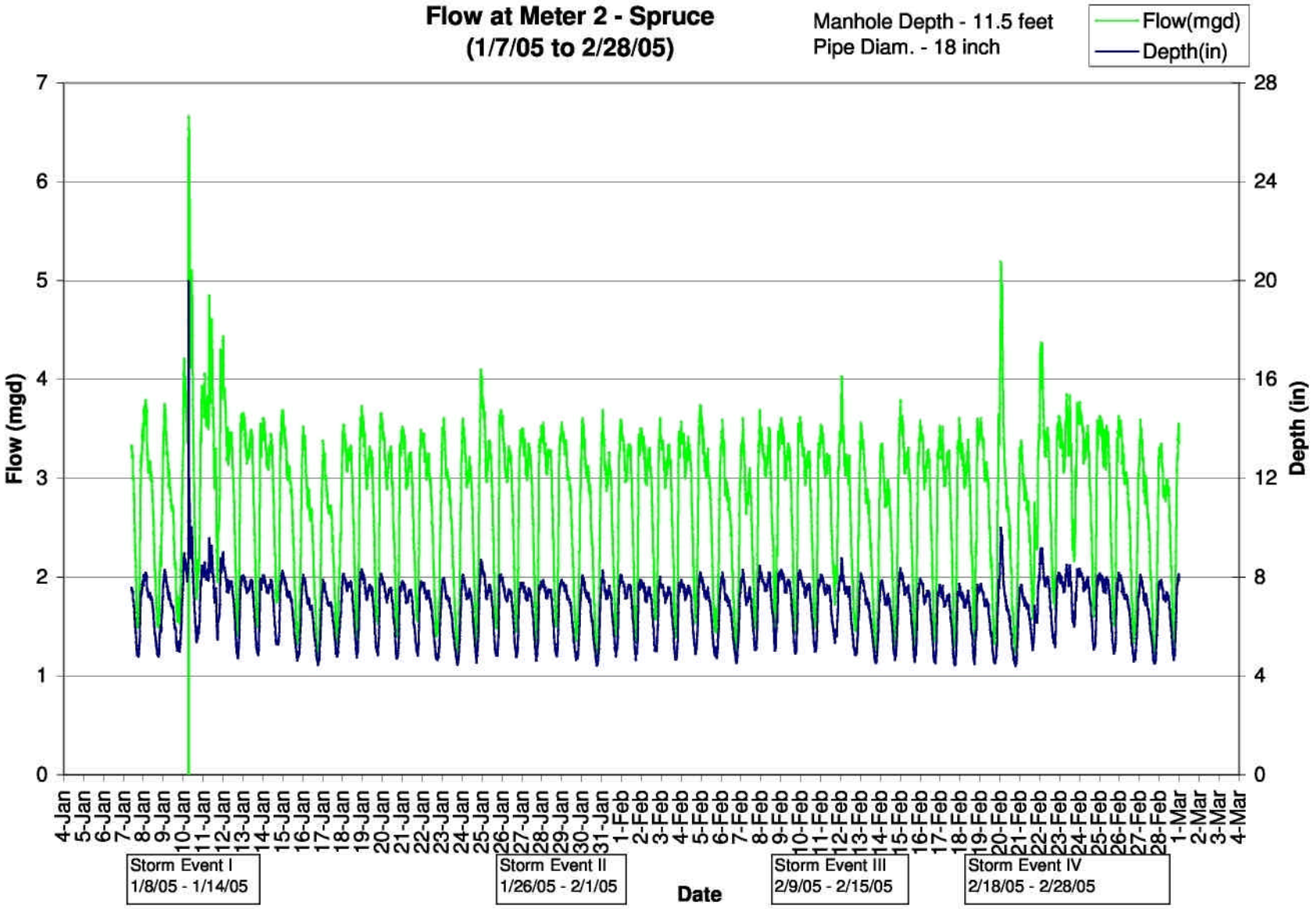
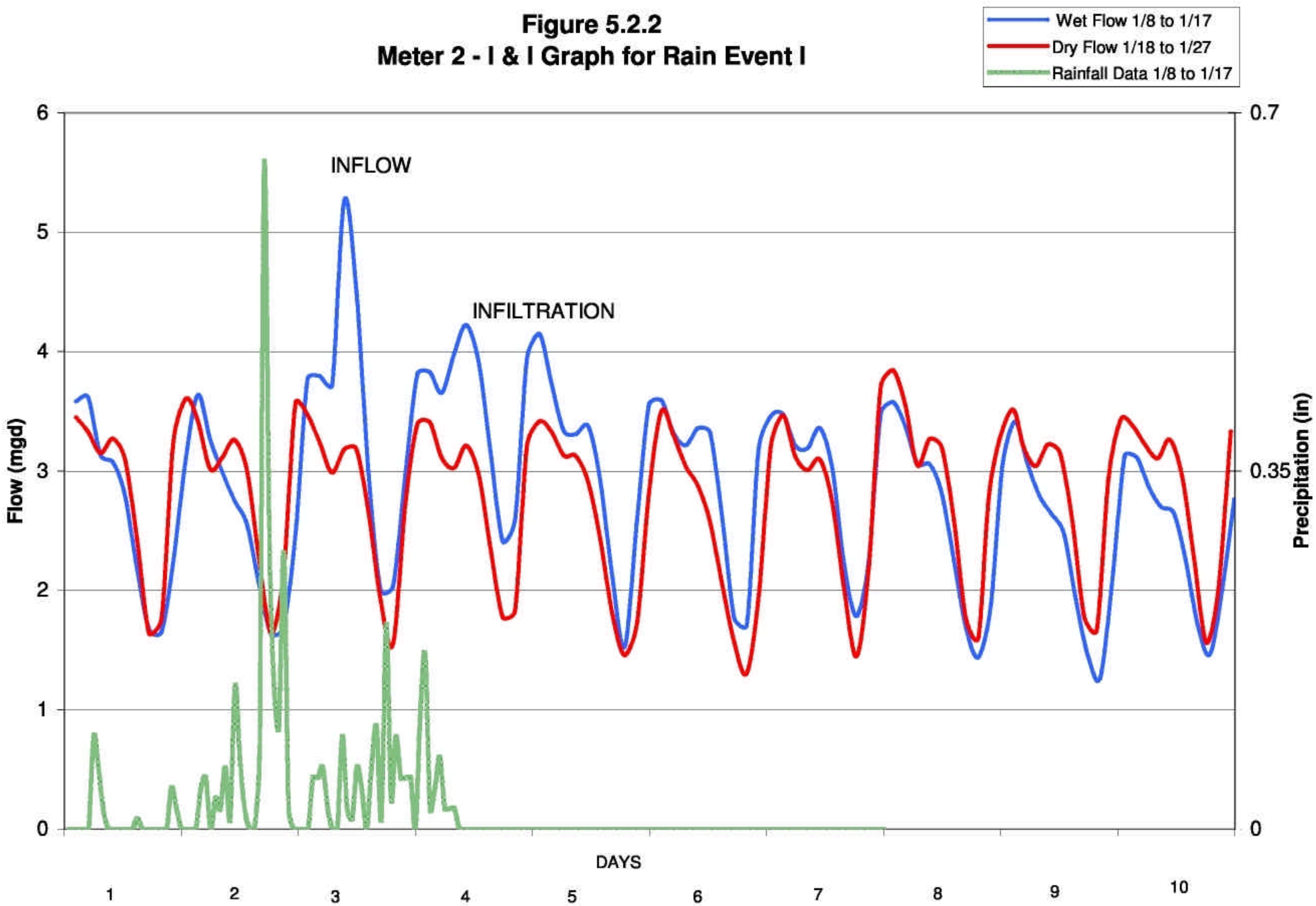


Figure 5.2.2
Meter 2 - I & I Graph for Rain Event I



Storm Event I Jan, 05
Note: A 10 day period was chosen for this storm event, starting and ending on different days.

City of Riverside
Sewer I and I Study

Figure 5.2.3
Meter 2 - I & I Graph for Rain Event II

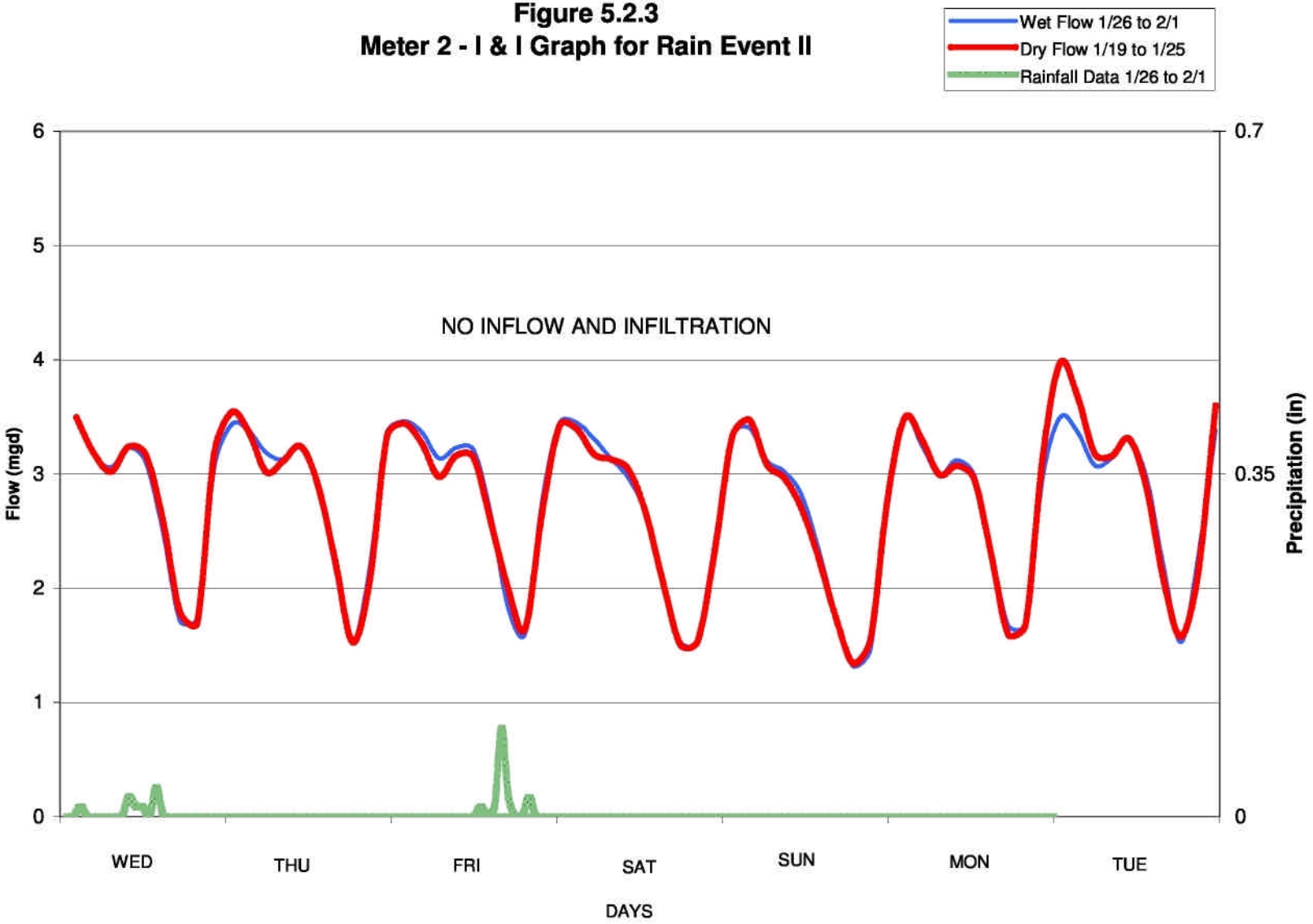


Figure 5.2.4
Meter 2 - I & I Graph for Rain Event III

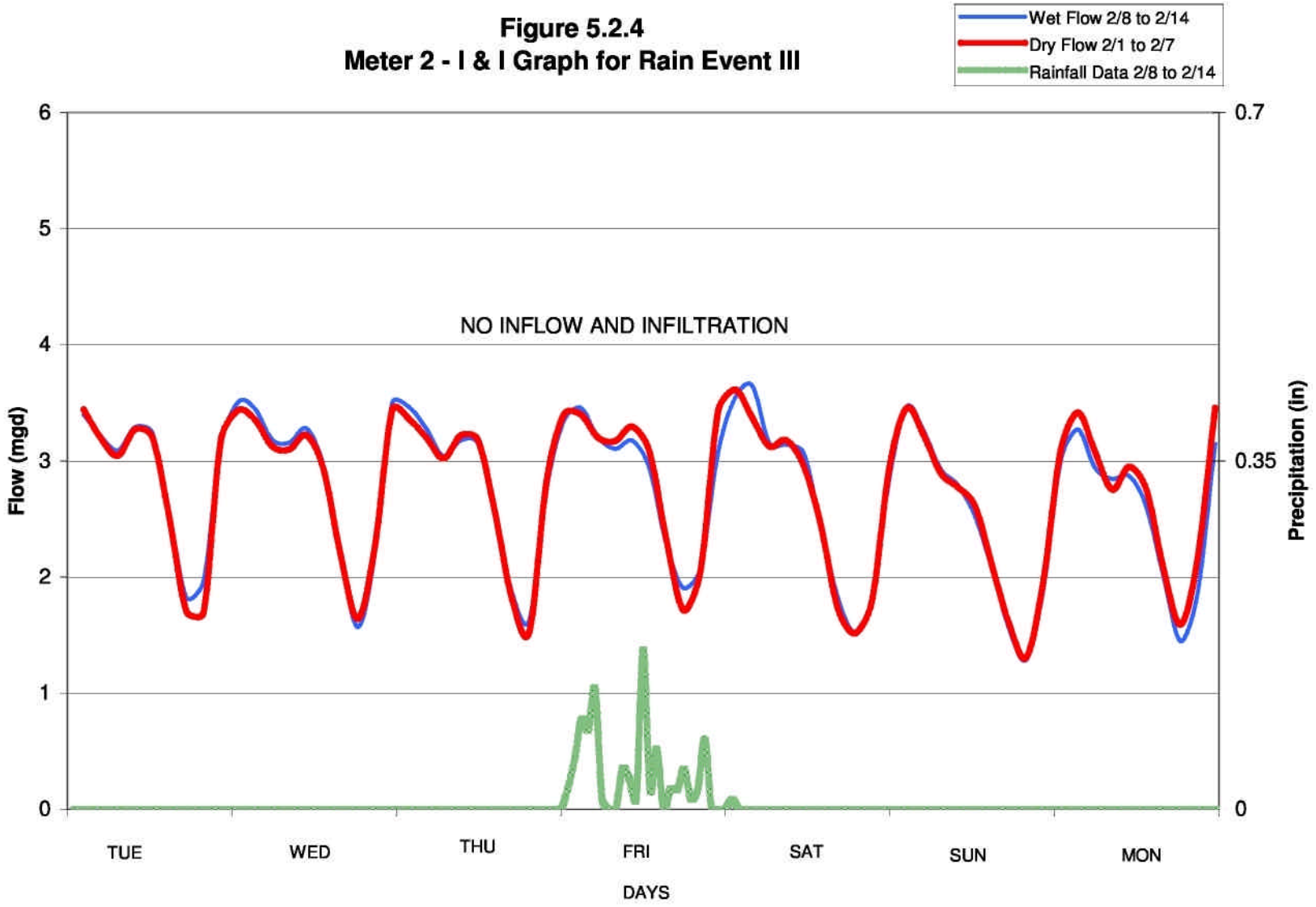
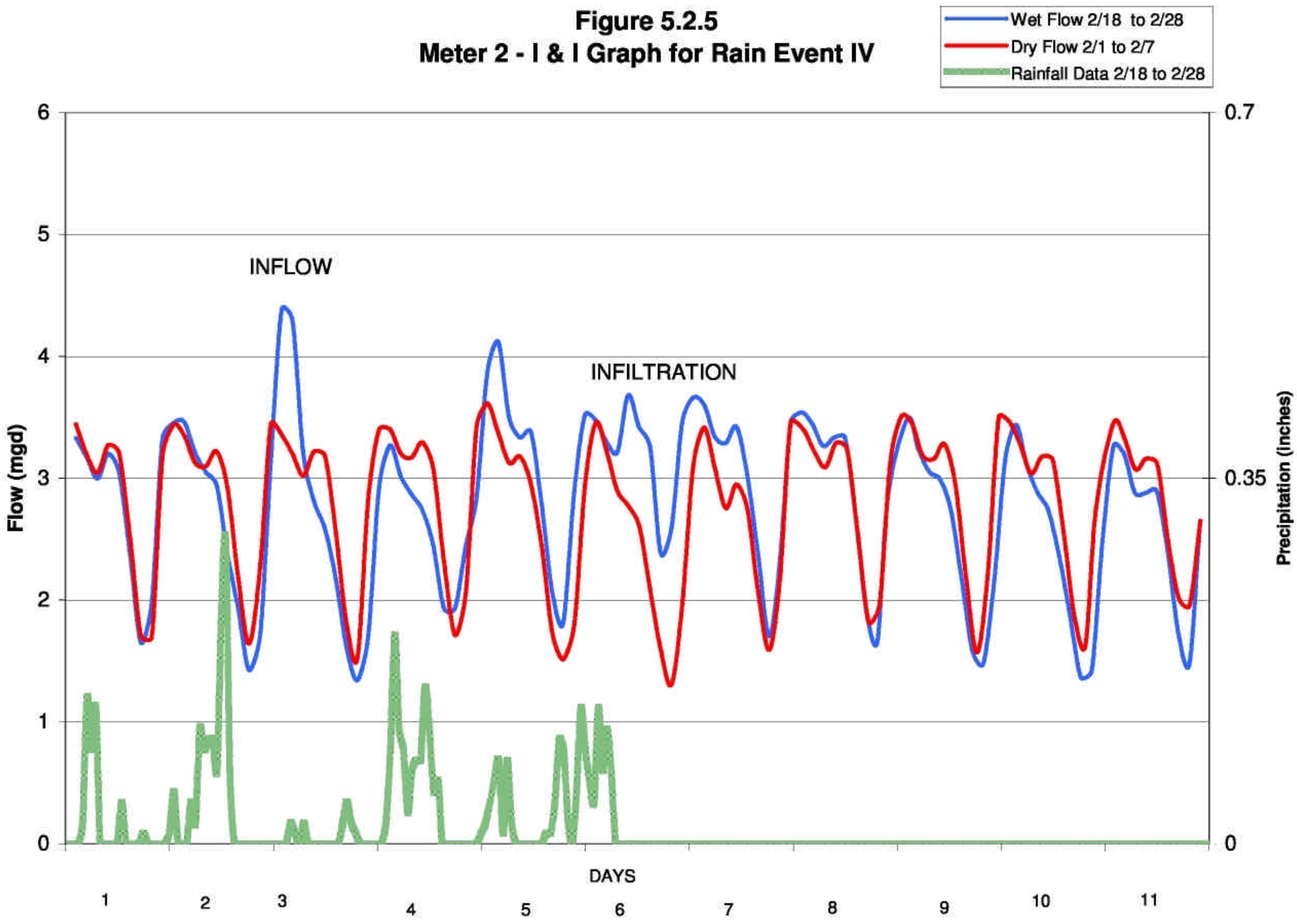


Figure 5.2.5
Meter 2 - I & I Graph for Rain Event IV



Storm Event IV Feb, 05
Note: An 11 day period was chosen for this storm event, starting and ending on different days.

City of Riverside
Sewer I and I Study

Station 3

GOLF COURSE

Figure 5.3.1
Flow at Meter 3 - Golf Course
(1/7/05 to 2/28/05)

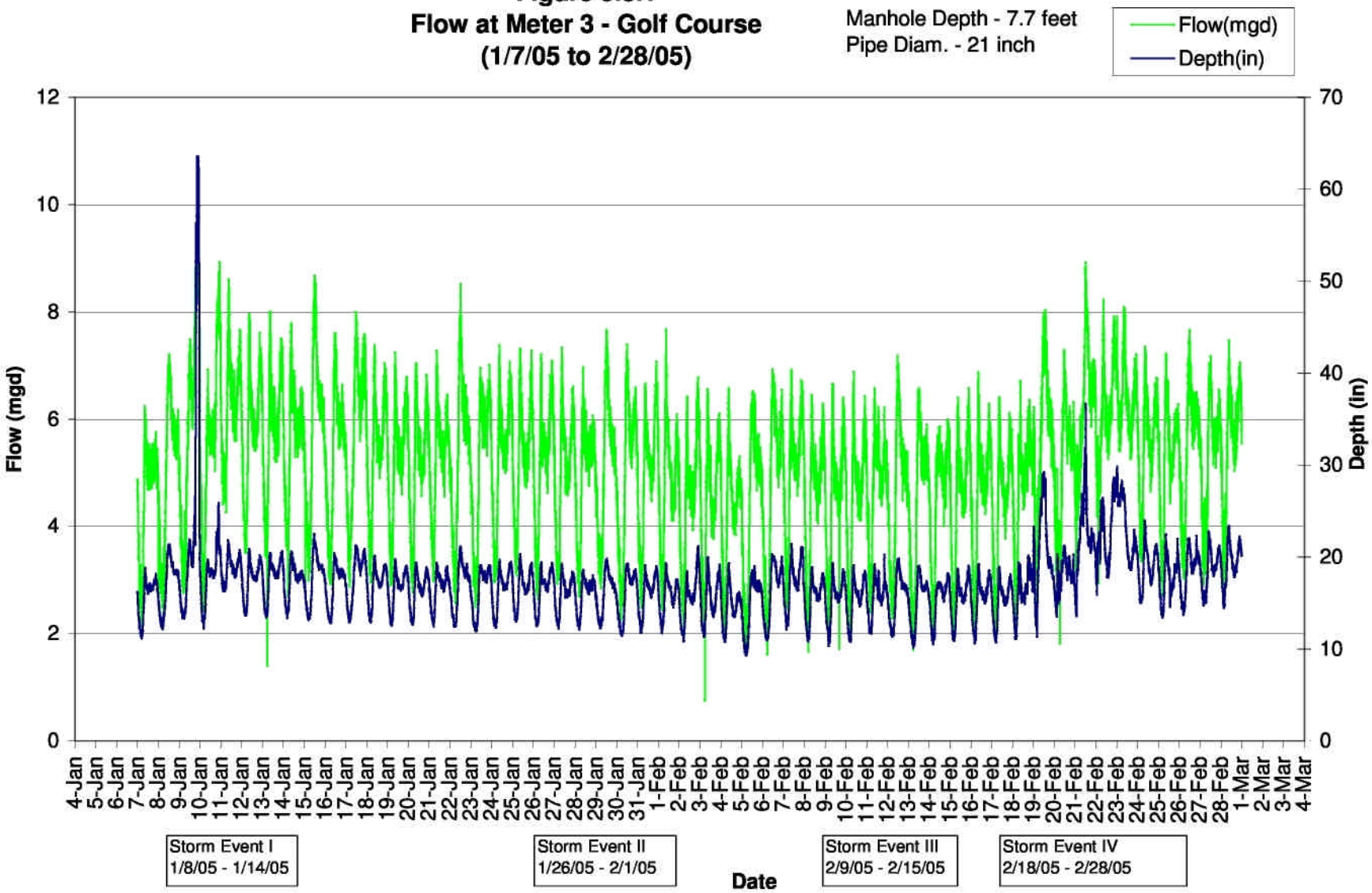
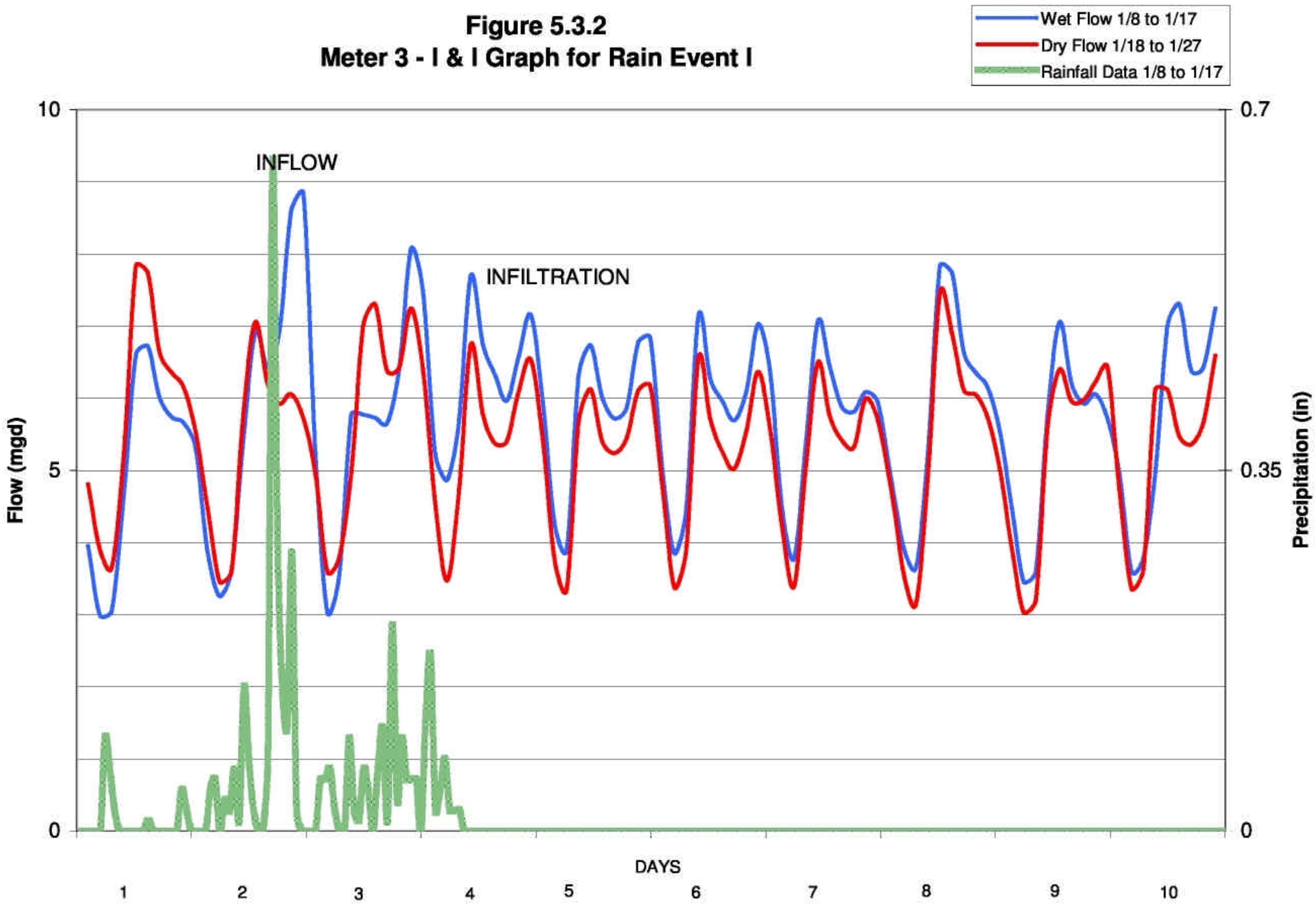


Figure 5.3.2
Meter 3 - I & I Graph for Rain Event I



Storm Event I Jan, 05
Note: A 10-day period was chosen for this storm event, starting and ending on different days.

City of Riverside
Sewer I and I Study

Figure 5.3.3
Meter 3 - I & I Graph for Rain Event II

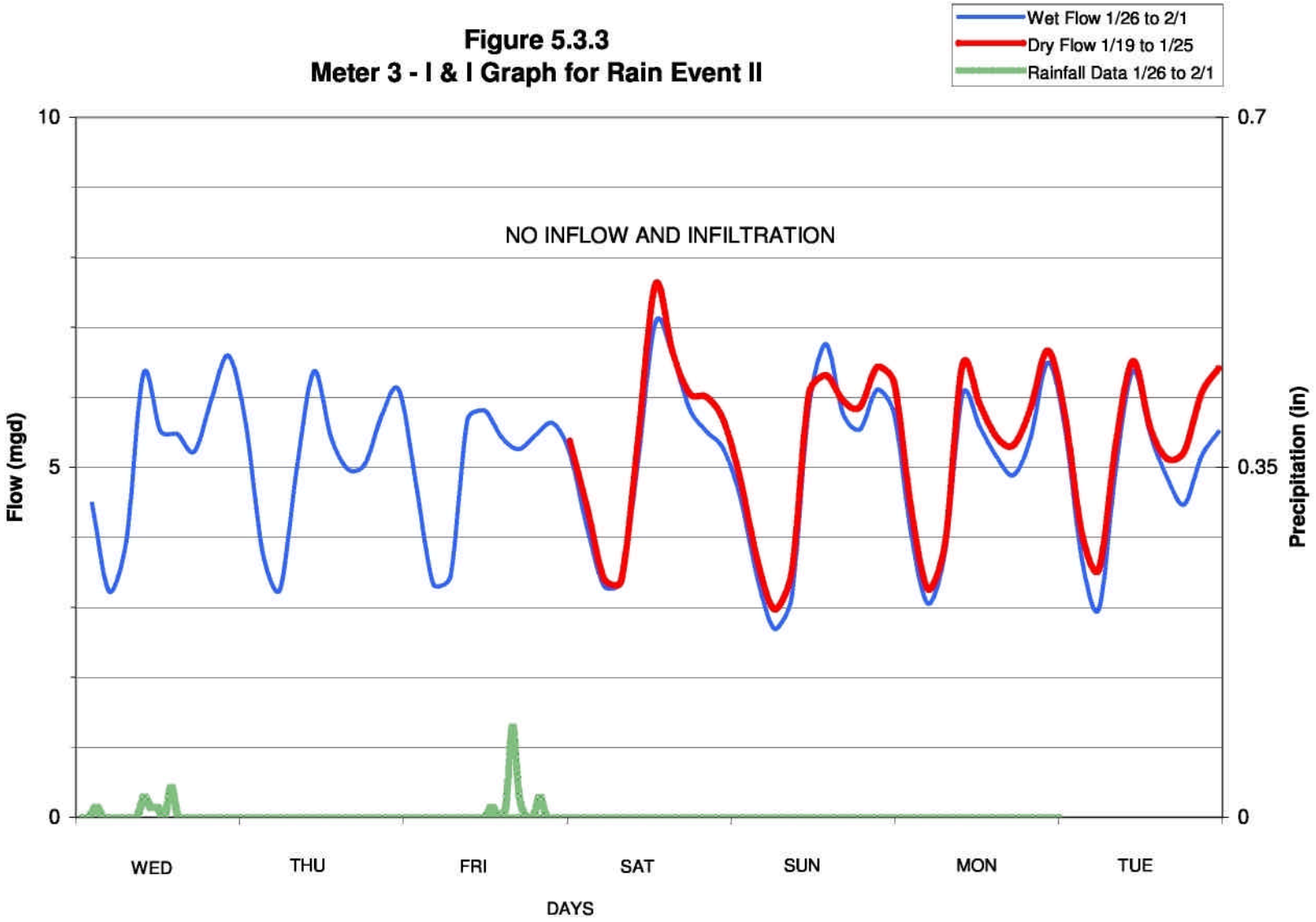


Figure 5.3.4
Meter 3 - I & I Graph for Rain Event III

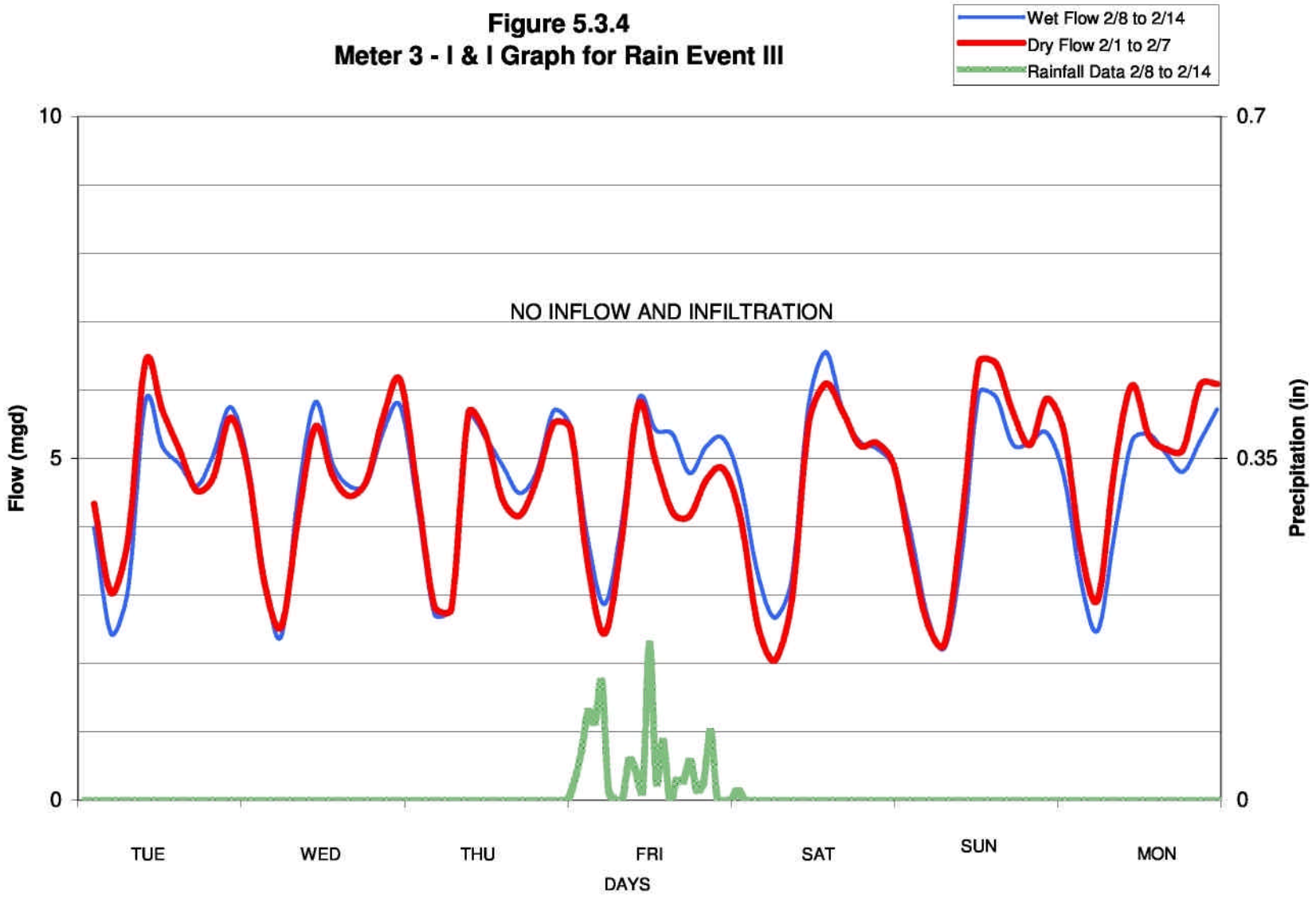
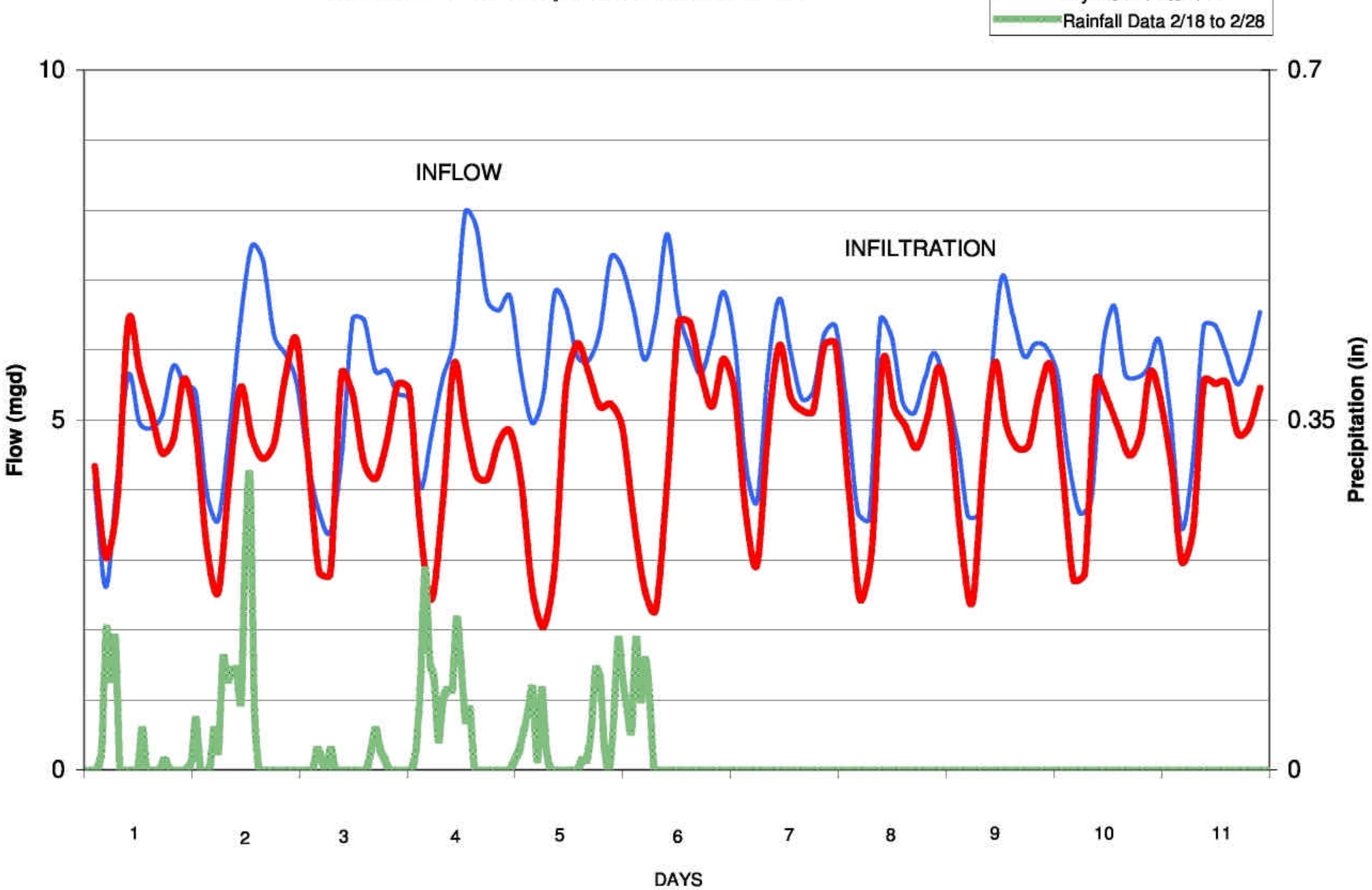


Figure 5.3.5
Meter 3 - I & I Graph for Rain Event IV



Storm Event IV Feb, 05
Note: An 11 day period was chosen for this storm event, starting and ending on different days.

City of Riverside
Sewer I and I Study

Station 4

BROCKTON

Figure 5.4.1
Flow at Meter 4 - Brockton
(1/7/05 to 2/28/05)

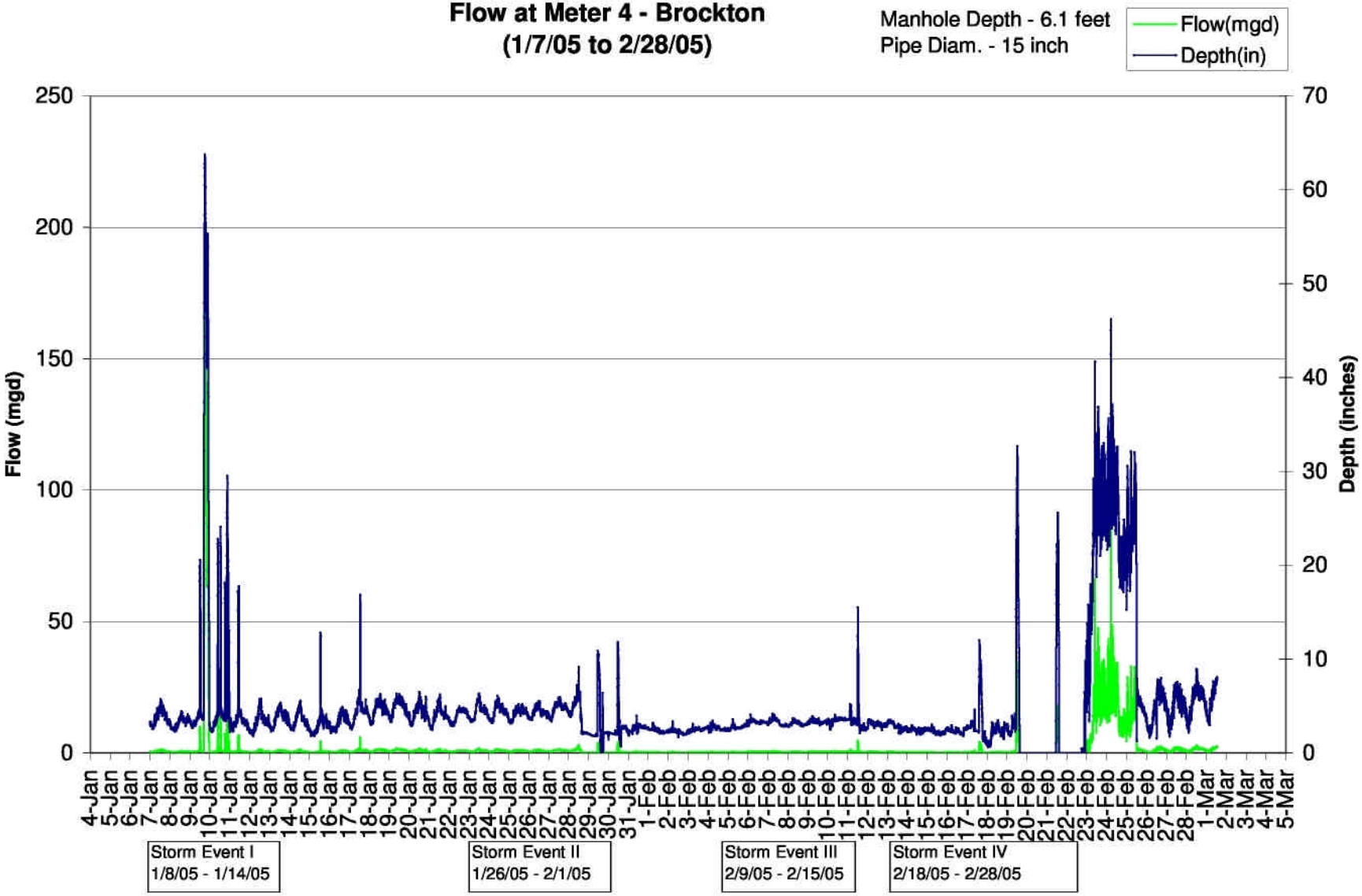
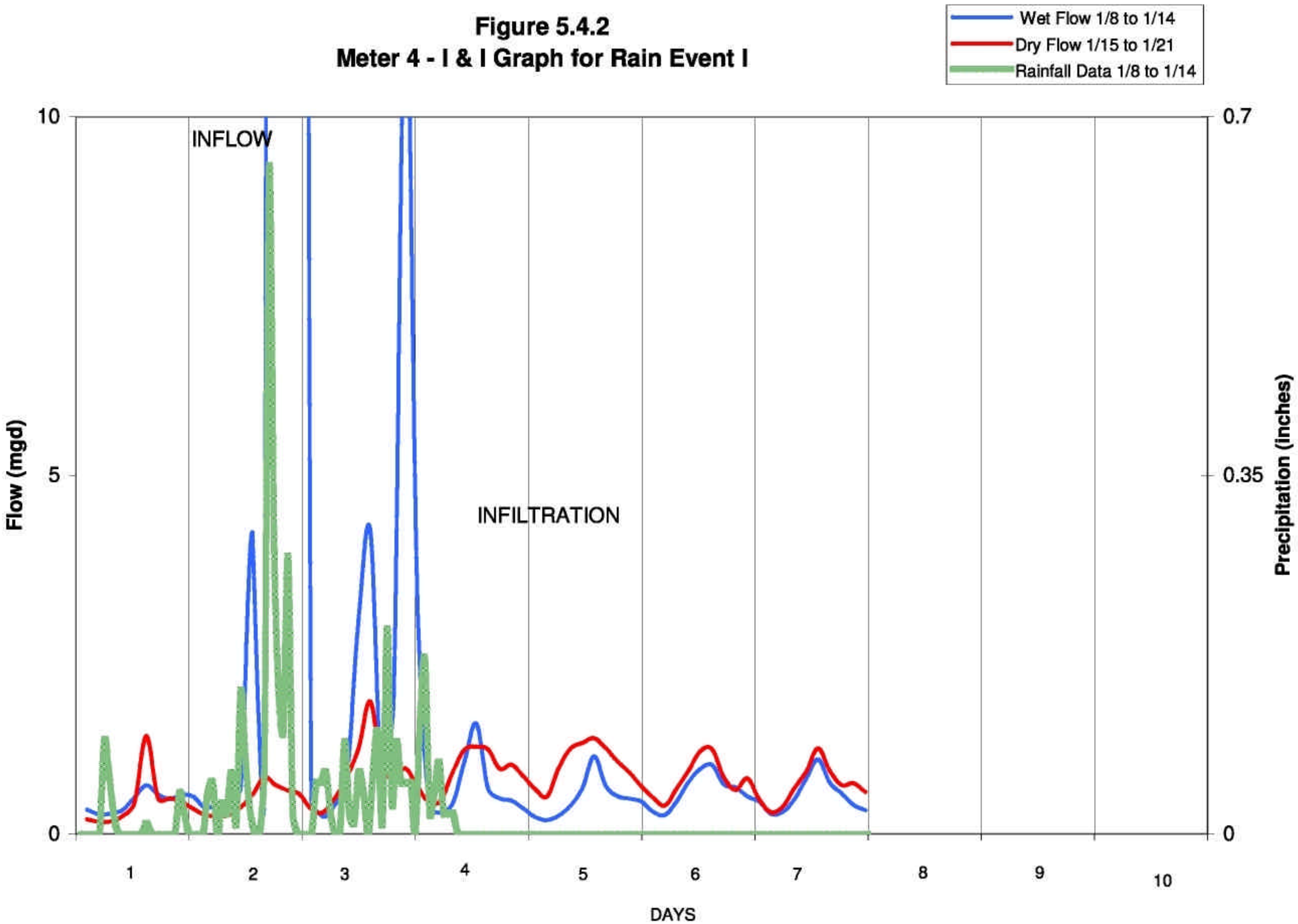


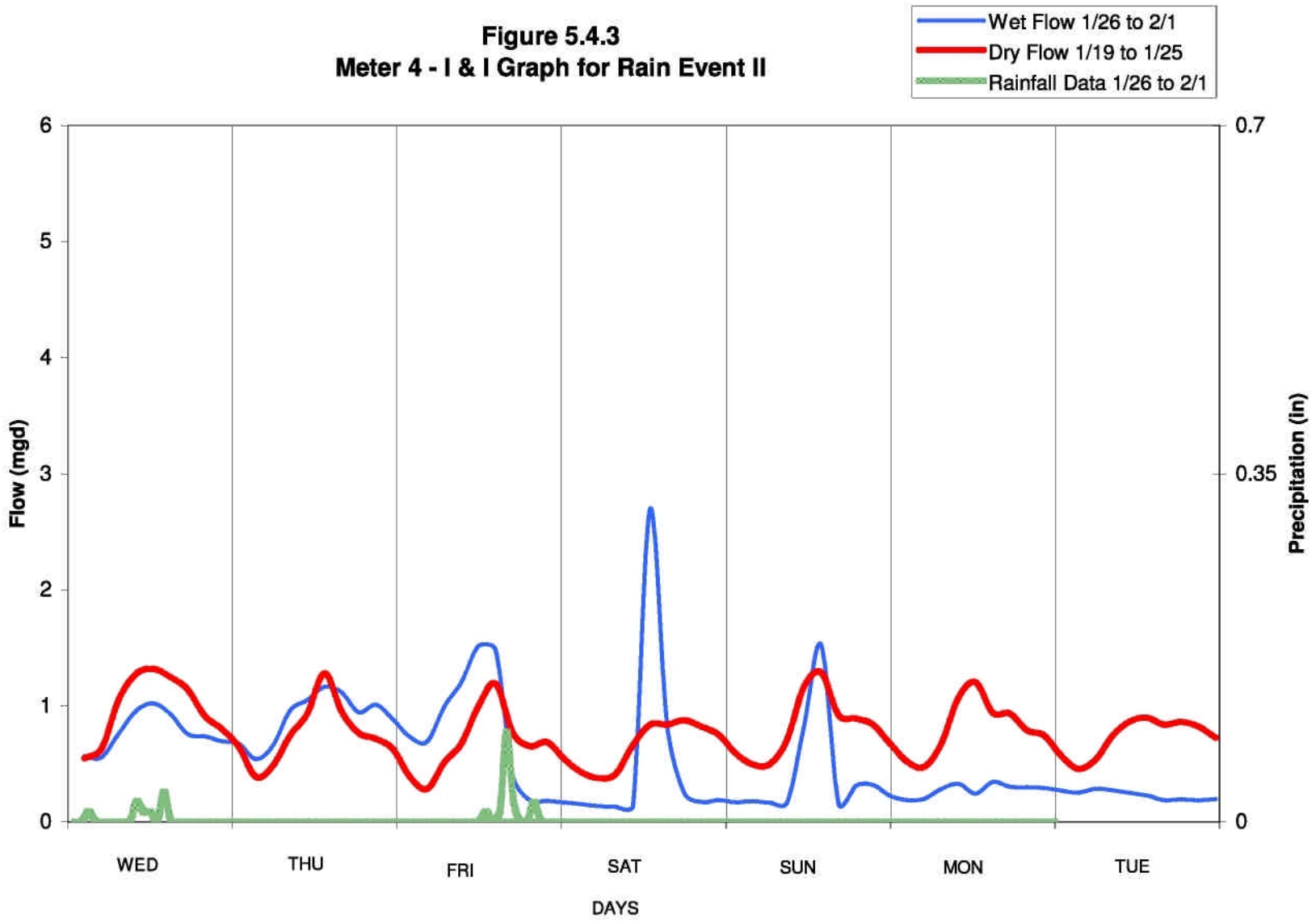
Figure 5.4.2
Meter 4 - I & I Graph for Rain Event I



Storm Event I Jan, 05
Note: A 10-day period was chosen for this storm event, starting and ending on different days.

City of Riverside
Sewer I and I Study

Figure 5.4.3
Meter 4 - I & I Graph for Rain Event II



Station 5

TEQUESQUITE

Figure 5.5.1
Flow Chart at Meter 5 - Tequesquite
(1/7/05 to 2/28/05)

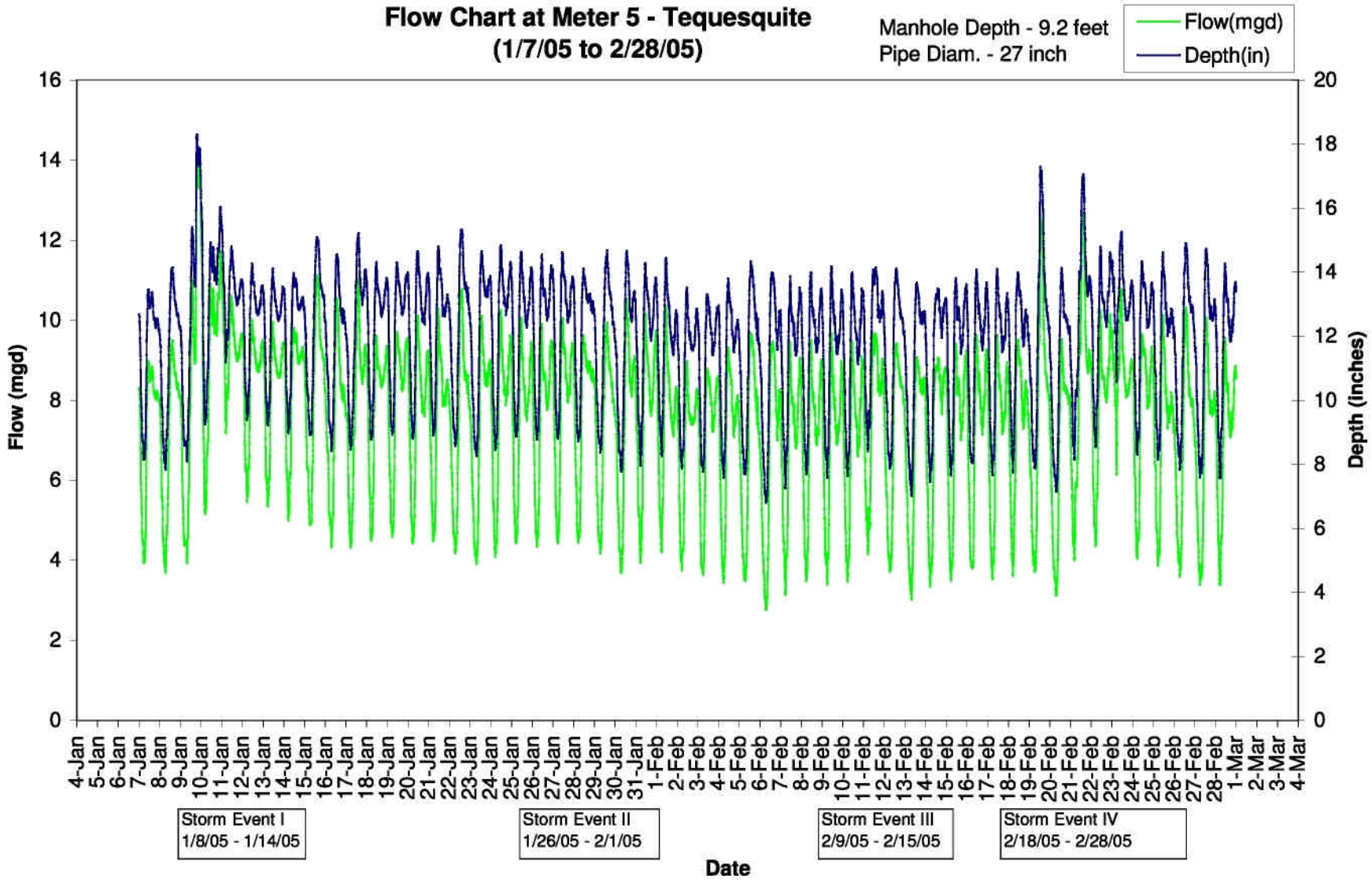


Figure 5.5.2
Meter 5 - I & I Graph for Rain event I

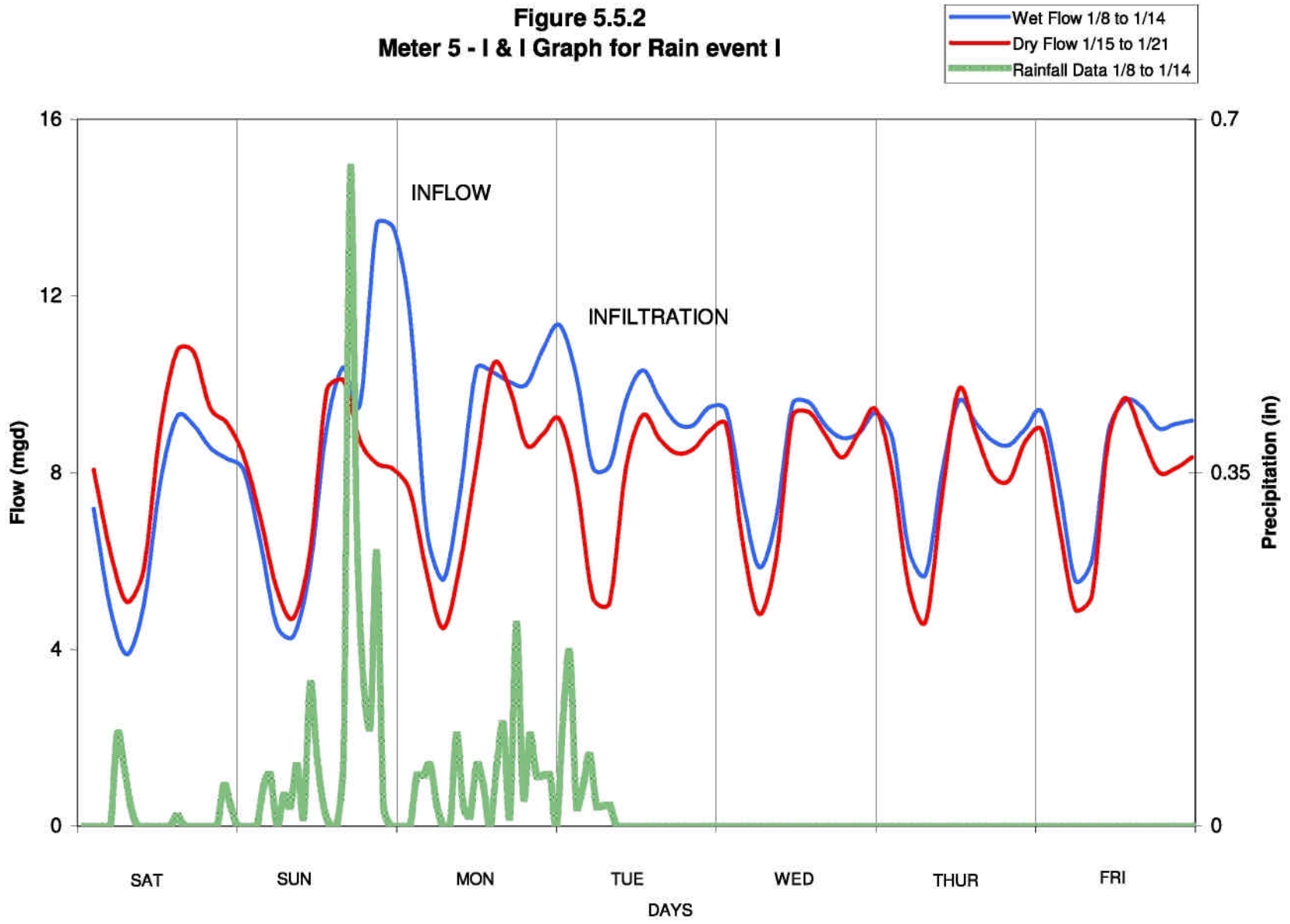


Figure 5.5.3
Meter 5 - I & I Graph for Rain Event II

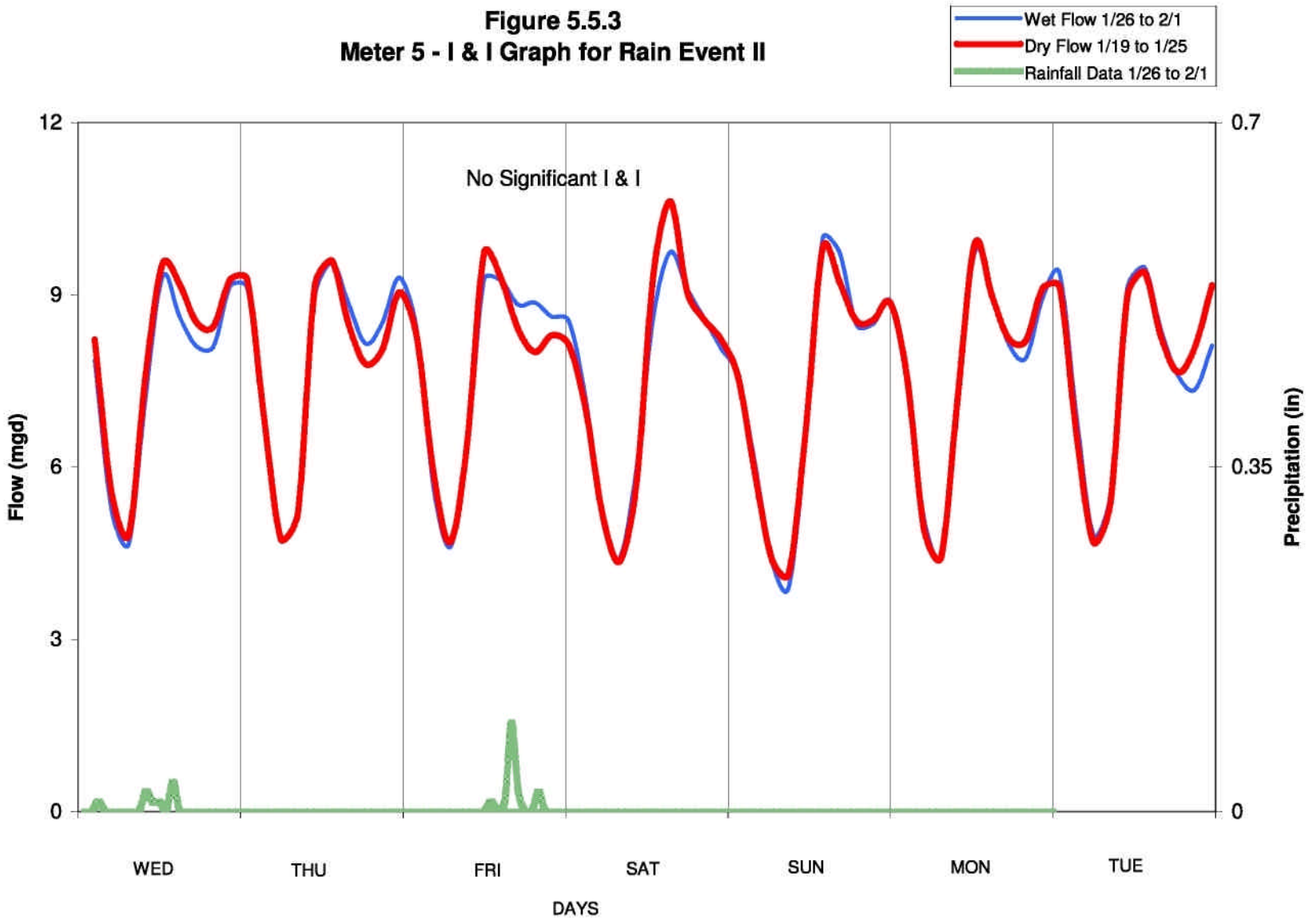


Figure 5.5.4
Meter 5 - I & I Graph for Rain Event III

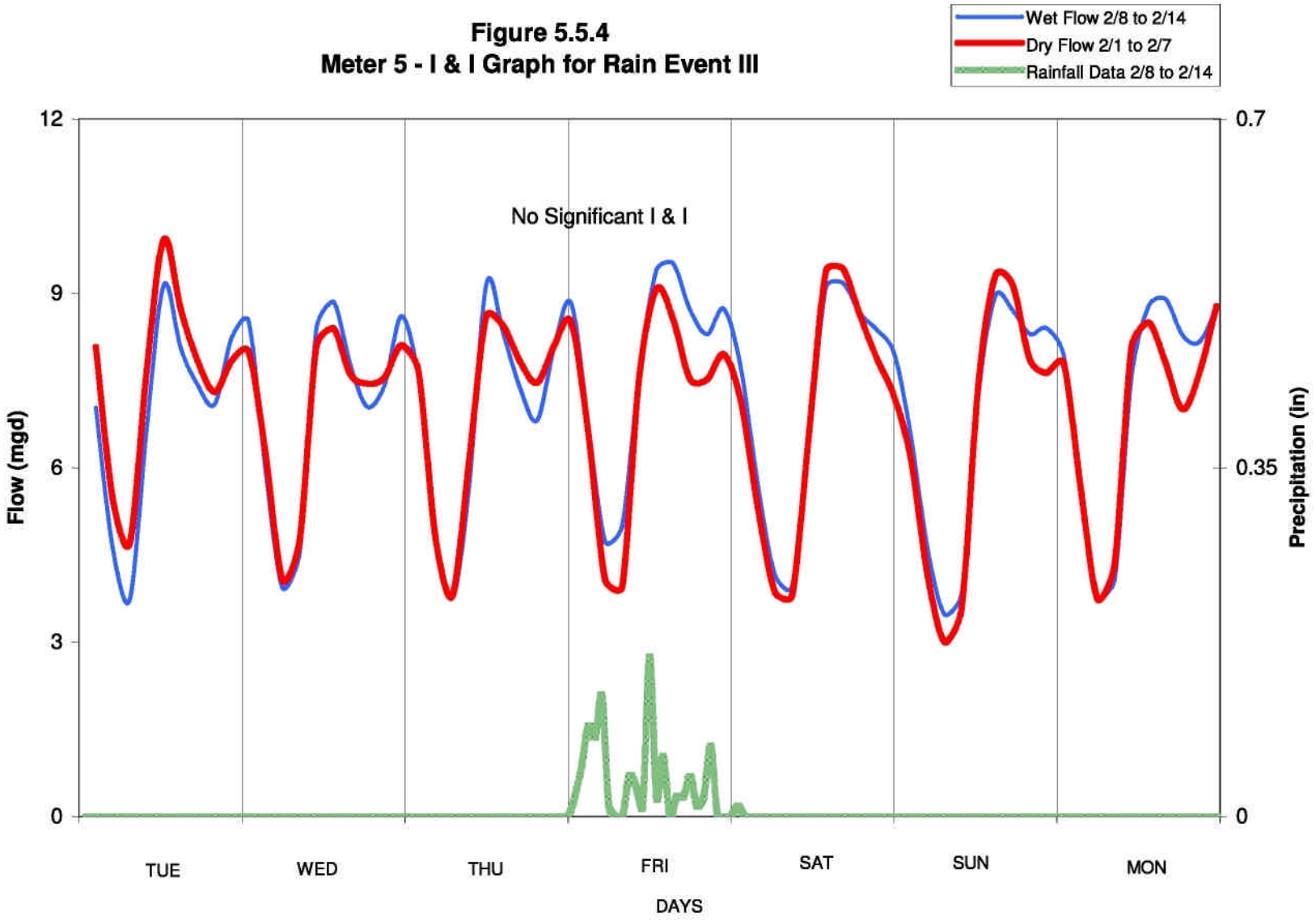
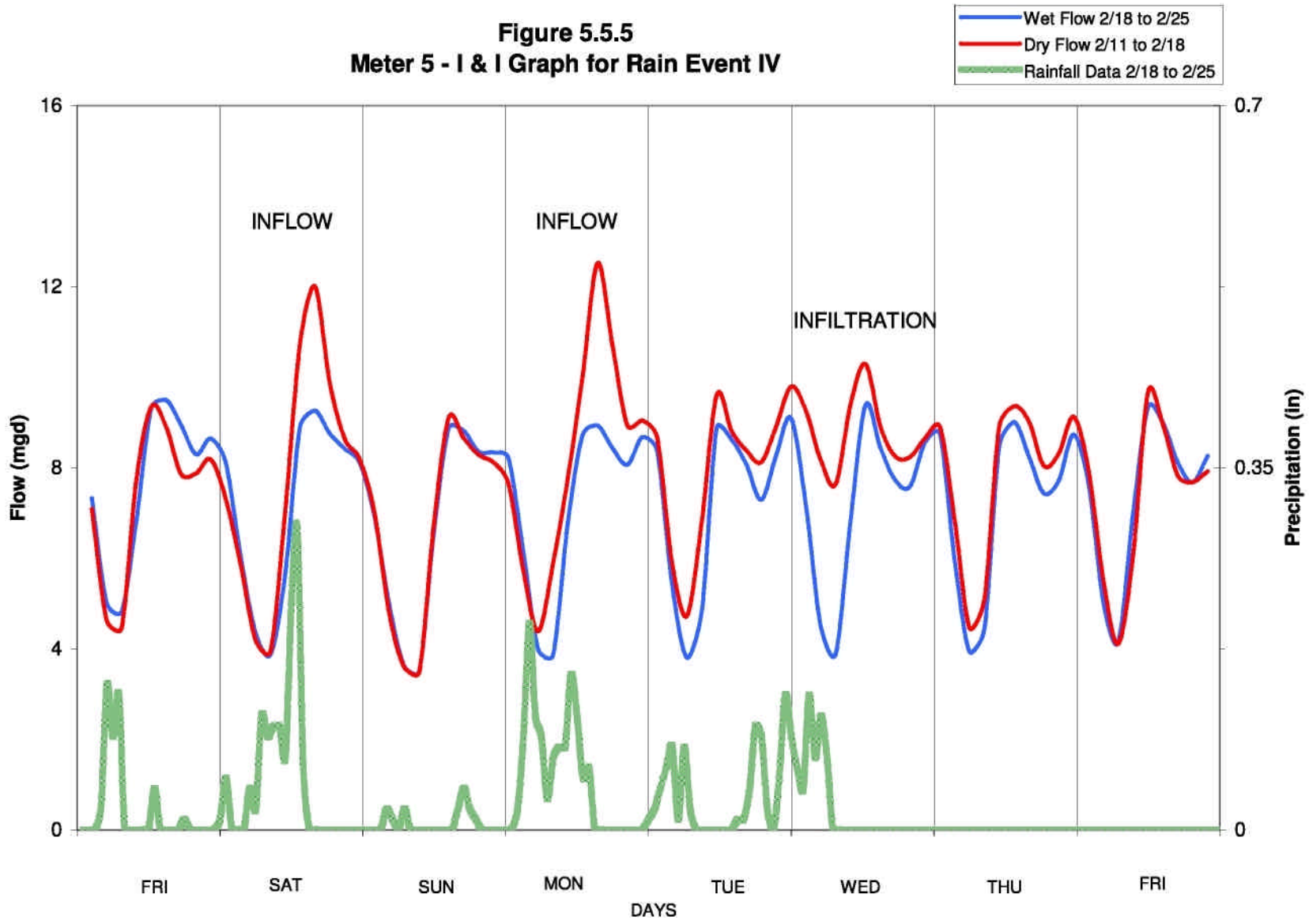


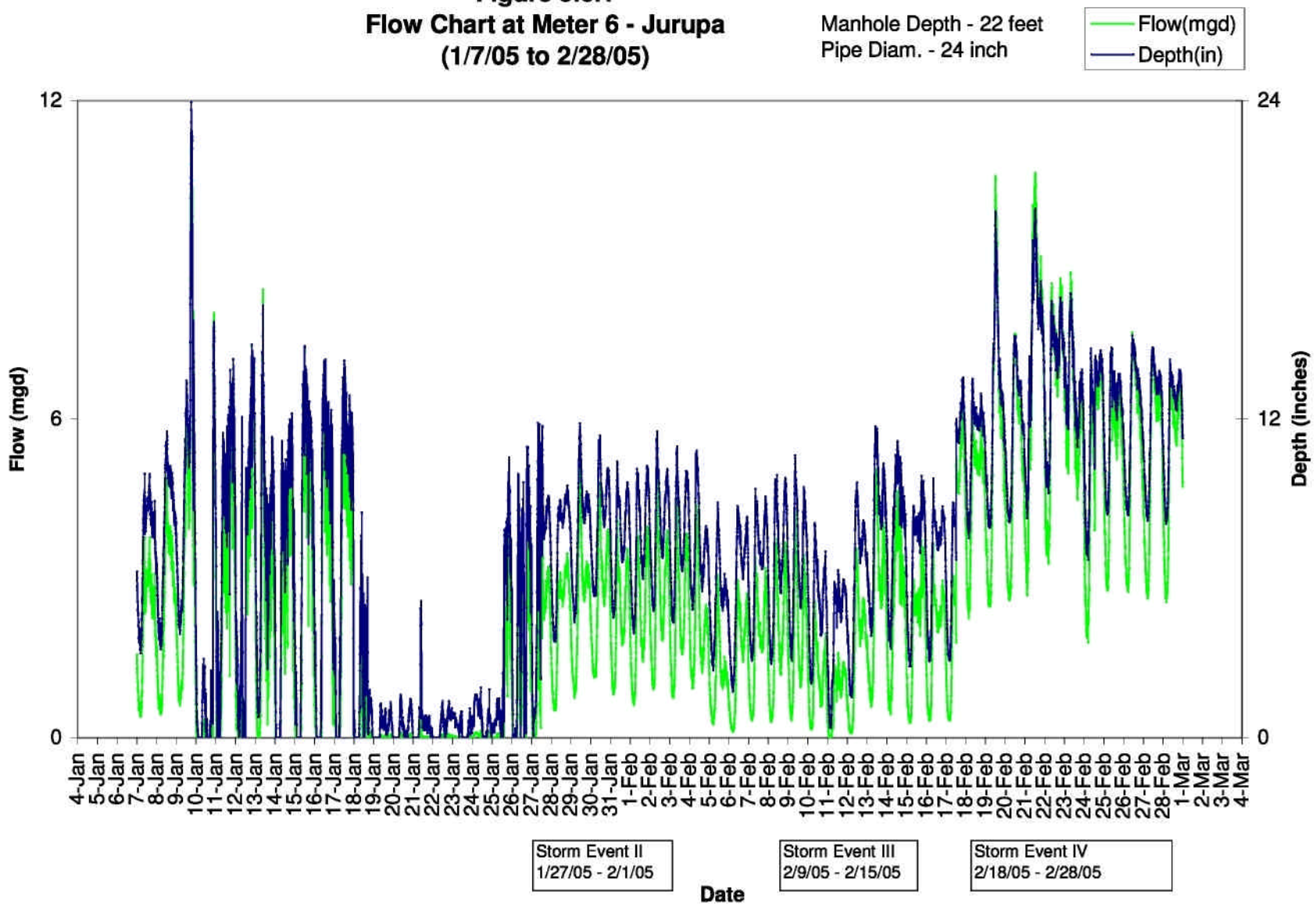
Figure 5.5.5
Meter 5 - I & I Graph for Rain Event IV



Station 6

JURUPA

Figure 5.6.1
Flow Chart at Meter 6 - Jurupa
(1/7/05 to 2/28/05)



Station 7
ARLINGTON

Figure 5.7.1
Flow Chart at Meter 7 - Arlington
(1/7/05 to 2/28/05)

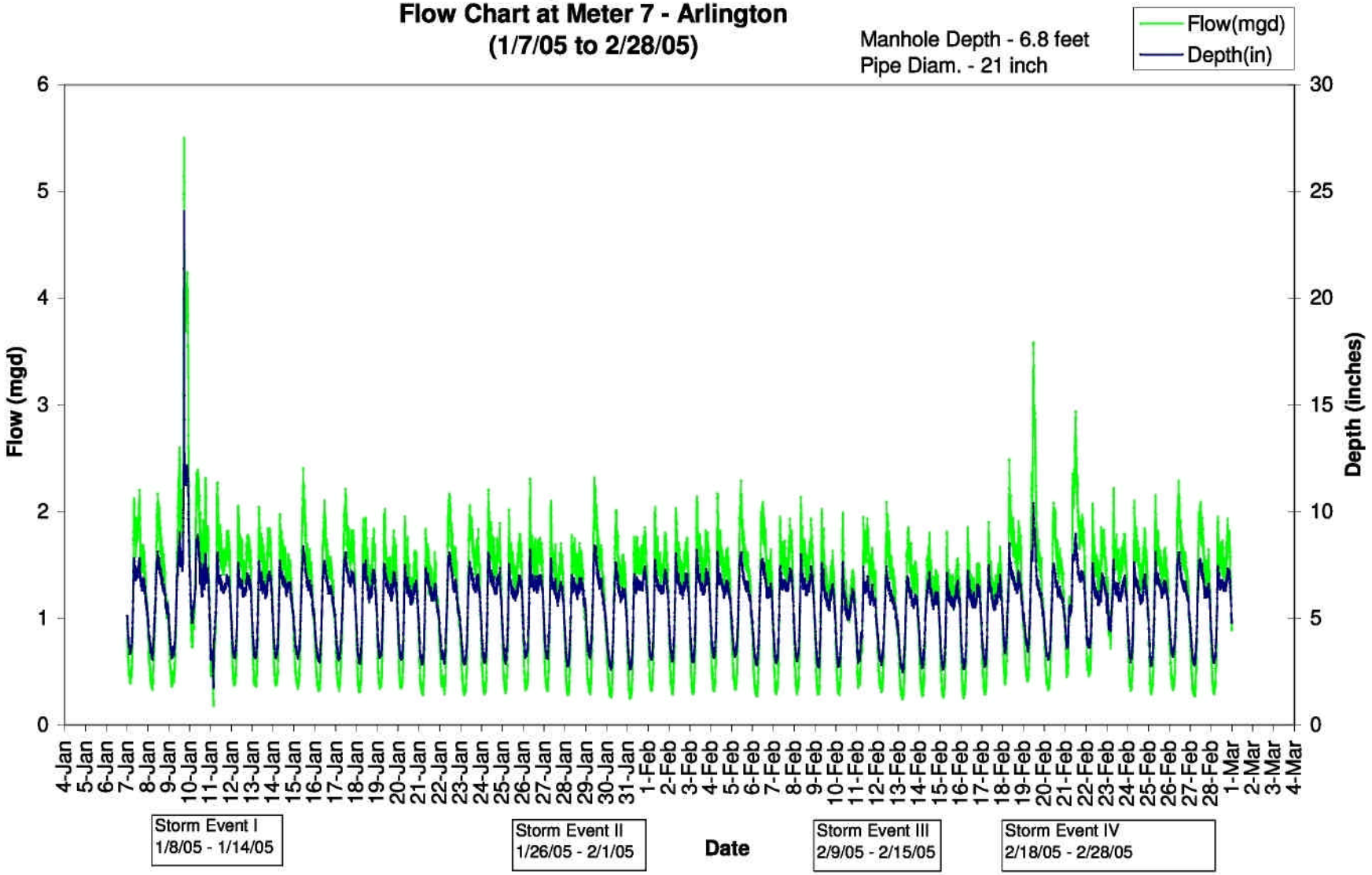


Figure 5.7.2
Meter 7 - I & I for Rain Event I

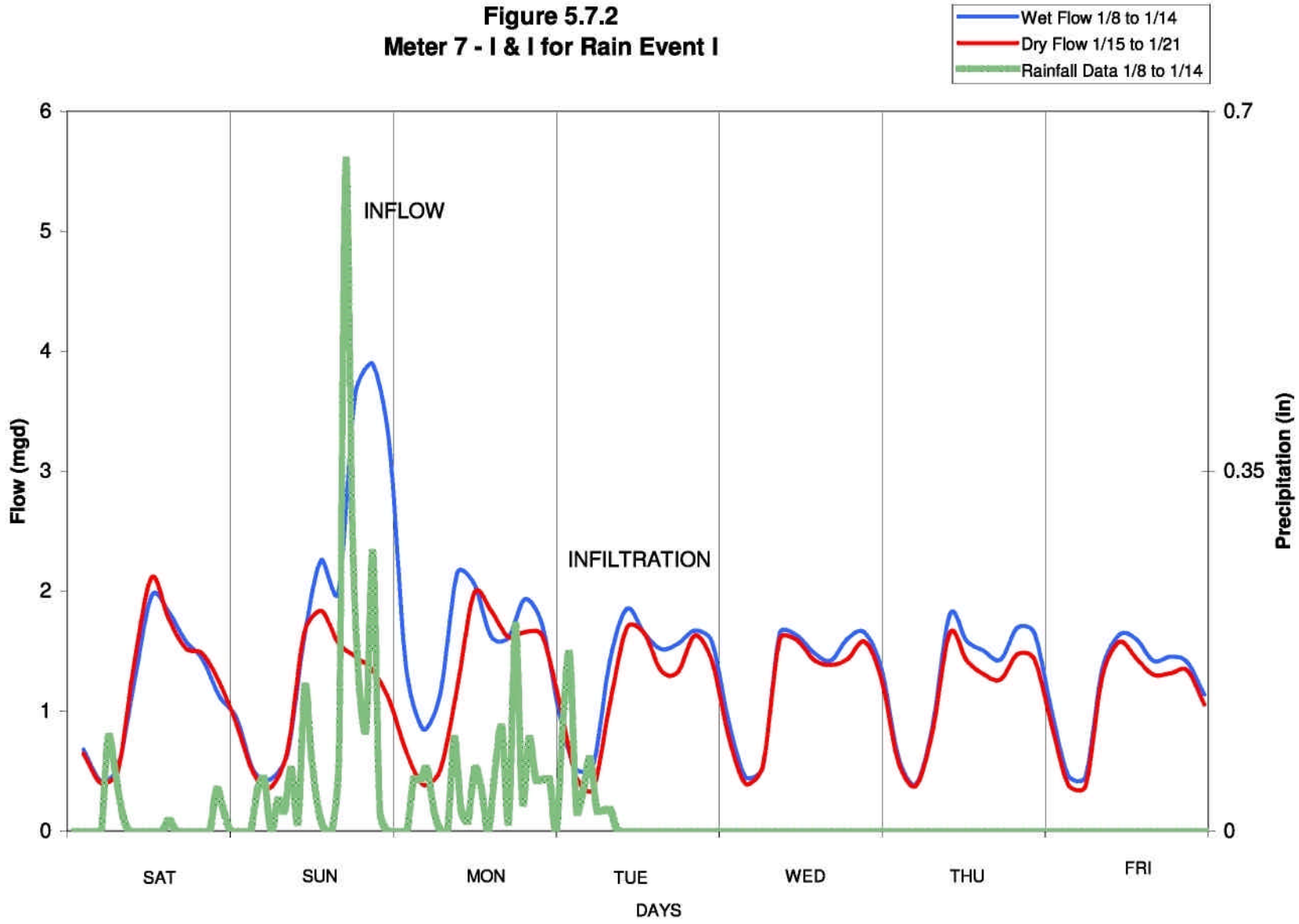


Figure 5.7.3
Meter 7 - I & I Graph for Rain Event II

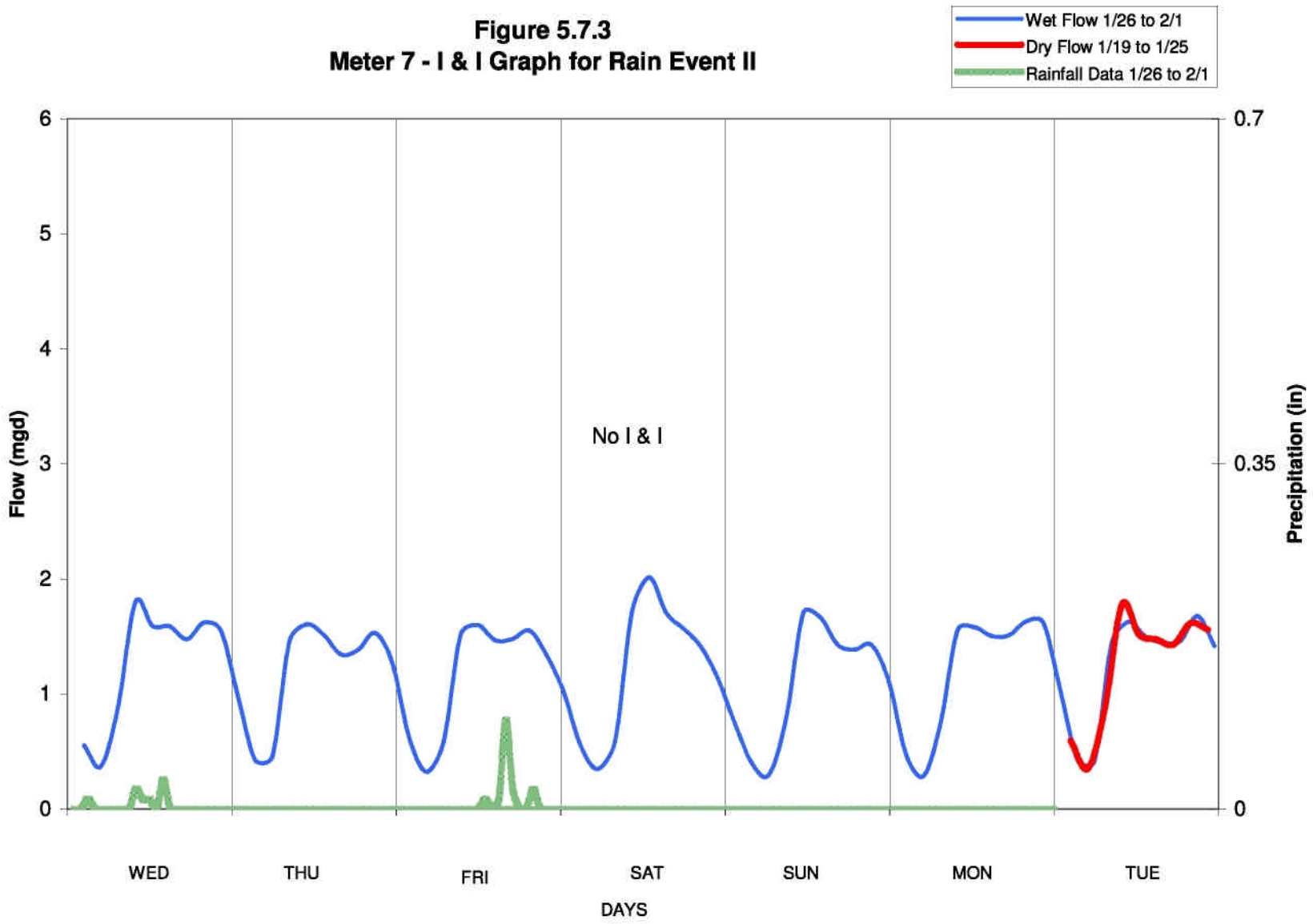


Figure 5.7.4
Meter 7 - I & I Graph for Rain Event III

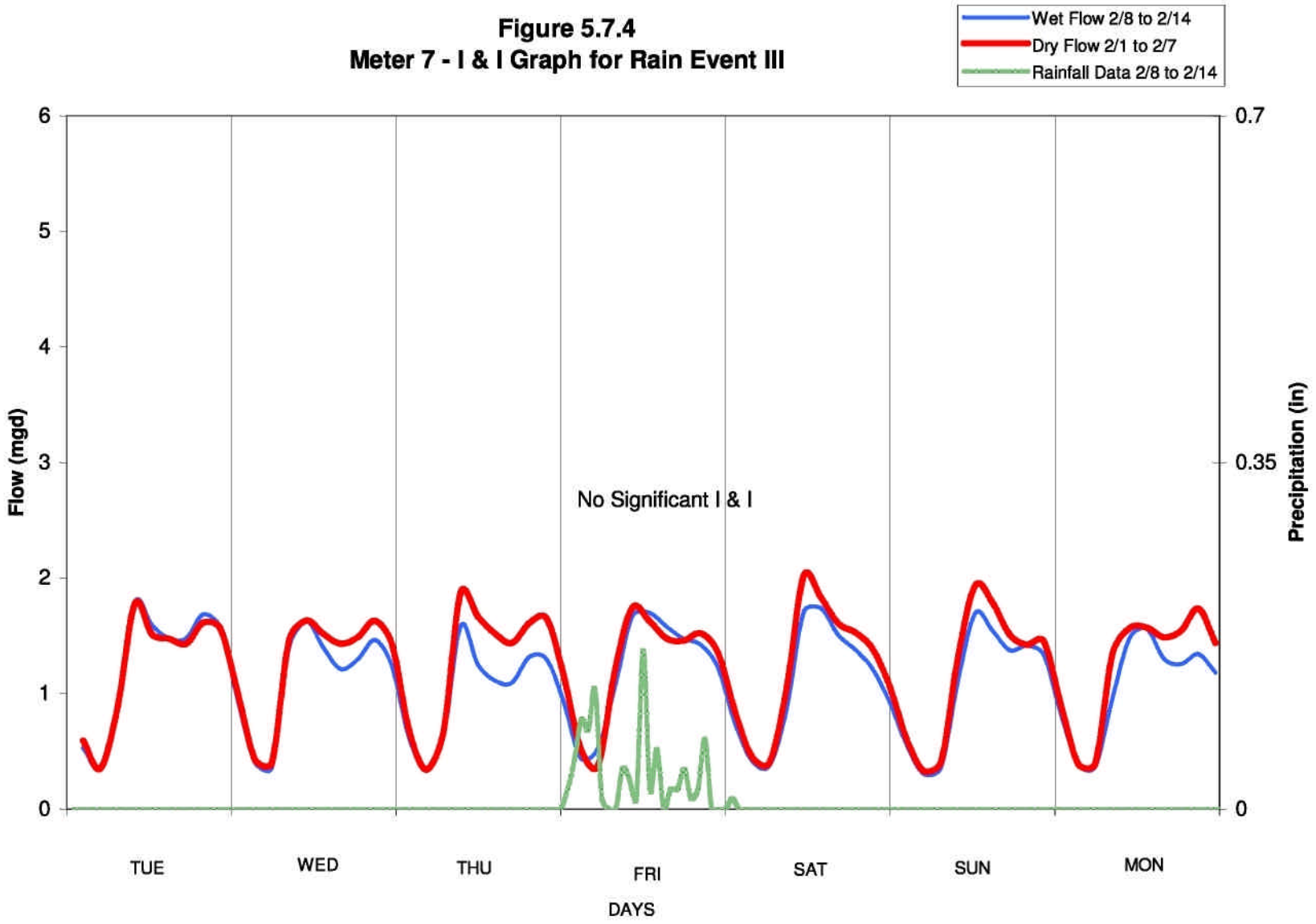
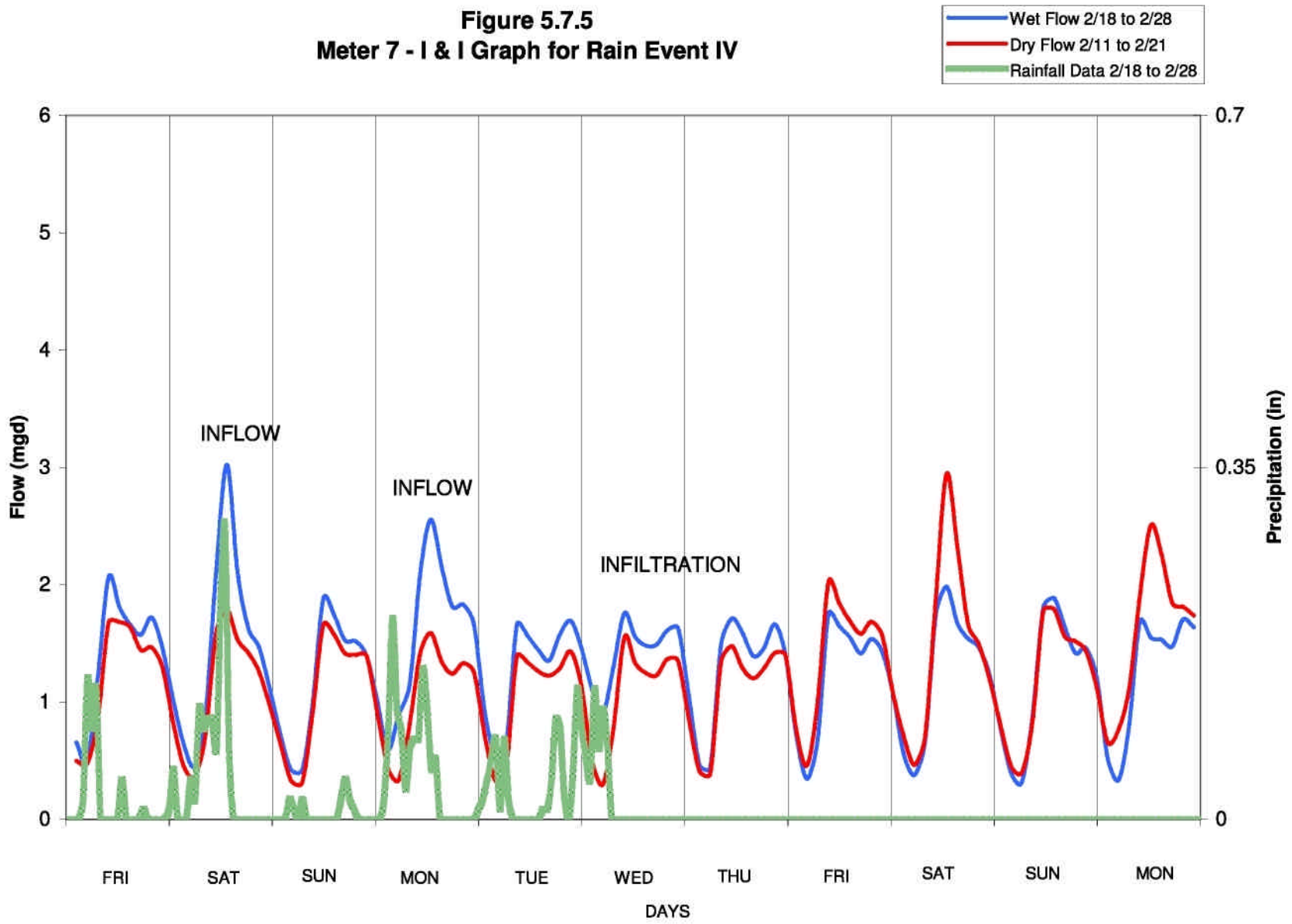


Figure 5.7.5
Meter 7 - I & I Graph for Rain Event IV



Storm Event IV Feb 05

Station 8

RWQCP

Figure 5.8.1
Flow Chart at Meter 8 - Treatment Plant
(1/7/05 to 2/28/05)

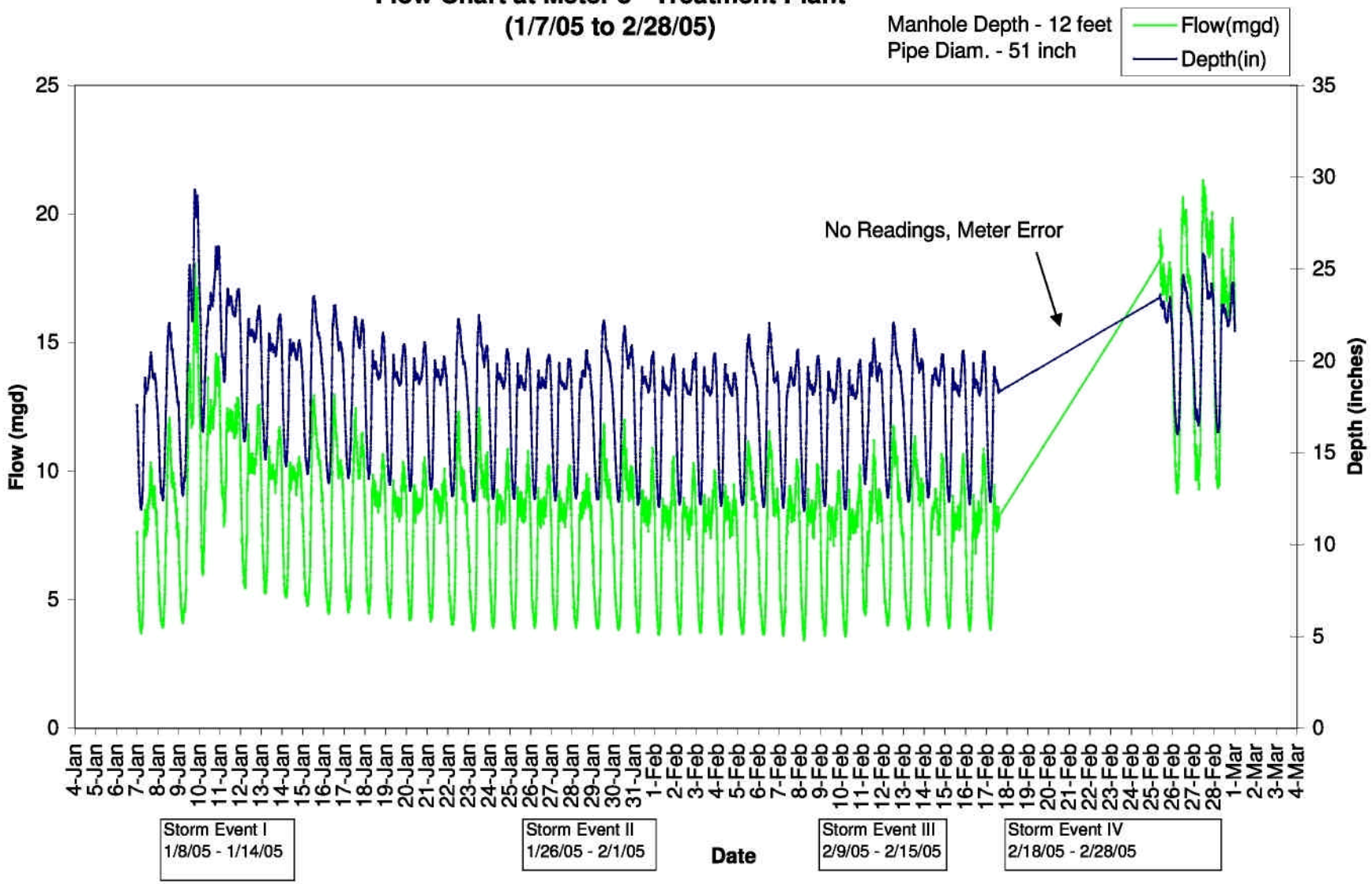


Figure 5.8.2
Meter 8 - I & I Graph for Rain Event I

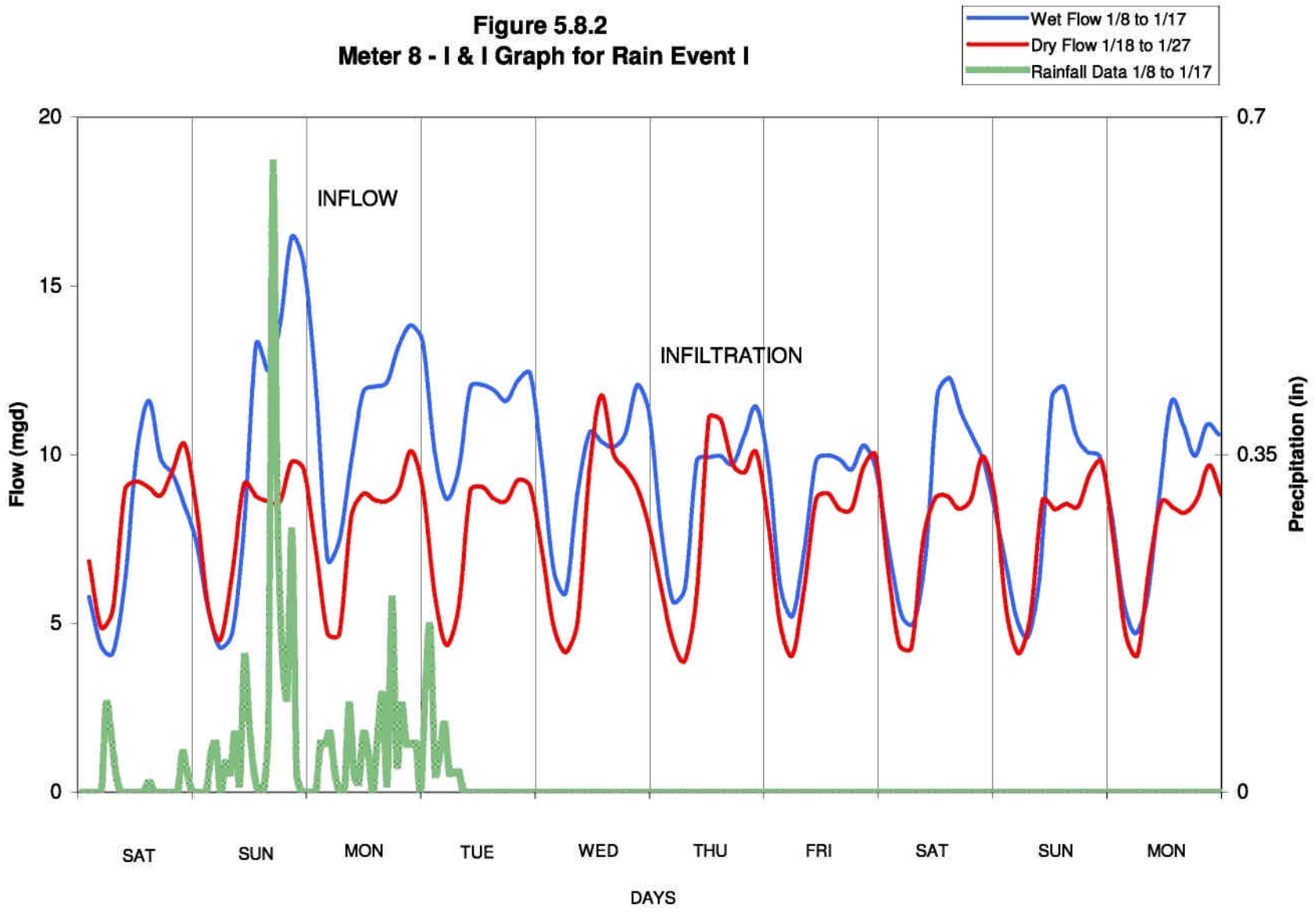


Figure 5.8.3
Meter 8 - I & I Graph for Rain Event II

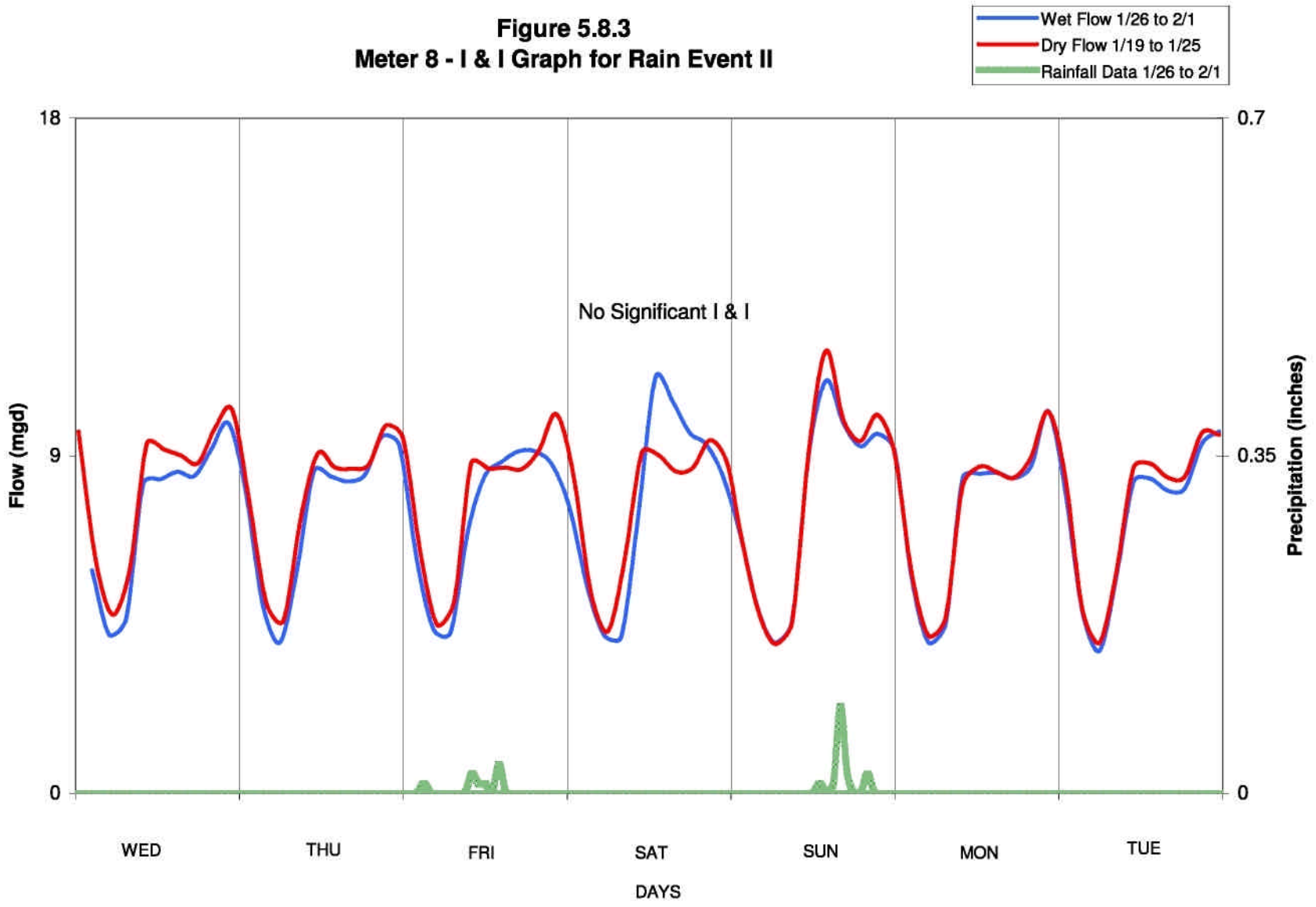
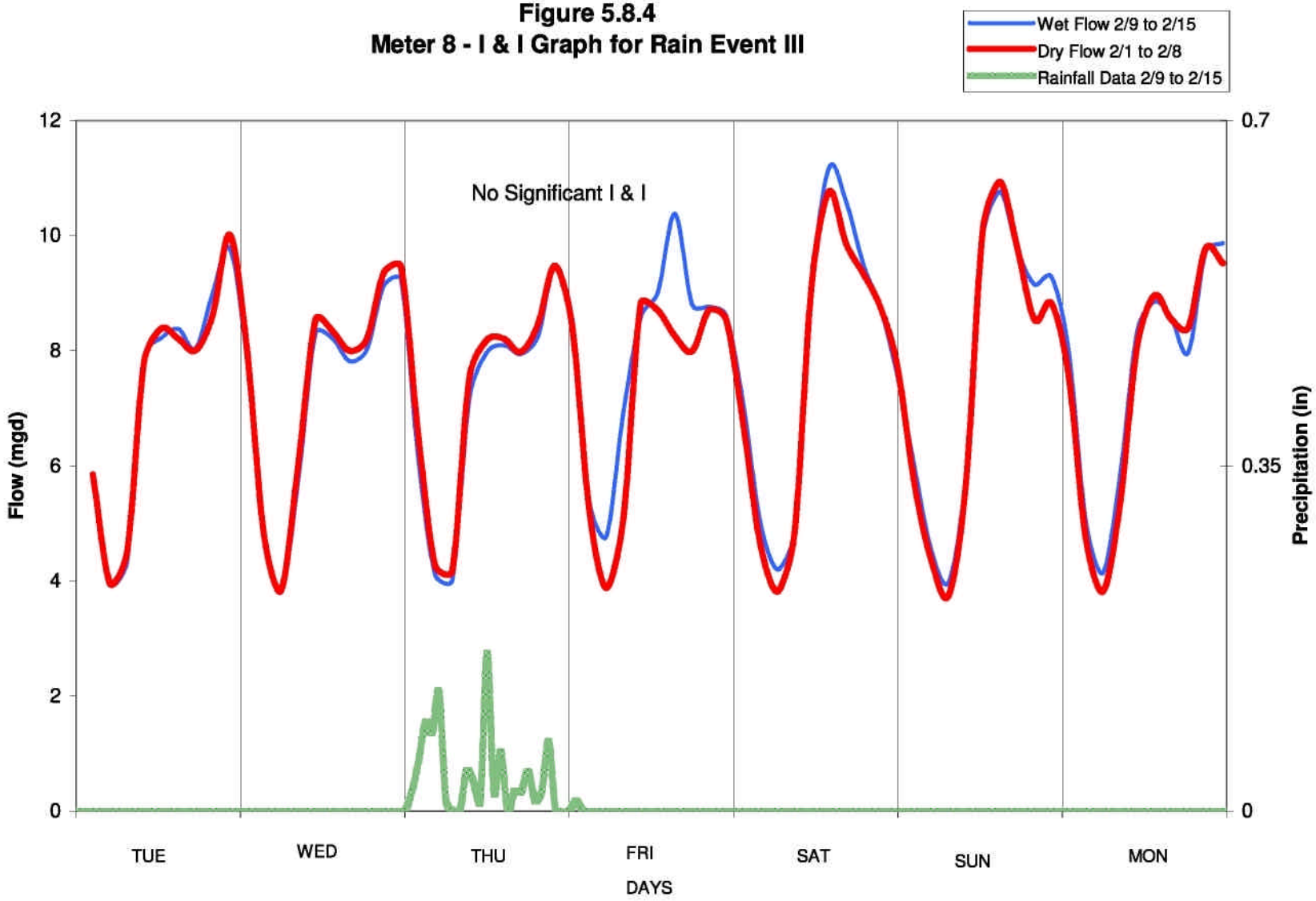


Figure 5.8.4
Meter 8 - I & I Graph for Rain Event III



Station 9

JACKSON

Figure 5.9.1
Flow Chart at Meter 9 - Jackson
(1/7/05 to 2/28/05)

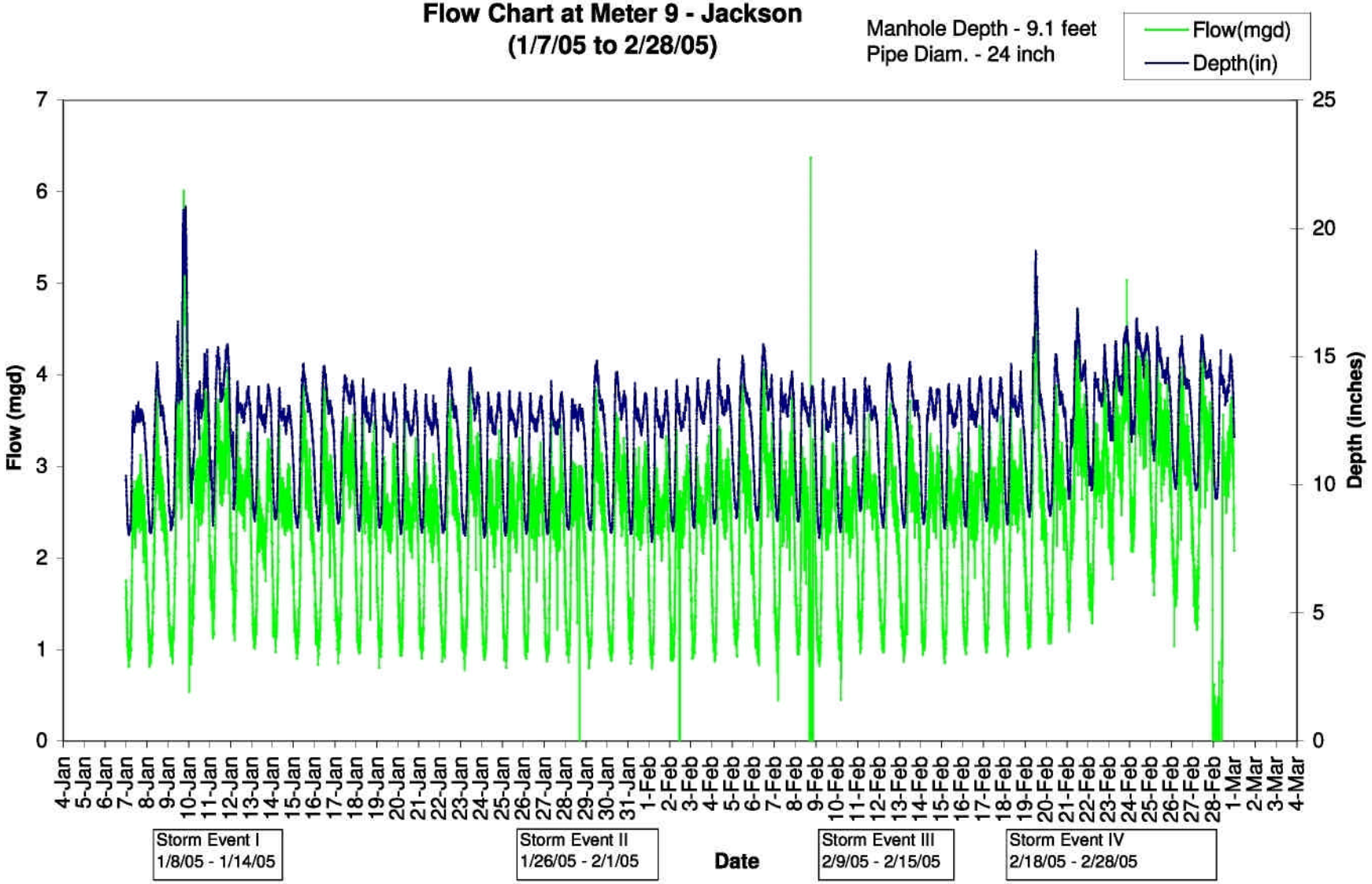


Figure 5.9.2
Meter 9 - I & I Graph for Rain Event I

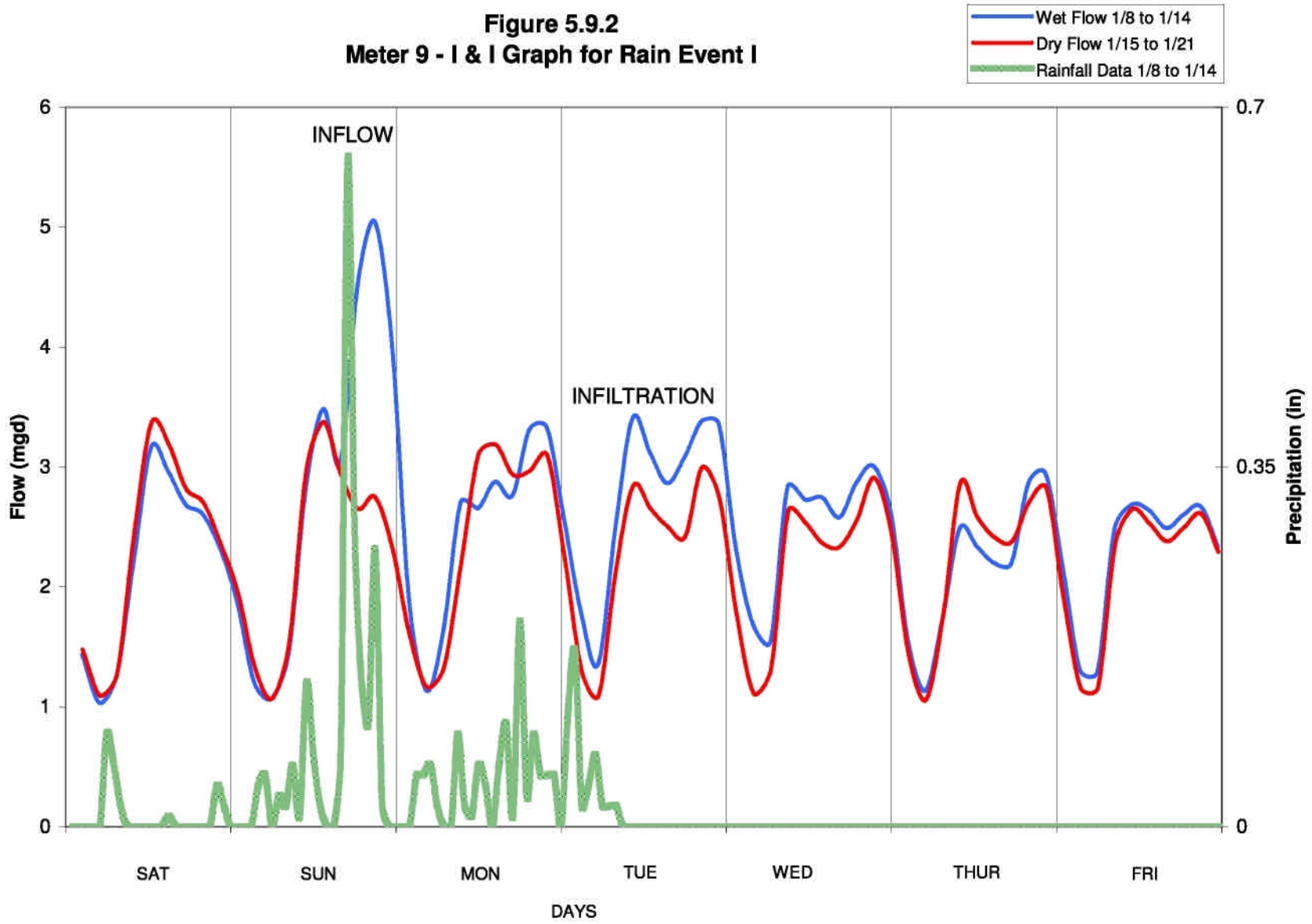


Figure 5.9.3
Meter 9 - I & I Graph for Rain Event II

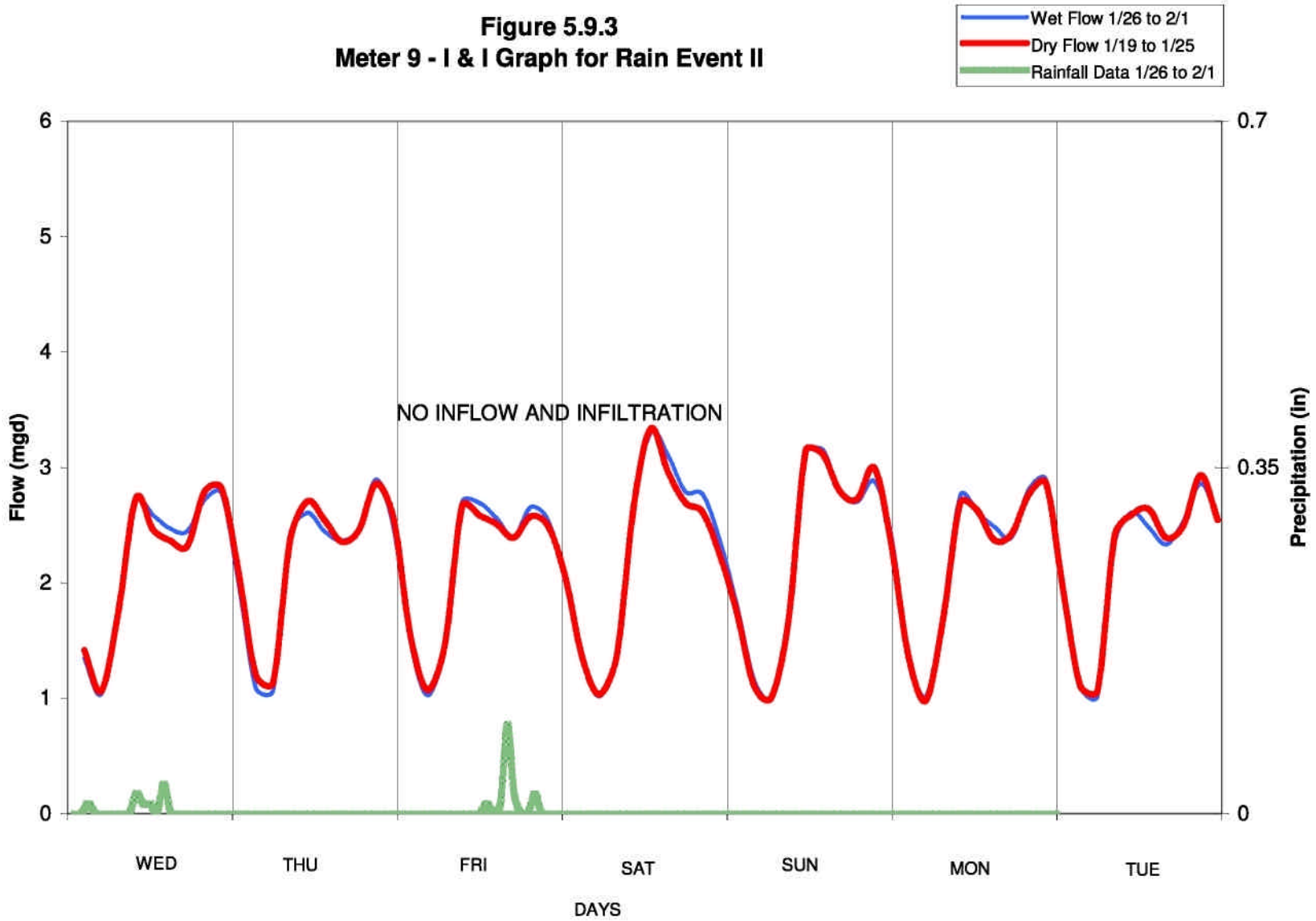


Figure 5.9.4
Meter 9 - I & I Graph for Rain Event III

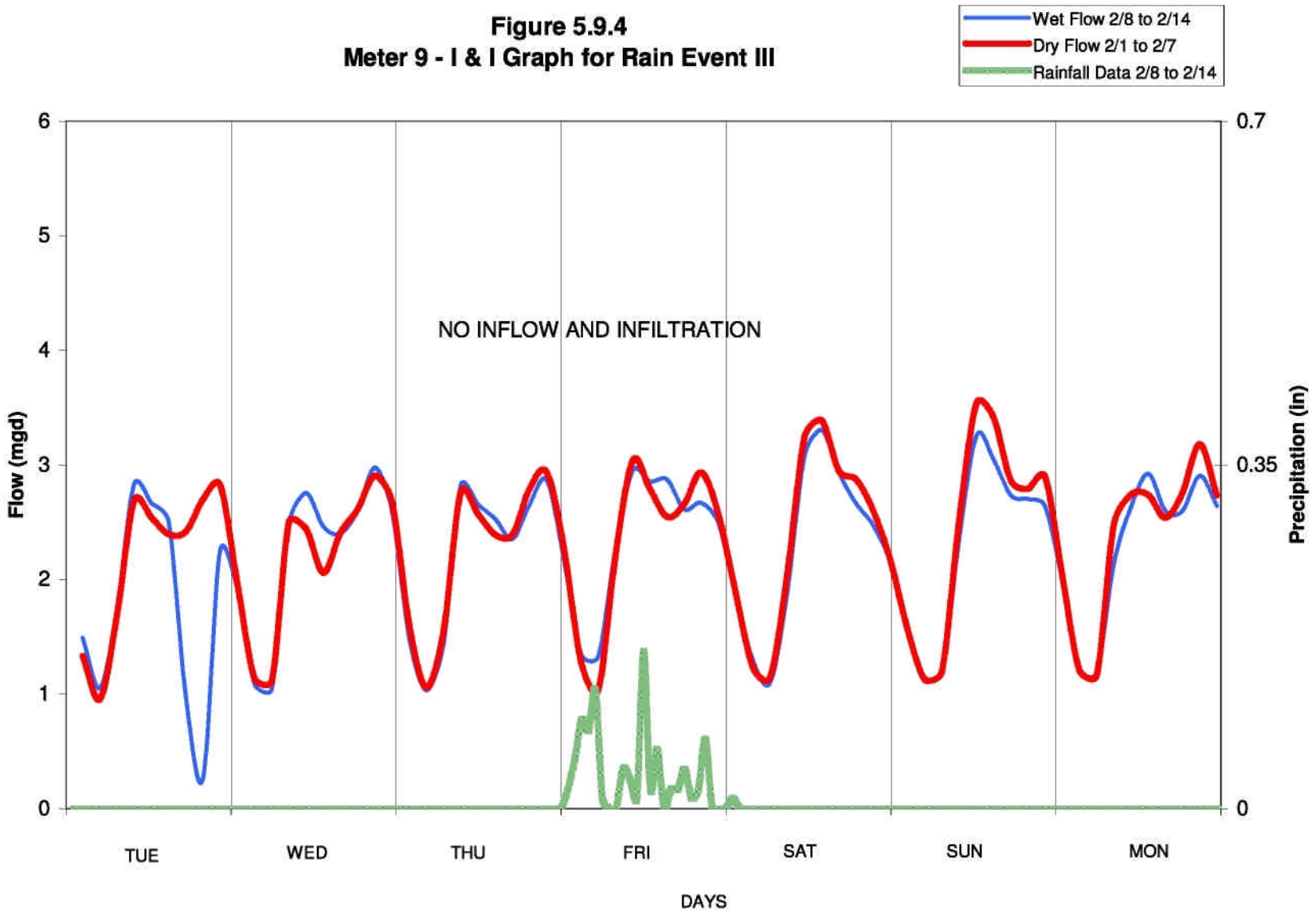
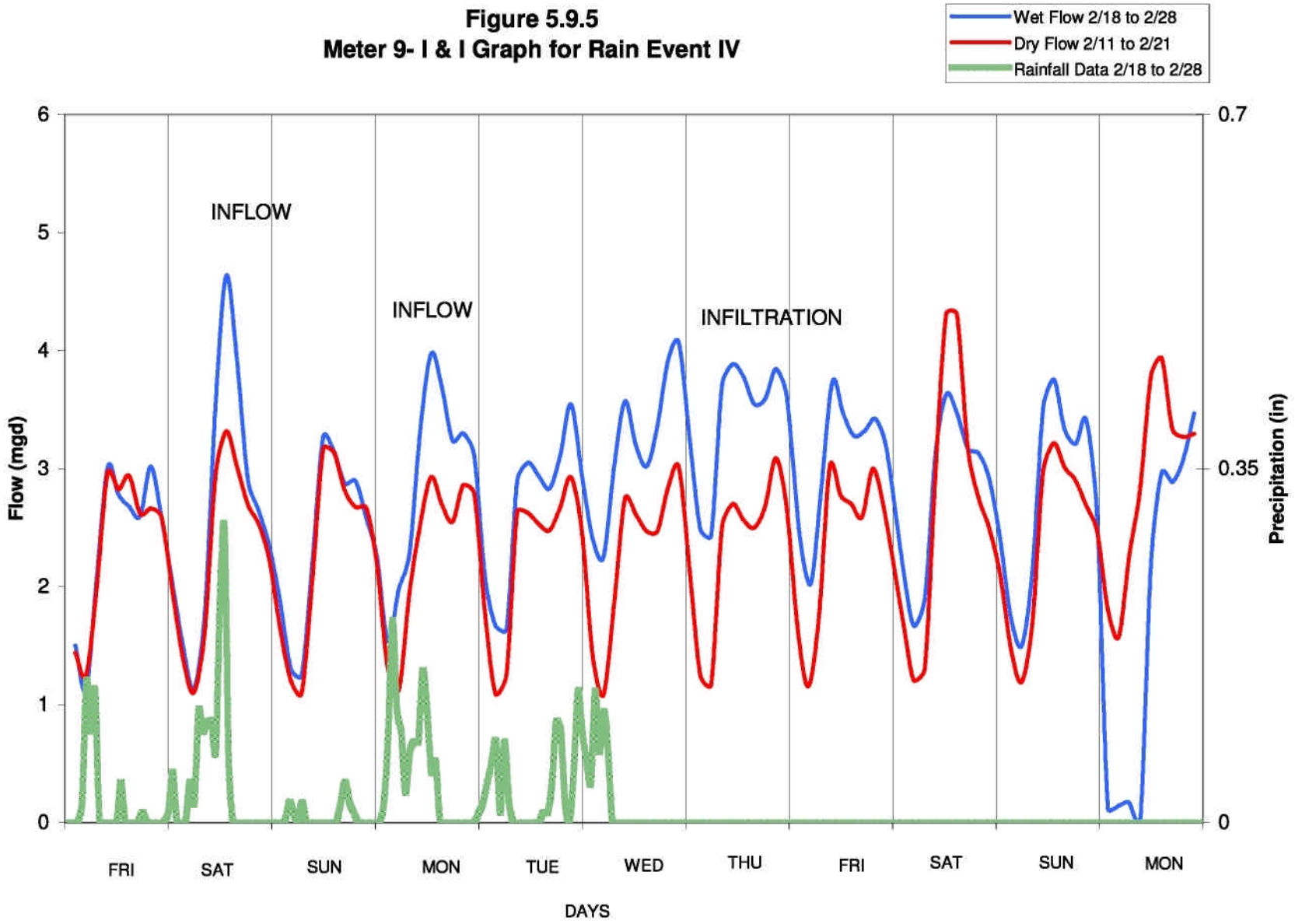


Figure 5.9.5
Meter 9- I & I Graph for Rain Event IV



Storm Event IV Feb 05

Appendix A

Flow Data from Downstream Services Inc.

Appendix B

Rainfall Data from CMIS Web Site

Appendix G
COLLECTION SYSTEM COSTS

Table G-1 CSMP Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Study Area	Priority	Location[1]	Total Project Cost (Million Dollars)[2]	Annual CIP Costs (Million Dollars)[3][4]									
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Arlanza	A	Collett Avenue	$0.38	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06
		Fillmore Street	$0.41	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06
		Golden Avenue	$0.26	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04
		RWQCP Sewer	$0.33	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05
	B	Monticello Avenue	$1.59	$0.16	$0.17	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.24
	C	Acorn Street	$1.44	$0.14	$0.15	$0.16	$0.17	$0.18	$0.19	$0.20	$0.20	$0.21	$0.22
		Arizona Avenue	$0.69	$0.07	$0.07	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11
		Collett Avenue	$0.90	$0.09	$0.09	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13	$0.14
		Fillmore Street	$0.62	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.10
		Golden Avenue	$0.73	$0.07	$0.08	$0.08	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11
		Harrison Street	$0.43	$0.04	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
		Jackson Street	$1.78	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27
		Jones Avenue	$1.07	$0.11	$0.11	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.16
		La Sierra Channel	$1.80	$0.18	$0.19	$0.20	$0.21	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28
		Magnolia Avenue	$0.55	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09
		Monroe Street	$0.51	$0.05	$0.05	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08
		RWQCP Sewer	$0.64	$0.06	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10
		Van Buren Boulevard	$6.83	$0.68	$0.72	$0.77	$0.81	$0.86	$0.90	$0.93	$0.97	$1.01	$1.05

Table G-1 CSMP Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Study Area	Priority	Location[1]	Total Project Cost (Million Dollars)[2]	Annual CIP Costs (Million Dollars)[3][4]									
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Northside	B	Marlborough Avenue	$0.12	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	C	Fairmount Boulevard	$0.57	$0.06	$0.06	$0.06	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08	$0.09
		Fairmount Trunk	$2.43	$0.24	$0.26	$0.27	$0.29	$0.31	$0.32	$0.33	$0.34	$0.36	$0.37
		Marlborough Avenue	$0.26	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04
		Strong Street	$0.49	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08
Phoenix	A	Central Avenue	$0.54	$0.05	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08
		Hillside Avenue	$2.57	$0.26	$0.27	$0.29	$0.31	$0.32	$0.34	$0.35	$0.36	$0.38	$0.39
		Phoenix Avenue	$0.13	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
		Santa Ana River Pipeline	$1.52	$0.15	$0.16	$0.17	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.23
	B	Madison Street	$0.56	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09
	C	Madison Street	$1.32	$0.13	$0.14	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19	$0.19	$0.20
		Phoenix Avenue	$2.03	$0.20	$0.21	$0.23	$0.24	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31
Spruce	B	Chicago Avenue	$1.02	$0.10	$0.11	$0.11	$0.12	$0.13	$0.13	$0.14	$0.14	$0.15	$0.16
	C	Chicago Avenue	$0.44	$0.04	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07
Tequesquite	A	Eastridge Avenue	$0.21	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	B	Eastridge Avenue	$0.73	$0.07	$0.08	$0.08	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11

Table G-1 CSMP Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Study Area	Priority	Location[1]	Total Project Cost (Million Dollars)[2]	Annual CIP Costs (Million Dollars)[3][4]									
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
		Trautwein Road	$0.65	$0.06	$0.07	$0.07	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10
	C	Tequesquitte Avenue	$0.31	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
		Wood Road	$0.85	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13
Total (Million Dollars)			**$37.71**	**$4.24**	**$4.49**	**$4.76**	**$5.05**	**$5.25**	**$5.46**	**$5.68**	**$5.90**	**$6.14**	**$6.39**

Notes:
(1) Projects categorized as "not required" and "completed" have been removed from the CIP list.
(2) Costs in August 2006 dollars.
(3) Costs are distributed evenly over the 10-year period.
(4) Costs are escalated from 2006 at 6% through 2011, and 4% thereafter.

Table G-2 Replacement & Rehabilitation Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Total Project Cost[1]	Annual R&R Costs (Million Dollars)[2][3]											
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Before 1943	Unknown	$22.14	$0.47	$0.50	$0.53	$0.56	$0.58	$0.60	$0.63	$0.65	$0.68	$0.71	$0.74	$0.77
	4	$0.02	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$85.96	$1.82	$1.93	$2.05	$2.17	$2.26	$2.35	$2.44	$2.54	$2.64	$2.75	$2.86	$2.97
	8	$172.87	$3.66	$3.88	$4.12	$4.36	$4.54	$4.72	$4.91	$5.11	$5.31	$5.52	$5.74	$5.97

Table G-2 Replacement & Rehabilitation Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Total Project Cost[1]	Annual R&R Costs (Million Dollars)[2][3]											
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	10	$19.16	$0.41	$0.43	$0.46	$0.48	$0.50	$0.52	$0.54	$0.57	$0.59	$0.61	$0.64	$0.66
	12	$14.15	$0.30	$0.32	$0.34	$0.36	$0.37	$0.39	$0.40	$0.42	$0.43	$0.45	$0.47	$0.49
	14	$1.93	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
	15	$10.67	$0.23	$0.24	$0.25	$0.27	$0.28	$0.29	$0.30	$0.32	$0.33	$0.34	$0.35	$0.37
	16	$2.28	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08
	18	$8.45	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29
	20	$1.40	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
	21	$6.22	$0.13	$0.14	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.21
	24	$18.54	$0.39	$0.42	$0.44	$0.47	$0.49	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64
	27	$5.43	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19
	30	$0.25	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	36	$0.45	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02
1944 to 1956	9	$0.49	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02
	4	$0.04	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$1.01	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	8	$39.86	$0.85	$0.90	$0.95	$1.01	$1.05	$1.09	$1.13	$1.18	$1.22	$1.27	$1.32	$1.38
	10	$2.64	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09

Table G-2 Replacement & Rehabilitation Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Total Project Cost[1]	Annual R&R Costs (Million Dollars)[2][3]											
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	12	$2.25	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08
	15	$0.55	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	21	$0.76	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03
Total (Million Dollars)		$418	$8.85	$9.38	$9.95	$10.54	$10.96	$11.40	$11.86	$12.33	$12.83	$13.34	$13.87	$14.43

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over A 50-yr period.
(3) Costs are escalated from 2006 by 6% through 2011, and by 4% thereafter.

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Before 1943	Unknown	$0.80	$0.83	$0.86	$0.90	$0.93	$0.97	$1.01	$1.05	$1.09	$1.13	$1.18	$1.22	$1.27
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$3.09	$3.21	$3.34	$3.47	$3.61	$3.76	$3.91	$4.07	$4.23	$4.40	$4.57	$4.76	$4.95
	8	$6.21	$6.46	$6.72	$6.99	$7.27	$7.56	$7.86	$8.18	$8.50	$8.84	$9.20	$9.56	$9.95
	10	$0.69	$0.72	$0.74	$0.77	$0.81	$0.84	$0.87	$0.91	$0.94	$0.98	$1.02	$1.06	$1.10

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	12	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64	$0.67	$0.70	$0.72	$0.75	$0.78	$0.81
	14	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11
	15	$0.38	$0.40	$0.41	$0.43	$0.45	$0.47	$0.49	$0.50	$0.52	$0.55	$0.57	$0.59	$0.61
	16	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13
	18	$0.30	$0.32	$0.33	$0.34	$0.36	$0.37	$0.38	$0.40	$0.42	$0.43	$0.45	$0.47	$0.49
	20	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08
	21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.31	$0.32	$0.33	$0.34	$0.36
	24	$0.67	$0.69	$0.72	$0.75	$0.78	$0.81	$0.84	$0.88	$0.91	$0.95	$0.99	$1.03	$1.07
	27	$0.20	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31
	30	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	36	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03
1944 to 1956	9	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06
	8	$1.43	$1.49	$1.55	$1.61	$1.68	$1.74	$1.81	$1.89	$1.96	$2.04	$2.12	$2.21	$2.29
	10	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15
	12	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.12	$0.13

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	15	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	21	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Total (Million Dollars)		$15.00	$15.60	$16.23	$16.88	$17.55	$18.26	$18.99	$19.74	$20.53	$21.36	$22.21	$23.10	$24.02

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over A 50-yr period.
(3) Costs are escalated from 2006 by 6% through 2011, and by 4% thereafter.

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Before 1943	Unknown	$1.32	$1.38	$1.43	$1.49	$1.55	$1.61	$1.68	$1.74	$1.81	$1.89	$1.96	$2.04	$2.12
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$5.14	$5.35	$5.56	$5.79	$6.02	$6.26	$6.51	$6.77	$7.04	$7.32	$7.61	$7.92	$8.24
	8	$10.34	$10.76	$11.19	$11.64	$12.10	$12.59	$13.09	$13.61	$14.16	$14.72	$15.31	$15.92	$16.56
	10	$1.15	$1.19	$1.24	$1.29	$1.34	$1.39	$1.45	$1.51	$1.57	$1.63	$1.70	$1.77	$1.84
	12	$0.85	$0.88	$0.92	$0.95	$0.99	$1.03	$1.07	$1.11	$1.16	$1.21	$1.25	$1.30	$1.36

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
	14	$0.12	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18
	15	$0.64	$0.66	$0.69	$0.72	$0.75	$0.78	$0.81	$0.84	$0.87	$0.91	$0.95	$0.98	$1.02
	16	$0.14	$0.14	$0.15	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22
	18	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64	$0.67	$0.69	$0.72	$0.75	$0.78	$0.81
	20	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13
	21	$0.37	$0.39	$0.40	$0.42	$0.44	$0.45	$0.47	$0.49	$0.51	$0.53	$0.55	$0.57	$0.60
	24	$1.11	$1.15	$1.20	$1.25	$1.30	$1.35	$1.40	$1.46	$1.52	$1.58	$1.64	$1.71	$1.78
	27	$0.32	$0.34	$0.35	$0.37	$0.38	$0.40	$0.41	$0.43	$0.44	$0.46	$0.48	$0.50	$0.52
	30	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	36	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
1944 to 1956	9	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10
	8	$2.39	$2.48	$2.58	$2.68	$2.79	$2.90	$3.02	$3.14	$3.26	$3.39	$3.53	$3.67	$3.82
	10	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.22	$0.22	$0.23	$0.24	$0.25
	12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.22

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
	15	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05
	21	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07
Total (Million Dollars)		$24.98	$25.98	$27.02	$28.10	$29.23	$30.40	$31.61	$32.88	$34.19	$35.56	$36.98	$38.46	$40.00

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over A 50-yr period.
(3) Costs are escalated from 2006 by 6% through 2011, and by 4% thereafter.

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]											
		2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Before 1943	Unknown	$2.21	$2.29	$2.39	$2.48	$2.58	$2.68	$2.79	$2.90	$3.02	$3.14	$3.27	$3.40
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$8.56	$8.91	$9.26	$9.63	$10.02	$10.42	$10.84	$11.27	$11.72	$12.19	$12.68	$13.19
	8	$17.22	$17.91	$18.63	$19.37	$20.15	$20.96	$21.79	$22.67	$23.57	$24.52	$25.50	$26.52
	10	$1.91	$1.99	$2.06	$2.15	$2.23	$2.32	$2.42	$2.51	$2.61	$2.72	$2.83	$2.94
	12	$1.41	$1.47	$1.52	$1.59	$1.65	$1.72	$1.78	$1.86	$1.93	$2.01	$2.09	$2.17

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]											
		2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	14	$0.19	$0.20	$0.21	$0.22	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.30
	15	$1.06	$1.11	$1.15	$1.20	$1.24	$1.29	$1.35	$1.40	$1.45	$1.51	$1.57	$1.64
	16	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31	$0.32	$0.34	$0.35
	18	$0.84	$0.88	$0.91	$0.95	$0.98	$1.02	$1.07	$1.11	$1.15	$1.20	$1.25	$1.30
	20	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.21
	21	$0.62	$0.64	$0.67	$0.70	$0.73	$0.75	$0.78	$0.82	$0.85	$0.88	$0.92	$0.95
	24	$1.85	$1.92	$2.00	$2.08	$2.16	$2.25	$2.34	$2.43	$2.53	$2.63	$2.73	$2.84
	27	$0.54	$0.56	$0.59	$0.61	$0.63	$0.66	$0.68	$0.71	$0.74	$0.77	$0.80	$0.83
	30	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04
	36	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07
1944 to 1956	9	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	6	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13	$0.14	$0.14	$0.15	$0.15
	8	$3.97	$4.13	$4.30	$4.47	$4.65	$4.83	$5.03	$5.23	$5.44	$5.65	$5.88	$6.11
	10	$0.26	$0.27	$0.28	$0.30	$0.31	$0.32	$0.33	$0.35	$0.36	$0.37	$0.39	$0.40
	12	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.30	$0.31	$0.32	$0.33	$0.35

Table G-2 Replacement & Rehabilitation Project Costs, Continued.
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]											
		2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
	15	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08
	21	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11	$0.12
Total (Million Dollars)		$41.60	$43.26	$44.99	$46.79	$48.66	$50.61	$52.64	$54.74	$56.93	$59.21	$61.58	$64.04

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over A 50-yr period.
(3) Costs are escalated from 2006 by 6% through 2011, and by 4% thereafter.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 1: EXISTING FACILITIES

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 1: EXISTING FACILITIES

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Chapter 1

EXISTING FACILITIES

1.1 PURPOSE

The purpose of this chapter is to summarize the existing facilities at the Regional Water Quality Control Plant (RWQCP). This includes descriptions of treatment facilities, support facilities, plant access, parking, and a summary of the surrounding area. This report does not include the design and reliability criteria of the unit processes, which will be described in Volume 4, Chapter 3 - Process Design/Reliability Criteria report.

1.2 BACKGROUND

The RWQCP began operation as a regional facility in 1978. Primary and secondary treatment capacity was constructed to provide treatment for wastewater from the Rubidoux and Jurupa Community Service Districts. Tertiary capacity was built at the same time. Subsequent projects have added capacity and upgraded the existing primary, secondary, tertiary, and solids handling facilities to increase the treatment capacity at the RWQCP.

With the installation of the new headworks, the RWQCP has the hydraulic capacity to convey peak flows up to 100 mgd through the treatment works.

1.3 EXISTING SUPPORTING AND TREATMENT FACILITIES

Figure 1.1 shows the layout of the existing facilities. The RWQCP consists of approximately 121 acres of land, including an additional 25 acres on the east end acquired in 1990. The main entrance to the plant is on Acorn Street. To the right of the entrance is the employee and visitor parking lot. To the left of the entrance is the Lab/Administration building. The Laboratory Services Program provides technical support for the Sewerage Systems Service Program and for Jurupa, Rubidoux, and Edgemont Community Services Districts. Analytical services provided include chemical, biological, and microbiological analyses.

The major crossroads of the RWQCP are Van Buren Road on the west, Jurupa Avenue on the south, and Payton Road on the east. There is not much of a buffer zone around the plant except by the Santa Ana River on the north side. There are businesses to the immediate east and south sides of the plant.

Figure 1.2 shows a flow schematic for the plant based on current operation. The RWQCP incorporates two separate plants (Plant 1 and Plant 2). The sewerage comes into the RWQCP at the headworks, where it is then sent to Plant 1 and Plant 2 for independent treatment to a primary and secondary level. The flow is split 40 percent to Plant 1 and 60 percent to Plant 2.

KEY

1. Headworks
2. Biofilter
3. Primary Sedimentation Basins for Plant 1
4. Primary Sedimentation Basins for Plant 2
5. Secondary Sedimentation Basins - Plant 1 (Abandoned)
6. Secondary Sedimentation Basins - Plant 2
7. Chlorine Contact Basins
8. Chlorine Injection Structure (Abandoned)
9. Waste Backwash Lagoons
10. Tertiary Filters
11. Dissolved Air Flotation Thickeners
12. Digesters
13. Sludge Hopper Building
14. Caustic Soda Feed Pump Station (Abandoned)
15. Combined Aeration Basin Distribution Structure
16. Maintenance/Storage Building
17. Pump Station
18. RAS Distribution Structure
19. Primary Effluent Distribution Structure
20. Equalization Distribution Structure
21. Distribution Structure
22. Trickling Filter Effluent Metering Structure
23. Solids Metering Structure
24. Final Effluent Metering Structure
25. Dewatering Flow Metering and Sampling Structure
26. Distribution Box 2 (Abandoned)
27. Junction Box
28. Grit Storage (Abandoned)
29. Junction Structure
30. Parshall Flume
31. Transformer
32. Electrical Pad
33. Motor Control Center, Operations Lab and Pump Station
34. Boiler 1 and Pump Station 9
35. Dechlorination Building
36. Digester Control Building and Pump Station
37. Digester Control Building
38. New Blower Building
39. Sewer Line Maintenance Building
40. Bioassay Studies Building
41. Office Maintenance Building
42. Landscape Maintenance Storage Building
43. Indian Rocks Reserve Area
44. Storage
45. Sampling Station
46. Equalization Ponds
47. Aeration Basins Plant 2
48. Aeration Basins Plant 1
49. Secondary Sedimentation Basin, Plant 1
50. Cogeneration
51. Belt Press Building
52. Storage/Electrical Shop
53. Maintenance Building
54. Chemical Building
55. Backwash Storage Tank
56. Lab/Administration Building
57. Old Administration Building

Legend

- Headworks
- Primary Treatment Facilities
- Secondary Treatment Facilities
- Tertiary Treatment Facilities
- Disinfection
- Equalization Ponds
- Solids Handling Facilities
- Cogeneration Building
- Waste Lagoons
- Supporting Facilities

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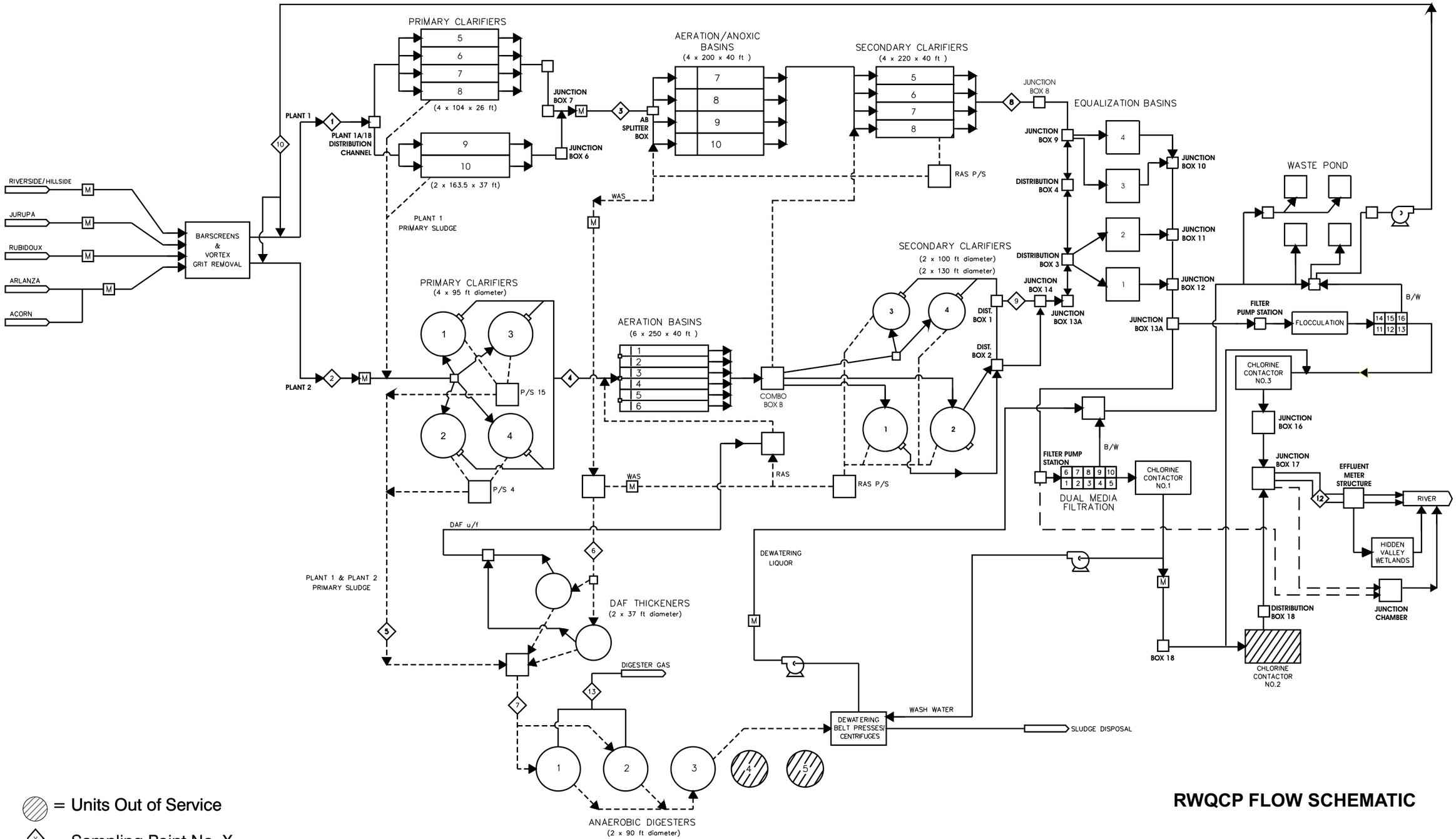
EXISTING SITE PLAN

FIGURE 1.1



= Units Out of Service

= Sampling Point No. X

RWQCP FLOW SCHEMATIC

FIGURE 1.2

Plant 1 has a total of six rectangular primary clarifiers, four rectangular aeration basins, and four rectangular secondary clarifiers. Plant 2 has four circular primary clarifiers, six rectangular aeration basins, and four circular secondary clarifiers. The secondary effluents from both plants combine and go into four equalization ponds, which are then sent to tertiary treatment.

The equalized secondary effluent feeds into the two tertiary filter trains, where it gets further treatment. Currently, the tertiary effluent goes through Chlorine Contact Basin No. 1 (CCB1) and Chlorine Contact Basin No. 3 (CCB3) for disinfection. The final effluent is discharged either to the Santa Ana River directly or to the Hidden Valley Wetlands for further nitrogen treatment before discharge to the Santa Ana River.

The following sections describe the major treatment processes in further detail.

1.3.1 Influent Sewers

The RWQCP receives influent from six lines: the Arlanza trunk, the Riverside trunk, the Hillside trunk, the Acorn trunk, and the Jurupa and Rubidoux force mains. Each trunk line is metered and sampled for 5-day Biological Oxygen Demand (BOD_5), suspended solids, ammonia nitrogen, and other parameters. The City of Riverside (City) and each of the Community Service Districts are responsible for the operation and maintenance of their own collection facilities. The City is planning to upgrade the influent metering facilities to obtain accurate information on the sewerage entering the RWQCP. Table 1.1 describes the meter types, trunk sizes, and average dry weather flow (ADWF) as of the year 2005.

Table 1.1 Influent Sewers
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Influent Line	Current Meter Type	Trunk Size (in.)	2005 (ADWF) Flows (mgd)
Arlanza	(Combined) Open Channel insert	51	11[(1)]
Acorn		36	3[(1)]
Riverside	(Combined) Open Channel insert	45	13.4[(2)]
Hillside		24	3.8[(2)]
Jurupa	Magnetic Parshall Flume	18	2.75
Rubidouz	Magnetic	18	2.1

Notes:
(1) Flow is estimated based on ratios of the cross-sectional areas of the Acorn/Arlanza lines, as these lines share one meter. The combined flow for these lines is 14 mgd.
(2) Flow is estimated based on ratios of the cross-sectional areas of the Riverside/Hillside lines, as these lines share one meter. The combined flow for these lines is 17.2 mgd.

1.3.2 Headworks Facilities

Headworks facilities are installed for protection of the plant's equipment. These processes include screening and grit removal. Both screenings and grit are washed, dewatered, and sent to a sanitary landfill. In 1999, the RWQCP completed construction of a new headworks facility. This facility combines the flow from the incoming sewers, including the Community Service Districts of Jurupa and Rubidoux. The combined flow is passed through four parallel screens and two vortex grit removal basins. Once the water has been screened and degritted, it is divided between Plants 1 and 2 for additional treatment. Table 1.2 describes the headworks treatment processes.

Table 1.2 Headworks Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
HEADWORKS	
Influent screenings Generation, cu. yds/day[(1)]	
Average (wet screenings)	15
Average (washed/compacted)	7.5
Maximum (wet screenings)	22.5
Maximum (washed/compacted)	11
Grit Production, cu. yds/day[(1)]	
Average	4
Maximum	8
Influent Bar Screens	
Numbers	4
Width, ft	3.5
Clear Openings Between Bars, inch	0.5
Type	Climber
Wet Screenings Conveyor	
Numbers	2
Type	Shaftless Screw
Screenings washing compactor units	
Numbers	2
Dry Screenings Conveyor	
Numbers	2
Type	Shaftless Screw

Table 1.2 Headworks Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
Vortex Grit Removal Units	
Numbers	2
Diameter, ft	20
Capacity, each, mgd	50
Grit Removal Efficiency, percent	
>50 Mesh	95
>100 Mesh	65
Grit Pumps	
Number per tank	1
Capacity, gpm	250
Head, ft	45
Type	Centrifugal Recessed Impeller
Grit Classifiers (Teacup)	
Number	2
Type	Hydraulic Vortex
Diameter, inch	42
Capacity, gpm/each	250
Grit Dewatering Equipment (Snail)	
Number	2
Belt Width, inch	18
BIOFILTER	
Air Residence Time, seconds	62
Biomedia Depth, ft	3
Air Velocity through media, fpm	2.89
Air humidity	Saturated
Foul Air blower, each	2
Capacity, scfm	13,800
Type and material	Centrif., Fiberglass
Drive	Variable Speed, Flow Controlled

Notes:
(1) Based on a design average daily flow of 50 mgd and a peaking factor of 2.0.

1.3.3 Primary Clarifiers

The purpose of the primary clarifiers is to remove settleable organic materials from the wastewater. Primary clarifiers typically remove about 70 percent of the incoming total suspended solids (TSS) and about half of the biochemical oxygen demand (BOD). The primary effluent from the primaries flows by gravity to the aeration basins of each plant.

The primary sedimentation facilities at Plant 1 were originally designed to pump the settled solids into gravity thickeners. The gravity thickeners have since been taken out of service and the settled solids from the Plant 1 primaries are pumped into the primary influent splitter box for Plant 2. There, they are resettled with the Plant 2 primary solids. The Plant 2 primary clarifier solids are thickened in the primaries and are pumped directly to the anaerobic digesters. Ferric Sulfate is added to the primary clarifiers at Plant 1 to keep the hydrogen sulfide levels within the South Coast Air Quality Management District (SCAQMD) limits.

Table 1.3 Primary Treatment
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
PRIMARY SEDIMENTATION	
Plant 1A	
Basins	Rectangular
Number	4
Length, ft	104
Width, ft	26
Volume Total, gals	688,700
Surface Area, Total ft^2	10,816
Sludge Pumps	
Number	3
Type	Non-Clog Centrifugal
Size, gpm/each	450
Plant 1B	
Basins	Rectangular
Number	2
Length, ft	163.5
Width, ft	37
Volume Total, gals	768,900
Surface Area, Total ft^2	12,100

Table 1.3 Primary Treatment Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Sludge Pumps	
Number	2
Type	Non-Clog Centrifugal
Size, gpm/each	450
Plant 2	
Basins	Circular
Number of Basins	4
Diameter, ft	95
Volume Total, mill-gals	2.004
Surface Area, Total ft^2	28,350
Sludge Pumps	
Number	6
Type	Progressive Cavity
Size, gpm/each	100
FERRIC SULFATE	
Number of Tanks	1
Volume, gallons	6,000
Usage, gallons/day	700-1,200

1.3.4 Secondary Treatment

1.3.4.1 Aeration Basins

The aeration basins provide biological treatment. In these units, the wastewater is actively mixed with a large concentration of microorganisms that break down the soluble organic matter and convert it into carbon dioxide. In addition, ammonia nitrogen is converted to nitrate. The RWQCP includes modifications to the aeration basins for denitrification. The Plant 1 and Plant 2 aeration basins have been modified to include a section with low dissolved oxygen known as an anoxic zone. These zones are where nitrate is converted to nitrogen gas. The anoxic zones in both plants occupy approximately 20 to 25 percent of the total volume of the aeration basins. The aeration basins include high volume mixed liquor recycle pumps that allow for a more effective use of the anoxic zones by recycling the nitrates formed in the aerobic zone to this section. Additional nitrogen removal occurs in the portion of the effluent that passes through the Hidden Valley Wetlands.

Two blowers, Blower Nos. 4 and 5, are used for supplying variable volumes of air to the aeration basins for Plant 1 and two blowers, Blower Nos. 1 and 2, are used for supplying variable volumes of air to the aeration basins for Plant 2. One blower, Blower No. 3, serves as a "swing"/standby blower. All five blowers are motor driven, single-stage centrifugal, vertical split type.

1.3.4.2 Secondary Clarifiers

Secondary clarifiers settle out the microorganisms following the aeration basins. The majority of the solids removed from the wastewater stream, referred to as return activated sludge (RAS), are returned to the aeration basins to maintain the mixed liquor concentration. The remaining solids, known as waste activated sludge (WAS), are thickened in the dissolved air flotation (DAF) thickeners before being sent to anaerobic digestion. The secondary clarifiers in Plant 1 have the capability of accepting mixed liquor from Plant 2, if a Plant 2 clarifier is out of service.

Table 1.4 Secondary Treatment
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
AERATION BASINS	
Plant 1	
Number of Basins	4
Volume in Service, MG	4.05
Anoxic Fraction, %	22
Internal Recycle Capacity, mgd	56
Plant 2	
Number of Basins	6
Volume In Service, MG	7.85
Anoxic Fraction, %	25
Internal Recycle Capacity, mgd	80
Blower Nos. 1, 2, and 3	
Types	Single-Stage Centrifugal, vertical Split
Flow, scfm each	12,500
Discharge pressure, psig	9.2
Inlet Temp, degrees F	110
Blower Nos. 4 and 5	
Types	Single-Stage Centrifugal, vertical Split
Flow, scfm each	9,000
Discharge pressure, psig	8.8

Table 1.4 Secondary Treatment Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Inlet Temp, degrees F	110
SECONDARY CLARIFIERS	
Plant 1	
Rectangular	
Number of Basins	4
Length, ft	220
Width, ft	40
Surface Area, Total ft^2	35,200
Plant 2	
Circular	
Number of Basins	4
Diameter Units 5 and 6, ft	100
Diameter Units 7 and 8, ft	130
Surface Area, Total ft^2	42,250
RAS PUMPING	
Plant 1	
Number of Units	4 duty + 1 standby
Capacity, gpm each	4,000
Type	Vertical Centrifugal
Plant 2	
Number of Units	4 duty + 2 standby
Capacity, gpm each	3 @ 3,000, 3 @ 5,700
Type	Vertical Centrifugal
WAS PUMPING	
Plant 1	
Number of Units	1 duty + 1 standby
Capacity, gpm each	500
Type	Vertical Centrifugal
Plant 2	
Number of Units	3 duty + 3 standby
Capacity, gpm each	2 @ 300, 4 @ 315
Type	Vertical Centrifugal

1.3.5 Flow Equalization

Flow equalization precedes the final filtration. These units are constructed basins that dampen daily variations in flow and provide the filters with a stable flow. The flow equalization basins are shared by the two plants. Flow into the equalization basins is by gravity. The secondary effluent is pumped from the basins to the tertiary filters.

Table 1.5 Flow Equalization
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
EQUALIZATION PONDS	
Number of Units	4
Volume, Each, MG	1.5

1.3.6 Tertiary Treatment

Filtration removes suspended solids that are not eliminated by settling, which reduces the chlorine demand of the water and improves the disinfection process. The current installation includes 16 filters, Filters 1 to 10 and Filters 11 to 16. Each of the filters has a 24-inch layer of anthracite and a 15-inch layer of silica sand. Filters 11 to 16 are preceded by a chemical flocculation step that aggregates very small particles so that they can be efficiently removed in the filters.The plant uses alum ew-401 as a coagulant to aid in the filtration process. Alum is dosed continuously as required by the permit.

Table 1.6 Tertiary Treatment
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
TERTIARY FILTRATION	
Number of filters	16
Anthracite Depth, inches	24
Silica Sand Depth, inches	15
Surface Area, Each, ft^2 Filters 1-10	552
Surface Area, Each, ft^2 Filters 11-16	650
FLOCCULATION BASINS	
Number	10
Number of stages, each	2
Volume per basin, gallons	178,000
FILTER INFLUENT PUMPS	
Plant 1	2 duty + 1 standby
Plant 2	2 duty + 1 standby

Table 1.6 Tertiary Treatment Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Plant 1 Capacity, gpm	3 @ 13,050
Plant 2 Capacity, gpm	3 @ 8,000
MAIN BACKWASH PUMPS	
Number	2 duty + 1 standby
Capacity, gpm	3,200
Max. filter backwash rate, ft rise/min	0.3-0.4
Max. filter backwash rate, gpm/sf (unit)	25.52-26
Max filter backwash rate, gpm/filter	14,082/16,900
BACKWASH STORAGE TANKS	
Number	2
Volume, MG (each)	0.66
ALUM FEED SYSTEM	
Average Alum dosage, mg/L	10
Max. alum dosage, mg/L	20
Metering Pumps	2 duty + 1 standby
Capacity, gph each	48
Alum Storage Capacity, gallons	12,900
POLYMER FEED SYSTEM	
Average polymer dosage, mg/L	0.1
Max. polymer dosage, mg/L	1.0
Metering pumps	2
Capacity, gph each	410
Polymer storage capacity, gallons	3,000

1.3.7 Disinfection

Disinfection of the wastewater stream destroys the remaining pathogens in the treated effluent. This is accomplished by adding sodium hypochlorite and providing adequate contact time. Dechlorination, removal of the excess chlorine through the addition of sodium bisulfite, protects aquatic life after discharge to the Santa Ana River or the Hidden Valley Wetlands. This is done at the end of the chlorine contact basins before the water is discharged. The RWQCP has three chlorine contact basins. CCB1 discharges into Chlorine Contact Basin No. 2 (CCB2) or CCB3. Currently, CCB1 effluent is discharged into CCB3 and CCB2 is out of service.

Table 1.7 Disinfection Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
CHLORINE CONTACT BASINS	
Number of Units	3
CCB1	
Volume, gallons	448,320
Length to Width ratio	18.5:1
CCB2	
Volume, gallons	1,426,470
Length to Width ratio	63.5:1
CCB3	
Volume, gallons	2,900,000
Length to Width ratio	48:1
CHLORINATION SYSTEM	
Sodium hypochlorite	
Storage tanks, gallons	2 @ 20,000
Chemical metering pumps, gph	2 @ 360
Dechlorination System	
Sodium Bisulfite	
Storage tanks, gallons	2 @ 8,000
Chemical metering pumps, gph	2 @ 350

1.3.8 Other Facilities

1.3.8.1 Cogeneration

Cogeneration is a reliable power source, which could use existing energy resources such as the gas produced from the plant's anaerobic digesters and/or from the City-owned Tequesquite Landfill. By definition, cogeneration is the simultaneous production of two useful forms of energy from the same fuel source. Along with electric generation from cogeneration, recovered waste heat from the process is also used to meet the facilities' thermal demands.

Currently, the RWQCP is using digester gas sweetened with natural gas as the fuel source for the cogeneration. The cogeneration facility is made up of three units with internal combustion engines, each producing approximately 1,100 kW of power.

1.3.8.2 Impure Water and Makeup Water System

Many water uses within the plant do not require the potable quality of the City water system. An impure water system and a makeup water system have been installed to provide non-potable water for seal water for pumps, foam spray in aeration basins, polymer mixing/dilution water, alum mixing/dilution water, chlorine solution and injection, wash-down water, makeup water for process operation, and water hydrants throughout plant site. Table 1.8 shows the details of the impure water and makeup water pumps.

Table 1.8 Impure Water and Makeup Water Pumps
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
IMPURE WATER PUMPS (PUMP STATION NO. 21)	
Number of Units	5
Type	Centrifugal
Capacity, gpm	4 @ 500, 1 @ 1,050
MAKE-UP WATER PUMPS (PUMP STATION NO. 8)	
Number of Units	4
Type	Non-Clog Centrifugal
Capacity, gpm	2 @ 700, 2 @ 800

1.3.8.3 Hidden Valley Wetlands

Constructed wetlands are a treatment process that uses natural wetland species to control nitrogen. The Hidden Valley Wetlands are used to reduce the total inorganic nitrogen (TIN) in the plant effluent. Approximately 10 mgd of flow is diverted through the wetlands. A total of 70 acres of wetlands has been developed. Additional wetlands may be developed in the future as flow increases.

Table 1.9 Hidden Valley Wetlands
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
HIDDEN VALLEY WETLANDS	
Number of Acres	
Maximum Amount	490
Currently Operated	49

1.3.8.4 Solids Handling Facilities

The solids handling facilities are discussed in the Biosolids section of the Master Plan in Volume 8, Chapter 1 - Existing Facilities.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 2: SUMMARY OF PLANNING STUDIES

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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SUMMARY OF PLANNING STUDIES

2.1 PURPOSE

The purpose of this chapter is to summarize the past planning studies that have been done for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP).

2.2 PLANNING STUDIES REVIEWED

The four planning studies that were reviewed for this chapter are:

1. 1992 Master Plan.
2. Treatment Capacity Optimization Evaluation and Analysis of Treatment Cost Allocations.
3. Sewer Enterprise Business Plan (SEBP).
4. Membrane Reactor Feasibility Study.

Brief summaries of each of these studies are described in the following sections. Summaries of major findings and recommendations for each study are also included in this chapter.

Five other planning studies will be reviewed as part of specific Master Plan volumes/chapters:

1. Recycled Water Phase 1 Feasibility Study and Citywide Master Plan.
2. Regional WQCP Biosolids Handling Improvements.
3. Odor Control Study.
4. Sewer Collection System Modeling.
5. SCADA Management Plan.

The Ultrasonic Destruction of Biosolids study will not be reviewed because the City has determined that it is not a viable process for the RWQCP.

2.3 1992 MASTER PLAN

The 1992 Master Plan served as an update to the City's 1985 Master Plan. This master plan update was initiated by the City in response to a number of key issues that had not been addressed in the 1985 Master Plan.

2.3.1 Purpose

The purpose of this master plan was to specifically address six issues that had not been addressed in the 1985 Master Plan. These concerns included backup power/cogeneration, water reclamation, sludge disposal, Inland Surface Waters Plan, air quality, and land use/site master planning. This master plan update addressed each of these issues in six separate technical memorandums (TMs), which are discussed in the following sections.

2.3.2 TM No. 1 - Backup Power/Cogeneration

This TM investigated the feasibility and cost effectiveness of a reliable dual power supply system, including the dual feed system upgrade and cogeneration with digester gas and/or landfill gas. Gas use/disposal options were also investigated with the power supply options to develop feasible project alternatives.

2.3.2.1 Summary of Findings

1. Analysis of the RWQCP digester gas production data, during the period from January 1, 1991 through October 23, 1991, indicated an average flow of 288,000 cubic feet per day (cfd) or 200 cubic feet per minute (cfm). This was relatively low in comparison to other wastewater treatment facilities in Southern California.
2. At the time of the study, the average monthly energy demand ranged from 1,750 to 2,100 kilowatt (kW), with an annual average of approximately 1,950 kW. An Additional 400-kW load (for raw water pumps) was expected at a RWQCP flow of 40 mgd.
3. The RWQCP critical power load at the time of the study was 1,370 kW. Based on estimated power demand projections, the critical load at a RWQCP capacity of 40 mgd was estimated to be 1,750 kW, and ranged from 2,100 W to 2,450 kW between 46 and 50 mgd.
4. Three power generator options were examined: gas turbines, steam turbines, and internal combustion/reciprocating engines.
5. Five alternatives were developed to meet the RWQCP backup power requirements, optimize resource recovery from digester gas and landfill gas, and minimize or eliminate air quality and environmental concerns related to gas disposal methods. The five alternatives were:
    a. Alternative 1: Dual feed system (no cogeneration).
    b. Alternative 2: Dual feed system (with separate power generation at the landfill).
    c. Alternative 3: Cogeneration with both gases.
    d. Alternative 4: Cogeneration with digester gas only.
    e. Alternative 5: Two separate cogeneration facilities.

6. Alternative 3 can generate 2,000 kW of power, while Alternative 4 or 5 can generate only 1,100 kW of electricity. Only Alternative 3 came close to providing the 27,000,000 BTU/hr of energy required, with limited supplemental fuel to meet the power demand of 2,600 kW.

7. Alternative 3A, cogeneration with both digester gas and landfill gas (with supplemental fuel) as the primary fuel source, was demonstrated to have the best economic incentive.

2.3.2.2 Recommendations

1. Cogeneration with landfill gas at the RWQCP site was more cost-effective and beneficial to the City than burning gas at the landfill site.

2. Cogeneration with digester gas and landfill gas is a viable alternative for a dual feed power supply system.

3. Cogeneration with both digester and landfill gases was selected as the most viable alternative for further consideration.

4. Due to the low digester gas production and volatile suspended solids (VSS) reduction rates, the study recommended that digester performance be optimized by frequent monitoring and subsequent process adjustment.

5. The study recommended that further field study be conducted to verify the actual gas available at the landfill in order to effectively manage this gas.

It was recommended that the critical load at the RWQCP be investigated in detail by considering the actual demand of each piece of essential equipment for the plant's critical operations.

2.3.3 TM No. 2 - Water Reclamation

This report focused on a market survey and assessment of reclaimed water for landscape and industrial users, development of a core distribution system, a concept level cost estimate, project funding investigations, and implementation plans. Water quality issues were also addressed, as they pertain to direct non-potable reuse.

2.3.3.1 Summary of Findings

1. About 70 percent of the City's 60,000 acre-feet per year (AFY) total potable water consumption is for non-potable uses; therefore, approximately 40,000 AFY could theoretically be replaced with reclaimed water.

2. The market survey showed that the non-potable markets for the City included landscape and agricultural irrigation, industrial processes, and commercial uses. Agricultural irrigation users represented a major potential market.

3. The market survey identified existing and future potential reuse by urban users, totaling about 11,600 AFY, agricultural irrigation users totaling 30,000 AFY, and additional users near the City limits, which could use 2,300 AFY. These users added up to a grand total of 43,900 AFY of reclaimed water in the area.

4. A core distribution system was developed for the City, including pipelines, reservoirs, booster pumping stations, and pressure reducing valves. The piping system is comprised of 24 pipes with a total length of 34.3 miles. Two storage reservoirs with a combined capacity of 15 million gallons were recommended to meet peak demand conditions with minimum pumping energy. Two booster-pumping stations were recommended to fill the storage facilities. Three pressure-reducing valves also were recommended to keep pressures within allowable limits of service.

5. Based on the estimated distribution of 11,000 AFY, the reclaimed water cost was estimated to be $400 per acre-foot.

2.3.3.2 Recommendation

The study recommended implementing the water reclamation project. The study determined the project is cost-effective for the City at a water production rate of $400/AF.

2.3.4 TM No. 3 - Sludge Management

This TM discussed the existing sludge disposal practices at the time of the study, identified pertinent regulatory requirements, and defined potential sludge stabilization and disposal methods. It also developed and evaluated sludge management alternatives and recommended short- and long-term sludge management to the City.

2.3.4.1 Summary of Findings

1. The sludge management practices at the time of the study included digestion, mechanical dewatering, air drying, and disposal by a private contractor.

2. Air drying is no longer available due to odor complaints, new regulatory requirements, and increases in sludge quantities resulting in increased land requirements.

3. Regulations would facilitate implementation of sludge disposal by land application, distribution, marketing, and disposal to monofills. Other available disposal methods at the time of the study (including incineration, surface disposal, and co-disposal landfills), were not feasible for RWQCP sludge due to regulatory constraints and the complicated permitting process.

4. Based on a sludge quality evaluation, the actual concentration of heavy metals and organic compounds in the RWQCP sludge were substantially lower than the concentration levels set by the current and proposed state and federal regulatory requirements.

5. The sludge after stabilization can be marketed for use in agricultural and non-agricultural applications.

6. Seven stabilization options and five disposal options were identified in the report. Three stabilization options (including chemical stabilization, composting, drying) and two disposal options (including land application and distribution and marketing) were retained after preliminary screening.

7. At the time it was conducted, the study concluded that the practice of sludge dewatering, air drying, and hauling of the sludge by private contractor was the most cost-effective for the RWQCP in the short term, but did not comply with Air Quality Management District (AQMD) requirements, caused negative public reaction, and lacked diversity of disposal options.

8. The most viable replacement alternative in the short term that the study considered was mechanical dewatering and sludge application to dedicated lands.

9. Thermal dewatering and sludge hauling by a private contractor would be as viable as the above alternative if the cogeneration facility is constructed on the plant site to provide the heat needed for sludge drying at low cost.

10. Composting/co-composting with green waste and self-marketing of compost was the most viable sludge management practice in the long term for the RWQCP.

2.3.4.2 Recommendations

The recommended sludge management plan consisted of two parts, short-term and long-term sludge management goals.

Short-Term Recommendations:

1. Continue the existing practice of air drying on drying beds and sludge disposal by private contractor, while developing other sludge management alternatives.

2. If a cogeneration facility is constructed at the plant site, replace the air drying of sludge with thermal dewatering.

3. Identify other private contractors for sludge disposal to create a more competitive bid atmosphere.

4. Undertake a feasibility study to evaluate and develop a dedicated land application site for sludge disposal.

5. Allocate approximately 8 acres of the additional 25 acres of land reserved for a new sludge management facility at the northeast plant corner according to the RWQCP updated master site plan.

Long-Term Recommendations:

1. Continue to work with the County and other regional agencies to establish a long-term sludge management plan.

2. Conduct a feasibility study for composting RWQCP sludge and co-composting with the City's green waste.

3. Develop an in-vessel sludge composting operation.

4. Pursue alternative private contractors or self-market options for compost distribution.

5. Evaluate market potential of Envessel pasteurized sludge and investigate the implementation feasibility and if a market for the final product exists.

2.3.5 TM No. 4 - Inland Surface Waters Plan and National Pollutant Discharge Elimination System Permit Compliance

The purpose of this TM was to establish plant effluent quality requirements based on various regulations and studies, evaluate feasible options, and select the most cost-effective measure for permit compliance. The report included identification of regulatory requirements, review of the 1992 NPDES Permit, evaluation of the permit compliance status of RWQCP effluent, development of compliance alternatives, analysis of alternatives, development of recommendations, and development of an implementation plan/schedule.

2.3.5.1 Summary of Findings

1. Several reclaimed water discharge regulations and studies have had major impacts on the RWQCP permit requirements, the 1987 Clean Water Act Amendments, the California Inland Surface Waters Plan (ISWP), and the Water Quality Control Plan (Basin Plan).

2. The Regional Board did not allow the RWQCP to comply with the toxicity objectives at the river discharge point with a mixing zone, but agreed to use the splitter box station as the point of sampling for compliance for both acute and chronic toxicity objectives.

3. RWQCP Permit Compliance Status: Plant effluent quality data from January 1990 through May 1992, were used for analysis of general and groundwater protection requirements.

4. In general, the RWQCP effluent met the 1992 NPDES permit requirements. Compliance was not attained or close monitoring at the time of the study was not necessary for the following requirements:
    a. Ammonia nitrogen/unionized ammonia.
    b. Coliform organisms.
    c. Acute toxicity/fish bioassay.
    d. Chronic toxicity.
    e. Dissolved oxygen (DO).
    f. Chlorine residual.
    g. Total Filterable Residue/Total Dissolved Solids (TFR/TDS).
    h. Total Inorganic Nitrogen (TIN).
    i. Trace metal objectives.

5. Eight options were identified to serve as full or partial solutions for permit compliance:
    a. Litigation-no action.
    b. Source control.
    c. Water reclamation.
    d. Land application.
    e. Ocean discharge.
    f. Additional treatment.
    g. Groundwater recharge.
    h. Intertie to the Orange County spreading basins.
6. Eight integrated alternatives were developed based on the eight permit compliance options described above:
    a. Alternative 1 - No action (litigation).
    b. Alternative 2 - Ocean discharge.
    c. Alternative 3 - Source control only.
    d. Alternative 4a - Source Control and Additional Treatment (including RO).
    e. Alternative 4b - Source Control and Additional Treatment (excluding RO).
    f. Alternative 5 - Source Control and Wetlands Treatment.
    g. Alternative 6 - Source Control, Wetlands Treatment, and Percolation Ponds.
    h. Alternative 7 - Source Control and Percolation Ponds.

2.3.5.2 Recommendations

The TM recommended Alternative 7 as the preferred alternative, which involves transporting the nitrified RWQCP effluent to percolation ponds in the Hidden Valley Wildlife Area (HVWA) or other appropriate sites, such as the Nature Center and Chino III sub-basin sites.

The study also concluded that the 1992 NPDES permit could be reopened before its expiration date to include or revise waste discharge requirements. Without a final clear picture of potential discharge requirements, recommendations for permit compliance alternatives could not be solidified, since requirements could change. The study provided the following list of recommendations, in general, for compliance with NPDES permit requirements:

1. Contact regulatory agencies for their acceptance of the preferred permit compliance alternative (Alternative 7).
2. Plan to meet all compliance schedules as specified in the NPDES permit.
3. Refine the 1991 in-house toxicity study and conduct a toxicity identification evaluation (TIE) to identify toxicants other than unionized ammonia and chlorine residual that cause acute/chronic toxicity in the RWQCP.
4. Use potable water of the best obtainable quality.

5. Conduct an extensive source control program, including a survey to specifically identify the type and quantity of constituents input from local industries and households to the RWQCP.

6. Establish appropriate local effluent discharge limits for industries based on their classifications.

7. Implement water reclamation throughout the City and the CSDs to maximize direct non-potable reuse and minimize the impact of ISWP/NPDES permit compliance.

2.3.6 TM No. 5 - Air Quality

The purpose of this TM was to address the air quality planning and implementation as a long-term process. The report was divided into three major tasks:

1. Task 1: Scoping Study, which included identifying regulatory agency considerations and air permitting status and compliance, as well as evaluating existing conditions at the time of the study.

2. Task 2: Comprehensive Evaluation of Facilities Alternatives, which evaluated air quality compliance for cogeneration and sludge management alternatives.

3. Task 3: Development of air quality goals for the RWQCP, which consisted of a list of recommendations based on the evaluations conducted in Tasks 1 and 2.

2.3.6.1 Summary of Findings

1. Under the Existing Source Standards, the RWQCP was expected to comply with the new AB 2599 and Rule 1179, which deal with the toxics database and the odors and reactive organic gases database.

2. Under the regulations of new sources, in order to incorporate the addition of cogeneration facilities and new types of sludge handling facilities, the RWQCP was expected to be in compliance with Regulation XIII New Source Review and Rule 1401 New Source Review of Carcinogenic Air Contaminants.

3. Due to regulatory developments including, the definition of major sources being decreased from 100 tons per year of air contaminants in the 1970 Clean Air Act to 10 tons per year or greater in the 1990 Clean Air Act, significantly more processes and equipment at the RWQCP may be affected.

4. At the time of the study, the only emission control device at the RWQCP was the waste gas flare.

5. Organic compound emissions at the RWQCP raised the greatest regulatory concern. The emissions had received the most attention because of their high potential as smog precursors and their carcinogenic and toxicity effects.

6. Heavy metals detected in the RWQCP sludge included chromium (CR) at 5.5 mg/kg, copper (Cu) at 16.7 mg/kg, lead (Pb) at 9.3 mg/kg, mercury (Hg) at 0.2 mg/kg, and zinc (Zn) at 32.3 mg/kg.

7. The use of digester or landfill gas for the cogeneration facility would meet the SB 166 definition of resource recovery. SB 166 requires the SCAQMD to permit projects that generate less than 50 MW of electricity provided the project uses BACT and the facility demonstrates a good faith effort to secure all available emission offsets to mitigate the project's emissions.

8. For permitting activities, the RWQCP will be required to investigate all aspects of air emissions for cogeneration processes using digester gas and landfill gas.

9. For permitting activities, the RWQCP will be required to investigate all aspects of air emissions for sludge management alternatives.

2.3.6.2 Recommendations

The following presents the recommendations that were developed in the Air Quality TM, to aid in continued compliance with regulatory requirements:

Near-Term Goals:

1. It was strongly recommended that the RWQCP establish an In-Plant Air Quality Program, to ensure that the facility identifies, tracks, and satisfies the air quality requirements at the POTW.

2. The RWQCP should consider membership in Joint Emissions Inventory Program (JEIP), a collective effort of various POTWs. The JEIP would result in the release of a single joint plan, coordinated source testing and an emission inventory Report for all JEIP member POTWs. This was a cost-effective and efficient approach to influence future regulations and aid in compliance with Rule 1179 requirements.

3. The study recommended two levels of effort for sludge testing: (1) The City should collect samples on a routine basis and perform total and hexavalent chromium analyses on these samples, and (2) the City should evaluate the particulate emissions from the sludge beds.

4. The RWQCP should evaluate collection system controls for odorous compounds in addition to in-plant evaluations. The RWQCP should study the feasibility of adding ferric chloride within the collection system.

Long-Term Goals:

1. Long-term goals were defined as the continued compliance with all applicable regulations addressing air quality during the next 50 years from the time of the study.

2. The RWQCP should begin the planning process to implement a strong source control program, which would target contributing industry as well as residents.

3. The RWQCP should begin the planning process to cover and scrub the headworks and cover the primary clarifiers.

4. The RWQCP should become active in the county planning process to ensure residences do not encroach on the existing facility boundary.

5. The RWQCP should consider the elimination or update of the incineration system at the facility.

6. The RWQCP should begin planning to decommission the sludge beds.

7. The RWQCP should keep abreast of the changing regulations to ensure smooth operation of the facility. The RWQCP should include provisions for the technical and regulatory considerations associated with normal operations as well as future changes.

2.3.7 TM No. 6 - Land Use/Site Master Plan

TM No. 6 addressed the development of potential projects, which would be in response to existing deficiencies, ultimate capacity expansion to 60 mgd, and regulatory requirements. It considered all potential projects with potential site impacts for the development of a comprehensive, long-term land use/site master plan.

2.3.7.1 Summary of Findings

The following is a summary of the potential projects that were identified at the time of this master plan in response to deficiencies, capacity requirements for future growth, regulatory requirements, safety, reliability, improved public image, and enhanced working environment. Since then, some of these projects have been completed and addressed.

General Development Projects:

1. The Architectural/Landscape Master Plan should incorporate the locations of future treatment facilities, promote architectural continuity, improve traffic flow throughout the plant, and integrate the entire site plan with roads, parking, landscaping, community buffers, and a water reclamation demonstration area.

2. Acquire additional land along Acorn Avenue from Jurupa Avenue to the plant entrance to expand the existing access road. Acquire Riverside County land along the southwest corner of the plant site to provide an additional access route from Jurupa Avenue. Land acquisition east of the plant should be considered to provide an additional buffer.

3. Acquire and/or reserve land to provide a buffer zone around the plant.

Process Facilities Projects:

1. Construct a new headworks with an average design capacity of 60 mgd and standard redundancy.
2. Construct a cogeneration facility for 2,600 kW capacity using Tequesquite landfill and digester gases.
3. Plant 1 Primary/Secondary Expansion: A capacity evaluation study would be required to determine the Plant 1 primary and secondary capacities and identify the requirements to bring Plant 1 to 20 mgd and total plant capacity to 40 mgd.
4. Denitrification Upgrade: To comply with the regulatory requirements, denitrification of plant effluent is required if effluent is to be discharged to the Santa Ana River.
5. Installation of the required covers and scrubbers on the headworks, primaries, dissolved air floatation (DAF) thickeners, and belt presses to meet and satisfy air quality requirements for the plant.
6. Evaluation of disinfection methods other than gaseous chlorine.
7. Discontinue usage of on-site drying beds.
8. Water Reclamation and Reuse: The City should consider reuse of non-potable reclaimed water from the RWQCP for direct reuse, groundwater recharge, wetlands, and other applications.
9. Replacement of the aging 10-mgd Plant 1A primary sedimentation basins was proposed.
10. Expansion of treatment capacity from 40 to 50 mgd for liquid and solid treatment processes, including primary, aeration, and secondary treatment; flow equalization; tertiary filtration; chlorination/dechlorination; chlorine contact; thickeners; digesters; belt press; and related appurtenances.
11. Secure the cesspool dumping facility to provide continuous monitoring of cesspool cleaning operations and prevent illegal dumping.

Service/Support Facilities:

1. New Technical Support Facility: A new Technical Support Facility was proposed for plant administration, compliance and monitoring activities, and visitor center requirements.
2. A 4,900-square foot expansion to the existing 5,100-square foot laboratory was proposed to meet the increasing demands for analytical work.
3. A 750-square foot expansion and demolition of an old building used for the Collection Systems Maintenance Office.

4. A 29,600-square foot expansion to the maintenance facility.

5. Construction of a 3,000-square foot training facility, annex to the proposed Technical Support Facility or maintenance building.

2.3.7.2 Recommendations

The study recommended systematic implementation of the identified projects. The following actions were identified as necessary and recommended for a timely and effective implementation of the Master Plan:

1. Initiate a comprehensive Capacity Evaluation Study and Stress test.

2. Initiate the Architectural/Landscape Master Plan.

3. Investigate land acquisition requirements.

4. Develop applicable CEQA documents for the projects to be implemented prior to the 50 mgd capacity expansion.

5. Consider cost-effective loans for project funding such as State Revolving Funds (SRF), Water Reclamation Loan, Energy Commission Loan, and others.

6. Consider near-term projects (to be started by 1998) in the 1993 Capital Improvement Program (CIP) for funding.

7. Screen Van Buren Boulevard by landscaping as soon as possible.

8. Consider demolishing of unused/abandoned facilities for site cleaning, better plant circulation, and public image.

9. Consider a buffer zone of approximately 300 feet wide around the plant to minimize the health risk from toxic pollutant emissions from the plant.

2.4 TREATMENT CAPACITY OPTIMIZATION EVALUATION AND ANALYSIS OF TREATMENT COST ALLOCATIONS

This study looked at the existing regulatory requirements at the time of the study and how they influence capacity allocation at the RWQCP. In addition, the study looked at the existing facilities and current operation, along with a loading analysis, to establish the capacity for each unit process over a range of influent wastewater characteristics.

Because changes in plant operations affect the cost for treatment, the cost allocation analysis was performed to determine the unit costs of treatment for each constituent of the wastewater, which could be used to provide an equitable billing system for the CSDs.

2.4.1 Purpose

The purpose of this study was to optimize the capacity of the treatment facilities at the RWQCP and to establish a rate structure that is fair and equitable and can be supported by all parties involved.

2.4.2 Major Findings and Recommendations

2.4.2.1 Permit Requirements and Existing Treatment Facilities

This section summarized the requirements of the NPDES permit and described the existing facilities. The major conclusions presented in this chapter were:

1. Flow, oxygen demand (biochemical oxygen demand (BOD) or COD), total suspended solids (TSS), and ammonia are the major water quality parameters, which influence RWQCP capacity and treatment costs.
2. Nitrogen removal or TIN may be considered in establishing RWQCP capacity. Other constituents, including TDS and heavy metals, are regulated under the permit and affect the cost of treatment, but are beyond the scope of this study.
3. BOD is used to monitor and bill the parties for the oxygen demand component of their wastewater. However, it may be beneficial to replace BOD with chemical oxygen demand, which is determined through a faster and more precise laboratory test.

2.4.2.2 Data Evaluation

The Data Evaluation Chapter summarized the long-term operating data for the RWQCP. This included a review of flows and loads for the past 5 years. The major conclusions were:

1. Flows and loads were fairly constant over the 5-year period, from 1994 to 1999.
2. The average flow into the RWQCP was 28.1 mgd. The average daily flow for the maximum month was 30.2 mgd and the maximum day was 35.0 mgd. Peak hourly flows of more than 54 mgd have been experienced in this time frame.
3. The BOD load to the RWQCP averaged 49,400 pounds per day (lb/day) and was 58,600 lb/day in the maximum month. This corresponded to an average concentration of about 211 mg/L and a maximum month average concentration of 233 mg/L. These values were used for modeling.
4. The solids load to the RWQCP averaged 48,200 lb/day and was 54,000 lb/day in the maximum month. This corresponded to an average concentration of about 206 mg/L and a maximum month average concentration of 214 mg/L. These values were used for modeling.

5. Average loads for the CSDs were developed from billing information. Jurupa contributed 10 percent of the flow, 12 percent of the BOD, and 14 percent of the TSS. Rubidoux contributed 6 percent of the flow, 7 percent of the BOD, and 7 percent of the TSS.

6. Plant performance was calculated and presented in a summary table in Chapter 4. Loads to Plant 2 were higher than to Plant 1 because Plant 1 primary solids were sent to Plant 2. Plant 1 had higher ammonia loads because dewatering recycle streams and waste backwash flows were treated in Plant 1.

2.4.2.3 Allowable Loading

This chapter described the computer model used to evaluate and determine the allowable loading for the RWQCP. The model used existing plant operations data from January 1, 1993 through December 31, 1997, plant stress testing data, and "Tabletop Analysis" data to develop mass balances for each process and the RWQCP as a whole. The following is a list of conclusions from this section of the report.

1. The solids retention time (SRT) for the activated sludge process should not be less than 5.0 days for complete nitrification to be achieved.

2. Plant 1 has reduced denitrification capacity because of no internal recycle.

3. Plant 2 has the greatest denitrification capacity because of higher organic loading. Operation at higher recycle rates would allow more TIN to be removed.

4. The historical nitrogen removal capacity of the Hidden Valley Wetlands has been about 530 lb/day of Nitrate-N. This rate is independent of flow.

5. If Hidden Valley removal rates remain constant, the tertiary effluent TIN concentration at 40 mgd should not be greater than 14.4 mg/L-N to meet the permit discharge concentration of 12.85 mg/L-N. This should be possible under the current average loading, but the permit would likely be exceeded under maximum monthly organic loadings.

6. At maximum loading, a flow of 40 mgd, and normal settling conditions, the clarifier safety factor (CSF) for the secondary clarifiers is 1.75. A CSF of at least 2.0 is generally recommended.

7. At maximum monthly loading and a flow rate of 40 mgd, the secondary treatment facilities, particularly the secondary clarifiers, may not perform well.

8. At a flow of 40 mgd and average BOD and TSS loading, additional solids handling facilities were determined to be necessary.

9. Based on a CSF of 1.75 and a flow of 40 mgd, the maximum loading values of BOD, COD, NH3-N, and TSS were presented in the study. These maximum loading values represent the total amount of each constituent that can be discharged to the RWQCP without reducing the capacity below 40 mgd. At concentration levels from each of the

parties at the time of the study, no additional limits appeared necessary for the RWQCP to meet the NPDES permit. However, if the discharge of these constituents increases so that it approaches these loading limits, it may be appropriate to develop additional limits for discharges into the RWQCP.

2.4.2.4 Cost Allocations

This chapter described the treatment cost model. The model, using budgets developed by RWQCP staff, allocated the budgeted costs to the unit processes, allocated the costs for each unit process among the billable constituents, and calculated a unit cost for each billable constituent. These unit costs were applied to the flows and loads of each of the CSDs for 1997/98 to calculate a representative bill, based on flow, BOD, and TSS.

Alternate billing methods were also developed to assess the impact on costs to each of the CSDs. One alternative substituted COD for BOD as a billable constituent. Another alternative used NH_3 as a fourth billable constituent. A third alternative included the addition of the repair and replacement portion of the capital costs as a part of the monthly billing cost to each CSD, instead of the current practice of paying for each project on a negotiated basis. The conclusions are described below.

1. A billing method which uses flow, BOD, and TSS to calculate the bill for Jurupa and Rubidoux resulted in a decrease over the existing method, approximately 10 percent for Jurupa and 11 percent for Rubidoux.
2. Including the capital repair and replacement costs in the monthly billing would result in a significant increase over the existing billing system, an estimated 30 percent for both Jurupa and Rubidoux.
3. Because NH_3 data was not available from Jurupa and Rubidoux, it was assumed that all parties discharged the same concentration of ammonia (i.e., ammonia loads are proportionate to flow). This was the basis in calculation of the costs. The costs indicated that the impacts are insignificant. The real cost impacts on Jurupa and Rubidoux cannot be evaluated until NH_3 data is available. Since NH_3 plays a role in calculating costs and capacities for the secondary treatment system and because nitrogen removal is a key factor in determining plant capacity, it may be desirable to use it for future billings.
4. Using COD instead of BOD as the oxygen demand billable constituent resulted in a slight redistribution of costs between the parties. Since the impact was minimal, it may be beneficial to replace BOD with COD, which is determined by a faster and more precise laboratory test.

2.5 SEWER ENTERPRISE BUSINESS PLAN

The SEBP serves as a strategic and operational planning tool for the RWQCP, which provides sewerage services to over 280,000 people residing in the City. The SEBP is the link between the City's strategic planning and annual budget. The goals, objectives, and strategies feed upward into the Strategic Plan, while the action items in the SEBP sub-plans support outcomes identified in the City's annual budget and annually updated CIP.

2.5.1 Purpose

The purpose of the SEBP was to provide:

1. A total picture of how the Sewer Enterprise plans and manages sewerage services.
2. A defined Sewer Enterprise policy on each management issue addressed by the plan.
3. A systematic blueprint for future planning and management focusing on a realistic prioritized set of strategies over the term of the SEBP.
4. A logical and defensible basis for making planning and management decisions, which can be made in the context of the total picture rather than considering only details in isolation.
5. A basis for annual reports on service delivery, operational performance, and SEBP implementation.

2.5.2 Contents

The SEBP is made up of a Business Plan, a Policy Document, and nineteen sub-plans. All sub-plans were organized around several key result areas and are presented in the following format:

1. Purpose of Plan: A statement of the purpose and the main issues covered by each sub-plan.
2. Policy: An outline of the existing policy regarding issues covered by the relevant sub-plan.
3. Constraints and Influences: A series of statements on the significant external constraints, industry trends, reform agendas, and other factors which will impact, influence, or require action to be addressed by the sub-plan.
4. Current Status: An outline of the current planning or management position regarding addressing related issues and an indication of any intended new directions or current planning initiatives.

5. Future Direction: A tabulation identifying the relevant key result area and goal from the Business Plan and the sub-plan objective, together with strategies for achieving the objective, performance targets for each strategy, and a key to action plans that match each strategy.
6. Implementation Strategy and Action Plans: Describes how each of the strategies is to be implemented with a listing of actions, additional details on the scope and outcomes covered by each action, and monitoring and management responsibilities.
7. Appendices: A-Forms or Tables, B-Supporting Documents.

The purpose, issues/challenges, and action plans of the nineteen sub-plans are summarized and described in the following sections.

2.5.3 Summaries of Sub-Plans

2.5.3.1 Customer Service Plan

2.5.3.1.1 *Purpose*

The purpose of this sub-plan was to provide an overview of current customer service practices and related future initiatives for improving customer awareness of sewerage services.

2.5.3.1.2 *Summary of Issues*

The main issue and challenge was to align the Sewer Enterprise procedures with the City's introduction of the 311 system.

2.5.3.1.3 *Action Plans*

1. Develop Customer Service Standards and issue customer charter and brochure.
2. Work with the City to implement the new 311 service.
3. Maintain a cost-effective customer service monitoring and response system.
4. Undertake public consultation/communication for all new major Sewer Enterprise initiatives.
5. Update customer request forms to facilitate reporting of Customer Service Standards targets.
6. Undertake an annual customer survey.

2.5.3.2 Financial Management Plan

2.5.3.2.1 *Purpose*

The purpose of this plan was to provide an overview of the current status of financial management initiatives, outline 10-year financial projections for the Sewer Enterprise, and outline a strategy to define and meet financial performance objectives.

2.5.3.2.2 *Summary of Issues*

The main issues and challenges were:

1. The need to increase rates and charges.
2. The need to quantify the financial impact of aging assets and the cost to address increased effluent, biosolids, and air quality standards.

2.5.3.2.3 *Action Plans*

1. Develop a Revenue Plan based on future pricing requirements for industrial waste, residential, commercial, and developer charges as the basis for City Council consideration.
2. Investigate opportunities to implement an annually updated Revenue Plan including annually updated rates and charges.
3. Maintain annually reviewed and updated capital/infrastructure charges and connection fees.
4. Maximize opportunities from government subsides/grants.
5. Maintain a 10-year financial model and rate structure and annually update the Revenue Plan.
6. Review and update CSD Charges.

2.5.3.3 Operations Management Plan

2.5.3.3.1 *Purpose*

The purpose of the Operations Management Plan was to provide an overview of the current operational practices and to outline planned initiatives in operations management.

2.5.3.3.2 *Summary of Issues*

The main challenge was to provide refurbishment and updates to accommodate for operational activities to meet current requirements.

2.5.3.3.3 *Action Plans*

1. Operate systems to meet regulatory requirements, standards, and customer service targets.
2. Use operational monitoring and control systems to optimize performance of existing infrastructure.
3. Review and update operating procedures.

2.5.3.4 Maintenance Management Plan

2.5.3.4.1 *Purpose*

The purpose of the Plan was to provide an overview of the City Sewer Enterprise maintenance management program and to outline future initiatives to optimize the maintenance management program based on minimizing total life-cycle costs.

2.5.3.4.2 *Summary of Issues*

The main issues and challenges were:

1. The need to increase the ratio of planned to unplanned maintenance, especially for active plant assets.
2. 70 to 90 percent of laterals were not recorded on CADME (GIS).
3. Manhole locations were not all recorded geographically correctly on GIS; some manholes were up to 60 feet off actual locations.
4. Structures were built over manholes.
5. As-constructed sewer grades did not match design drawings.
6. There was limited access to some sections of the sewer system.

2.5.3.4.3 *Action Plans*

1. Maintain a cost-effective maintenance program for all assets.
2. Review and update maintenance procedures.
3. Implement SYNERGEN as a replacement for the current work order systems.

2.5.3.5 Asset Evaluation and Renewal Plan

2.5.3.5.1 *Purpose*

The purpose of this plan was to provide an overview of:

1. Current knowledge regarding the value and condition of existing assets.
2. Current systems for ongoing evaluation of sewerage infrastructure.
3. Future asset evaluation initiatives.

2.5.3.5.2 *Summary of Issues*

The main issues and challenges were:

1. Excessive hydrogen sulfide generation downstream of the Pierce Street Pump Station.

2. Assumed economic useful life of 99 years for sewer pipes in the final asset register.

3. Limited information on Financial Asset Register (FAR), on which to base replacement funding needs.

2.5.3.5.3 *Action Plans*

1. Maintain a rolling program for assessing asset condition, performance, residual life, valuation, and renewal works.

2. Update asset registers and valuations.

3. Enhance proactive asset management activities.

2.5.3.6 Infrastructure Planning Plan

2.5.3.6.1 *Purpose*

The purpose of plan was to provide an overview of the Council's current infrastructure planning process and documentation. This plan also outlined issues that must be addressed in the planning process and future planning activities.

2.5.3.6.2 *Summary of Issues*

The main issues and challenges were:

1. There was no strategic or Master Plan for the collection system.

2. There was increasing pressure to provide sewerage to areas adjoining the City service area.

3. The following were identified as the failing elements of the plant: secondary basin, aeration capacity, and biosolids handling facilities.

2.5.3.6.3 *Action Plans*

1. Establish and maintain a rolling program of strategic and detailed planning studies.

2. Maintain a 10-year CIP.

3. Carry out strategic planning for sewerage systems.

2.5.3.7 Asset Procurement and Commissioning Plan

2.5.3.7.1 *Purpose*

The purpose of this plan was to improve management and selection of contractors and to enhance the Enterprise's current project management framework and methodology.

2.5.3.7.2 *Summary of Issues*

The main issues was that a review of current sewer design standards may be beneficial in the light of recent testing of developer-built sewers.

2.5.3.7.3 *Action Plans*

The main action required was to review and update purchasing strategies to address the needs of the sewer services program.

2.5.3.8 Sewer Infiltration/Inflow Management Plan

2.5.3.8.1 *Purpose*

The purpose of the plan was to provide an overview of current infiltration/inflow (I/I) management practices and proposed future initiatives and to outline how the City proposes to address the EPA requirements for an effective CMOM program.

2.5.3.8.2 *Summary of Issues*

The main issues and challenges were:

1. Limited storage at Pierce Street Pump Station. Storage is estimated at 1.5 hours during peak flow, with a high water alarm at 15 feet 19 inches and overflow at 16 feet 4 inches.
2. Pump station SCADA does not currently record flow rates and does not always correctly indicate operating status.
3. Sewer spills ranked third in the annual cost of all risks currently faced by the City.

2.5.3.8.3 *Action Plans*

The main action item required was to review and update current CMOM and I/I programs and to monitor catchment flows at all major pump stations.

2.5.3.9 Energy Management Plan

2.5.3.9.1 *Purpose*

The purpose of this plan was to provide an overview of energy management practices and to outline future initiatives in energy management.

2.5.3.9.2 *Summary of Issues*

The main issues and challenges were:

1. The identification of the full costs of energy, especially for energy produced from the cogeneration plant. Current costs do not include depreciation expenses or account for a return on capital invested.
2. Clarification was needed from the City energy utility on the existing arrangement at the time of the study.
3. There was limited capacity of the cogeneration facility at the time of the study.

2.5.3.9.3 *Action Plans*

1. Continue to optimize system operations to minimize energy usage and costs.
2. Operate and maintain a cost effective cogeneration facility.
3. Optimize revenue generated from the cogeneration plant and formalize it in an Energy Revenue Plan.

2.5.3.10 Environmental Management Plan

2.5.3.10.1 *Purpose*

The purpose of this plan was to provide an overview of the City Sewer Enterprise initiatives in coordinating its environmental management activities.

2.5.3.10.2 *Summary of Issues*

The main issues and challenges were:

1. The range and extent of watershed issues being addressed by multiple agencies at the time of the study.
2. The potential for more stringent environmental regulation.
3. Compliance with emerging regulations on nitrogen, TDS, and endangered species.

2.5.3.10.3 *Action Plans*

1. Maintain compliance with regulatory requirements of the EPA, RWQCB, and AQMD.
2. Develop and implement an Environmental Management System based on ISO 14000.

2.5.3.11 Effluent Management Plan

2.5.3.11.1 *Purpose*

The purpose of this plan was to provide an overview of the Council's current effluent management practices and future initiatives in effluent management.

2.5.3.11.2 *Summary of Issues*

The main issues and challenges were:

1. To keep up with the increasingly stringent limits on the quality of effluent discharged to surface waters.
2. To change operational process to allow denitrification.
3. To monitor the bio-impact of effluent disposal due to increasing interest by regulators.
4. To simultaneously increase pressure to maximize reclamation of effluent and meet requirements to discharge a minimum of 12 to 13 mgd into Reach 3 of the Santa Ana River.

2.5.3.11.3 *Action Plans*

1. Maintain existing effluent disposal systems and a monitoring program.
2. Identify and optimize reuse options.
3. Maximize revenue from the sale of effluent to the City's Water Department.
4. Address California Code of Regulations (CCR) Title 22 requirements.

2.5.3.12 Biosolids Management Plan

2.5.3.12.1 *Purpose*

The purpose of this plan was to provide an overview of the City's biosolids management practices and future initiatives to provide an ecologically sustainable and long-term solution for managing biosolids.

2.5.3.12.2 *Summary of Issues*

The main issues and challenges were:

1. To implement a long-term solution for beneficial reuse and cost effective disposal of biosolids.
2. To mitigate odor generated by the biosolids handling procedure at the time of the study.

2.5.3.12.3 *Action Plans*

The main action item was to revise practices biosolids disposal upgrade.

2.5.3.13 Industrial Waste Management Plan

2.5.3.13.1 *Purpose*

The purpose of this plan was to provide an overview of:

1. The management and regulation of industrial and liquid waste discharged to the City's sewers and wastewater treatment plant.
2. The Sewer Enterprise programs and future initiative for industrial waste management.

2.5.3.13.2 *Summary of Issues*

The main issues and challenges were:

1. To maintain a professionally trained workforce fully conversant with all existing and emerging regulations.
2. To handle monitoring and reporting of increasingly stringent regulations.

2.5.3.13.3 *Action Plans*

1. Maintain and enhance existing industrial waste services.
2. Maintain the industrial waste NPDES pre-treatment program.
3. Review and upgrade the pre-treatment and industrial waste service Revenue Plan.

2.5.3.14 Air Quality Management Plan

No information was provided for this plan.

2.5.3.15 Quality Management Plan

2.5.3.15.1 *Purpose*

The purpose of this plan was to provide an overview of current quality management practices and to outline future initiatives and objectives in quality management procedures and systems.

2.5.3.15.2 *Summary of Issues*

The main challenge was to implement an integrated quality management system.

2.5.3.15.3 *Action Plans*

The main action was to implement a third-party accredited quality assurance system over 5 years from the time of the study.

2.5.3.16 Information Management and Performance Assessment Plan

2.5.3.16.1 *Purpose*

The purpose of this plan was to provide an overview of the current status of information management systems and to outline the required information outputs and strategies to achieve the required outputs.

2.5.3.16.2 *Summary of Issues*

The main issues and challenges were:

1. To implement SYNERGEN and to handle the subsequent impacts on the well established sewer maintenance program HANSEN.
2. To conduct the extensive work effort of collating monitoring and test result records into monthly and annual reports.

2.5.3.16.3 *Action Plans*

1. Maintain ongoing monthly and annual compliance and performance reporting.
2. Enhance the Sewer Enterprise's response and involvement in the City's Managing for Results program.
3. Enhance management of databases and reporting procedures to facilitate reporting of performance.

2.5.3.17 Risk Management Plan

2.5.3.17.1 *Purpose*

The purpose of this plan was to:

1. Overview the risks associated with provision of sewerage services for the City and adjoining CSDs.
2. Assess the likelihood and consequences of these risks.
3. Identify current and proposed risk management strategies.

2.5.3.17.2 *Summary of Issues*

The main issues and challenges were:

1. The need to update the documentation for the Part 68 Risk Management Program.
2. The need to review and update OS&H requirements including materials handling data sheets.
3. The need to supply adequate, including a standby basin redundancy, to provide for natural disasters.

2.5.3.17.3 *Action Plans*

1. Review and update the risk management plan and associated risk management strategies.
2. Apply operational risk analysis techniques to reduce the risks of not meeting operational performance targets.

2.5.3.18 Human Resources Management Plan

2.5.3.18.1 *Purpose*

The purpose of this plan was to provide an overview of:

1. Staff resources allocated to the City sewerage services program.

2. How the Sewer Enterprise proposed to address resource requirements for total life-cycle management of assets.

3. How the Sewer Enterprise addressed human resource issues associated with maintaining effective teamwork and training.

2.5.3.18.2 *Summary of Issues*

The main issues and challenges were:

1. To maintain adequate staff resources to carry out planned sewer maintenance on a day-to-day basis.

2. To adequately identify the owner for each asset and to define asset management functions.

3. To address staff issues, generally including culture, skills, training, and commitment.

2.5.3.18.3 *Action Plans*

1. Maintain an adequately resourced and capable workforce.

2. Maintain ongoing review of staff training needs and undertake staff development.

3. Implement a formal performance and review system.

4. Encourage and foster positive staff attitudes toward continuous improvement and a culture of innovation and customer focus.

2.5.3.19 Business Development Plan

2.5.3.19.1 *Purpose*

The purpose of this plan was to provide an overview of proposed business development initiatives and to outline future objectives to achieve the stated vision.

2.5.3.19.2 *Summary of Issues*

The following are the main issues and challenges:

1. Defining expectations and common goals for the different business units within the Sewer Enterprise.

2. Empowering an independent unit within the Sewer Enterprise.

3. Being creative and aware of where the wastewater industry is going and customize the Business Development Plan to meet the plant's needs.

2.5.3.19.3 *Action Plans*

1. Adopt an updated revenue plan for City residents, CSDs, developers, and industrial waste (IW) service.

2. Train management on how to empower staff.

3. Implement a staff recognition program.

4. Commit to education and certification of staff.

2.6 MEMBRANE REACTOR TECHNOLOGY

This study was completed in November 2005 as a result of increases in wastewater flows to the RWQCP and the more restricted treatment requirements that are anticipated for the facility. As a planning-level consideration, the study developed and assessed alternatives for incorporating an MBR system into the existing RWQCP operations.

2.6.1 Purpose

The purposes of this study are summarized as follows:

1. To provide an evaluation of available MBR treatment technologies and assess the feasibility of incorporating an MBR treatment system into the existing 40-mgd RWQCP.

2. To develop concept-level design criteria for an MBR system.

3. To develop order-of-magnitude construction and present-worth-cost estimates for selected alternatives.

4. To provide a summary of key findings to contribute to the City's decision-making process.

2.6.2 Contents

This study consisted of the following:

1. An evaluation of the existing conditions, which includes the regional permitting climate as well as an assessment of treatment process units at the RWQCP.

2. An analysis of MBR systems.

3. Development and evaluation of RWQCP site-specific alternatives.

4. Estimation of construction and O&M costs of the selected alternatives.

5. Identification and ranking of evaluation criteria for the proposed alternatives.

6. Recommendations and identified strategies.

2.6.3 Major Findings and Recommendations

2.6.3.1 Evaluation of the Existing Conditions

The plant effluent has to meet the requirements as outlined in the City NPDES Permit (No. CA0105350). A portion of the effluent is recycled for landscape irrigation. The recycled water is required to comply with Title 22, Division 4, Chapter 3, Sections 60301 through 60355, California Code of Regulations (CCR) and the "Guidelines for Use of Reclaimed

Water" by the California Department of Health Services (CDHS). These effluent discharge requirements were incorporated into the alternatives considered for the City.

Plant flow monitoring data from August 2001 through August 2005 showed that the annual average flow was 33 mgd, with the minimum flow recorded as 22.88 mgd in January 2005 and the maximum flow as 51.21 mgd in February 2005.

2.6.3.2 Analysis of MBR Systems

The analysis of MBR systems showed that all manufacturers evaluated in the report were listed as approved treatment technologies in the April 2003 CDHS Treatment Technology Report for Recycled Water. The Santa Ana Regional Water Quality Control Board (RB8) had agreed that from a process perspective, MBR systems do not require coagulation and sedimentation. Because the RB8 has declared Reach 3 of the Santa Ana River is a "recreational impoundment," the MBR effluent is required to meet Article 3, Section 60305 of Title 22, Division 4, Chapter 3, "Water Recycling Criteria" of the CCR. From the analysis, it is anticipated that the MBR systems evaluated would meet this water-quality objective.

MBR systems generate approximately 30 percent less sludge than conventional systems. From the solids-handling perspective, it was concluded that using MBR technologies would result in a solids-handling capacity benefit for the RWQCP.

Four of the major MBR manufacturers: Zenon ZeeWeed, Environquip/Kubota, U.S. Filter MemJet, and Mitsubishi sterapore, were contacted as part of the analysis. All MBR systems require a fine-screen facility upstream of the bioreactor to reduce membrane fouling. The screen opening sizes for MBR pretreatment were recommended at 1 to 3 millimeters (mm). Drum type screens are preferred to flat bar configurations. Operational MLSS concentrations varied among manufacturers (from 8,000 to 20,000 mg/L); however, most manufacturers recommend operating the system at an MLSS between 8,000 to 12,000 mg/L. Higher MLSS concentrations could reduce the oxygen transfer rate in the bioreactor. The expected membrane life is approximately 10 years. All MBRs require a form of aeration directly under the membrane to maintain the flux rate and also require a periodic recovery cleaning using chemical(s).

Preliminary budgetary proposals, which were based on a set of site-specific design criteria, were requested from the four manufacturers. Based on the design parameters, Zenon and Kubota MBR systems showed several advantages over the other manufacturers, and therefore were the only ones evaluated further. MBR systems from both manufacturers required approximately 3 million gallons (MG) of storage for a 10 mgd plant.

2.6.3.3 Development of Site-Specific MBR Alternatives

Four site-specific alternatives were identified based on field investigations and discussions with the City, and these are listed below:

1. Using existing rectangular primary clarifiers. These clarifiers are scheduled to retire from operation after new primary clarifiers are constructed within the next 5 years. The combined tankage volume is about 1.62 MG, about 54 percent of the required volume.
2. Using existing unused circular secondary clarifiers and a chlorine contact tank at the abandoned trickling filter plant. The combined tankage volume is about 1.73 MG, about 58 percent of the required volume.
3. Using existing Plant 1 activated sludge reactors. This alternative involves constructing two MBR basins contiguous to the existing aeration basins and membrane tanks. Existing Aeration Basin No. 10 would function as a swing reactor between the MBRs and the conventional plant. No available tankage exists.
4. Using a new site to be determined within the RWQCP.

Alternatives 1 and 2 were not considered viable due to the following constraints:

Alternative 1:

1. There are significant hydraulic constraints associated with the existing rectangular primary clarifiers.
2. The existing tankage supplies only approximately half (54 percent) of the required MBR system reactor volume.
3. The existing tanks are shallow, which will reduce the oxygen transfer efficiency of the converted aerobic reactors.
4. The existing concrete structures were built in 1953 for Plan 1A basins and 1958 for Plan 1B basins, therefore it was anticipated that these structures would be approaching the end of their useful life and might require significant rehabilitation to provide a reasonable service life for the MBR system.

Alternative 2:

1. The circular geometry and depth of the existing tanks are not suitable for MBR systems. Therefore, constructing the MBR system in these existing facilities will require complex and costly design customization.
2. The existing tankage supplies only approximately half (58 percent) of the required MBR system reactor volume.
3. Pumping would be required to convey the MBR effluent to Chlorine Contact Basin No. 3.

The two alternatives considered most viable were Alternatives 3 and 4. Alternative 3 provides the MBR system in the most logical site where all secondary processes are located. One advantage of Alternative 3 is that the existing blower building would be situated nearby and side-streams are already piped to the area. In addition, Alternative 3 would add operation and construction flexibility to the RWQCP. This would result because, in this configuration the existing Reactor No. 10 could be used to provide treatment for either the conventional or the MBR treatment system, depending on operations and maintenance needs.

Alternative 4 proposed an independent 10-mgd MBR treatment train at a new site within the RWQCP. Under this option, all reactors would be new and sited near the headworks. Alternative 4 allows for hydraulic optimization and efficient site use through specification of MBR design parameters, such as efficient reactor side water depths (e.g., 20 to 25 feet for aeration basins). The MBR-specific tank configurations would achieve higher oxygen transfer efficiency, reducing power consumption. Finally, construction could logically proceed without a large number of process interruptions.

2.6.3.4 Present Worth Opinion for Alternatives 3 and 4

Order of magnitude cost opinions were developed for the two alternatives. The costs were prepared in 2005 dollars, which included a 20 percent contingency and 20 percent for engineering and administration. The estimated capital costs were $54 million for Alternative 3 and $61 million for Alternative 4.

It was assumed that power consumption for both alternatives would be equal, and therefore the annual power cost for both alternatives was estimated to be $610,000. The present-worth opinion of power cost for the 10 mgd MBR, based on an interest rate of 6 percent and a life cycle of 20 years, was estimated to be close to $7 million.

Similar to power consumption, all other O&M costs for both alternatives were assumed to be the same. This included membrane replacement, membrane cleaning, labor, chemicals, and maintenance parts. The estimated annual total O&M cost was $1.3 million. The estimated present-worth opinion for O&M was $14.9 million. This brought the total present worth opinion to $68.5 million for Alternative 3 and to $77 million for Alternative 4.

2.6.3.5 Recommendations

In conclusion, the study recommended that the City consider MBR Alternative 3 as a viable RWQCP rehabilitation and upgrade alternative. To move the recommended MBR Alternative 3 forward, the study recommended that the City consider implementation of the following:

1. **Develop an MBR Conceptual Design**. The Conceptual Design to include preliminary design data, site plans, preliminary hydraulic profiles, a yard piping plan, overall mechanical plans, cross sections of major MBR units, electrical single-line diagrams,

a preliminary site power plan, P&IDs for major process components, and refined construction cost estimates.

2. **Implement Pilot MBR Testing.** MBR manufacturers (Zenon and Kubota) may wish to participate in a side-by-side MBR testing program to evaluate the performance of the hollow-fiber and flat-panel membranes.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 3: PROCESS DESIGN AND RELIABILITY CRITERIA

FINAL
February 2008

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10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 3: PROCESS DESIGN AND RELIABILITY CRITERIA

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PROCESS DESIGN AND RELIABILITY CRITERIA

3.1 PURPOSE

The purpose of this chapter is to summarize the existing plant capacity, the basis of design, and the design criteria for future facilities at the Regional Water Quality Control Plant (RWQCP). This chapter includes a summary of the wastewater quality and flow data, which was used to calibrate computer models, and the design criteria for future facilities. In subsequent chapters, the calibrated computer models will be used for the evaluation of options for increasing plant capacity. This chapter does not include a detailed description of the existing facilities, which is included in Volume 4, Chapter 1 - Description of Existing Facilities.

3.2 CONCLUSIONS

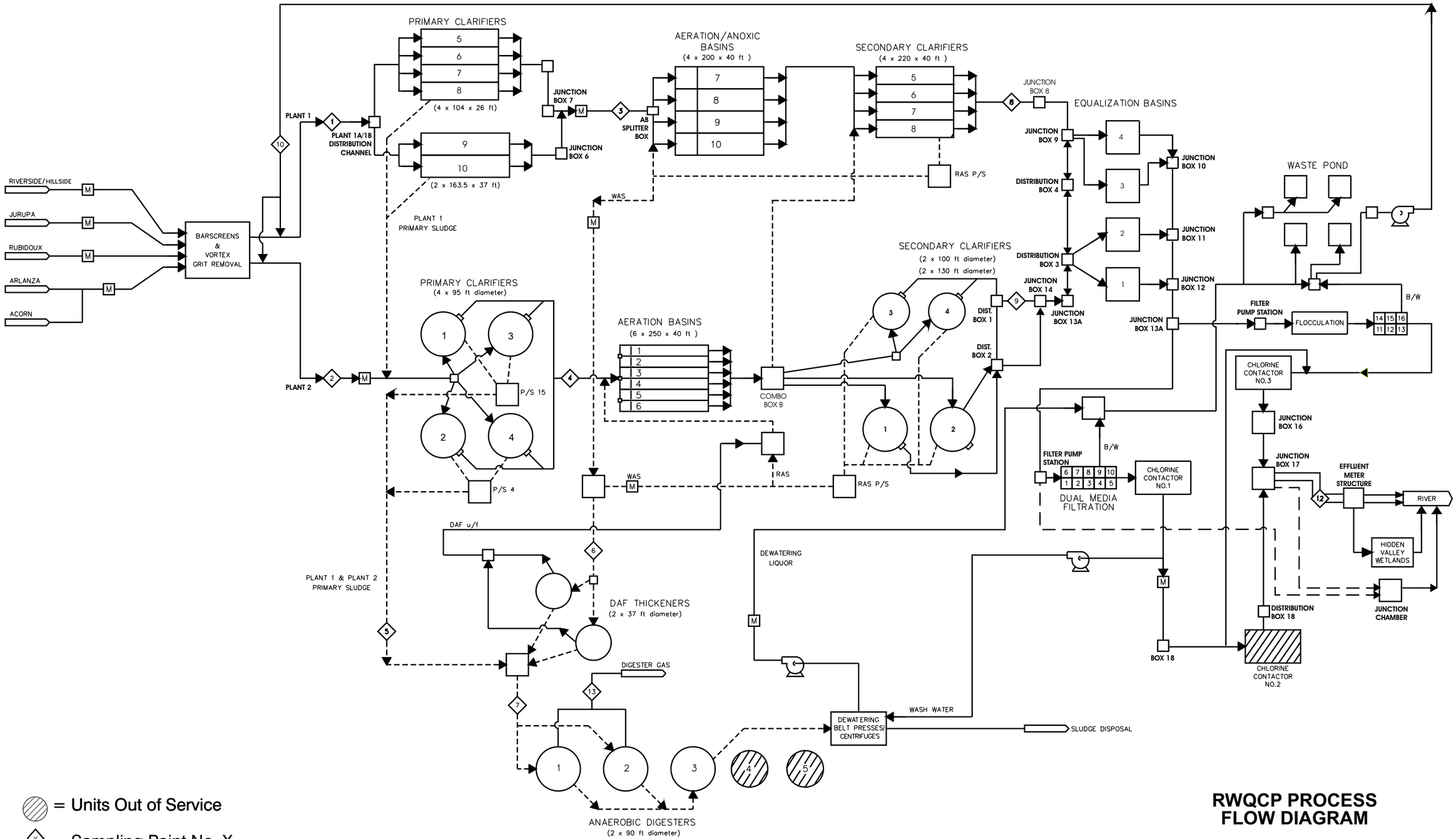
- Based on the Biotran and BioWin™ models, the capacity of the existing facilities is 40 mgd annual average flow rate.
- The design criteria for expansion of the wastewater facilities at the RWQCP are listed in Tables 3.6 and 3.7.

3.3 DESCRIPTION OF EXISTING TREATMENT

The existing RWQCP consists of preliminary, primary, secondary, tertiary, and solids treatment. Figure 3.1 shows the flow schematic of the existing facilities. Wastewater that enters the RWQCP is screened and de-gritted before it is split into two treatment trains (Plant 1 and Plant 2) for further treatment. The flow is split between Plant 1 and Plant 2 in roughly a 40:60 ratio.

In both Plant 1 and Plant 2, wastewater flows by gravity into the primary clarifiers and then to the secondary treatment process. Plant 1 has a total of six rectangular primary clarifiers, four rectangular aeration basins, and four rectangular secondary clarifiers. Plant 2 has four circular primary clarifiers, six rectangular aeration basins, and four circular secondary clarifiers. The secondary effluent from each plant combines and flows into four equalization basins.

Equalized secondary effluent is pumped into the tertiary filters. The filtered effluent then goes through chlorine contact basins for disinfection and final effluent is discharged either to the Santa Ana River directly or to the Hidden Valley Wetlands for further nitrogen removal before discharge to the Santa Ana River.



= Units Out of Service

= Sampling Point No. X

RWQCP PROCESS FLOW DIAGRAM

FIGURE 3.1

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For a detailed description of the existing facilities, refer to Volume 4, Chapter 1 - Description of Existing Facilities. The description of facilities for handling waste solids generated during the wastewater treatment process is discussed separately in Volume 8, Chapter 1 - Existing Facilities. The design criteria for the solids handling facilities is discussed in Volume 8, Chapter 3 - Biosolids Management: Design Criteria Development.

3.3.1 Review of Recent Operating Data

Table 3.1 presents the influent wastewater characteristics for the period of January 2000 to July 2006. The data was split into three separate periods as shown, due to influent or process changes during the time period. The influent Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) concentrations appear to have increased in the past few years. Until March 2006, the recycle streams, including filter backwash water and filtrate from belt-filter presses and centrifuge, were returned to the Plant 1 primary clarifiers. Since March 2006, all the recycle flows are split between the two plants, with approximately 20 percent flowing to Plant 1 and 80 percent flowing to Plant 2.

Table 3.1 Summary of the Process Operating Parameters Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Parameter	Units	Jan 2000 - Dec 2003	Jan 2004 - Mar 2006	March 2006 - July 2006
Flow[(1)]				
Daily Average Flow	mgd	30.6	31.9	32.3
Maximum Flow	mgd	39.9	46.5	34.8
Max-Month Peak Factor		1.3	1.45	1.1
Average Influent Quality				
BOD	mg/L	221.5	249.5	252.5
TSS	mg/L	221.9	249.3	234.6
TKN as N	mg/L	34.8	35.2	36.3
Ammonia-N	mg/L	20.5	22.8	29.0
BOD/TKN Ratio		6.4	7.1	7.0
Influent Loads				
Average BOD Load	lb/day	61,600	76,000	79,000
30-day Moving Average Maximum BOD Load	lb/day	84,900	86,900	84,000
Average TSS Load	lb/day	61,800	76,000	73,300
30-day Moving Average Maximum TSS Load	lb/day	73,800	88,100	77,000
Average Ammonia-N Load	lb/day	6,900	8,300	8,100
30-day Moving Average Maximum Ammonia Load	lb/day	10,200	10,800	11,100

Table 3.1 Summary of the Process Operating Parameters Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Parameter	**Units**	**Jan 2000 - Dec 2003**	**Jan 2004 - Mar 2006**	**March 2006 - July 2006**
Average Secondary Effluent Quality				
BOD	mg/L	2.0	3.0	2.8
TSS	mg/L	1.8	1.9	2.9
TKN as N	mg/L	1.7	N/A	N/A
Ammonia as N	mg/L	0.5	0.9	0.2
Nitrate as N	mg/L	12.1	10.4	9.0

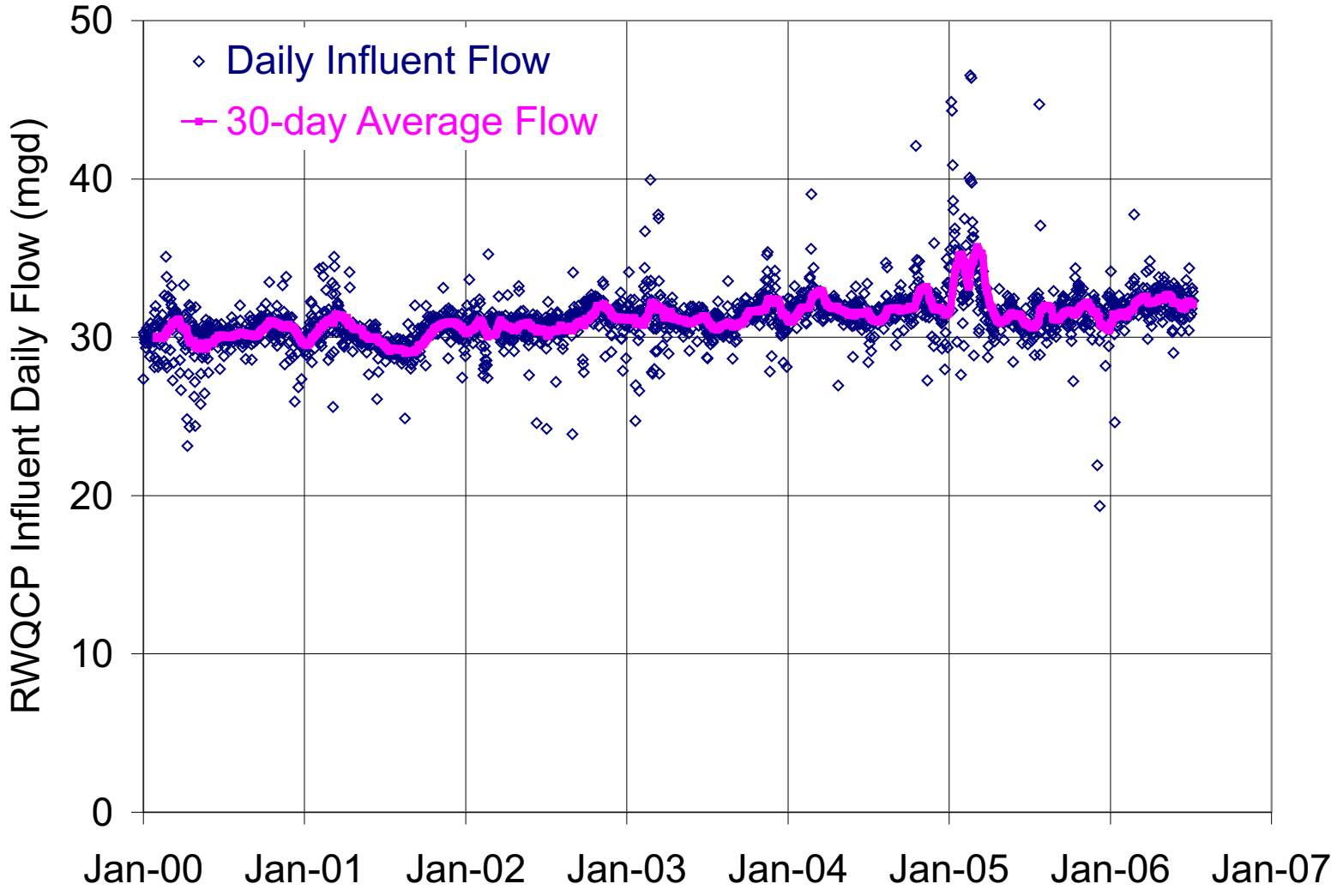
Notes:
(1) The influent flow data presented is based on a calculation provided by the City of Riverside.

Figure 3.2 shows the influent flow data for the period January 2000 to July 2006. The mid-2006 30-day moving average influent flow is about 32.0 mgd. Figures 3.3, 3.4, 3.5, and 3.6 show the influent BOD, TSS, Total Kjeldahl Nitrogen (TKN), and ammonia data for the period January 2000 to July 2006, respectively. Vertical lines in the figures are shown at January 1, 2004 and March 17, 2006. Since March 17, 2006 the ability to divert part of the recycles stream to Plant 2 was added.

The data suggests that the influent wastewater characteristics have changed over the past few years. As seen in Figure 3.3, the influent BOD has increased from an average of about 210 mg/L, for the period January 2000 to December 2003, to an average of about 250 mg/L, for the period 2004 to mid-2006. This implies that the influent average influent BOD has increased by as much as 20 percent. The average influent TSS shows a similar trend. The average TSS increased from about 215 mg/L to about 240 mg/L, which is about a 12 percent increase.

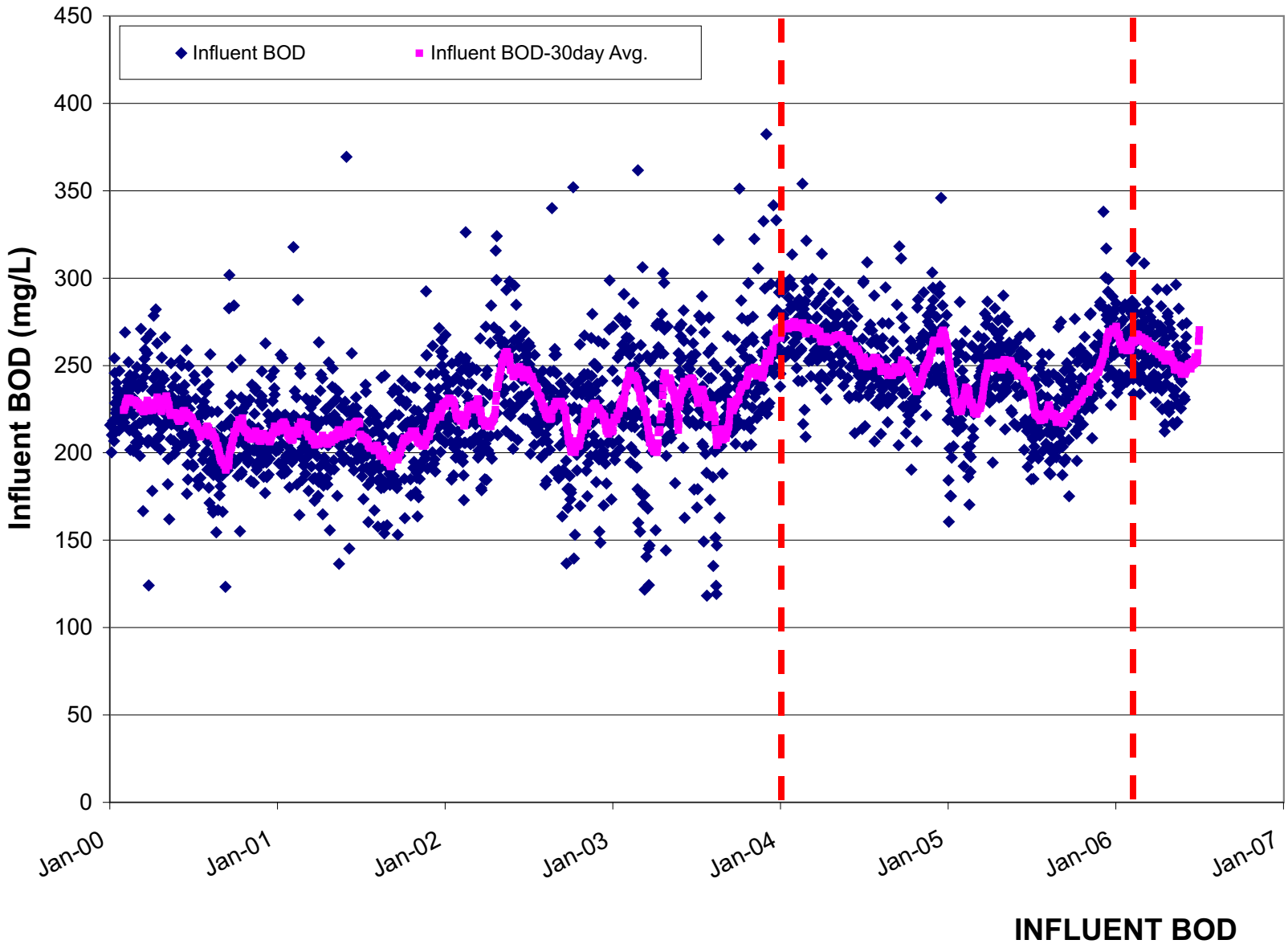
Although the ammonia and TKN data is limited, the current average influent ammonia and TKN values are higher than what they were a few years back. The average ammonia used for design in 2002 was 20.8 mg/L as N, whereas the average for the period 2000 to 2006 is 27.7 mg/L as N, which is approximately 33 percent higher. The average TKN used for design in 2002 was 28.1 mg/L as N, whereas the average for 2000 to 2006 is 35.2 mg/L as N, which is approximately 25 percent higher.

As the average values for wastewater parameters have increased in the past few years, it is suggested that the most recent data (for the period of January 2004 to March 2006) be used for the design of future facilities.



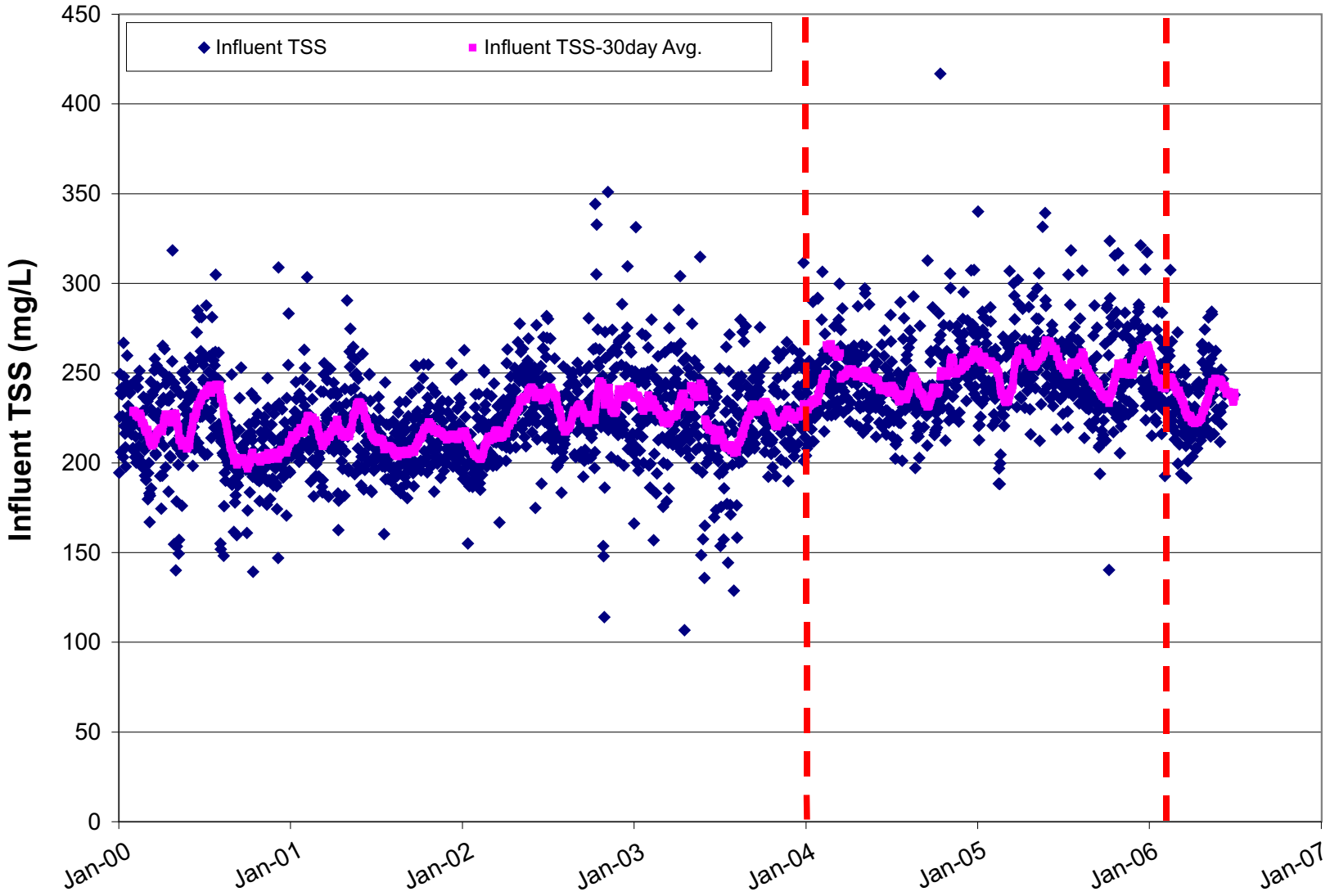
DAILY INFLUENT FLOW AND 30-DAY RUNNING AVERAGE FLOW AT RWQCP

FIGURE 3.2



INFLUENT BOD

FIGURE 3.3



INFLUENT TSS

FIGURE 3.4

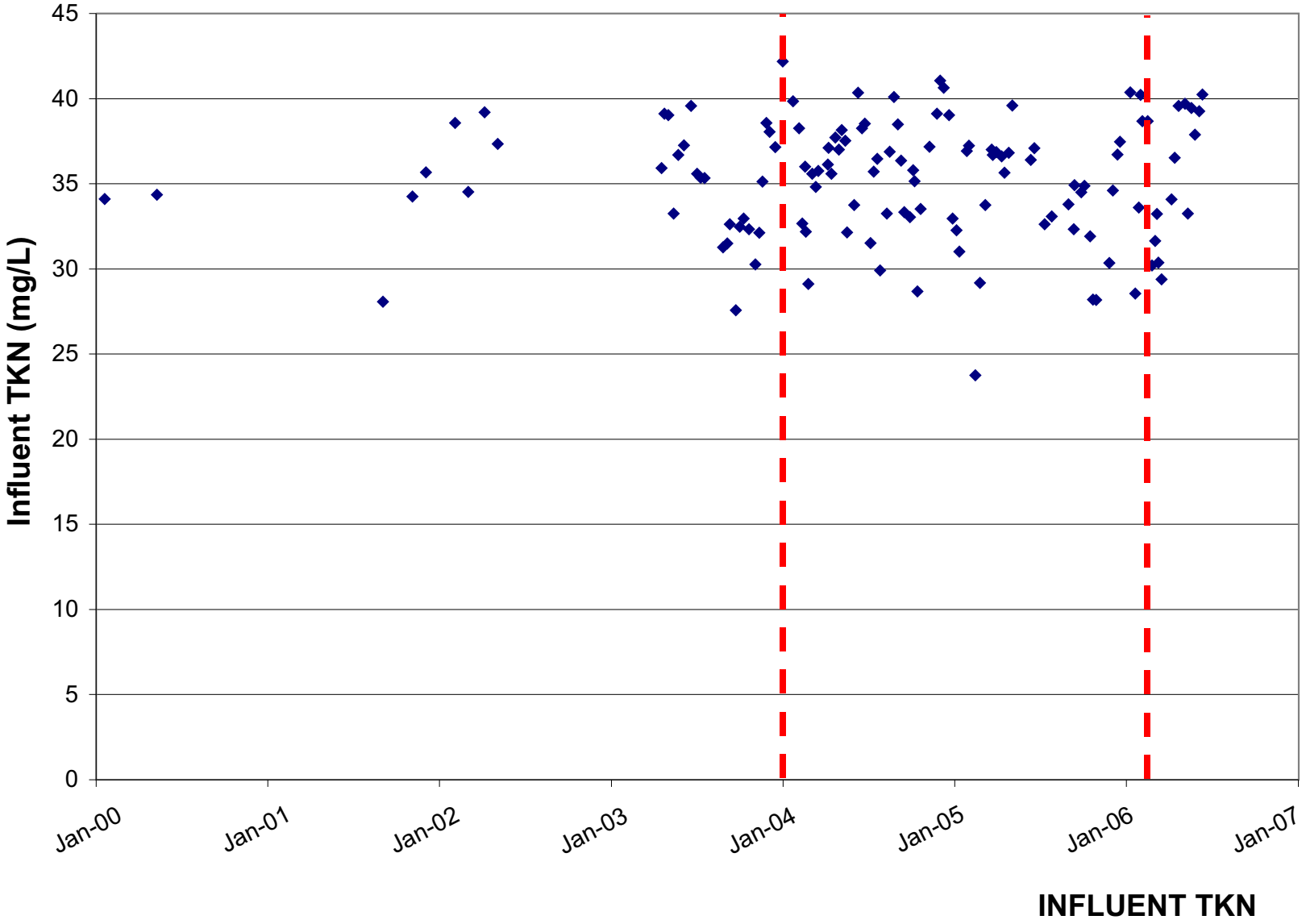
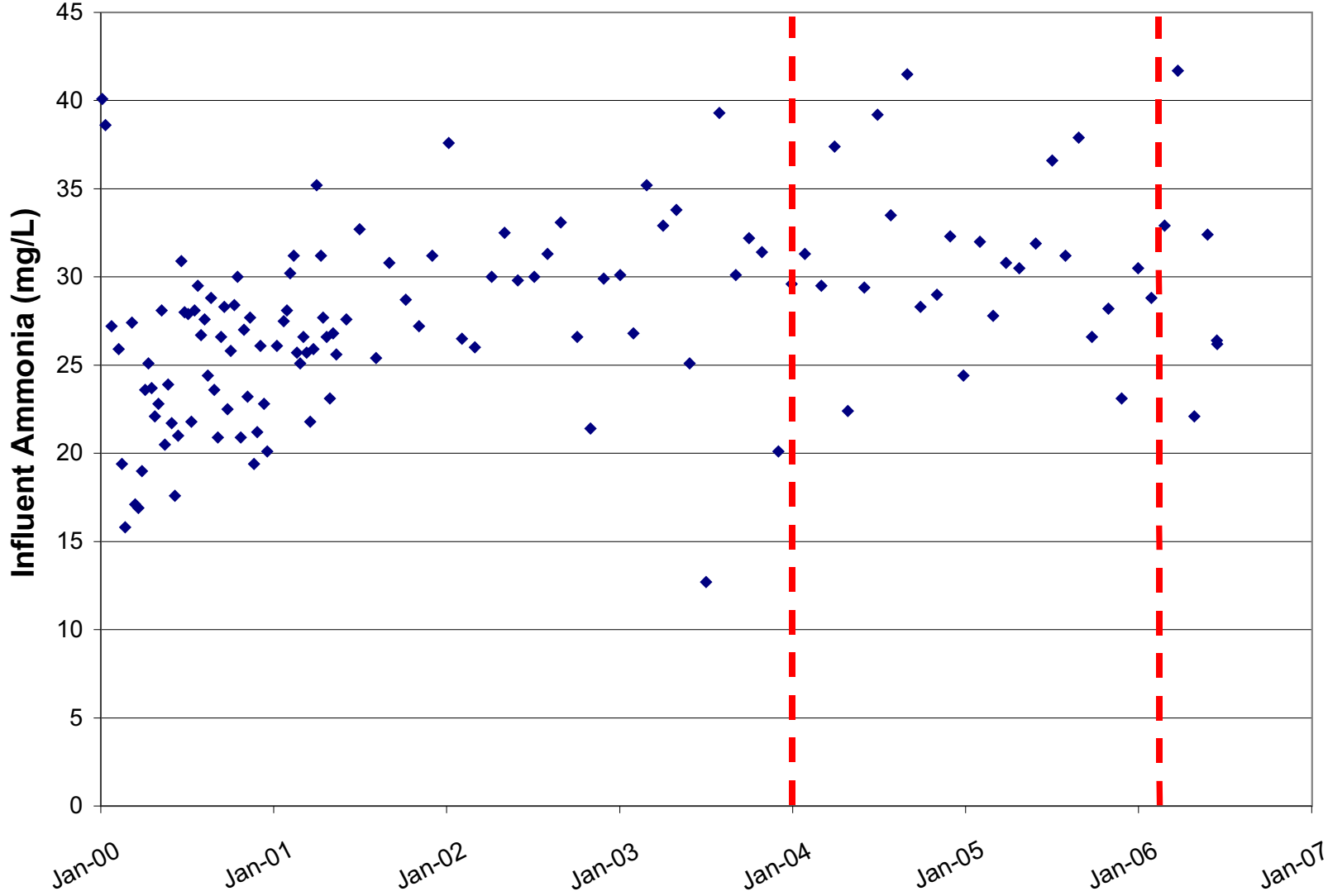

Influent TKN (mg/L)
45
40
35
30
25
20
15
10
5
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
INFLUENT TKN

FIGURE 3.5



INFLUENT AMMONIA

FIGURE 3.6

Wastewater treatment facilities are designed to handle both hydraulic and pollutant load peaks. Figures 3.7 and 3.8 show the influent BOD and TSS loads, respectively. As shown, a peaking factor of 1.25 covers most load peaks and hence was chosen for model calibration and for design of future expansion. The peaking factors for wastewater flow and BOD and TSS loads are summarized in Table 3.1. The discussion on peaking factors for wastewater flow is presented in Volume 2, Chapter 3 - Population and Flow Projections. These peaking factors would be confirmed during design.

Table 3.2 Peaking Factors
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Peaking Factor
Wastewater Flows	
Peak Wet Weather Flow	2.2
Peak Dry Weather Flow	1.8
Tertiary Peak	1.5(1)
Wastewater Characteristics	
BOD Load	1.25
TSS Load	1.25
TKN Load(2)	1.25

Notes:
(1) Based on the assumption that secondary effluent is equalized prior to tertiary filtration.
(2) Due to limited availability of influent nitrogen data, the TKN peak factor was based on the BOD and TSS peak factors.

In order to properly size the future expansion project it is necessary to project the future flow conditions. Anticipated wastewater influent flow to the RWQCP is presented in Volume 2, Chapter 3 - Population and Flow Projections.

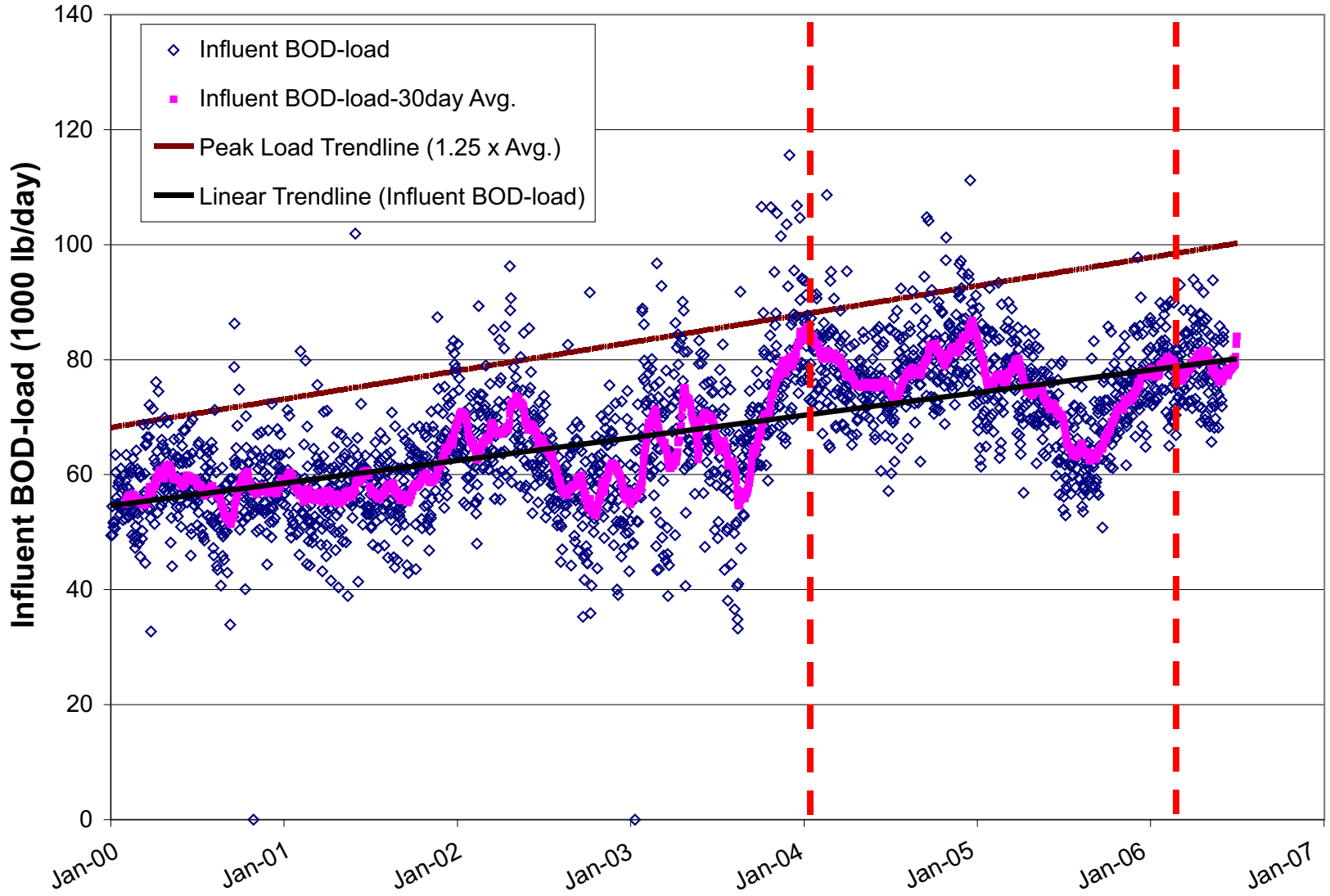
3.3.2 Effluent Wastewater Quality Criteria

The RWQCP has to meet the effluent discharge requirements summarized in Table 3.3.

Table 3.3 Criteria for Effluent
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

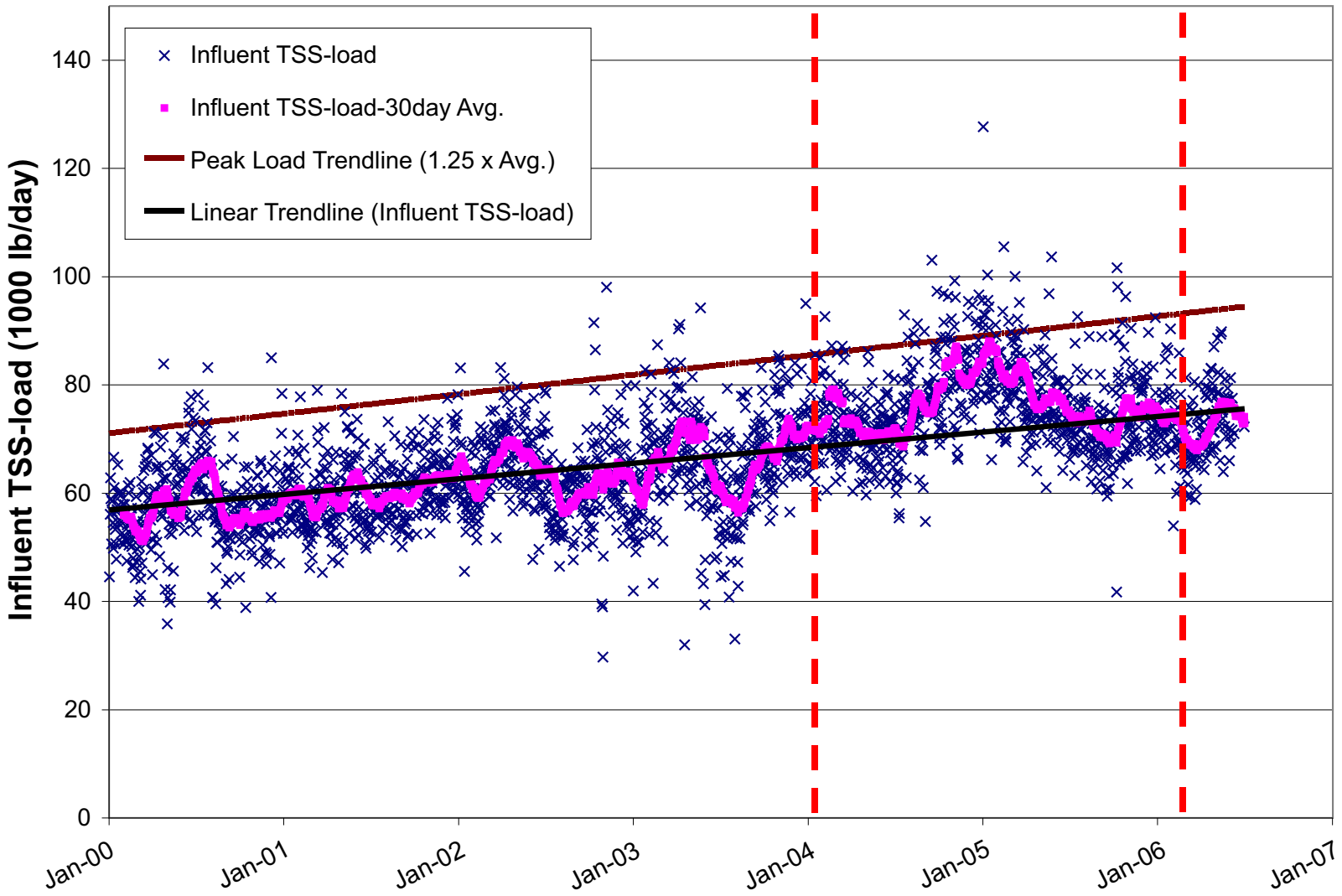
Parameter	30-day Average (mg/L)	7-day Average (mg/L)
BOD	20	30
TSS	20	30
Total Inorganic Nitrogen (as N)	10(1)	N/A

Notes:
(1) Permit requirement is 13 mg/L for flows less than 35 mgd and 10 mg/L for flows above that. A design value of 8 mg/L is used to provide a safety factor.



INFLUENT BOD LOAD

FIGURE 3.7



INFLUENT TSS LOAD

FIGURE 3.8

In addition to the water quality criteria listed above, total coliform, toxic pollutants, and other Basin Plan constituents of concern are addressed in the discharge permit and Title 22.

3.4 MODELING OF EXISTING TREATMENT FACILITIES

3.4.1 Biotran and BioWin™ Process Models

Carollo Engineers (Carollo) employs a customizable spreadsheet based process model, Biotran, to perform mass balances and evaluate operating criteria over an entire treatment plant. A Biotran process model was set up for the RWQCP. A copy of the Biotran model is included in Appendix A.

In addition to the Biotran spreadsheet model, Carollo uses the commercially available process model BioWin™ to simulate and design the activated sludge system. A BioWin™ model was set up for the RWQCP to simulate the performance of the activated sludge process for both Plant 1 and Plant 2.

3.4.2 Calibration

As a first step in applying Biotran for evaluating plant operations, a historical time period is selected, over which operations are reasonably steady to calibrate and check the model predictions against actual operations. Operating data for the RWQCP were examined to select an appropriate period for calibration, and average values of wastewater parameters for the period from January 2004 to March 2006 were used for the calibration of the model.

3.4.3 Calibration Modeling Results

Calibration modeling results are summarized in Table 3.4.

Table 3.4 Comparison of Plant Data and Model Calibration Results Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Effluent Parameter	Plant Data	Biotran Model Result	BioWin™ Model Result
Plant 1			
NH_4-N, mg/L	0.6	0.1	0.3
NO3-N, mg/L	20.4	17.7	16.8
TIN, mg/L	21.0	17.8	17.1
WAS Production, lb/day	8,450	7,850	7,763
Plant 2			
NH_4-N, mg/L	0.9	0.1	0.3
NO3-N, mg/L	4.9	5.6	5.1
TIN, mg/L	5.8	5.7	5.4
WAS Production, lb/day	21,950	22,570	21,712

The calibrated Biotran and BioWin™ models show a reasonable agreement with the actual data as far as solids production is concerned. In terms of effluent quality, there is reasonable agreement for effluent ammonia-nitrogen. The effluent nitrate-nitrogen (and thus the effluent total inorganic nitrogen) shows some difference. The difference may be due to operational changes during the calibration period or due to dewatering centrate effects that will be discussed in Volume 4, Chapter 10 - Recycle Stream Management.

Both the Biotran and BioWin™ models show reasonable agreement with the plant data and would be applicable in evaluating future options. The calibrated Biotran (refer to Appendix A) model was used to assess the treatment capacity of the existing facilities. The Biotran model estimates the existing treatment capacity to be 40 mgd (annual average flow rate). This capacity estimate is based on the assumption that the influent flow split between Plant 1 and Plant 2 will be in a 50:50 ratio. Previously, during the secondary system upgrades project, done by Carollo in 2002, the Biotran showed that the plant capacity was approximately 36 mgd. The increase from 36 to 40 mgd is due to the results of the *Clariflux*™ modeling that was done for the master plan. These results will be described in Volume 4, Chapter 7 - Secondary Treatment.

3.5 BASIS OF RWQCP EXPANSION

3.5.1 Reliability and Units Out of Service

The following reliability criteria were established for the maximum number of operating units for each unit out of service. Table 3.5 shows the summary of the reliability and units out-of-service criteria.

Table 3.5 Reliability and Units Out-of-Service Criteria
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Number of Units in Service (Up To)	Units Considered Out of Service
Process Tankage(1)	9	1
Tertiary Filters	6	1
Rotating Mechanical Equipment	4	1

Notes:
(1) Applies to aeration basins, secondary clarifiers, and digesters only.

3.5.2 Process Design Criteria and Unit Sizing

The following information (Table 3.6) was used to develop the process design and unit sizing for all various unit processes.

Table 3.6 Unit Process Design Criteria and Sizing
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Value	Notes
Headworks - Screens		
Bar Spacing	3/8”	
Operation Mode	One standby unit and one bypass channel	
Primary Clarifiers	1,200 gpd/ft^2	Annual Average Flow.
	2,250 gpd/ft^2	Peak Hourly Wet Weather Flow.
Primary Clarifier Covers	Low Profile Aluminum Covers	
Odor Control - Biofilters		
Application Rate	3.0 to 5.0 cfm/ft^2	
Typical Depth	3 to 4 ft	
Aeration Basins		
SRT	5 to 8	Days at Max Month Loading Conditions.
Membrane Bioreactor		
SRT	5 to 8	
Operating MLSS	8,000 - 10,000 mg/L	
IFAS Process		
SRT	5 to 8 days	
Equivalent MLSS Increase	40 lbs. per 1,000 ft^2 of media	
Secondary Clarifiers		
Surface Overflow Rate	1,500 gpd/ft^2	At Max Month Conditions
Tertiary Facilities		
Tertiary Facilities Design Flow to Annual Average Flow	1.5:1	Flow equalized prior to tertiary facilities.
Dual Media	4.0	gpm/sq. ft. with one cell out of service and one in backwash.
Cloth Disk Filter	4.5	gpm/sq. ft. (rated with one unit out of service for every seven installed).

Table 3.6 Unit Process Design Criteria and Sizing Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Parameter	**Value**	**Notes**
Disinfection - Chlorination		
Chlorine Contact Basins Ct-value	450 mg/L-min	
Modal Contact Time	90 min	
(Modal Contact Time/ Detention Time) Ratio	85%	
Disinfection - UV		
UV Transmittance (UVT)	55% (to be confirmed)	Typical range 50% to 70%. The UVT value for design would be established by conducting laboratory tests during the preliminary design stage.
Disinfection - Ozone		
Ozone Dose	15 mg/L	Typical range 5 to 40 mg/L. Dose varies with the initial coliform count.
HRT	15 min	

All unit processes shall be capable of treating or hydraulically conveying all flow as identified in the influent characteristics with the largest unit out of service.

Table 3.7 presents a summary of the parameters (flow and wastewater quality) that were used as a basis for evaluating and selecting the various unit processes/operations for expansion of the RWQCP.

Table 3.7 Design Criteria for Expansion of RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Effluent Parameter	**Value**
Design Flows	
Average Dry Weather Flow (ADWF), mgd	52.2
Peak Wet Weather Flow (PWWF), mgd	115[(1)]
Approximate Recycle Flow to Headworks, mgd	5.5
Average Influent Wastewater Characteristics[(2)]	
BOD, mg/L	250
TSS, mg/L	250
TKN, mg/L as N	35.5

Table 3.7 Design Criteria for Expansion of RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Effluent Parameter	**Value**
Effluent Quality Requirements	
BOD, mg/L	<10
TSS, mg/L	<10
Total Inorganic Nitrogen, mg/L	<8
Ammonia-Nitrogen, mg/L	<1[(3)]

Notes:
(1) Based on an instantaneous peak flow factor of 2.2.
(2) Does not include impact of recycle streams from dewatering, thickening and tertiary filter backwash.
(3) To ensure stable nitrification performance.

APPENDIX A
BIOTRAN MODEL

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT:	PROCESS ANALYSIS AND MASS BALANCE

Calc by	Date	Time	Chk by/Date	FileName:
CFP,NV	10/12/2006	9:03 AM		Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
NOTES regarding this application:					With Default Sludge Settleability 35:65 Recycle Split			With Better Sludge Settleability 40:60 Recycle Split Based on aeration capacity			With Better Sludge Settleability 40:60 Recycle Split Based on aeration capacity Centrifuge, not BP				
SUMMARY:															
FLOW RATES, mgd:															
- Raw WW Flow		11.0	20.1		17.8	22.2		22.2	22.2		22.2	22.2			
- Flow to Primaries		14.5	20.9		19.4	26.5		24.3	26.8		24.1	26.5			
- Flow to Activated Sludge		13.7	21.2		18.2	27.3		22.9	27.3		22.8	26.9			
SECONDARY EFFLUENT QUALITY, mg/L:															
- BOD (est.), mg/L		2	2		3	3		3	3		3	3			
- TSS (nominal), mg/L		5	4		5	4		5	4		5	4			
- NH3-N, mg/L	[Note]	0.07	0.05		0.26	0.46		0.31	0.44		0.27	0.35			
- NO3/NO2-N, mg/L		17.7	5.6		8.5	8.5		7.8	8.0		8.1	8.5			
- T.I.N., mg/L		17.8	5.6		8.8	8.9		8.1	8.5		8.4	8.9			
PRIMARY CLARIFIERS															
- # of Clarifiers		6	4		6	4		6	4		6	4			
- # in Service		6	4		6	4		6	4		6	4			
- Surface Overflow Rate, gpd/sf		631	736		848	935		1,061	946		1,052	934			
AERATION BASINS															
- # of Basins		4	6		4	6		4	6		4	6			
- # in Service		4	6		4	6		4	6		4	6			
- Hydraulic Deten. Time, hr		7.1	8.9		5.3	6.9		4.2	6.9		4.3	7.0			
- Operating Last-Pass MLSS, mg/L		2,860	3,170		2,780	2,330		3,500	2,500		3,500	2,500			
- Design Temperature, deg C		24.9	24.9		20.0	20.0		20.0	20.0		20.0	20.0			
- Unaerated Volume Fraction		0.25	0.19		0.25	0.19		0.25	0.19		0.25	0.19			Selected
- Aerobic SRT, days		8.84	7.78		3.63	2.75		3.22	2.80		3.33	2.94			
-- Min. Aerobic SRT for Nitrification		3.05	3.14		4.17	4.19		4.15	4.23		4.15	4.23			
- Total SRT, days		11.79	9.56		4.83	3.38		4.29	3.44		4.44	3.61			
-- Recommended Min. Total SRT for Nitrification		4.07	3.86		5.56	5.14		5.53	5.19		5.53	5.19			
- F/M, lb BOD Appl./lb MLSS-day		0.16	0.17		0.32	0.35		0.34	0.34		0.34	0.34			
- Aer. BOD Loading, lb BOD/1000 cf-day		28	33		56	51		74	53		74	52			
- ML Recirculation Ratio		2.9	2.1		2.2	1.6		1.7	1.6		1.8	1.6			Selected
- Process Air (est.), scfm		6,110	10,200		10,390	17,560		14,040	17,580		13,940	17,380			
SECONDARY CLARIFIERS															
- # of Basins		4	4		4	4		4	4		4	4			
- # in Service		4	4		4	4		4	4		4	4			
- Sec. Clarifier SOR, gpd/sf		386	494		509	627		645	631		641	623			
- Sec. Clar. Solids Loading, lb/day-sf		15	23		19	18		25	18		25	17			
- Clarifier Safety Factor (CSF)		2.6	1.8		2.0	2.0		2.8	2.8		2.8	2.9			
-- CSF Target		2.3	2.2		2.0	2.0		2.0	2.0		2.0	2.0			

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
DETAILED CALCULATIONS:															
RAW WASTEWATER (excluding Recycles)															
o Plant Flow Rate, mgd		11.0	20.1		17.8	22.2		22.2	22.2		22.2	22.2			
o Flow Characteristic Ratios															
- Max Month/Annual Avg	*	1	1		1.11	1.11		1.11	1.11		1.11	1.11			Default
- Peak 4-hr Wet-W Flow/Annual Avg	*	2.0	1.9		2.0	1.9		1.9	1.9		1.9	1.9			Default
- Typical 4-hr Diurnal Peak/Daily Avg	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
o Wastewater Characteristics															
- BOD, mg/L, Annual Average	*	**233**	**233**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1	1		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective BOD, mg/L		233	233		282	282		282	282		282	282			
"Effective" concentrations correspond to Peak Mass Loads with the flow rate used in the calculation															
- TSS, mg/L, Annual Average	*	**232**	**232**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1	1		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective TSS, mg/L		232	232		282	282		282	282		282	282			
- Fpv, VSS fraction	*	0.83	0.83		0.83	0.83		0.83	0.83		0.83	0.83			Default
-- Effective VSS, mg/L		192	192		234	234		234	234		234	234			
- NH3-N, mg/L, Annual Average	*	21.0	21.0		21.0	21.0		21.0	21.0		21.0	21.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1	1		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective NH3-N, mg/L		21.0	21.0		23.6	23.6		23.6	23.6		23.6	23.6			
Organic-N, mg/L, Annual Average	*	14.5	14.5		14.5	14.5		14.5	14.5		14.5	14.5			Default
-- Mass Load (lb/d) Peaking Factor	*	1	1		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Org-N, mg/L		14.5	14.5		16.3	16.3		16.3	16.3		16.3	16.3			
- NO3-N, mg/L, Annual Average	*	0	0		0	0		0	0		0	0			Default
- Alkalinity, mg/L, Annual Average	*	250	250		250	250		250	250		250	250			Default
- Filterable ("soluble") BOD															
-- fraction, Fbf	*	0.25	0.25		0.25	0.25		0.25	0.25		0.25	0.25			Default
-- mg/L		58	58		70	70		70	70		70	70			
- Fvu, Fraction VSS that is Unbiodeg	*	0.600	0.600		0.600	0.600		0.600	0.600		0.600	0.600			Estimated
- Total Phosphorus, mg/L, Annual Average	*	10.5	10.5		11.0	11.0		11.0	11.0		11.0	11.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1	1		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Total-P, mg/L		10.5	10.5		12.4	12.4		12.4	12.4		12.4	12.4			
-- Fraction filterable ("soluble")	*	0.33	0.33		0.32	0.32		0.32	0.32		0.32	0.32			Default
-- Filterable P, mg/L		3.50	3.50		3.94	3.94		3.94	3.94		3.94	3.94			
o Design Temperature, deg. C															
- Minimum (Winter)	*	20	20		20	20		20	20		20	20			Default
- Maximum (Summer)	*	29	29		29	29		29	29		29	29			Default
- Design	*	24.9	24.9		20	20		20	20		20	20			Winter
RECYCLE TO HEADWORKS/PRIM CLAR.S															
o Flow Rate, mgd															
- Filter Backwash	*	3.102	0.000	3.102	1.399	2.598	3.997	1.777	2.665	4.441	1.759	2.639	4.399		
- Dewatering Filterate + Washwater/Centrate	*	0.361	0.000	0.361	0.265	0.493	0.758	0.337	0.505	0.842	0.157	0.236	0.393		
- Primary Sludge From Plant 1	*	0.000	0.766		0.000	1.232		0.000	1.441		0.000	1.397			
- Total		3.462	0.766		1.664	4.323		2.114	4.612		1.917	4.273			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		43	1,702		65	589		64	636		55	675			
-- TSS		176	3,000		224	1,015		226	1,093		136	1,073			
-- VSS		127	2,387		168	813		170	877		104	869			
-- NH3-N		51	28		62	52		62	51		69	55			
-- Organic-N		11	141		14	48		15	52		10	50			
-- NO3/NO2-N		10	2		8	6		7	5		8	5			
-- Alkalinity		313	265		347	321		346	318		369	333			
-- Filterable ("soluble") BOD		4.2	45.2		6.3	23.0		6.3	24.6		5.2	24.8			
-- Total soluble Organic N		2.3	0.0		2.5	1.8		2.5	1.7		2.5	1.7			
-- Fpv, VSS fraction		0.72	0.80		0.75	0.80		0.75	0.80		0.77	0.81			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default

* Input Data

CAROLLO ENGINEERS, PC

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Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
PRIMARY TREATMENT		In Service	In Service		In Service	In Service		In Service	In Service		In Service	In Service			
o Flow Rate, mgd															
- Raw Wastewater		11.0	20.1		17.8	22.2		22.2	22.2		22.2	22.2			
- Recycle stream		3.46	0.77		1.66	4.32		2.11	4.61		1.92	4.27			
- Total Influent		14.5	20.9		19.4	26.5		24.3	26.8		24.1	26.5			
o Wastewater Characteristics, mg/L															
- BOD		187	287		263	332		263	343		264	345			
- TSS		218	333		277	401		277	421		270	409			
- VSS		177	273		228	328		228	344		223	336			
- NH3-N		28	21		27	28		27	28		27	29			
- Organic-N		14	19		16	21		16	22		16	22			
- NO3-N		2	0		1	1		1	1		1	1			
- Alkalinity		265	251		258	262		258	262		259	263			
- Filterable ("soluble") BOD		45	58		65	63		65	63		65	63			
- Fpv, VSS fraction		0.81	0.82		0.82	0.82		0.82	0.82		0.83	0.82			
o Basin dimensions (inside)															
- Basins Set - 1,2,3,4															
- Number of Basins	*	4	4		4	4		4	4		4	4			
- Number of Units in Service	*	4	4		4	4		4	4		4	4			
- Diameter, ft	*	0	95		0	95		0	95		0	95			
- Side Water Depth, ft	*	9	9		9	9		9	9		9	9			
- Surface Area per Basin, sf		2,704	7,088		2,704	7,088		2,704	7,088		2,704	7,088			
- Surface Area in Service, sf		10,816	28,353		10,816	28,353		10,816	28,353		10,816	28,353			
- Basins Set - 5,6															
- Number of Basins	*	2	0		2	0		2	0		2	0			
- Number of Units in Service	*	2	0		2	0		2	0		2	0			
- Diameter, ft	*	0	0		0	0		0	0		0	0			
- Side Water Depth, ft	*	9	0		9	0		9	0		9	0			
- Surface Area per Basin, sf		6,050	0		6,050	0		6,050	0		6,050	0			
- Surface Area in Service, sf		12,099	0		12,099	0		12,099	0		12,099	0			
- Total Surface Area in Service, sf		22,915	28,353		22,915	28,353		22,915	28,353		22,915	28,353			
o Surface Overflow Rate, gpd/sf															
- At Design Flow		631	736		848	935		1,061	946		1,052	934			
- At Diurnal Peak Flow		820	957		993	1,096		1,243	1,108		1,233	1,094			
- At Peak WW Flow		1,278	1,409		1,493	1,614		1,830	1,631		1,816	1,611			
o Detention Time, hr		1.2	2.2		0.9	1.7		0.7	1.7		0.7	1.7			
o Chemically Enhanced Primary Treatment															
- CEPT applied? [Y=1; N=0]	*	0	0		0	0		0	0		0	0			Default
- Ferric Chloride dosage, mg/L as FeCl3	*	10	10		10	10		10	10		10	10			Default
-- FeCl3 used, lb/d		0	0		0	0		0	0		0	0			
- Polymer dosage, mg/L	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			Default
-- Polymer used, lb/d		0	0		0	0		0	0		0	0			
- Chem Sludge Generated, lb/d															
-- Total, lb/d		0	0		0	0		0	0		0	0			
- Alkalinity Reduction, mg/L		0	0		0	0		0	0		0	0			
o Removal Efficiency, %															
- BOD Removal, %		**45.3**	**43.2**		**42.3**	**40.5**		**39.2**	**40.5**		**39.4**	**40.9**			
- TSS Removal, %		**71.3**	**67.0**		**66.7**	**62.7**		**62.0**	**62.5**		**62.2**	**62.8**			
- Non-volatile SS %, Rpn		76.5	72.5		71.8	68.1		66.8	67.9		67.0	68.1			
- Organic-N Removal, %		52.2	52.3		48.8	49.9		45.6	50.3		45.2	50.1			
o Primary Sludge															
- Solids removed, lb/d															
-- Non-chemical primary solids		19,173	38,971		30,833	55,911		36,066	59,153		34,964	56,967			
-- Chemical solids from CEPT		0	0		0	0		0	0		0	0			
-- Total solids removed		19,173	38,971	58,144	30,833	55,911	86,744	36,066	59,153	95,219	34,964	56,967	91,932		
- Concentration, %	*	0.3	3.5		0.3	3.5		0.3	3.5		0.3	3.5			Default
- Flow Rate, mgd		0.766	0.134		1.232	0.192		1.441	0.203		1.397	0.195			
- Organic N removed, lb/d		901	1,754		1,362	2,388		1,601	2,539		1,539	2,423			
o Primary Effluent Flow, mgd		13.7	20.7		18.2	26.3		22.9	26.6		22.7	26.3			
o Primary Effluent, mg/L															
- BOD		102	163		152	197		160	204		160	204			

* Input Data

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- TSS		63	110		92	149		105	158		102	152			
- VSS		53	94		78	126		89	133		87	129			
- NH3-N		28.2	21.3		27.0	28.3		26.9	28.3		27.2	28.7			
- Organic-N		6.54	9.13		8.28	10.78		8.81	11.13		8.68	10.86			
- NO3-N		2.4	0.1		0.7	1.0		0.6	0.9		0.6	0.9			
- Alkalinity		265	251		258	262		258	262		259	263			
- Filterable ("soluble") BOD		45	58		65	63		65	63		65	63			
RECYCLE TO ACTIVATED SLUDGE															
o Flow Rate, mgd															
- DAF Underflow	*	0.000	0.431	0.431	0.000	0.920	0.920	0.000	0.611	0.611	0.000	0.583	0.583		
- Stream 2	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Stream 3	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Spray Water to Basins	*	0.033	0.060		0.048	0.060		0.060	0.060		0.060	0.060			Default
- Total		0.033	0.491		0.048	0.980		0.060	0.671		0.060	0.643			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		0	83		0	136		0	228		0	227			
-- TSS		0	371		0	407		0	693		0	693			
-- VSS		0	309		0	346		0	587		0	589			
-- NH3-N		0	0		0	0		0	0		0	0			
-- Organic-N		0	24		0	28		0	47		0	47			
-- NO3-N		0	9		0	8		0	7		0	8			
-- Alkalinity		0	120		0	126		0	124		0	122			
-- Filterable ("soluble") BOD		0.0	0.7		0.0	1.1		0.0	1.1		0.0	1.1			
-- Total soluble Organic N		0.0	1.9		0.0	2.2		0.0	2.1		0.0	2.1			
-- Fpv, VSS fraction		0.00	0.83		0.00	0.85		0.00	0.85		0.00	0.85			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default
ACTIVATED SLUDGE PROCESS															
o Flow Rate, mgd															
- Main-Stream Influent		13.70	20.73		18.19	26.33		22.87	26.61		22.72	26.28			
- Recycle directly to AS		0.03	0.49		0.05	0.98		0.06	0.67		0.06	0.64			
- Total to Activated Sludge		13.73	21.22		18.24	27.31		22.93	27.28		22.78	26.92			
o Influent Characteristics, mg/L															
- Total BOD		102	161		151	195		159	204		159	205			
- TSS		62	116		92	159		105	171		102	165			
- VSS		53	99		78	134		89	144		86	140			
- NH3-N		28	21		27	27		27	28		27	28			
- Organic-N		7	9		8	11		9	12		9	12			
- NO3-N		2	0		1	1		1	1		1	1			
- Alkalinity		264	248		258	257		258	258		259	260			
- Filterable ("soluble") BOD		45	56		65	60		65	61		65	62			
- Fpv, VSS fraction		0.84	0.85		0.85	0.84		0.85	0.84		0.85	0.85			
- AB Influent D.O. Concentration, mg/L		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0			
o Basin dimensions															
- Main Basins														For MBR,	MBR
-- No. of Basins	*	4	6		4	6		4	6		4	6		enter	0
-- Number of Units in Service	*	4	6		4	6		4	6		4	6		Basin	0
-- Length, ft (inside)	*	200	250		200	250		200	250		200	250		dimen.s	0
-- Width, ft (inside)	*	40	40		40	40		40	40		40	40		in the	0
-- Side Water Depth, ft	*	16.9	17.5		16.9	17.5		16.9	17.5		16.9	17.5		MBR	0
.. Recomm inside Wall height, incl. Freeboard, ft		19.9	20.5		19.9	20.5		19.9	20.5		19.9	20.5		section	3
-- Liquid Volume per Basin, mil gal		1.01	1.31		1.01	1.31		1.01	1.31		1.01	1.31		(not HERE)	0.00
- Supplemental Basins or Sections															
-- Identification	*													calcs	Membrn Zn
-- No. of Basins	*	0	0		0	0		0	0		0	0			0
-- Number of Units in Service	*	0	0		0	0		0	0		0	0		into	0
-- Length, ft (inside)	*	200	200		200	200		200	200		200	200		< - - these	0
-- Width, ft (inside)	*	100	100		100	100		100	100		100	100		columns	0
-- Side Water Depth, ft	*	17	17		17	17		17	17		17	17			0

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity				
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		Setup info	Basis
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0			
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4			
-- Volume per Basin, mil gal		2.54	2.54		2.54	2.54		2.54	2.54		2.54	2.54			0.00	
o Total Volume of Basins, mil gal																
- Total Basin volume in service		4.05	7.85		4.05	7.85		4.05	7.85		4.05	7.85				
-- Reduction for MBR cassettes		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
- Biological Reaction Volume		4.05	7.85		4.05	7.85		4.05	7.85		4.05	7.85				
o Aerated Zone BOD Loading, lb/1,000 cf-day		28.5	32.9		56.0	50.7		74.3	52.9		73.8	52.3				
o Hydraulic Detention Time, hr		7.07	8.88		5.32	6.90		4.23	6.91		4.26	7.00				
o Selected Operating L-P MLSS, mg/L		2,858	3,173		2,782	2,327		3,500	2,500		3,500	2,500				
PROCESS LAYOUT																
o Zone Sizes (Fraction of Total Volume)																Selected
- Zone 1	*	0.125	0.186		0.125	0.186		0.125	0.186		0.125	0.186		**For MBR,**	0.000	
- Zone 2	*	0.125	0.214		0.125	0.214		0.125	0.214		0.125	0.214		*Copy*	0.000	
- Zone 3	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000		*& Paste*	0.000	
- Zone 4	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000		these - - >	0.000	
- Zone 5	*	0.000	0.200		0.250	0.200		0.250	0.200		0.250	0.200		calcs into	0.000	
- Zone 6	*	0.330	0.200		0.250	0.200		0.250	0.200		0.250	0.200		< - - these	0.000	
- Zone 7 (by difference)		0.420	0.200		0.250	0.200		0.250	0.200		0.250	0.200		columns	0.000	
-- Total		1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			0.000	
o DO in each Zone (Unaerated, Set = 0), mg/L																
- Zone 1	*	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		**For MBR,**	0.0	
- Zone 2	*	0.0	2.0		0.0	**2.5**		0.0	2.0		0.0	2.0		Adjust	2.0	
- Zone 3	*	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0		D.O. as	2.0	
- Zone 4	*	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0		needed,	2.0	
- Zone 5	*	2.0	2.0		2.0	**2.3**		2.5	2.0		2.5	2.0		**except** for	2.0	
- Zone 6	*	2.5	2.0		2.5	**2.0**		2.5	2.0		2.5	2.0		Zone 7	2.0	
- Zone 7	*	2.5	2.0		2.5	**2.0**		2.5	2.0		2.5	2.0		< - - copy	***0.0***	
o Aerated/Unaerated Fractions																
- Total Unaerated Volume Fraction		0.25	0.19		0.25	0.19		0.25	0.19		0.25	0.19				
-- Total Unaerated Volume, mil gal		1.01	1.46		1.01	1.46		1.01	1.46		1.01	1.46				
- Total Aerated Volume Fraction		0.75	0.81		0.75	0.81		0.75	0.81		0.75	0.81				
-- Total Aerated Volume, mil gal		3.03	6.39		3.03	6.39		3.03	6.39		3.03	6.39				
- Total Aerated Mass Fraction		0.75	0.81		0.75	0.81		0.75	0.81		0.75	0.81				
o Plant Influent Flow Routing																
- Fraction to Zone 1	*	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 3	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 4	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 5	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 6		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
o Return Sludge Routing																
- Fraction to Zone 1	*	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 3		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
o Mixed-Liquor Recirculation Routing																
- MLR Taken from Zone (3, 4, 5, 6, 7)	*	7	7		7	7		7	7		7	7				Default
- MLR Returned to Zone (1, 2, 3, 4, 5)	*	1	1		1	1		1	1		1	1				Default
- MLR Flow, mgd		40.00	44.00		40.00	44.00		40.00	44.00		40.00	44.00				
- MLR Ratio		2.91	2.07		2.19	1.61		1.74	1.61		1.76	1.63				
o Sludge Wasting Method														**For MBR,**		
- Wasting from RAS (1) or ML (0)	*	1	1		1	1		1	1		1	1		< - - copy	***0***	Default
-- If ML, Waste taken from Zone # (1, 2, - - 7)	*	(RAS)	(RAS)		(RAS)	(RAS)		(RAS)	(RAS)		(RAS)	(RAS)		< - - copy	*7*	Default
LOADING CRITERIA																
o BOD Applied, lb/d																
- Total Influent		11,692	28,475		23,025	44,442		30,479	46,492		30,273	45,946				
- (-) WAS Recycled		139	341		293	1,113		339	1,277		339	1,220				
- Net BOD Load		11,553	28,134		22,732	43,330		30,140	45,215		29,933	44,726				
o MLSS under aeration, lb		72,332	169,267		70,375	123,943		88,531	133,144		88,535	133,162				
- F/M, lb BOD Appl./lb MLSS-day		0.16	0.17		0.32	0.35		0.34	0.34		0.34	0.34				
o Organic Loading, Based on Aerated Zone																
- Aerated Volume in Service, 1,000 cf		406	855		406	855		406	855		406	855				

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Aer. BOD Loading, lb BOD/1000 cf-day		28.5	32.9		56.0	50.7		74.3	52.9		73.8	52.3			
o Unaerated Zone															
- Actual HRT (Throughflow), hr		0.39	0.44		0.35	0.42		0.34	0.44		0.35	0.44			
- Mixing Power, total															
-- Total BHP, all Unaerated Zones	*	35.4	51.1		35.4	51.1		35.4	51.1		35.4	51.1			
-- Mixing, hp/mil gal		35	35		35	35		35	35		35	35			
ACTIVATED SLUDGE - ZONE 1		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer			
o Zone Volume, mil gal	1	0.506	1.461		0.506	1.461		0.506	1.461		0.506	1.461			
o Flows Entering, mgd	1														
- Plant Influent Flow	1	13.73	21.22		18.24	27.31		22.93	27.28		22.78	26.92			
- RAS Stream	1	8.59	15.05		10.97	12.48		7.62	8.62		7.57	8.51			
- ML Recirculation	1	40.00	44.00		40.00	44.00		40.00	44.00		40.00	44.00			
- Total Flow to this Zone	1	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	1														
- ML Recirculated to Other Zones	1	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	1	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	1	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	1														
- Hydraulic Detention time, Actual, hr	1	0.19	0.44		0.18	0.42		0.17	0.44		0.17	0.44			
o Effluent from this Zone	1														
-- MLSS, mg/L	1	2,859	3,174		2,779	2,318		3,495	2,490		3,496	2,491			
-- NH3-N, mg/L	1	6.04	5.55		7.04	9.07		8.69	9.60		8.73	9.62			
-- NO3-N, mg/L	1	12.83	0.75		3.92	1.89		2.11	1.15		2.27	1.43			
-- D.O., mg/L	1	0.01	0.00		0.01	0.00		0.01	0.00		0.01	0.00			
o Biological Growth Summary	1														
- Increase in VSS, lb/d	1	1,427	2,313		2,919	3,946		3,703	3,851		3,710	3,871			
- Increase in ISS, lb/d	1	131	230		259	382		327	378		327	377			
ACTIVATED SLUDGE - ZONE 2		Un-Aer	Aerated		Un-Aer	Aerated		Un-Aer	Aerated		Un-Aer	Aerated			
o Zone Volume, mil gal	2	0.506	1.681		0.506	1.681		0.506	1.681		0.506	1.681			
o Flows Entering, mgd	2														
- Throughflow	2	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- Plant Influent to this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	2	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	2														
- ML Recirculated to Other Zones	2	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	2	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	2														
- Hydraulic Detention time, Actual, hr	2	0.19	0.50		0.18	0.48		0.17	0.50		0.17	0.51			
o Effluent from this Zone	2														
-- MLSS, mg/L	2	2,859	3,175		2,779	2,322		3,496	2,494		3,496	2,494			
-- NH3-N, mg/L	2	6.22	1.86		7.22	6.09		8.91	6.44		8.94	6.33			
-- NO3-N, mg/L	2	11.92	3.93		2.57	4.12		0.60	3.46		0.74	3.89			
-- D.O., mg/L	2	0.00	2.00		0.00	2.50		0.00	2.00		0.00	2.00			
o Biological Growth Summary	2														
- Increase in VSS, lb/d	2	-72	574		284	2,033		199	2,067		209	1,976			
- Increase in ISS, lb/d	2	1	252		36	463		35	486		35	469			
ACTIVATED SLUDGE - ZONE 3		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	3	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	3														
- Throughflow	3	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- Plant Influent to this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			

* Input Data

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Total Flow to this Zone	3	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	3														
- ML Recirculated to Other Zones	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	3	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	3														
- Hydraulic Detention time, Actual, hr	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	3														
-- MLSS, mg/L	3	2,859	3,175		2,779	2,322		3,496	2,494		3,496	2,494			
-- NH3-N, mg/L	3	6.22	1.86		7.22	6.09		8.91	6.44		8.94	6.33			
-- NO3-N, mg/L	3	11.92	3.93		2.57	4.12		0.60	3.46		0.74	3.89			
-- D.O., mg/L	3	0.00	2.00		0.00	2.50		0.00	2.00		0.00	2.00			
o Biological Growth Summary	3														
- Increase in VSS, lb/d	3	0	0		0	0		0	0		0	0			
- Increase in ISS, lb/d	3	0	0		0	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 4		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	4	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	4														
- Throughflow	4	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- Plant Influent to this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	4	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	4														
- ML Recirculated to Other Zones	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	4	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	4														
- Hydraulic Detention time, Actual, hr	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	4														
-- MLSS, mg/L	4	2,859	3,175		2,779	2,322		3,496	2,494		3,496	2,494			
-- NH3-N, mg/L	4	6.22	1.86		7.22	6.09		8.91	6.44		8.94	6.33			
-- NO3-N, mg/L	4	11.92	3.93		2.57	4.12		0.60	3.46		0.74	3.89			
-- D.O., mg/L	4	0.00	2.00		0.00	2.50		0.00	2.00		0.00	2.00			
o Biological Growth Summary	4														
- Increase in VSS, lb/d	4	0	0		0	0		0	0		0	0			
- Increase in ISS, lb/d	4	0	0		0	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 5		N.I.S.	Aerated		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil ga	5	0.000	1.571		1.011	1.571		1.011	1.571		1.011	1.571			
o Flows Entering, mgc	5														
- Throughflow	5	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- Plant Influent to this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	5	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	5														
- ML Recirculated to Other Zones	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	5	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	5														
- Hydraulic Detention time, Actual, h	5	0.00	0.47		0.35	0.45		0.34	0.47		0.35	0.47			
o Effluent from this Zone	5														
-- MLSS, mg/L	5	2,859	3,175		2,781	2,324		3,498	2,496		3,498	2,497			
-- NH3-N, mg/L	5	6.22	0.34		3.92	3.61		4.92	3.79		4.84	3.59			
-- NO3-N, mg/L	5	11.92	5.23		5.41	6.06		3.97	5.49		4.24	6.03			
-- D.O., mg/L	5	0.00	2.00		2.00	2.25		2.50	2.00		2.50	2.00			
o Biological Growth Summary	5														
- Increase in VSS, lb/d	5	0	-187		501	1,322		839	1,395		786	1,292			
- Increase in ISS, lb/d	5	0	162		202	370		288	393		278	375			

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT:	PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
ACTIVATED SLUDGE - ZONE 6		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil ga	6	1.335	1.571		1.011	1.571		1.011	1.571		1.011	1.571			
o Flows Entering, mgc	6														
- Throughflow	6	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- Plant Influent to this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	6	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone, mgd	6														
- ML Recirculated to Other Zones	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	6	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o HRT in this Zone	6														
- Hydraulic Detention time, Actual, h	6	0.51	0.47		0.35	0.45		0.34	0.47		0.35	0.47			
o Effluent from this Zone	6														
-- MLSS, mg/L	6	2,860	3,175		2,782	2,326		3,499	2,499		3,499	2,499			
-- NH3-N, mg/L	6	0.90	0.07		1.34	1.61		1.72	1.63		1.61	1.43			
-- NO3-N, mg/L	6	16.90	5.45		7.67	7.63		6.70	7.17		7.02	7.75			
-- D.O., mg/L	6	2.50	2.00		2.50	2.00		2.50	2.00		2.50	2.00			
o Biological Growth Summary	6														
- Increase in VSS, lb/d	6	-24	-696		346	994		664	1,058		600	935			
- Increase in ISS, lb/d	6	107	100		181	327		262	348		252	328			
ACTIVATED SLUDGE - ZONE 7		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil gal	7	1.699	1.571		1.011	1.571		1.011	1.571		1.011	1.571			
o Flows Entering, mgd	7														
- Throughflow	7	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
- (-) Removed as MBR Filtrate [Note]	7	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	7	62.31	80.28		69.21	83.80		70.55	79.91		70.35	79.43			
o ML Flow removed from this Zone (excl.MBR Filtr)	7														
- ML Recirculated to Other Zones	7	40.00	44.00		40.00	44.00		40.00	44.00		40.00	44.00			
- ML Wasted from this Zone	7	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net Flow to Next Zone, mgd	7	22.31	36.28		29.21	39.80		30.55	35.91		30.35	35.43			
o HRT in this Zone	7														
- Hydraulic Detention time, Actual, hr	7	0.65	0.47		0.35	0.45		0.34	0.47		0.35	0.47			
o Effluent from this Zone	7														
-- MLSS, mg/L	7	2,858	3,173		2,782	2,327		3,500	2,500		3,500	2,500			
-- NH3-N, mg/L	7	0.07	0.05		0.26	0.46		0.31	0.44		0.27	0.35			
-- NO3-N, mg/L	7	17.70	5.55		8.55	8.48		7.81	8.05		8.08	8.53			
-- D.O., mg/L	7	2.50	2.00		2.50	2.00		2.50	2.00		2.50	2.00			
o Biological Growth Summary	7														
- Increase in VSS, lb/d	7	-851	-1,070		30	632		285	664		208	517			
- Increase in ISS, lb/d	7	70	43		151	284		227	300		216	279			
WAS SOLIDS PRODUCTION															
o P-Removal															
- Include P-Removal in Calc? (Y=1, N=0)	*	0	0		0	0		0	0		0	0			
o Solids Production, TSS, lb/d															
- TSS Entering in Feed, lb/d		7,647	21,546		14,874	37,659		21,182	40,467		20,451	38,627			
- VSS Change in A.B. Zones		480	933		4,080	8,928		5,690	9,035		5,515	8,591			
- ISS Change in A.B. Zones		308	788		829	1,826		1,138	1,905		1,107	1,829			
- ISS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			
- Unbiodeg VSS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			
- Total Solids Production, lb/d		**8,435**	**23,267**		**19,784**	**48,413**		**28,009**	**51,407**		**27,073**	**49,046**			
MLSS CHARACTERISTICS															
o Mixed Liquor Components, mg TSS/L															
- Solids, mg TSS/L															
-- Slowly Biodegradable		14	14		29	31		40	32		39	31			
-- Active Biomass		832	939		1,217	992		1,513	1,049		1,515	1,049			
-- Endogenous Biomass		485	435		252	140		277	149		287	156			
-- Nitrifiers		63	33		51	27		58	28		60	29			
-- Unbiodegradable VSS (Influent + Bio-P)		991	1,239		832	803		1,094	881		1,089	881			

* Input Data

CAROLLO ENGINEERS, PC

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Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
-- Inorganic SS (influent + Biogrowth)		482	534		409	358		526	388		519	382			
-- Inorganic SS due to Bio-P (est.)		0	0		0	0		0	0		0	0			
-- Total Last-Pass MLSS		2,867	3,194		2,790	2,351		3,509	2,527		3,509	2,527			
-- Total Soluble Organic N (SolOrgN)		2.2	2.0		2.3	2.4		2.3	2.4		2.3	2.3			
-- Alkalinity, mg/L as CaCO3		109.3	154.7		134.3	134.9		137.1	136.3		136.0	134.2			
o Org N fraction of MLVSS (NinVSS)		0.080	0.079		0.082	0.082		0.081	0.082		0.081	0.081			
o MLVSS Fraction		0.83	0.83		0.85	0.85		0.85	0.85		0.85	0.85			
o BOD of AS Solids															
- BOD/TSS ratio		0.23	0.22		0.34	0.33		0.34	0.32		0.34	0.32			
SOLIDS RETENTION TIME, SRT															
o Total Solids Wasted, lb/d		8,435	23,267		19,784	48,413		28,009	51,407		27,073	49,046			
- Recycled WAS Solids, lb/d		254	1,522		379	3,328		481	3,879		474	3,715			
- Net lb Solids Yield/day		8,182	21,745		19,404	45,085		27,529	47,528		26,599	45,331			
o Total BOD Load, lb/d		11,553	28,134		22,732	43,330		30,140	45,215		29,933	44,726			
- Recycled BOD, lb/d		139	341		293	1,113		339	1,277		339	1,220			
- Net BOD Load, lb/d		11,414	27,793		22,439	42,217		29,801	43,938		29,594	43,506			
o Solids Production															
- lb Dry SS/lb BOD Applied		0.717	0.782		0.865	1.068		0.924	1.082		0.899	1.042			
o Total Mass TSS in System, lb		96,448	207,940		93,814	152,184		118,013	163,480		118,019	163,507			
- **Total SRT (Rs), days**		**11.79**	**9.56**		**4.83**	**3.38**		**4.29**	**3.44**		**4.44**	**3.61**			
o Total Mass TSS in Aerated Zones, lb		72,332	169,267		70,375	123,943		88,531	133,144		88,535	133,162			
- Nominal Aerated Mass Fraction		0.750	0.814		0.750	0.814		0.750	0.814		0.750	0.814			
- **Nominal Aerobic SRT, days**		**8.84**	**7.78**		**3.63**	**2.75**		**3.22**	**2.80**		**3.33**	**2.94**			
o Mass Fraction in Each Zone															
- Zone 1		0.125	0.186		0.125	0.186		0.125	0.186		0.125	0.186			
- Zone 2		0.125	0.214		0.125	0.214		0.125	0.214		0.125	0.214			
- Zone 3		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Zone 4		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Zone 5		0.000	0.200		0.250	0.200		0.250	0.200		0.250	0.200			
- Zone 6		0.330	0.200		0.250	0.200		0.250	0.200		0.250	0.200			
- Zone 7		0.420	0.200		0.250	0.200		0.250	0.200		0.250	0.200			
		1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			
o Min. Aer. SRT recommended for nitrification, days		3.1	3.1		4.2	4.2		4.1	4.2		4.1	4.2			
- Washout SRT(total)															
-- Rwashout = 1/(Ua*DOsw - ba)		1.48	1.38		2.26	2.04		2.24	2.07		2.24	2.07			
- Recommended Aerobic SRT															
-- Max slope criterion, dNH3/dSRT, mg/L-d	*	0.20	0.20		0.20	0.20		0.20	0.20		0.20	0.20			
-- Recomm. Min. Operating SRT(total)		4.1	3.9		5.6	5.1		5.5	5.2		5.5	5.2			
-- Recomm. Min. Operating SRT(Nominal aerobic)		3.1	3.1		4.2	4.2		4.1	4.2		4.1	4.2			
-- Nitrification Safety Factor		2.74	2.79		2.46	2.52		2.47	2.51		2.47	2.51			
AERATION REQUIREMENTS															
o Oxygen Required, lb/d															
- Net Oxygen Demand in Zone 1		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 2		0	19,045		0	18,275		0	18,313		0	18,539			
- Net Oxygen Demand in Zone 3		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 4		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 5		0	11,055		14,265	14,291		17,842	15,001		18,050	15,133			
- Net Oxygen Demand in Zone 6		17,838	7,599		11,744	12,862		14,534	13,613		14,557	13,498			
- Net Oxygen Demand in Zone 7		8,219	6,792		7,815	10,508		10,159	10,907		9,923	10,465			
- (-) Oxygen provided by MBR Scouring		0	0		0	0		0	0		0	0			
- Total Oxygen required lb/d		**26,058**	**44,490**		**33,824**	**55,936**		**42,535**	**57,834**		**42,530**	**57,635**			
o Diffuser Analysis		**26,058**	**44,490**		**33,964**	**56,243**		**42,715**	**58,144**						
Note: All values of air and blower requirements given below are preliminary estimates, to be refined during detailed design															
o Oxygen Transfer Efficiency		[EDI]	[EDI]		[EDI]	[EDI]		[EDI]	[EDI]		[EDI]	[EDI]			
- Diffuser Type		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel			

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Aeration Basin D.O. (Avg), mg/L		2.5	2.0		2.3	2.2		2.5	2.0		2.5	2.0			
- Design Water Temperature, C		29	29		29	29		29	29		29	29			Summer
- Diffuser submergence, ft		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
- Air loading, scfm/unit [Note]		1.00	1.00		1.25	1.25		1.25	1.25		1.25	1.25			
		scfm/sf	scfm/sf		scfm/sf	scfm/sf		scfm/sf	scfm/sf		scfm/sf	scfm/sf			
- Floor Coverage		25.5	20.9		34.6	28.8		46.8	28.8		46.5	28.5			
		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A			
- Clean Water SOTE	*	37.0	37.9		36.2	37.1		36.2	37.1		36.2	37.1			Mfr. lit.
- Site Conditions Adjustment Factor															
F = Actual / Standard OTE															
-- Alpha factor, including fouling		0.63	0.59		0.48	0.45		0.46	0.45		0.46	0.45			Estimate
-- Theta factor	*	1.024	1.024		1.024	1.024		1.024	1.024		1.024	1.024			Default
-- Temp. correction, Tau		0.85	0.85		0.85	0.85		0.85	0.85		0.85	0.85			
-- Elevation above MSL, ft	*	695	695		695	695		695	695		695	695			Site
-- ..Pressure correction, Omega		0.97	0.97		0.97	0.97		0.97	0.97		0.97	0.97			
-- Beta factor	*	0.99	0.99		0.99	0.99		0.99	0.99		0.99	0.99			Default
-- Equilibrium C*20		10.64	10.70		10.64	10.70		10.64	10.70		10.64	10.70			
..Depth Adjustment Factor	*	0.37	0.37		0.37	0.37		0.37	0.37		0.37	0.37			Default
- F = Alpha x [Theta ^(T-20)]		0.46	0.46		0.36	0.34		0.33	0.35		0.33	0.35			
x (Tau Beta Omega C*20 - C)/C*20															
- Oxygen Transfer Efficiency		16.87	17.26		12.88	12.61		11.99	13.02		12.07	13.13			
OTE = F x SOTE		Percent	Percent		Percent	Percent		Percent	Percent		Percent	Percent			
Preliminary Estimate															
o Surface Aerators		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A			
- Oxygen to be transferred, lb/hr															
- Aerator hp required															
[Ox. Requ.d/Eff.]															
- Peaking factor	*														
- Aerator hp Installed															
o SOTR Required															
- Average Day @ Design flow															
-- Actual Ox Tr Requd, AOTR, lb/d		26,058	44,490		33,824	55,936		42,535	57,834		42,530	57,635			
-- Site Conditions Adjustment, F		0.46	0.46		0.36	0.34		0.33	0.35		0.33	0.35			
-- Standard Ox Tr Rate, SOTR, lb/d		57,121	97,615		95,143	164,624		128,551	164,819		127,639	162,921			
SOTR = AOTR / F															
o Air Supply Required															
- Average Day @ Design flow															
-- Ox Transfer Rate, AOTR, lb/d		26,058	44,490		33,824	55,936		42,535	57,834		42,530	57,635			
-- Oxygen Supplied, lb/min		107.2	179.0		182.4	308.1		246.4	308.4		244.6	304.9			
-- cf Air/lb Oxygen		57.0	57.0		57.0	57.0		57.0	57.0		57.0	57.0			
[23.3 lb O2/100 lb Air]															
[0.0753 lb Air/scf]															
-- Process Air, scfm		6,110	10,200		10,390	17,560		14,040	17,580		13,940	17,380			
..scfm per lb/d Oxygen		0.234	0.229		0.307	0.314		0.330	0.304		0.328	0.302			
..scf/lb BOD Applied		762	522		658	584		671	560		671	560			
-- Other Uses, e.g. Channel Air	*	800	1,100		1,100	1,200		1,200	1,200		1,200	1,200			Default
-- Total Blower Air, scfm		6,910	11,300		11,490	18,760		15,240	18,780		15,140	18,580			
- Peak Day @ Design Flow															
-- Peaking factor	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
-- Process Air, scfm		7,900	13,300		13,500	22,800		18,300	22,900		18,100	22,600			
-- Total Blower Air, scfm		8,700	14,400		14,600	24,000		19,500	24,100		19,300	23,800			
o Diffusers															
- Expressed as active sq ft or # diffusers		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft			
- Recommended															
-- Air Loading, scfm/(sf or dfr)		1.00	1.00		1.25	1.25		1.25	1.25		1.25	1.25			
-- Number recommended per Basin		1,528	1,701		2,079	2,341		2,809	2,344		2,789	2,317			
- Actual Installed, per basin															
-- Main Basin	*	1,528	1,701		2,079	2,341		2,809	2,344		2,789	2,317			
-- Additional Basin	*	0	0		0	0		0	0		0	0			
- Total Installed, sf or dfr		6,112	10,203		8,315	14,047		11,235	14,063		11,155	13,902			
- Air Loading, scfm/sf or dfr															
-- Daily Average		1.00	1.00		1.25	1.25		1.25	1.25		1.25	1.25			

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PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 10/12/2006 9:03 AM | Chk by/Date: | FileName: Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Floor Coverage															
-- Total Basin Floor Area in Service, sf		32,000	60,000		32,000	60,000		32,000	60,000		32,000	60,000			
-- Total Aerated Floor Area in service		24,000	48,840		24,000	48,840		24,000	48,840		24,000	48,840			
-- Coverage		25.5	20.9		34.6	28.8		46.8	28.8		46.5	28.5			
.. Expressed as		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A			
- Active sf/diffuser, or 1		2.54	2.54		2.54	2.54		2.54	2.54		2.54	2.54			
- Number of diffuser units		2,406	4,017		3,274	5,530		4,423	5,537		4,392	5,473			
o Blower Discharge pressure															
- Head, ft water															
-- Submergence		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
-- Freeboard above normal op level		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0			
-- Diffuser head loss		1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5			
-- Pipe & Valve friction		2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5			
-- Total Head, ft		19.9	20.5		19.9	20.5		19.9	20.5		19.9	20.5			
- Discharge pressure, psig		8.6	8.9		8.6	8.9		8.6	8.9		8.6	8.9			
o Delivered Horsepower															
- Max Operating Air Temp, C	*	34	34		34	34		34	34		34	34			Default
- Barometric Pressure, psia		14.3	14.3		14.3	14.3		14.3	14.3		14.3	14.3			
- Blower Suction Pressure, psia		14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0			
- Daily Average Total Air, scfm		6,910	11,300		11,490	18,760		15,240	18,780		15,140	18,580			
- Avg Delivered Horsepower, hp		245	411		408	682		541	683		537	676			
- Peak Day Delivered hp		309	524		518	873		692	876		685	865			
o Wire power required															
- Energy Efficiency, %	*	61.0	61.0		61.0	61.0		61.0	61.0		61.0	61.0			Default
- Wire power required, hp															
-- Daily Average		400	670		670	1,120		890	1,120		880	1,110			
-- Firm Installed		510	860		850	1,430		1,130	1,440		1,120	1,420			
SECONDARY SEDIMENTATION BASINS															
o Flow Rates, mgd															
- AS Influent, Q		13.73	21.22		18.24	27.31		22.93	27.28		22.78	26.92			
- Net Sed. Basin Inflow (excl. RAS), Qci		13.73	21.22		18.24	27.31		22.93	27.28		22.78	26.92			
- Return Sludge Flow, Qr (not including waste sludge flow)		8.59	15.05		10.97	12.48		7.62	8.62		7.57	8.51			
- Total Sed Basin Inflow		22.31	36.28		29.21	39.80		30.55	35.91		30.35	35.43			
- Total Sed. Basin Underflow		8.71	15.42		11.29	13.30		7.86	9.25		7.80	9.11			
- Net Sec. Effluent, Qe		13.60	20.86		17.92	26.49		22.69	26.66		22.55	26.33			
o Basin dimensions															
- Group 1	*														
-- No. of Basins	*	4	2		4	2		4	2		4	2			
-- Number of Units in Service	*	4	2		4	2		4	2		4	2			
-- Diameter, ft (inside)	*	0	130		0	130		0	130		0	130			
-- Side Water Depth, ft	*	11.9	14.0		11.9	14.0		11.9	14.0		11.9	14.0			
-- Surface Area per Basin, sf		8,800	13,273		8,800	13,273		8,800	13,273		8,800	13,273			
-- Volume per Basin, cf		104,720	185,825		104,720	185,825		104,720	185,825		104,720	185,825			
- Group 2	*														
-- No. of Basins	*	0	2		0	2		0	2		0	2			
-- Number of Units in Service	*	0	2		0	2		0	2		0	2			
-- Diameter, ft (inside)	*	120	100		120	100		120	100		120	100			
-- Side Water Depth, ft	*	14.0	10.3		14.0	10.3		14.0	10.3		14.0	10.3			
-- Surface Area per Basin, sf		11,310	7,854		11,310	7,854		11,310	7,854		11,310	7,854			
-- Volume per Basin, cf		158,336	80,503		158,336	80,503		158,336	80,503		158,336	80,503			
o Flow Split															
- Fraction of ML Flow to Group 1:															
-- Fraction based on Surface Area		1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.63			
-- Fraction selected	*	1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.63			
- Effective (Flow-weighted) SWD, ft		11.90	12.61		11.90	12.61		11.90	12.61		11.90	12.61			
o Surface Overflow Rate															
- Group 1															
-- Surface Area in service, sf		35,200	26,546		35,200	26,546		35,200	26,546		35,200	26,546			
-- Surface Overflow Rate, gpd/sf		386	494		509	627		645	631		641	623			
- Group 2															

* Input Data

CAROLLO ENGINEERS, PC

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		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
-- Surface Area in service, sf		0	15,708		0	15,708		0	15,708		0	15,708			
-- Surface Overflow Rate, gpd/sf		0	494		0	627		0	631		0	623			
o Solids Loading Rate, lb/day-sf															
- Group 1		15	23		19	18		25	18		25	17			
- Group 2		0	23		0	18		0	18		0	17			
o Volume in service, mil gal															
- Group 1		3.13	2.78		3.13	2.78		3.13	2.78		3.13	2.78			
- Group 2		0.00	1.20		0.00	1.20		0.00	1.20		0.00	1.20			
o Hydraulic Detention Time, hr (based on Q)															
- Group 1		5.5	5.0		4.1	3.9		3.3	3.9		3.3	3.9			
- Group 2		N.A.	3.7		N.A.	2.8		N.A.	2.9		N.A.	2.9			
o Weir Loading															
- Group 1															
-- Actual weir length per unit, ft	*	425	745		560	745		709	745		705	745			Default
-- Weir loading, gpd/ft		8,000	8,801		8,000	11,177		8,000	11,246		8,000	11,107			
- Group 2															
-- Actual weir length per unit, ft	*	0	556		0	556		0	556		0	556			Default
-- Weir loading, gpd/ft		0	6,973		0	8,856		0	8,910		0	8,800			
o Sludge Settling Characteristics															
- Design Max. SVI, ml/g	*	150	150		150	150		150	150		150	150			Default
ISV = a x exp(-b MLSS), ft/h															
- "a" Value, ft/hr	*	19.0	19.0		19.0	19.0		21.3	21.3		21.3	21.3			
- "b" Value [x 1,000,000]	*	430	430		430	430		218	218		218	218			
o Target Settling Values															
- Effluent rise rate (SOR), ft/hr															
-- Group 1		2.15	2.75		2.84	3.49		3.59	3.51		3.57	3.47			
-- Group 2		N.A.	2.75		N.A.	3.49		N.A.	3.51		N.A.	3.47			
-- Average		2.15	2.75		2.84	3.49		3.59	3.51		3.57	3.47			
- Clarifier Safety Factor, CSF	*	2.3	2.2		2.0	2.0		2.0	2.0		2.0	2.0			Default
- Initial Settling Velocity, ISV, ft/hr		5.0	6.1		5.7	7.0		7.2	7.0		7.1	6.9			
- Preferred Max. Last-Pass MLSS, mg/L		3,100	2,660		2,782	2,327		4,987	5,086		5,016	5,143			
o Selected Settling Values															
- Operating L-P MLSS conc, mg/L		2,858	3,173		2,782	2,327		3,500	2,500		3,500	2,500			
- Operating ISV, ft/h		5.6	4.9		5.7	7.0		9.9	12.4		9.9	12.4			
- Operating CSF															
-- Group 1		2.6	1.8		2.0	2.0		2.8	2.8		2.8	2.9			
-- Group 2		N.A.	1.8		N.A.	2.0		N.A.	2.8		N.A.	2.9			
SLUDGE RETURN AND WASTAGE															
o Wasting Method (see Process Layout)															
- Waste Flow from RAS, Qw		0.129	0.363		0.317	0.820		0.239	0.625		0.230	0.594			
- Waste Flow from MLSS, Zone 7, Qmw		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Return Sludge															
- Qr/Q, fraction	*	0.63	0.71		0.60	0.46		0.33	0.32		0.33	0.32			
- RAS flow to Aer Basin, Qr, mgd Average		8.59	15.05		10.97	12.48		7.62	8.62		7.57	8.51			
- RAS concentration, mg/L		7,310	7,462		7,190	6,954		13,590	9,693		13,602	9,717			
o Sludge Wastage															
- Total Solids Wasted, lb/d		8,435	23,267		19,784	48,413		28,009	51,407		27,073	49,046			
- Adjustment for ESS:															
-- Solids in Effluent, lb/d		567	696		747	884		946	889		940	878			
-- Solids in WAS, lb/d		7,868	22,571	30,439	19,036	47,529	66,566	27,063	50,518	77,581	26,132	48,167	74,300		
- Concentration, mg/L		7,310	7,462		7,190	6,954		13,590	9,693		13,602	9,717			
- Organic N, lb/d		524	1,493		1,332	3,313		1,866	3,505		1,805	3,344			
- Flow Rate, mgd Average		0.129	0.363	0.492	0.317	0.820	1.137	0.239	0.625	0.864	0.230	0.594	0.825		
o WAS Characteristics, mg/L															
- Wasting from -		RAS	RAS		RAS	RAS		RAS	RAS		RAS	RAS			
- BOD		1,658	1,646		2,427	2,291		4,558	3,137		4,560	3,132			
- TSS		7,310	7,462		7,190	6,954		13,590	9,693		13,602	9,717			
- VSS		6,082	6,214		6,136	5,896		11,551	8,205		11,589	8,249			
- NH3-N		0.1	0.1		0.3	0.5		0.3	0.4		0.3	0.3			
- Organic-N		486.7	493.5		503.1	484.6		937.0	672.6		939.6	674.5			
- NO3-N		17.7	5.6		8.5	8.5		7.8	8.0		8.1	8.5			

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		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Alkalinity		109	155		134	135		137	136		136	134			
- Filterable ("soluble") BOD		0.9	0.8		1.1	1.3		1.2	1.3		1.1	1.2			
- Total soluble Organic N		2.2	2.0		2.3	2.4		2.3	2.4		2.3	2.3			
o Recommended Installed Capacity															
- Return Sludge Pumps, gpm		9,530	15,250		12,660	18,950		15,910	18,930		15,810	18,680			
- WAS Pumps															
-- Wasting operation, hr/day	*	24	24	24	24	24	24	24	24	24	24	24	24		
-- Pump Capacity (2 x Qwas), gpm		180	510	690	450	1,140	1,580	340	870	1,200	320	830	1,150		
-- WAS Solids Peak Handling Capacity, lb/hr		660	1,890	2,540	1,590	3,970	5,550	2,260	4,210	6,470	2,180	4,020	6,200		
SECONDARY EFFLUENT															
o Flow Rate															
- Net Secondary Effluent, mgd		13.60	20.86	34.46	17.92	26.49	44.41	22.69	26.66	49.35	22.55	26.33	48.87		
o Secondary Effluent Quality															
- BOD, mg/L		2	2	2.0	3	3	3.0	3	3	3.0	3	3	3.0		Estimate
- TSS (nominal), mg/L	*	5	4	4.4	5	4	4.4	5	4	4.4	5	4	4.4		Default
- VSS, mg/L		4.2	3.3	3.7	4.3	3.4	3.7	4.2	3.4	3.7	4.3	3.4	3.7		
- NH3-N, mg/L		0.1	0.1	0.1	0.3	0.5	0.4	0.3	0.4	0.4	0.3	0.3	0.3		
- Total Organic N, mg/L		2.6	2.3	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6		
- NO3/NO2-N, mg/L		17.7	5.6	10.3	8.5	8.5	8.5	7.8	8.0	8.0	8.1	8.5	8.4		
- Alkalinity, mg/L		109	155	137	134	135	135	137	136	137	136	134	135		
- Soluble Organic N, mg/L		2.2	2.0	2.1	2.3	2.4	2.3	2.3	2.4	2.3	2.3	2.3	2.3		
- T.I.N., mg/L		17.8	5.6	10.4	8.8	8.9	8.9	8.1	8.5	8.3	8.4	8.9	8.7		
- Total N, mg/L		20.3	7.9	12.8	11.4	11.6	11.5	10.8	11.1	11.0	11.0	11.5	11.3		
TERTIARY FILTRATION				In Service			In Service			In Service			In Service		
o Tertiary Filtration in Service? (Y=1, N=0)	*			1			1			1			1		
o Influent															
- Flow, mgd															
-- Total				34.5			44.4			49.3			48.9		
- BOD, total, mg/L				2.0			3.0			3.0			3.0		
- SS, total, mg/L				4.4			4.4			4.4			4.4		
o Filter Area															
- Surface Area per Filter, sf	*			200			200			200			200		
- Backwash - Continuous (0) or Intermittent (1)?	*			0			0			0			0		
- Standby Units Provided	*			2			2			2			2		
- Number of Filters															
-- Existing	*			10			10			10			10		
-- New	*			0			0			0			0		
-- Total				10			10			10			10		
- Number of Units in Service				8			8			8			8		
o Filter Loading															
- Equalization provided? (Y=1, N=0)	*			1			1			1			1		
- Peaking factor	*			1.10			1.10			1.10			1.10		Default
- Surface Area in Service, sf				1,600			1,600			1,600			1,600		
- Loading rate, gpm/sf				16.4			21.2			23.5			23.3		
o Removal															
- SS Removal, %	*			70			70			70			70		Default
- SS removed, lb/d				884			1,140			1,266			1,254		
- BOD removed, lb/d				233			468			511			516		
o Backwash Flow															
- Percent of Flow, %	*			9			9			9			9		Cont BW
- Backwash Flow, mgd				3.10			4.00			4.44			4.40		
o Backwash Characteristics, mg/L															
- BOD				10			15			15			15		
- TSS				34			34			34			34		
- VSS				28			29			29			29		
- NH3-N				0.1			0.4			0.4			0.3		
- Organic-N				4			5			5			5		
- NO3-N				10.3			8.5			8.0			8.4		
- Alkalinity				137			135			137			135		
o Net Flow to Disinfection, mgd															

* Input Data

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Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Undisinfected Plant Water Used	*			0.00			0.00			0.00			0.00		
- To Disinfection				31.36			40.42			44.91			44.48		
o Tertiary Effluent Quality, mg/L															
- BOD				1.2			1.7			1.8			1.7		
- SS				1.3			1.3			1.3			1.3		
- VSS, mg/L				1.1			1.1			1.1			1.1		
- NH3-N, mg/L				0.1			0.4			0.4			0.3		
- Total Organic N, mg/L				2.2			2.4			2.4			2.4		
- NO3/NO2-N, mg/L				10.3			8.5			8.0			8.4		
- Alkalinity, mg/L				137			135			137			135		
- Filterable ("soluble") BOD				0.8			1.2			1.2			1.2		
- Soluble Organic N, mg/L				2.1			2.3			2.3			2.3		
- T.I.N., mg/L				10.4			8.9			8.3			8.7		
- Total N, mg/L				12.6			11.3			10.8			11.1		
CHLORINE CONTACT TANKS				In Service			In Service			In Service			In Service		
o Flow Rate, mgd				31.36			40.42			44.91			44.48		
- Peaking factor	*			1.1			1.1			1.1			1.1		
o Number of Tanks	*			2			2			2			2		
o Volume per Tank, mil gal	*			1.436			1.851			2.057			2.037		
o Detention Time @ peak, min.				120			120			120			120		
FINAL EFFLUENT															
o Flow Rate, mgd															
- Plant Water used	*			0.19			0.41			0.46			0.00		
- Final Effluent Flow				31.17			40.01			44.45			44.48		
RESIDUALS MANAGEMENT															
SOLIDS GENERATED															
o Total Primary Sludge															
- Flow, mgd			0.134	0.134		0.192	0.192		0.203	0.203		0.195	0.195		
- Solids, lb/d			38,971	38,971		55,911	55,911		59,153	59,153		56,967	56,967		
- Concentration, %			3.5	3.5		3.5	3.5		3.5	3.5		3.5	3.5		
- VSS, %			80	80		80	80		80	80		81	81		
- Organic N, lb/d			1,754	1,754		2,388	2,388		2,539	2,539		2,423	2,423		
o Total Waste Activated Sludge															
- Flow, mgd		0.129	0.363	0.492	0.317	0.820	1.137	0.239	0.625	0.864	0.230	0.594	0.825		
-- Recomm Installed Capacity, gpm		180	510	690	450	1,140	1,580	340	870	1,200	320	830	1,150		
- Solids, lb/d		7,868	22,571	30,439	19,036	47,529	66,566	27,063	50,518	77,581	26,132	48,167	74,300		
-- Recomm Installed Capacity, lb/hr		660	1,890	2,540	1,590	3,970	5,550	2,260	4,210	6,470	2,180	4,020	6,200		
- Concentration, mg/L		7,310	7,462	7,422	7,190	6,954	7,020	13,590	9,693	10,770	13,602	9,717	10,802		
- VSS, %		83	83	83	85	85	85	85	85	85	85	85	85		
- Organic N, lb/d		524	1,493	2,017	1,332	3,313	4,645	1,866	3,505	5,371	1,805	3,344	5,149		
- BOD/TSS ratio		0.23	0.22	0.22	0.34	0.33	0.33	0.34	0.32	0.33	0.34	0.32	0.33		
WAS THICKENING				In Service			In Service			In Service			In Service		
o Sludge Feed															
- Flow, mgd				0.492			1.137			0.864			0.825		
- Solids, lb/d				30,439			66,566			77,581			74,300		
- Concentration, mg/L				7,422			7,020			10,770			10,802		
- VSS, %				83			85			85			85		
- Organic N, lb/d				2,017			4,645			5,371			5,149		
- Solids BOD, lb/d				6,760			22,072			25,418			24,277		
- NH3-N, mg/L				0.1			0.4			0.4			0.3		
- NO3-N, mg/L				10.3			8.5			8.0			8.4		
- Alkalinity				137			135			137			135		
- Filterable ("soluble") BOD, mg/L				0.8			1.2			1.2			1.2		
- Soluble OrgN, mg/L				2.1			2.3			2.3			2.3		
-- N/VSS ratio for solids				0.080			0.082			0.082			0.082		
o Number of Units	*			2			2			2			2		
- Number of Units in Service	*			2			2			2			2		
- Diameter, ft	*			37			37			37			37		

* Input Data

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Calc by	Date	Time	Chk by/Date	FileName:
CFP,NV	10/12/2006	9:03 AM		Recycle Mass Balance.xls

Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Effective Area in Service, sf				1,980			1,980			1,980			1,980		
- Operating cycle, hr/week	*			168			168			168			168		Default
o Hydraulic loading, gpm/sf				0.31			0.70			0.66			0.63		
o Solids Loading, lb/d-sf				15.4			33.6			39.2			37.5		
o Thickened Sludge															
- Solids Capture, %	*			95			95			95			95		
- Solids, lb/d				28,917			63,237			73,702			70,585		
- Percent Solids, %	*			5.7			3.5			3.5			3.5		
- Volume, mgd				0.061			0.217			0.252			0.242		
- Volatile Solids, lb/d				24,076			53,716			62,477			60,001		
- Organic N, lb/d				1,917			4,417			5,107			4,896		
o Underflow															
- Underflow solids, lb/d				1,522			3,328			3,879			3,715		
- Flow, mgd				0.431			0.920			0.611			0.583		
- Characteristics, mg/L															
-- BOD				95			145			251			251		
-- TSS				423			434			761			764		
-- VSS				353			368			645			650		
-- NH3-N				0.1			0.4			0.4			0.3		
-- Organic-N				28			30			52			52		
-- NO3-N				10.3			8.5			8.0			8.4		
-- Alkalinity				137			135			137			135		
ANAEROBIC DIGESTION				In Service			In Service			In Service			In Service		
o Digester Feed															
- Flow, total, mgd				0.194			0.408			0.455			0.437		
- Solids, total, lb/d				67,889			119,148			132,855			127,552		
- Volatile Solids, total, lb/d				55,396			98,595			109,922			105,937		
- Organic N, total, lb/d				3,671			6,805			7,647			7,319		
o Digester Size															
- Smaller Size Units															
-- Number	*			2			2			2			2		
-- Diameter, ft	*			90			90			90			90		
-- SWD, ft	*			32			32			32			32		
-- Volume per Digester, kcf				203.6			203.6			203.6			203.6		
- Larger Size Units															
-- Number	*			0			0			0			0		
-- Diameter, ft	*			70			70			70			70		
-- SWD, ft	*			25.5			25.5			25.5			25.5		
-- Volume per Digester, kcf				98.1			98.1			98.1			98.1		
- Gross Volume, kcf															
-- All Units in Service				407			407			407			407		
-- One Unit OOS				204			204			204			204		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															
-- All Units in Service				387			387			387			387		
-- One Unit OOS				193			193			193			193		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				0.143			0.255			0.284			0.274		
-- One Unit OOS				0.286			0.510			0.568			0.548		
- Detention Time, days															
-- All Units in Service				14.9			7.1			6.4			6.6		
-- One Unit OOS				7.4			3.5			3.2			3.3		
o Digested Sludge															
- VSS destruction, %	*			47			42			42			42		Default
- VSS destroyed, lb/d				26,054			41,771			45,736			44,193		
- Discharge Total Solids, lb/d				41,835			77,377			87,119			83,359		
-- TSS, %				2.58			2.27			2.30			2.29		
-- VSS, %				70.1			73.4			73.7			74.1		
o Gas Production															
- cf/lb VSS destroyed	*			15			15			15			15		Default

* Input Data

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
- Gas Production, kcf/d				391			627			686			663		
o Nitrogen in Dig Sludge Filtrate															
- Assumed Sol OrgN in Digester effl, mg/L	*			5			5			5			5		
- Org N/VSS in Digester Solids				0.066			0.069			0.069			0.069		
- VSS destroyed, lb/d				26,054			41,771			45,736			44,193		
- Ammonia generated, lb/d				1,723			2,876			3,174			3,045		
- NH3 Concentration, mg/L				1,063			845			836			836		
- Alkalinity, mg/L				3,796			3,017			2,986			2,985		calc
DEWATERING (Belt Presses)				In Service			In Service			In Service			N.I.S.		
o Sludge Feed															
- Flow rate, mgd	*			0.194			0.408			0.455			0.437		
- Total Solids, lb/d	*			41,835			77,377			87,119			83,359		
- Total VSS, lb/d	*			29,342			56,824			64,186			61,743		
o Number of Belt Presses (2m)	*			3			3			3			0		
- Number of Units in Service	*			3			3			3			0		
- Feed Rate, gpm per unit	*			110			110			110			110		Default
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				11.4			24.0			26.8			0.0		
o Sludge Cake															
- Capture, %	*			90			90			90			90		Default
- Concentration, %	*			16.15			14.23			13.86			13.87		Default
- Cake Solids, lb/d															
-- Dry Solids, lb/d				37,651			69,640			78,407			83,359		
-- Wet Cake, tons/d				116.6			244.6			282.8			N.I.S.		
- Flow, mgd				0.028			0.059			0.068			0.437		
o Filtrate															
- Filtrate Flow, mgd				0.166			0.350			0.387			0.000		
- Characteristics, mg/L															
-- BOD	*			700			700			700			700		Default
-- TSS	*			250			250			250			250		Default
-- VSS				175			184			184			185		
-- NH3-N				1,063			845			836			836		
-- Organic-N				17			18			18			18		
-- NO3-N				0			0			0			0		
-- Alkalinity				3,796			3,017			2,986			2,985		
o Wash Water															
- Wash water, mgd/mgd feed	*			1.00			1.00			1.00			1.00		Default
-- Wash Water flow, mgd				0.194			0.408			0.455			0.000		
- Solids in Wash Water															
-- Unrecovered Solids, lb/d				4,183			7,738			8,712			0		
-- Solids in Filtrate				347			729			808			0		
-- Solids in Wash Water, lb/d				3,837			7,009			7,904			0		
-- TSS in Wash Water, mg/L				2,367			2,059			2,082			0		
- Characteristics, mg/L															
-- BOD				2			3			3			3		

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Biotran05 v.1106

		Calibration			Design Capacity			Design Capacity			Design Capacity			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	11.0	20.1	31.1	16.0	20.0	36.0	20.0	20.0	40.0	20.0	20.0	40.0		
Design (Max-Month) Flow, mgd		11.0	20.1	31.1	17.8	22.2	40.0	22.2	22.2	44.4	22.2	22.2	44.4		
-- TSS				2,367			2,059			2,082			0		
-- VSS				1,660			1,512			1,534			0		
-- NH3-N				0.0			0.0			0.0			0.0		
-- Organic-N				112			106			109			2		
-- NO3-N				10.3			8.5			8.0			8.4		
-- Alkalinity				137			135			137			135		
-- Filterable ("soluble") BOD				0.8			1.2			1.2			1.2		
-- Total soluble Organic N				2.1			2.3			2.3			2.3		
o Combined Filtrate & Wash Water															
- Flow, mgd															
-- Filtrate				0.166			0.350			0.387			0.000		
-- Wash Water				0.194			0.408			0.455			0.000		
-- Total				0.361			0.758			0.842			0.000		
- Characteristics, mg/L															
-- BOD				324			325			323			0		
-- TSS				1,391			1,224			1,240			0		
-- VSS				975			899			914			0		
-- NH3-N				490			390			384			0		
-- Organic-N				68			65			67			0		
-- NO3-N				6			5			4			0		
-- Alkalinity				1,824			1,464			1,447			0		
-- Filterable ("soluble") BOD				33			33			33			0		
-- Total soluble Organic N				3.4			3.6			3.6			0.0		
CENTRIFUGE DEWATERING/THICKENING				N.I.S.			N.I.S.			N.I.S.			In Service		
o Application				Anaerobic Dig Dewat			Anaerobic Dig Dewat			Anaerobic Dig Dewat			Anaerobic Dig Dewat		
o Sludge Feed															
- Flow Rate, mgd				0.194			0.408			0.455			0.437		
- TSS, %				2.58			2.27			2.30			2.29		
- Solids, lb/d				41,835			77,377			87,119			83,359		
-- VSS fraction				0.70			0.73			0.74			0.74		
o Number of Centrifuges	*			0			0			0			3		
- Number of Units in Service				0			0			0			2		
- Feed Rate, gpm per unit	*			125			125			125			250		
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				0.0			0.0			0.0			17.0		
o Chemical Dose															
- Ferric chloride, lb/ton	*			0			0			0			0		
- Ferric chloride, lb/day				0			0			0			0		
- Polymer, lb/ton	*			16			16			16			16		
- Polymer, lb/day				324			600			675			646		
- Chemical Sludge generated, lb/d				0			0			0			0		
o Sludge Cake															
- Capture, %	*			0			0			0			95		Default
- Cake Solids, lb/d				41,835			77,377			87,119			79,191		
- Concentration, %	*			2.6			2.3			2.3			21.7		Default
- Flow, mgd				0.1943			0.4082			0.4551			0.0438		
o Filtrate															
- Filtrate Flow, mgd				0.000			0.000			0.000			0.393		
- Characteristics, mg/L															
-- BOD	*			500			500			500			500		Default
-- TSS				0			0			0			1,271		
-- VSS				0			0			0			941		
-- NH3-N	*			1,063			845			836			836		
-- Organic-N	*			5			5			5			70		
-- NO3-N	*			0			0			0			0		
-- Alkalinity	*			3,796			3,017			2,986			2,985		

* Input Data

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 4: PLANT HYDRAULICS

FINAL
February 2008

Carollo Engineers...Working Wonders With Water™

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
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PLANT HYDRAULICS

4.1 PURPOSE

The purpose of this chapter is to evaluate the ability of the Regional Water Quality Control Plant (RWQCP) to convey flows up to the peak wet weather flow (PWWF) through the facilities. The chapter also presents any bottlenecks that were identified during the analyses and any flow management strategies that could be used to address the problem areas.

4.2 CONCLUSIONS

- No hydraulic bottlenecks were identified during hydraulic model runs using existing facility average daily flow (ADF) treatment capacity (40 mgd) and existing ADF (33 mgd).
- Four hydraulic bottlenecks were identified for the PWWF. These bottlenecks include:
  - Plant 2 (24-inch) control valves/meters at the Headworks.
  - A 42-inch pipe connecting the Plant 2 primary clarifiers splitter box and the aeration basin influent splitter box.
  - Plant 1A/1B Distribution Channel.
  - A 54-inch pipe connecting Junction Box 13A and Junction Box 14.

These bottlenecks can be improved to an acceptable level with minimal additional piping and construction.

4.3 BACKGROUND

The RWQCP consists of two plants and currently receives inflow from six lines: the Arlanza trunk, the Riverside trunk, the Hillside trunk, the Acorn trunk, the Jurupa Community Services District (JCSD), and Rubidoux Community Services District (RCSD) force mains. The current design capacity of the RWQCP is 40 mgd, based on ADF. The headworks were redesigned in 1990 to convey a PWWF up to 100 mgd.

A hydraulic model was developed using the Carollo Engineers (Carollo) software, *Hydraulix*™, to simulate the hydraulics of the treatment plant. This model was developed based on existing plans. After the development of the hydraulic model, evaluations of the plant's hydraulics during existing flow, as well as for ADF and PWWF, were performed.

4.4 CURRENT PLANT FLOW RATE AND PEAKING FACTORS

Currently, the plant receives an inflow of approximately 33 mgd. Plant 1 treats 40 percent and Plant 2 treats the remaining 60 percent of the influent flow.

A Biotran model was developed for the RWQCP. Biotran models the steady state treatment capacity of the various process units. The Biotran estimated that the ADF capacity of the RWQCP is 40 mgd with a 50/50 split between Plant 1 and Plant 2. This is described more fully in Volume 4, Chapter 3 - Process Design and Reliability Criteria.

The wet weather peaking factor of 2.2, will be used to determine the RWQCP PWWF for most unit processes. The wet weather peaking factor for tertiary and disinfection processes is 1.5 because of the upstream equalization basins.

The equalization basins were sized to reduce the tertiary peaking factor to 1.5.

Table 4.1 summarizes the different flows that were used in the three hydraulic evaluations.

Table 4.1 Plant Flow Rates
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Flow Condition	Plant Influent Flow (mgd)
Existing Plant Flow	33
Average Daily Flow	40
Hourly Peak Wet Weather Flow(1)	88

Notes:
(1) The treatment plant downstream of the equalization basins receives a PWWF of 60 mgd (1.5 peaking factor). Upstream of the equalization basins, the PWWF factor is 2.2.

4.5 ASSUMPTIONS

The following are the general assumptions that were used in development of the model and evaluations:

- The 50-year floodwater surface elevation, 690.30 feet for the Santa Ana River, was used.
- Flow through Plant 2 secondary clarifiers are proportional to the sizes of the clarifiers.
- Filter backwash plus filtrate flow averages about 3.5 mgd, based on existing plant flow.
- Plant 1 waste activated sludge (WAS) flow is approximately 0.15 mgd, based on existing plant flow. This was scaled proportionally for the other two flows.
- Plant 2 WAS flow is approximately 0.43 mgd, based on existing plant flow. This was scaled proportionally for the other two flows.
- Return activated sludge (RAS) flow is set at one times the ADF.
- According to the City staff, the recycle flow is split with a 20:80 ratio between Plant 1 and Plant 2.

- Currently, Chlorine Contact Basin No. 2 (CCB2) is out of service, secondary treatment goes through Chlorine Contact Basin No. 1 (CCB1) and Chlorine Contact Basin No. 3 (CCB3) only.

Table 4.2 lists the different operational settings used for the three hydraulic evaluations.

Table 4.2 Operational Assumptions
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Operation	Current Flow	ADF	PWWF
Plant 1/Plant 2 Flow Distribution	40/60	50/50	50/50
Equalization Basins	Assuming only three are in operation		Assuming all four are in operation
Chlorine Contact Basin(1)	CCB3 treats up to 42.6 mgd. Flow above that level needs to be diverted to CCB2.		

Notes:
(1) CCB3 capacity was calculated based on a 90-minute contact time with a basin volume of 3.02 million gallons, and a Modal Contact Time/Detention Time ratio of 0.85.

One important note is that the hydraulic model is based on benchmarks that were used in the multiple sets of the existing facility plans. These benchmarks are about 0.22 feet above the benchmarks used in the 2003 RWQCP topographic map. For the hydraulic profile, it was decided to use the benchmarks from the existing facility plans to lessen the chance for error when referencing sets of plans that are based on the existing plan benchmarks. For elevations based on the new 2003 topographic benchmark elevations, subtract 0.22 feet from the elevations indicated on the hydraulic profile.

4.6 RESULTS

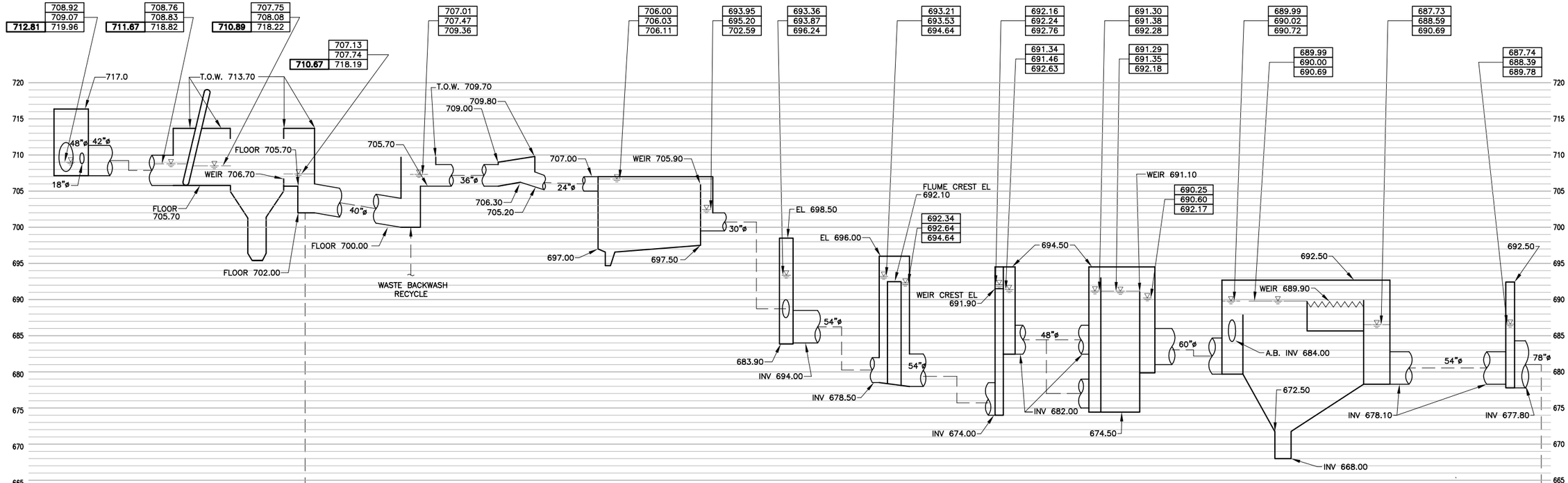
The purpose of the evaluations was to determine whether the plant could handle the different flow rates hydraulically. A freeboard criterion of 6 inches was used to determine any problem areas. A hydraulic profile of the plant is shown in Figure 4.1. It shows water surface elevations for all three hydraulic evaluations.

4.6.1 Existing Plant Flow

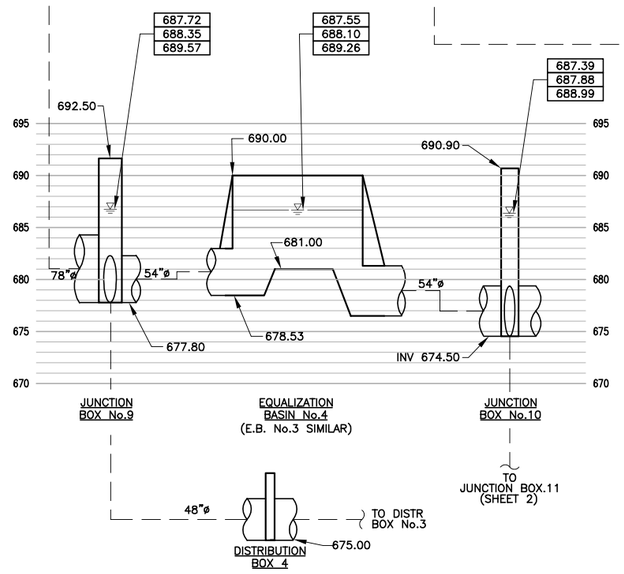
Based on the existing plant flow of 33 mgd, with a 40/60 flow-split between Plant 1 and Plant 2, and assuming three operational equalization basins and CCB2 is out of service, no bottlenecks were identified.

4.6.2 Average Daily Flow

Using the ADF capacity of 40 mgd, with a 50/50 split between Plant 1 and Plant 2, and assuming three operational equalization basins and CCB2 is out of service, no bottlenecks were identified.



UPSTREAM BOX | SCREENINGS CHANNEL | VORTEX GRIT CHAMBER | PLANT 1A/1B DISTRIBUTION CHANNEL | PLANT 1A FLUME | PRIMARY CLARIFIER 5,6,7,8 (EXISTING PLANS PRIMARY CLARIFIER 1,2,3,4) | JUNCTION BOX No. 7 | FLOW METER STRUCTURE | AERATION BASIN SPLITTER BOX | AERATION BASINS (7,8,9,10) | SECONDARY CLARIFIERS (5,6,7,8) (EXISTING PLANS S.C. 9,10,11,12) | JUNCTION BOX No.8

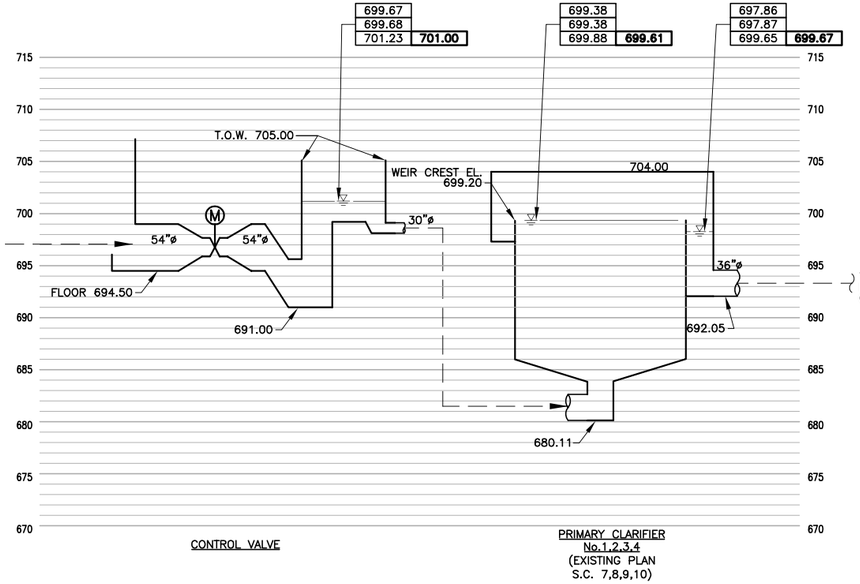


JUNCTION BOX No.9 | EQUALIZATION BASIN No.4 (E.B. No.3 SIMILAR) | JUNCTION BOX No.10

TO JUNCTION BOX.11 (SHEET 2)

TO DISTR BOX No.3

DISTRIBUTION BOX 4



TO AERATION BASINS 1–6 (SHEET 2)

CONTROL VALVE

PRIMARY CLARIFIER No.1,2,3,4 (EXISTING PLAN S.C. 7,8,9,10)

LEGEND

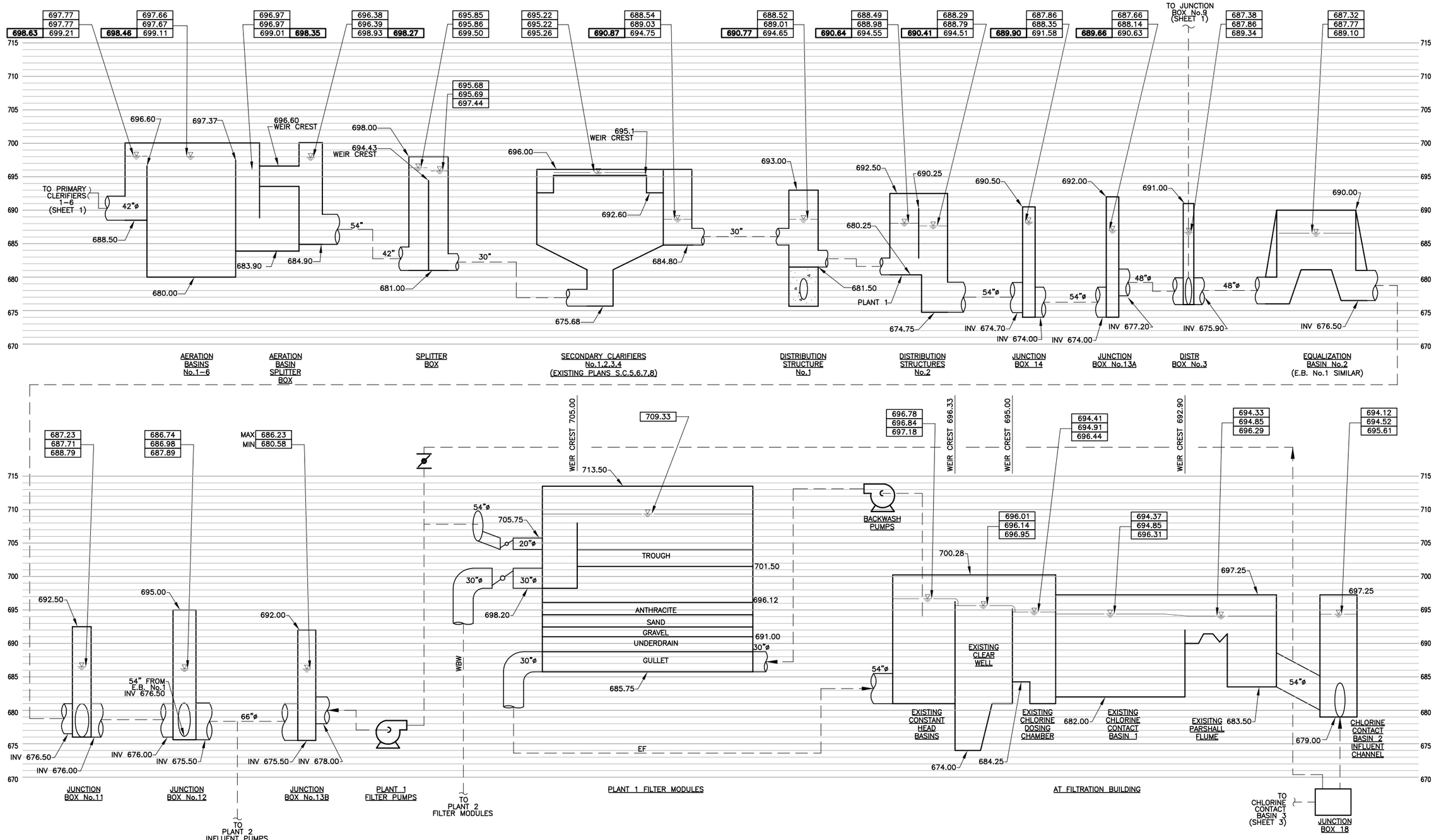
XXX	EXISTING FLOW (33 mgd)
XXX	AVERAGE DAILY FLOW (40 mgd)
XXX (BOLD)	PEAK WET WEATHER FLOW (88 mgd) AFTER CORRECTION
XXX	PEAK WET WEATHER FLOW (88mgd)

NOTES

1. HYDRAULIC PROFILE IS BASED ON BENCH MARK ELEVATIONS FROM EXISTING PLAN, FOR ELEVATIONS BASED ON THE 2003 TOPO BENCHMARK ELEVATIONS, SUBTRACT 0.22 FEET FROM THE ELEVATIONS INDICATED ON THE HYDRAULIC PROFILE.
2. FOR EXISTING FLOW SCENARIO, A 40/60 FLOW SPLIT WAS USED FOR PLANT 1 & PLANT 2 A 50/50 FLOW SPLIT WAS APPLIED FOR ADF AND PWWF SCENARIOS.
3. IT WAS ASSUMED ONLY THREE EQUALIZATION PANELS ARE AVAILABLE FOR EXISTING FLOW AND ADF SCENARIOS (WORST CASE). ALL FOUR EQUALIZATION PONDS WERE ASSUMED TO BE IN SERVICE DURING PWWF.
4. ASSUMED CHLORINE CONTACT BASIN (CCB) 3 HAS A MAXIMUM CAPACITY OF 43.6mgd (BASED ON AN EFFECTIVE VOLUME OF 2.92 MILLION GALLON AND A 90 MINUTE CONTACT TIME). FLOW ABOVE THAT LEVEL NEEDS TO BE DIRECTED TO CCB 2.

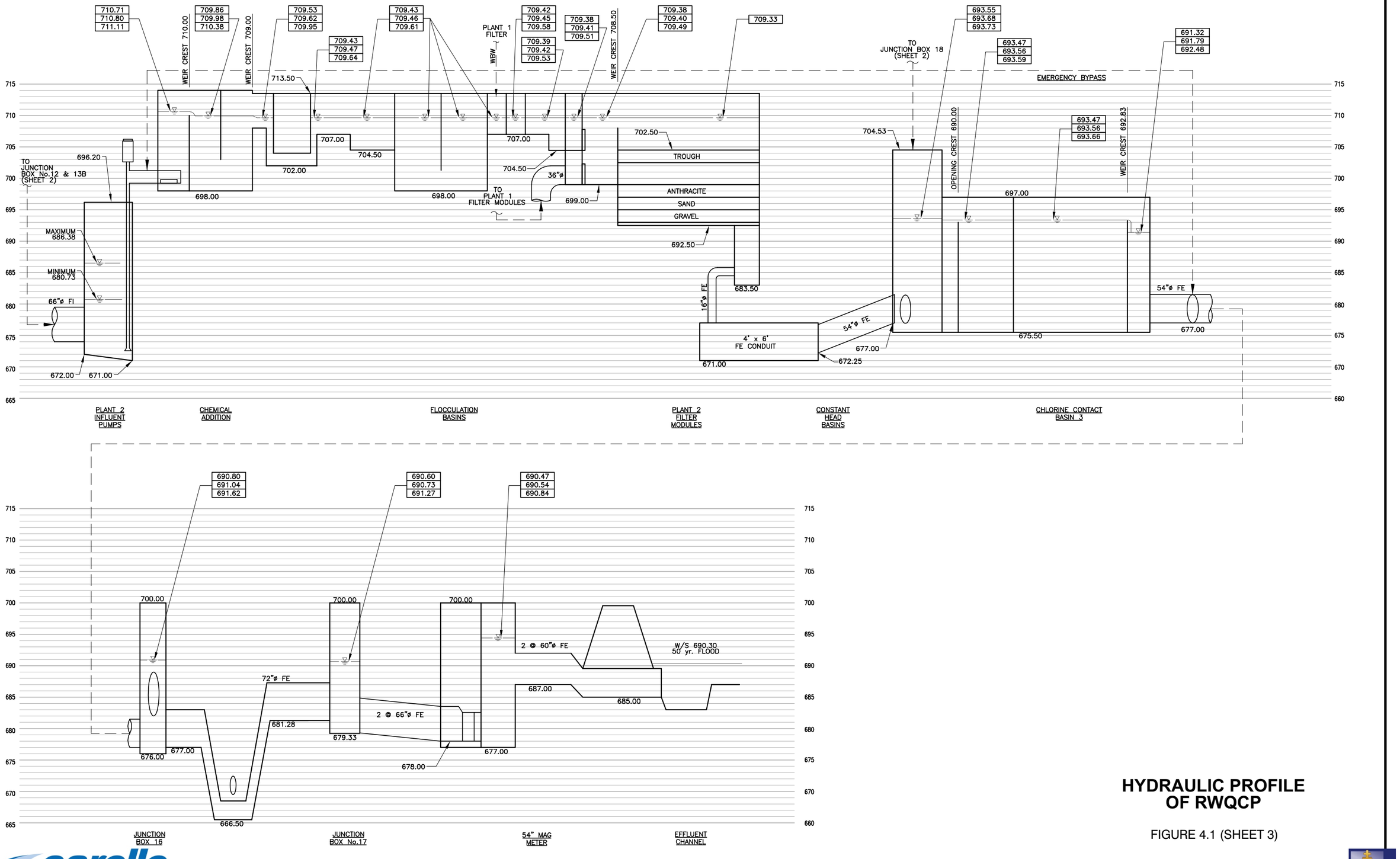
HYDRAULIC PROFILE OF RWQCP

FIGURE 4.1 (SHEET 1)



HYDRAULIC PROFILE OF RWQCP

FIGURE 4.1 (SHEET 2)



HYDRAULIC PROFILE OF RWQCP

FIGURE 4.1 (SHEET 3)

4.6.3 Peak Wet Weather Flow

Using the PWWF, with a 50/50 split between Plant 1 and Plant 2, and assuming all four equalization basins and CCB2 are in service, four bottlenecks were identified:

1. Plant 2 (24-inch) control valves/meters at the Headworks.
2. A 42-inch pipe connecting the Plant 2 secondary clarifiers splitter box and aeration basin influent splitter box
3. Plant 1A/1B Distribution Channel.
4. A 54-inch pipe connecting Junction Box 13A and Junction Box 14.

4.7 FLOW MANAGEMENT STRATEGIES

As stated above, the first bottleneck occurs at the headworks. It is is caused by the two 24-inch control valves/meters. Currently, the influent flow to Plant 2 goes through these two flow control valves. The problem caused by these valves can be alleviated with minimal impact by installing a third 24-inch flow control valve. The existing piping has blind flanges to enable installation of a new valve.

The second bottleneck occurs between the Plant 2 secondary clarifiers splitter box and the aeration basin influent splitter box. At PWWF, this bottleneck causes the weir to be submerged at the aeration basin and the primary clarifiers. This problem can be fixed by up sizing this pipe from 42 inches diameter to 54 inches diameter.

The third bottleneck occurs at Plant1A/1B distribution channel. This bottleneck will be addressed during the 2008 Expansion project.

The last bottleneck occurs at the 54-inch pipeline connecting Junction Boxes 13A and 14. A review of the existing plan indicated there is not enough space for installation of additional pipes between Boxes 13A and 14. This bottleneck, however, can be resolved by installing a new 48-inch pipeline between Distribution Box 3 and Junction Box 13A and modifying the boxes. Existing plans show that there is enough space in the yard to install a 48-inch pipe next to the current 48-inch pipe and increase the size of boxes to accommodate the parallel pipeline.

The surface water elevations for the PWWF condition, after the corrections, are listed on the Hydraulic profile in Figure 4.1. The proposed flow management strategies have eliminated the bottlenecks.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 5: PRELIMINARY TREATMENT

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

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Chapter 5

PRELIMINARY TREATMENT

5.1 PURPOSE

The purpose of this chapter is to develop a conceptual layout for a new headworks facility and estimate the overall capital cost using the conceptual layout. Alternatives for bar screens, screening conveyors and vortex grit basins are also evaluated. Final decisions about a specific layout and specific equipment type should be determined during the preliminary and final design.

5.2 CONCLUSIONS AND RECOMMENDATIONS

- The existing headworks facility is re-rated at a capacity of 37 mgd on an average daily flow basis. An additional separate headworks facility is planned for an average daily flow of 15 mgd.
- Based on the conceptual layout, the total project cost for the new headworks facility is estimated to be $9.89 million, based on an Engineering News-Record (ENR) value of 8,570 (Los Angeles, August 2006).
- Two mechanical bar screens (one duty and one standby) and one manual bypass bar screen are recommended for the new headworks.
- Climber-type and chain-and-rake-type are two alternatives for the bar screens. They should be further evaluated during preliminary design.
- A shaftless screw conveyor is recommended over a belt conveyor for screenings conveyance.
- A sloped-bottom vortex grit basin is recommended over a flat-bottom grit basin because the accumulation of settled grit can be minimized, and also because the equipment can be bid instead of sole-sourced.
- The headworks will be covered for odor control, and foul air will be continuously withdrawn and treated in a biofilter.

5.3 BACKGROUND

The current headworks facilities at the Regional Water Quality Control Plant (RWQCP) were built in 1999 based on an average daily flow of 50 mgd and a peaking factor of 2.0 (peak flow of 100 mgd). Table 5.1 lists the equipment included in the existing headworks facilities. There is a lack of redundancy, due to no standby grit chamber, and based on performance it appears that the grit chamber capacity is less than the manufacturer's rating of 50 mgd on an average daily flow basis. For this Integrated Master Plan, the grit chambers are re-rated at a more conservative capacity of 37 mgd for average daily flow. An

average daily flow of 52 mgd and a wet weather peaking factor of 2.2 are used for the Integrated Master Plan. Based on the apparent capacity of the existing grit basins, it was decided at the project meeting on September 20, 2006 that the sizing for an additional separate headworks facility would be planned for an average daily flow of 15 mgd and a wet weather peak flow of 33 mgd for the Integrated Master Plan.

Table 5.1 Existing Headworks Facility
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Equipment	Type	Qty	Note
Bar Screens	Climber	4	1/2-inch opening.
Raw Screenings Conveyors	Shaftless Screw	2	
Grit Screenings Conveyors	Shaftless Screw	2	
Grinders		2	
Washer/Compactors		2	
Grit Basins	Vortex (Sloped-Bottom Type)	2	20-foot diameter.
Grit Pumps	Centrifugal Recessed Impeller	2	250 gpm each, 45-foot head.
Grit Classifiers (Teacup)	Hydraulic Vortex	2	250 gpm each, 42-foot diameter.
Grit Dewatering Unit (Snail)		2	18-inch belt width.

5.4 CONCEPTUAL LAYOUT

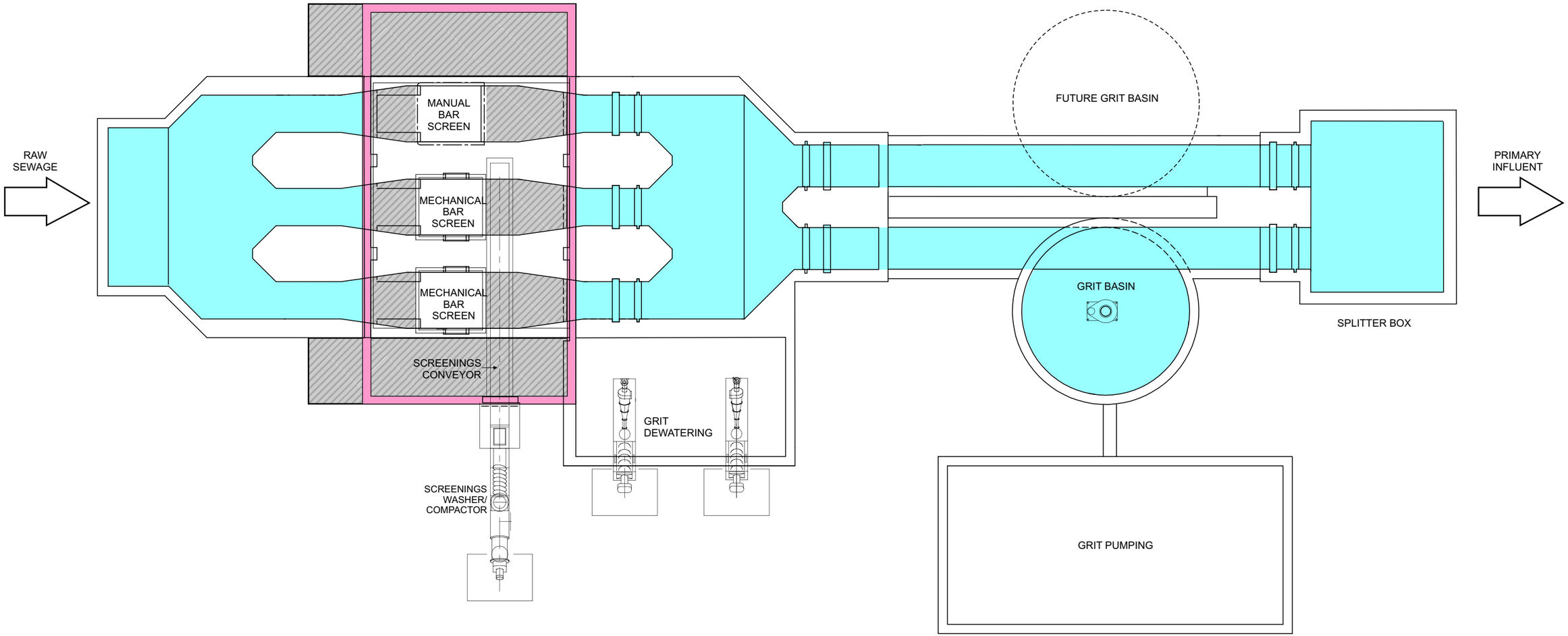
The conceptual layout for the new headworks with a wet weather peak flow of 33 mgd is shown in Figure 5.1.

The new headworks will have three channels for bar screens. Two mechanical bar screens are shown in two channels with one duty and one standby at peak flow, and one manual bar screen in a bypass channel for redundancy.

A conveyor will be required to convey screenings from the two automatic bar screens to the screenings washer and compactor for screenings disposal.

The screened wastewater will flow to a vortex grit basin. A bypass channel can be used if the grit basin needs to be bypassed. The space for a future grit basin is also included. The grit will be pumped to grit washers before disposal.

The new headworks will be covered for odor control. The bar screens will be enclosed in a building, and the channels and the grit basin will be covered by aluminum plate. The foul air will be continuously withdrawn and treated in a biofilter that is discussed in Volume 4, Chapter 6 - Primary Treatment.



NEW HEADWORKS LAYOUT

FIGURE 5.1

Upstream of the headworks, a metering and flow splitting facility will be provided to split flow between the existing and future headworks.

Based on the conceptual layout, the total project cost for the new headworks facility is estimated to be $9.89 million, based on an ENR value of 8,570 (Los Angeles, August 2006).

The total cost estimate for the new headworks facility is summarized in Table 5.2.

Table 5.2 Total Cost Estimate of New Headworks Facility
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

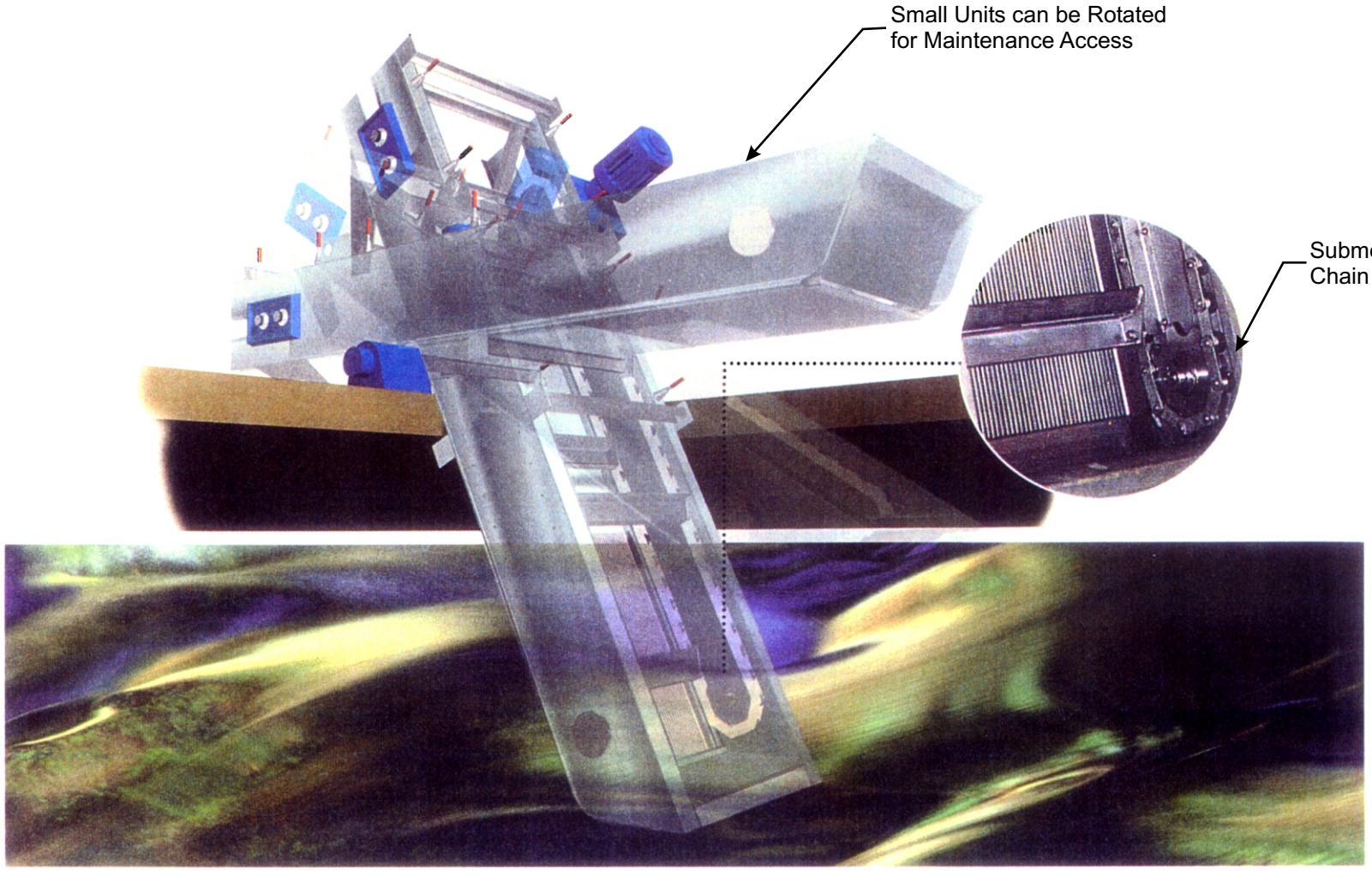
Item	Percentage	Value	Subtotal
Subtotal Direct Costs			$3,120,000
Sitework	10%	$310,000	
Electrical and Instrumentation	15%	$470,000	$3,900,000
Contingency	30%	$1,170,000	$5,070,000
General Conditions	10%	$510,000	$5,580,000
General Contractor Overhead and Profit	15%	$840,000	$6,420,000
Sales Tax on Materials	7.75%	$200,000	$6,620,000
Bid Market Allowance	15%	$990,000	$7,610,000
Engineering Management and Legal	30%	$2,280,000	
Total Project Cost			**$9,890,000**

5.5 BAR SCREENS

The existing headworks facility has climber-type bar screens. Climber-type bar screens are a well-proven technology with many successful installations. The primary advantage of climber-type bar screens over most other screens is that all moving parts are out of the wastewater. For future expansion, chain-and-rake-type bar screen with multiple rake bars mounted onto chains could be considered as an alternative to the climber-type screens.

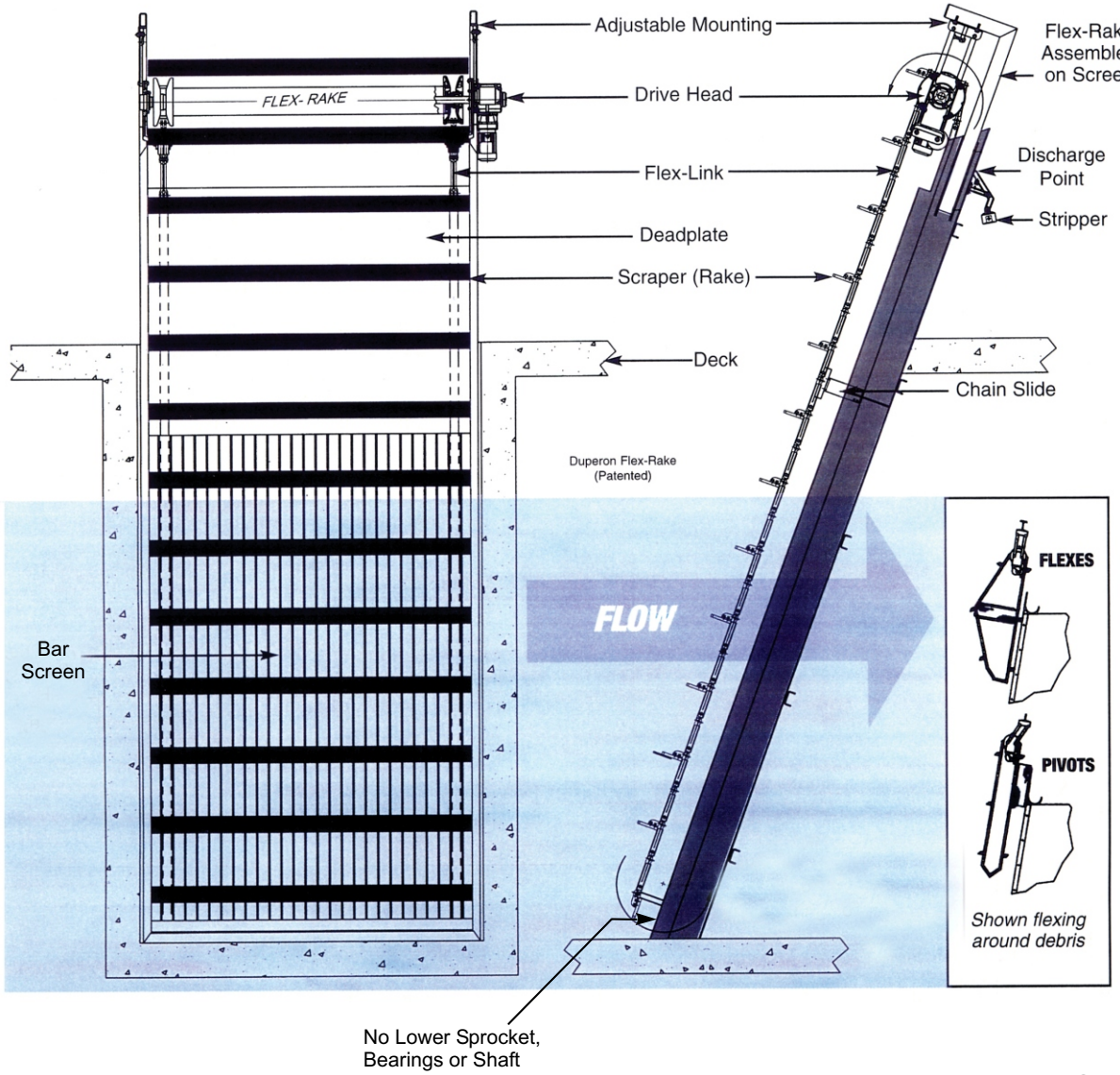
One option for a chain-and-rake-type bar screen is Mahr™, as shown in Figure 5.2. It has a lower profile than the climber-type bar screens, and requires less than 8 feet of headspace. Mahr™ is offered with a two-speed drive with automatic reverse ability to remove obstructions. Though the lower sprockets of Mahr™ are submerged in the wastewater, they have self-lubricated bearings and require no greasing.

Another option for a chain-and-rake-type bar screen is the Duperon® FlexRake, as shown in Figure 5.3. The chains (FlexLinks™) of the Duperon® FlexRake bend in only one direction providing both flexibility and rigidity. The design has no lower sprockets. The primary disadvantage of the Duperon® FlexRake is the limited number of long-term installations.



HEADWORKS®
MAHR™ BAR SCREEN

FIGURE 5.2



DUPERON® FLEXRAKE

FIGURE 5.3

A summary and comparison of climber-type and chain-and-rake-type bar screens are presented in Table 5.3 and Table 5.4. The City of Riverside (City) should re-evaluate both alternatives during preliminary design, when chain and rake type screens have more experience.

Table 5.3 Summary of Climber- and Chain-and-Rake-Type Bar Screen Advantages/Disadvantages
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Climber-Type Bar Screen Advantages	Climber-Type Bar Screen Disadvantages
• No moving parts in wastewater flow. • More installation experience.	• Height of equipment requires taller building. • Long cycle time for a deep channel. • Higher maintenance requirement.
Chain-and-Rake-Type Bar Screen Advantages	**Chain-and-Rake-Type Bar Screen Disadvantages**
• Reduced height of equipment above deck compared to existing climber-type unit. • Continuous operation and multiple rakes reduce cycle time. • Lower maintenance.	• Moving parts in wastewater flow. • Maintenance of bottom sprockets requires channel access (only for Mahr™). • Limited number of long-term installations.

Table 5.4 Comparison of Bar Screens
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Chain-and-Rake	Climber
Operating Experience	0/–(1)	+
Reliability	+/0(1)	+
Moving Parts in Wastewater	–/0(1)	+
Height of Equipment	+	–
Maintenance Access	–/0(1)	0
Maintenance Requirement	0	0
Equipment Cost	0	0
Capital Cost	0	–(2)
O&M Cost	0	–(3)

Notes:
(1) Varies by manufacturer (Mahr™/Duperon®).
(2) Requires the building to be taller.
(3) More foul air to treat.

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

5.6 SCREENING CONVEYORS

Shaftless screw conveyors are currently used at the RWQCP. A belt conveyor is compared as an alternative as requested at the project meeting on September 20, 2006. A typical belt conveyor and shaftless screw conveyor are shown in Figure 5.4 and Figure 5.5, respectively.

A summary and comparison of the two conveyor alternatives are presented in Table 5.5 and Table 5.6. Based on the discussion in the October 18, 2006 meeting, a shaftless screw conveyor is preferred for the new headworks.

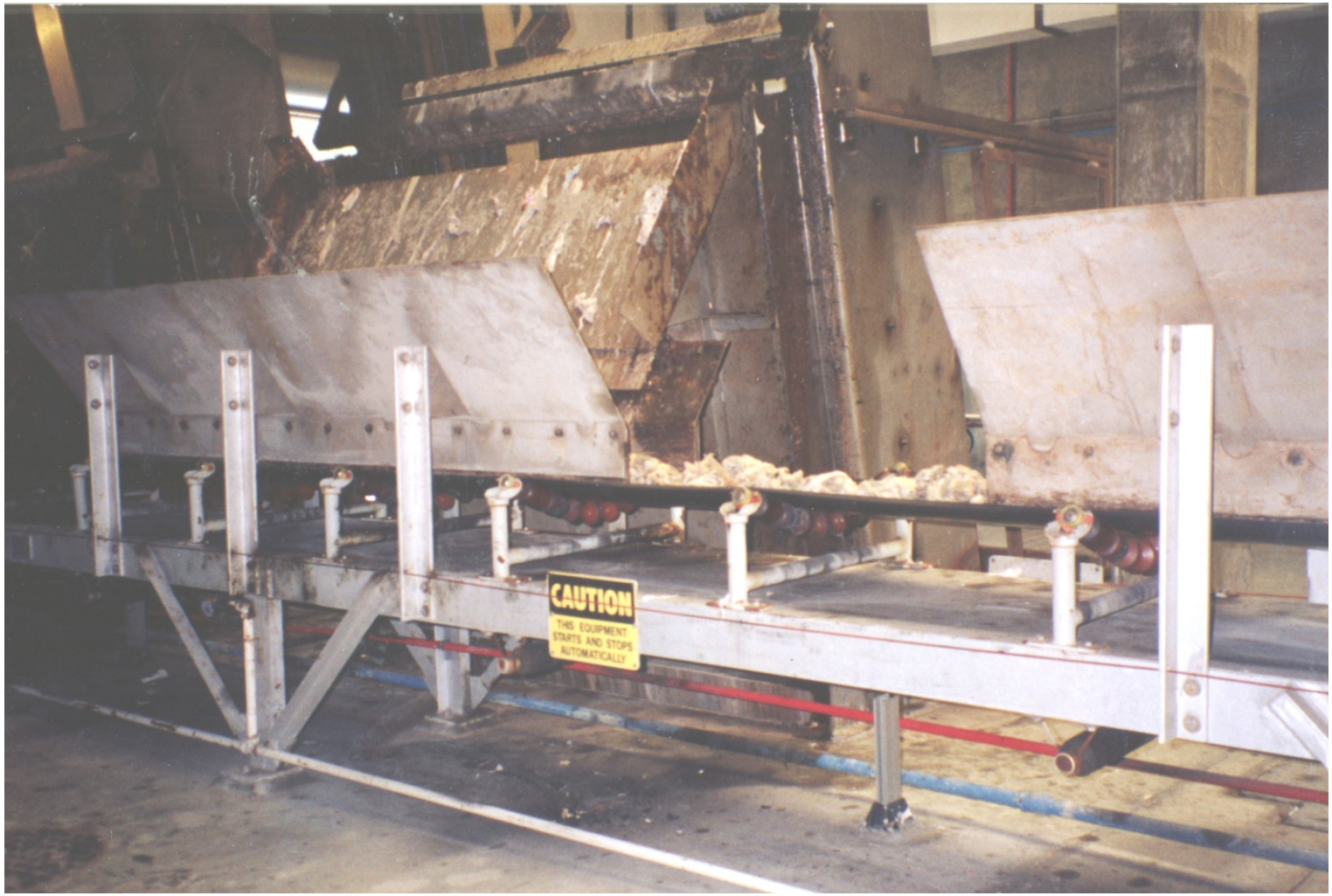
Table 5.5 Summary of Belt and Shaftless Screw Conveyor Advantages/Disadvantages
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Belt Conveyor Advantages	Belt Conveyor Disadvantages
• Can convey large objects.	• Can be messy (significant housekeeping requirements). • Not well suited for very wet material (with free water). • Spillage/carryover can generate additional odors. • Large number of rollers and idlers require frequent maintenance.
Shaftless Screw Conveyor Advantages	**Shaftless Screw Conveyor Disadvantages**
• Clean. • Suitable for wet material (with free water). • Few components.	• May have difficulty conveying large objects. • Conveying abrasive material will reduce the liner life.

Table 5.6 Comparison of Belt Conveyor and Shaftless Screw Conveyor
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

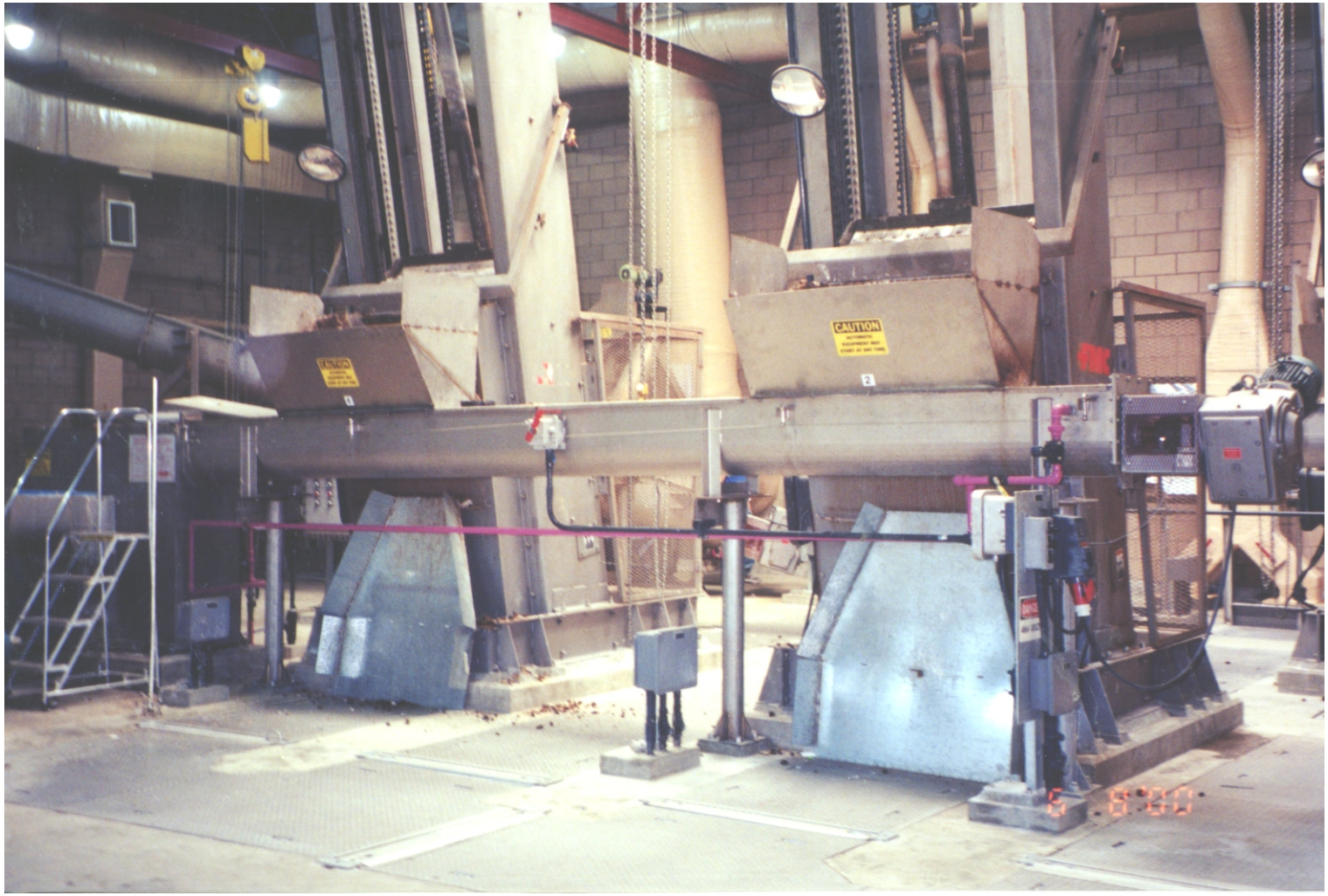
	Belt	Shaftless Screw
Cleanliness	–	+
Maximum Incline	0	+
Large Object Conveyance	+	–
Very Wet Material Conveyance	–	+
Number of Components	–	+
Maintenance Requirements	–	+
Odor Control Covers	–	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.



TYPICAL BELT CONVEYOR FOR SCREENINGS

FIGURE 5.4



TYPICAL SHAFTLESS SCREW CONVEYOR FOR SCREENINGS

FIGURE 5.5

A life-cycle cost analysis is performed for the two conveyor alternatives. As shown in Table 5.7, the life-cycle cost of the shaftless screw conveyor is slightly lower than the belt conveyor.

Table 5.7 Life Cycle Cost Analysis of Conveyors
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Belt	Shaftless Screw
Capital Cost	$58,000	$50,000
Replacement Frequency	Every 10 years	Every 4 years
Replacement Cost	$1,600(1)	$3,800(2)
Monthly Maintenance Cost(3)	$100	$0
Semi-Annual Maintenance Cost	$100	$100
Life Cycle Cost(5)	**$84,000**	**$67,700**

Notes:
(1) Belt cost of $800 plus labor of two people for 1 day at $50/hour.
(2) Liner cost of $3,000 plus labor of two people for 1 day at $50/hour.
(3) Grease bearings: 2-hour labor.
(4) Oil change: 2-hour labor.
(5) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

5.7 SCREENINGS WASHER/COMPACTOR

A screenings washer/compactor that achieves washing and dewatering would be used in the new headworks. A typical one that would be evaluated during preliminary design is shown as Figure 5.6.

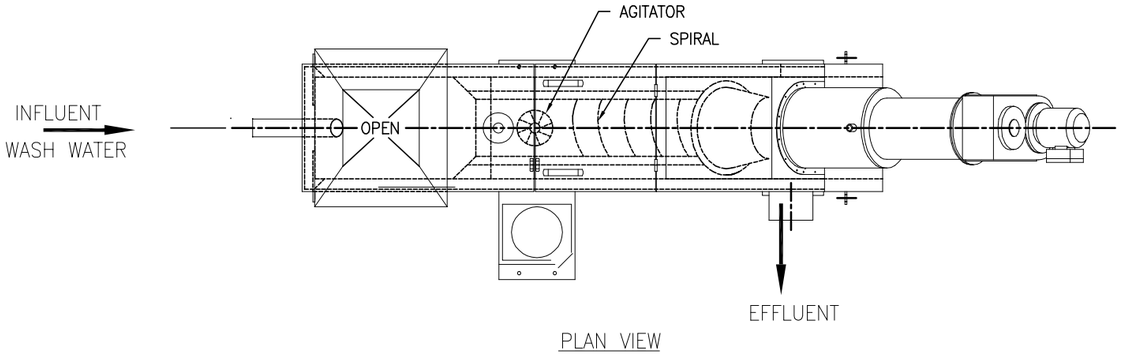
5.8 GRIT BASINS

It was decided the new headworks would include vortex grit basins at the project meeting on September 20, 2006. Typical sections of sloped-bottom and flat-bottom grit basins are shown in Figures 5.7 and Figure 5.8, respectively. These two alternatives are compared in Table 5.8. Carollo Engineers recommends sloped-bottom vortex basins because they minimize the accumulation of settled grit at the bottom, and also because they are non-proprietary, so they can be competitively bid.

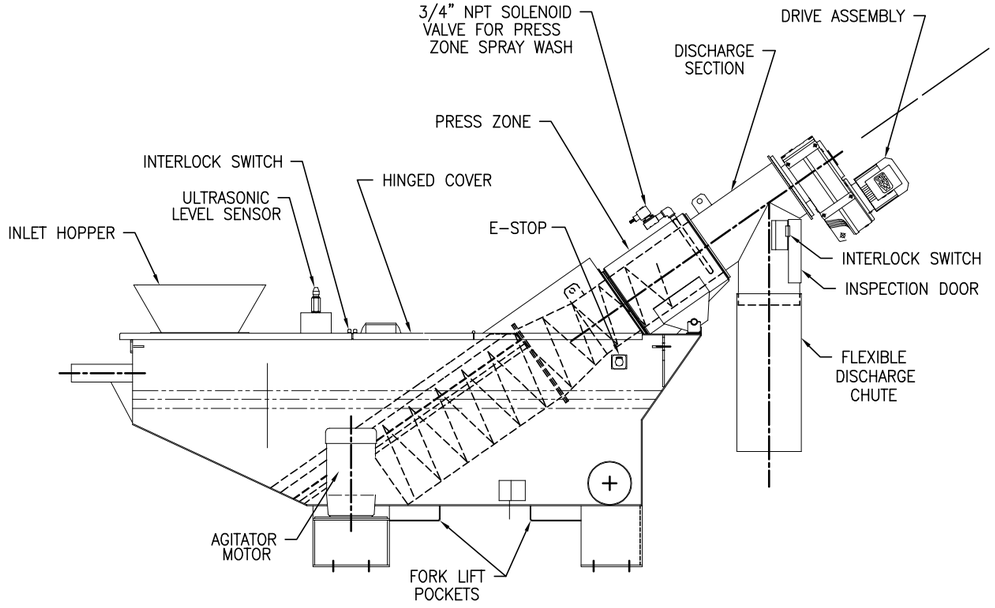
Table 5.8 Comparison of Flat- and Sloped-Bottom Vortex Grit Basins
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Characteristic	Flat-Bottom	Sloped-Bottom
Proprietary Equipment	–	+
O&M Requirements (Due to Grit Buildup on Basin Bottom)	–	+
Capital Cost	+	+
Required Land Area	+	+
Grit Removal	0	0
Odor Control Requirements	+	+
Reliability	0	0
Flow Turn Down	–	0
Hydraulic Head Loss	+	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.



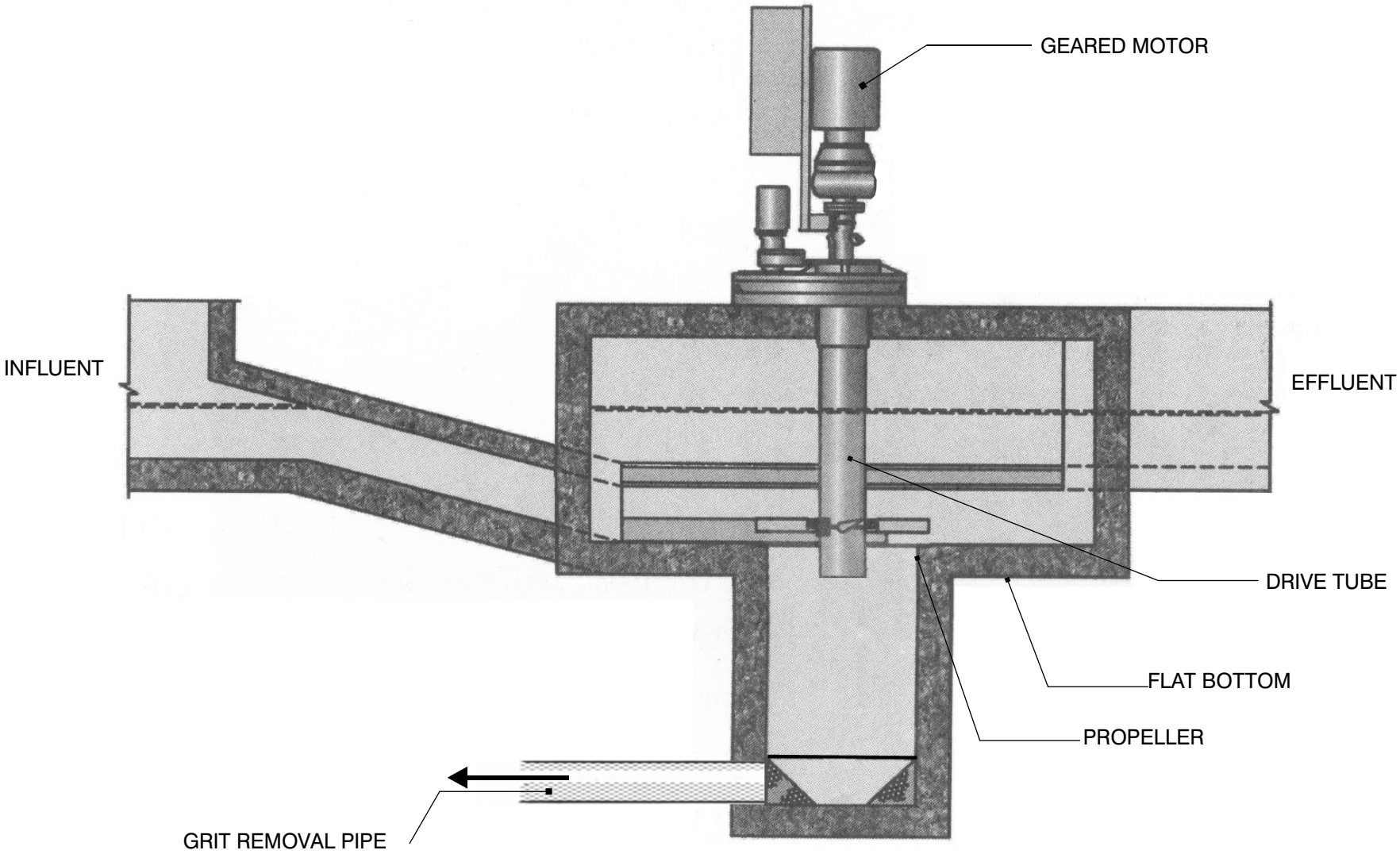
PLAN VIEW



ELEVATION VIEW

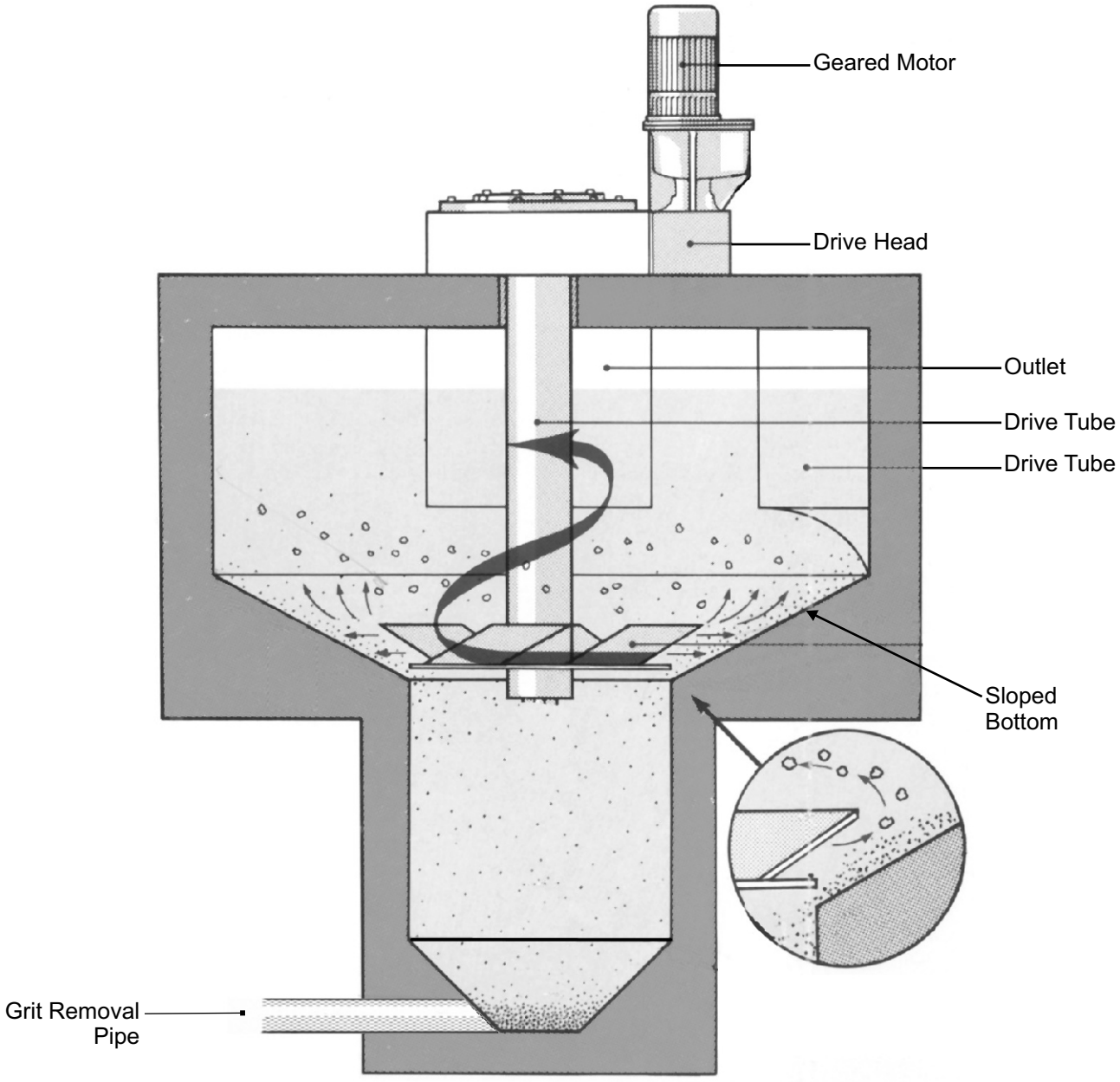
SHAFTLESS SCREW SCREENINGS COMPACTOR WITH WASHING SYSTEM

FIGURE 5.6



FLAT-BOTTOM GRIT BASIN
TYPICAL SECTION

FIGURE 5.7



SLOPED-BOTTOM VORTEX GRIT BASIN TYPICAL SECTION

FIGURE 5.8

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 6: PRIMARY TREATMENT

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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PRIMARY TREATMENT

6.1 PURPOSE

The purpose of this chapter is to evaluate the configuration alternatives for new primary clarifiers that will meet the expansion needs at the Regional Water Quality Control Plant (RWQCP).

6.2 CONCLUSIONS AND RECOMMENDATIONS

- The existing Plant 2 primary clarifiers have a capacity of 20 mgd on an annual average flow basis. New primary clarifiers will have an annual average flow capacity of 32 mgd and replace the existing Plant 1A and Plant 1B primary clarifiers.
- Rectangular and circular alternatives are compared. The life-cycle costs for the two alternatives are similar. Circular primaries will be used, given that the costs are similar, circular clarifiers are easier to maintain, and circular units will fit on the site.
- The type of primary sludge pumps will be decided during preliminary design based on flow quantity and pumping head.
- The abandoned Plant 1 secondary sedimentation basins and chlorine contact basin will be demolished and may be the location of a future primary effluent equalization basin.
- Biofilters will be used for odor control for the primary clarifiers (new Plant 1 and existing Plant 2) and for the new headworks facilities. The primary clarifiers will be covered with low profile aluminum domes for odor control. The biofilter is estimated to be 150 feet by 200 feet. The biofilter will be located at the existing Plant 1A primary clarifiers. Therefore, it will be built after the new clarifiers are put in service and the Plant 1A clarifiers are demolished.

6.3 BACKGROUND

It was decided at the project meeting on July 13, 2006 that the Plant 1 primaries would be replaced, because both Plant 1A and Plant 1B primaries were built in the 1950s and no longer consistently provide effective treatment. Primary facilities of the new Plant 1 and the existing Plant 2 will have a combined capacity of 52 mgd annual average daily flow, according to the flow projection for the year 2025. The Plant 2 primaries have a capacity of 20 mgd, so the new Plant 1 primaries will have a capacity of 32 mgd.

6.4 EXISTING PRIMARY TREATMENT FACILITIES

The existing primary treatment facilities are listed in Table 6.1. As discussed in Volume 4, Chapter 1 - Existing Facilities, the primary sedimentation facilities at Plant 1 were originally designed to pump the settled solids into gravity thickeners. However, currently, the settled solids from the Plant 1 primaries are pumped into the primary influent splitter box for Plant 2 and are resettled with the Plant 2 influent solids. The Plant 2 primary sludge is thickened in the primaries and is pumped directly to the anaerobic digesters. Ferric sulfate is added to the Plant 1 primaries to keep the RWQCP hydrogen sulfide levels within the South Coast Air Quality Management District (SCAQMD) limits.

Table 6.1 Existing Primary Treatment Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description		Value
Primary Sedimentation		
Plant 1		
Basins - Rectangular	Plant 1A	Plant 1B
Number	4	2
Length, feet	104	163.5
Width, feet	26	37
Units in Operation	All	All
Total Volume, gallons	688,700	768,900
Total Surface Area, feet^2	10,816	12,100
Sludge Pumps - Non-Clog Centrifugal	Plant 1A	Plant 1B
Number	3	2
Size, gpm/each	450	450
Plant 2		
Basins - Circular		
Number of Basins		4
Diameter, feet		95
Units in Operation		All
Total Volume, gallons		2,004,000
Total Surface Area, feet^2		28,350
Sludge Pumps - Progressive Cavity		
Number		6
Size, gpm/each		100
Ferric Sulfate		
Number of Tanks		1
Volume, gallons		6,000
Usage, gpm		700 to 1200

6.5 DESIGN CRITERIA

The Surface Overflow Rate (SOR) used to size the new primary sedimentation tanks is up to 1,200 gpd/ft^2 and 2,250 gpd/ft^2 at average and wet weather peak flow rates, respectively. The annual average and wet weather peak flow rates for the primaries will be 32 mgd and 70 mgd, respectively.

To size the biofilters, a foul air exchange rate of 12 changes per hour, and a load for the biofilters of no more than 3 scfm/ft^2 is used.

6.6 NEW PRIMARY CLARIFIER EVALUATION

Both circular and rectangular configurations are commonly used for primary clarifier basins at wastewater treatment plants. For the RQWCP, both configurations are evaluated based on a life cycle cost analysis as well as other non-economic factors.

6.6.1 Alternative 1 - Rectangular Primary Clarifiers

Figure 6.1 shows the layout of Alternative 1 – Rectangular Primary Clarifiers. There would be six (five duty and one standby) rectangular tanks, each with a width of 40 feet and a length of 160 feet. The outside dimension is estimated to be 260 feet by 210 feet including the pumps and splitting channel west of the channels.

Because of the existing Plant 1B primary effluent pipe, Alternative 1 would be constructed in two phases. The existing Plant 1B primaries would need to stay in service until Phase 1 of the new primaries was constructed. Approximately 30 feet of clearance would be provided between the new and existing structures. The rectangular tanks would be covered with aluminum covers.

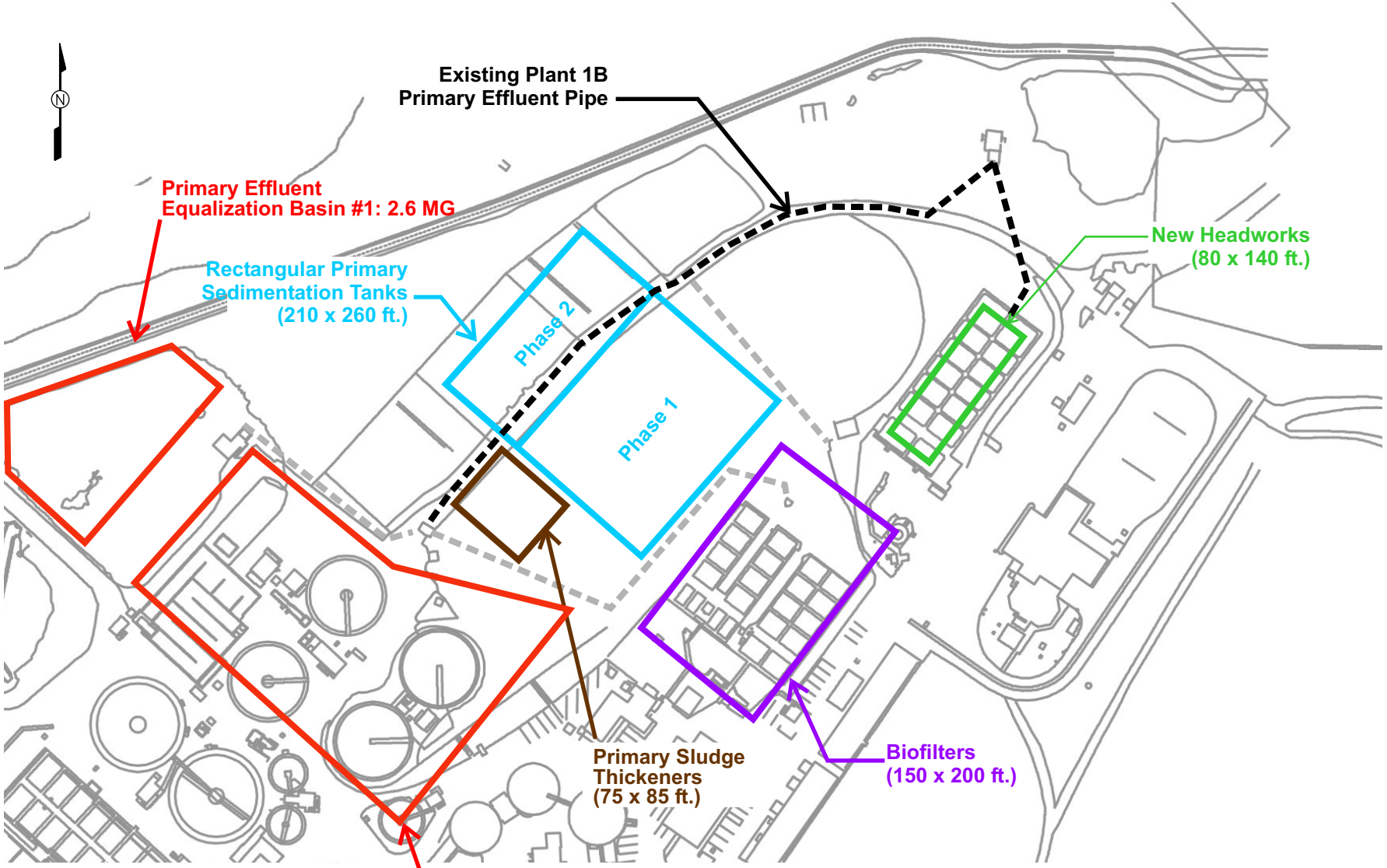
The rectangular clarifier chain and flight collection mechanism would be constructed of non-metallic material and would likely need replacement after approximately 10 to 15 years, assuming normal use and wear.

6.6.2 Alternative 2 - Circular Primary Clarifiers

Figure 6.2 shows the layout of Alternative 2 – Circular Primary Clarifiers. There would be four (three duty and one standby) circular clarifiers, each with a diameter of 120 feet. Two of the clarifiers would be located in the area of the abandoned sludge beds, which are currently used for debris storage.

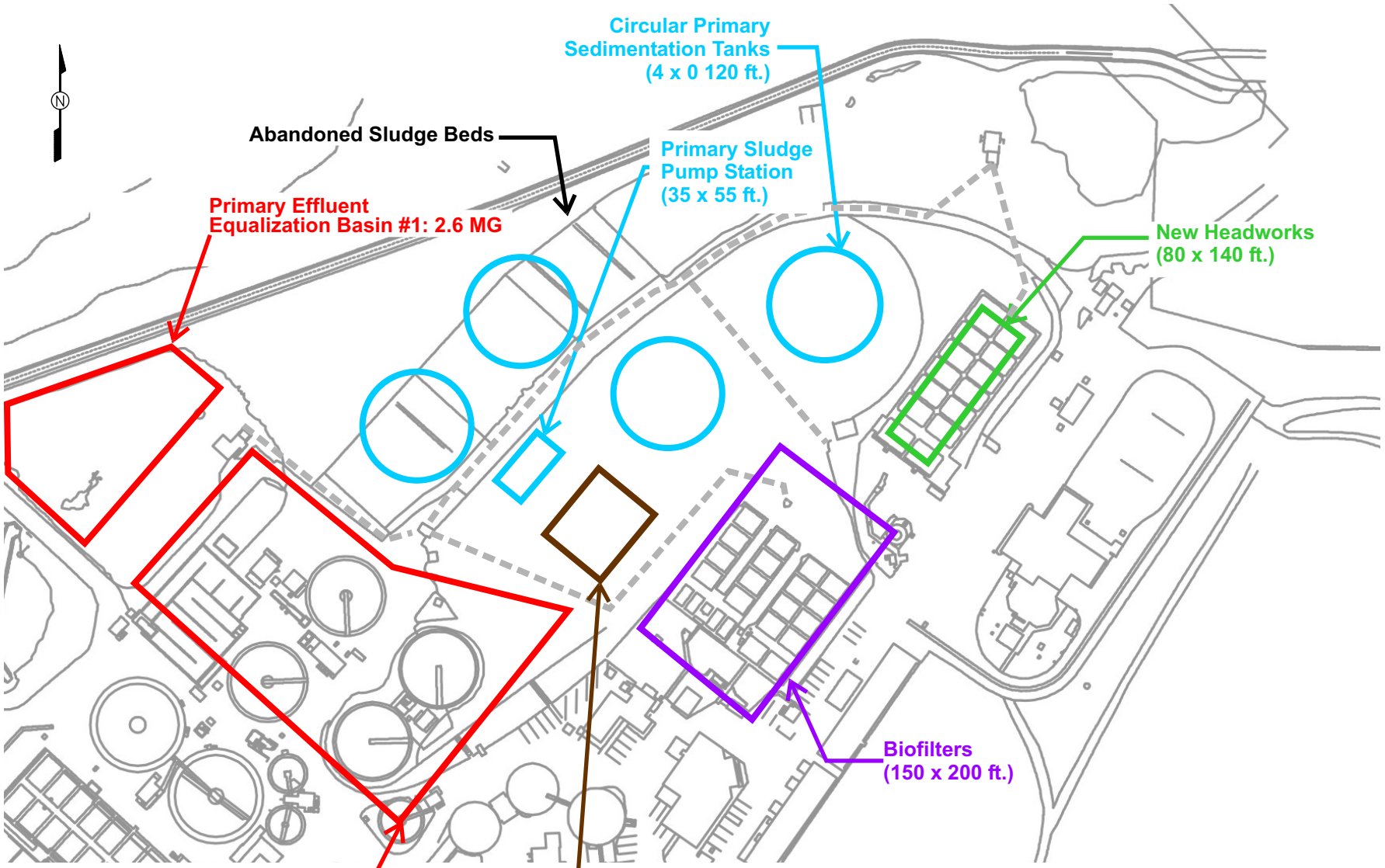
Circular clarifiers usually result in a higher headloss when compared to rectangular clarifiers, but there is adequate head available for circular clarifiers.

In general, circular clarifier sludge collection mechanisms are simpler to construct and are easier to maintain as compared to rectangular clarifier chain and flight mechanisms. Each link (and sprocket) in a chain and flight mechanism is a moving part and subject to wear,



NEW PRIMARY TREATMENT FACILITIES LAYOUT: PLANT 1 ALTERNATIVE 1

FIGURE 6.1



NEW PRIMARY TREATMENT FACILITIES LAYOUT: PLANT 1 ALTERNATIVE 2

FIGURE 6.2

whereas a circular collection mechanism has a single main rotating turntable that is located at the deck level above the water surface.

Circular primary clarifiers are more suited for in-tank-thickening. At the project meeting on September 20, 2006, it was decided that clarifiers will not be used to thicken the sludge.

6.7 COMPARISON AND LIFE-CYCLE COST OF ALTERNATIVES

A comparison of the two alternatives is presented in Table 6.2. Life-cycle costs for the two alternatives are shown in Table 6.3.

Table 6.2 Comparison of Rectangular and Circular Primary Clarifiers Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Alternative 1 Rectangular	Alternative 2 Circular
Average SOR (gpd/ft^2)	1,000	943
Maximum SOR (gpd/ft^2)	2,200	2,075
Quantity	6 (5 duty/1 standby)	4 (3 duty/1 standby)
Dimension	160-foot L by 40-foot W by 12-foot SWD	120-foot diameter by 12-foot SWD
Simplicity of Mechanism	–	+
Maintenance Requirement	–	+
Separate Flow Splitting Structure	+	–
Separate Sludge Pumping Station	+	–
Space Requirement	+	–
Construction Staging Requirement	–	+
Capital Cost	+	–
Maintenance Cost	–	+
Potential for In-Tank-Thickening	–	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

Table 6.3	Life-Cycle Cost of Rectangular and Circular Primary Clarifiers Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
	Alternative 1 - Rectangular	**Alternative 2 - Circular**
Direct Costs(1)	$7,570,000	$8,600,000
Total Project Cost(1)	$24,000,000	$27,200,000
Yearly Maintenance Cost	$12,000	$8,000
Mechanism Replacement Cost	$1,400,000(2)	$0
Total Life Cycle Cost(3)	**$25,500,000**	**$27,400,000**

Notes:
(1) Including primary clarifiers, influent splitter box, and primary sludge pump station.
(2) Replacement for chain and flight sludge collector every 10 years.
(3) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

The total project capital cost of Alternative 1 is slightly lower because of the common wall construction for rectangular clarifiers. The total life-cycle costs for the two alternatives are similar.

It was decided at the October 18, 2006 project meeting to use circular clarifiers, because the life-cycle costs are similar and they are easier to maintain than rectangular clarifiers.

6.8 PRIMARY SLUDGE PUMPING

The type of primary sludge pumps will be one of the following, depending on the final design criteria for the flow quantity and pumping head required.

- Non-clog centrifugal.
- Screw centrifugal.
- Progressing cavity.

The final decision will be made during preliminary design.

6.9 ODOR CONTROL

There are several options available for odor scrubbing. However on a life cycle cost basis, if sufficient land is available, biofilters are the best option. Since sufficient land is available at the RWQCP, it was decided at the project meeting on September 20, 2006 that biofilters would be used for odor scrubbing.

The biofilters will be built after the completion of the new primary clarifiers, when Plant 1A can be demolished for the space.

The foul air to be treated in the new biofilters comes from the new headworks, the new Plant 1 primaries, and the existing Plant 2 primaries. The dimension is estimated to be 150 feet by 200 feet, and the total project cost is estimated to be $16.7 million.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 7: SECONDARY TREATMENT

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 7: SECONDARY TREATMENT

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SECONDARY TREATMENT

7.1 PURPOSE

The purpose of this chapter is to summarize the evaluation of the existing secondary treatment facility at the City of Riverside (City) Regional Water Quality Control Plant (RWQCP). This chapter also includes a description of additions or modifications required for Secondary Treatment Facilities to increase capacity to 52.2-mgd annual average (AA) flow.

7.2 RECOMMENDATIONS AND CONCLUSIONS

- The existing treatment system was evaluated and the plant capacity is 40-mgd AA.
- Four options for expanding the RWQCP secondary treatment plant were considered: Conventional Activated Sludge (CAS), Enhanced Primary Treatment (EPT), Membrane Bioreactor (MBR), and Integrated Fixed Film Activated Sludge (IFAS).
- EPT reduced the aeration influent biochemical oxygen demand (BOD) such that denitrification is affected and no increase in capacity is achieved. EPT therefore is not feasible for increasing the secondary treatment capacity.
- CAS, MBR, and IFAS options can all achieve the required expanded capacity. The IFAS option presents more risks than the other alternatives due to the limited experience and number of installations using this technology.
- For meeting current effluent limits, CAS is the most cost-effective alternative followed by IFAS.
- For meeting current effluent limits plus improved Whole Effluent Toxicity (WET) results and better Endocrine Disrupting Compounds (EDCs) destruction, the life-cycle costs for all options are nearly the same, within the uncertainty of the cost estimate.
- Based on the ability to achieve better effluent quality, the City chose the MBR alternative for the future expansion at a meeting on November 17, 2006.
- The current influent flow to the RWCP is approximately 80 percent of the plant's rated capacity, indicating a need for expansion. However, because of a slow down in the housing market, the City has decided to perform this expansion in two phases. The first phase will expand the Plant 1 secondary treatment facilities from 20 to 26-mgd AA. The second phase will expand the secondary facilities from 26 to 32 mgd.

7.3 DESCRIPTION OF EXISTING TREATMENT

Figure 7.1 shows the flow schematic of the existing facilities. The influent wastewater stream is divided into two plants (Plant 1 and Plant 2) after screening and grit removal.

In both Plant 1 and Plant 2, wastewater is clarified in primary clarifiers before biological treatment. Plant 1 has four rectangular aeration basins and four rectangular secondary clarifiers, and Plant 2 has six rectangular aeration basins and four circular secondary clarifiers. For a detailed description of the existing facilities, refer to Volume 4, Chapter 1 - Description of Existing Facilities. The description of facilities for handling waste solids generated during the wastewater treatment process is discussed separately in Volume 8, Chapter 1 - Biosolids Management: Existing Facilities. The design criteria for the solids handling facilities are discussed in Volume 8, Chapter 3 - Biosolids Management: Design Criteria Development.

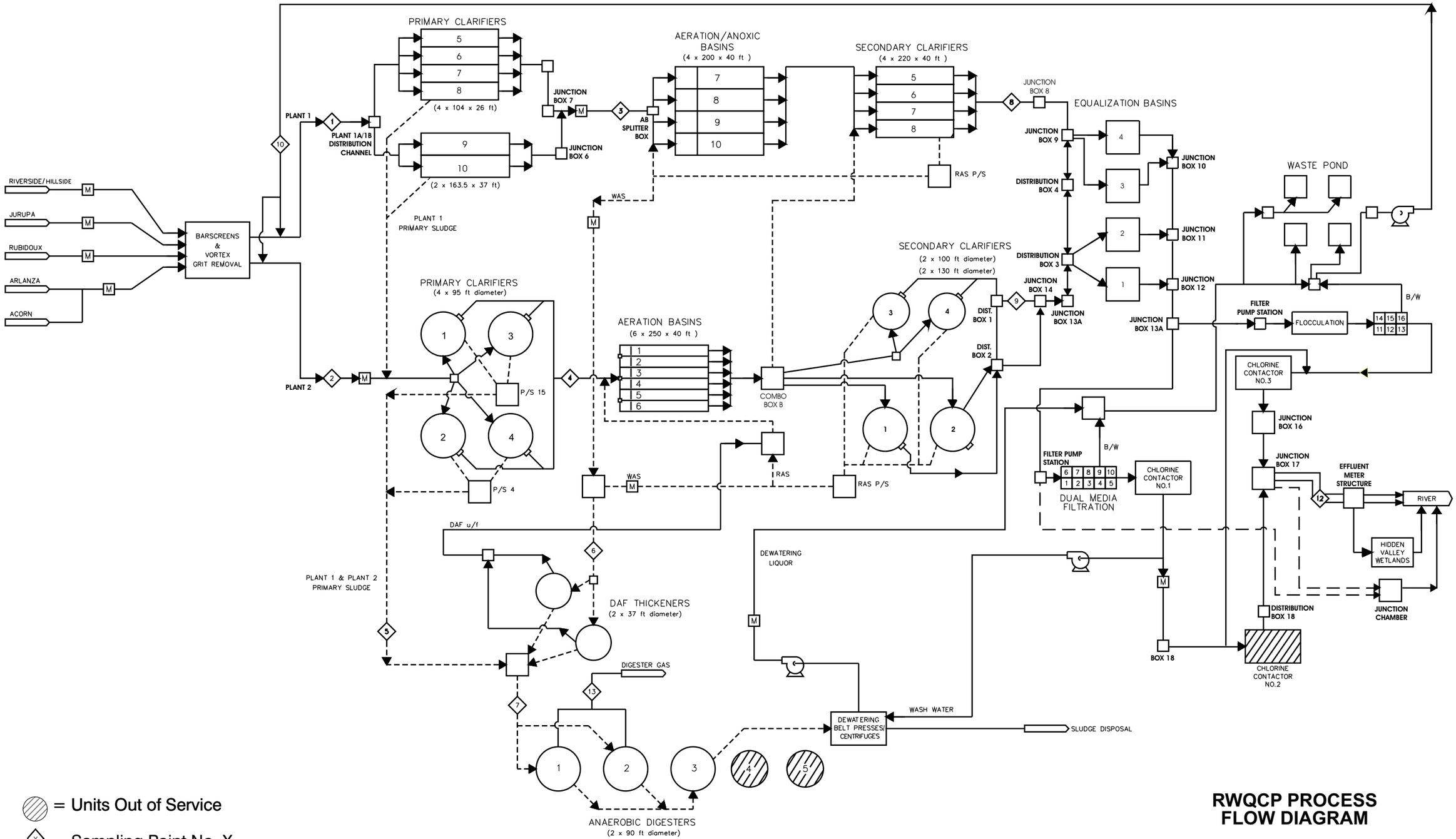
7.3.1 Process Design Criteria

Table 7.1 presents a summary of the design criteria for expansion of facilities at the RWQCP. For detailed information on the process design criteria, refer to Volume 4, Chapter 3 - Process Design and Reliability Criteria.

Table 7.1 Design Criteria for Expansion of the RWQCP Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Effluent Parameter	Value
Design Flows	
Average Dry Weather Flow (ADWF), mgd	52.2
Peak Wet Weather Flow (PWWF), mgd	115(1)
Approximate Recycle Flow to Headworks, mgd	5.5
Average Influent Wastewater Characteristics(2)	
BOD, mg/L	250
TSS, mg/L	250
TKN, mg/L as N	35.5
Effluent Quality Requirements	
BOD, mg/L	<10
TSS, mg/L	<10
Total Inorganic Nitrogen, mg/L as N	<10(3)

Notes:
(1) Based on a wet weather peak hour flow factor of 2.2.
(2) Does not include impact of recycle streams from dewatering, thickening, and tertiary filter backwash.
(3) The current requirement is 13 mg/L, but this will change to 10 mg/L when flows exceed 35-mgd AA.



= Units Out of Service

= Sampling Point No. X

RWQCP PROCESS FLOW DIAGRAM

FIGURE 7.1

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7.3.2 Sludge-Settling Characteristics - *Clariflux*™ Model

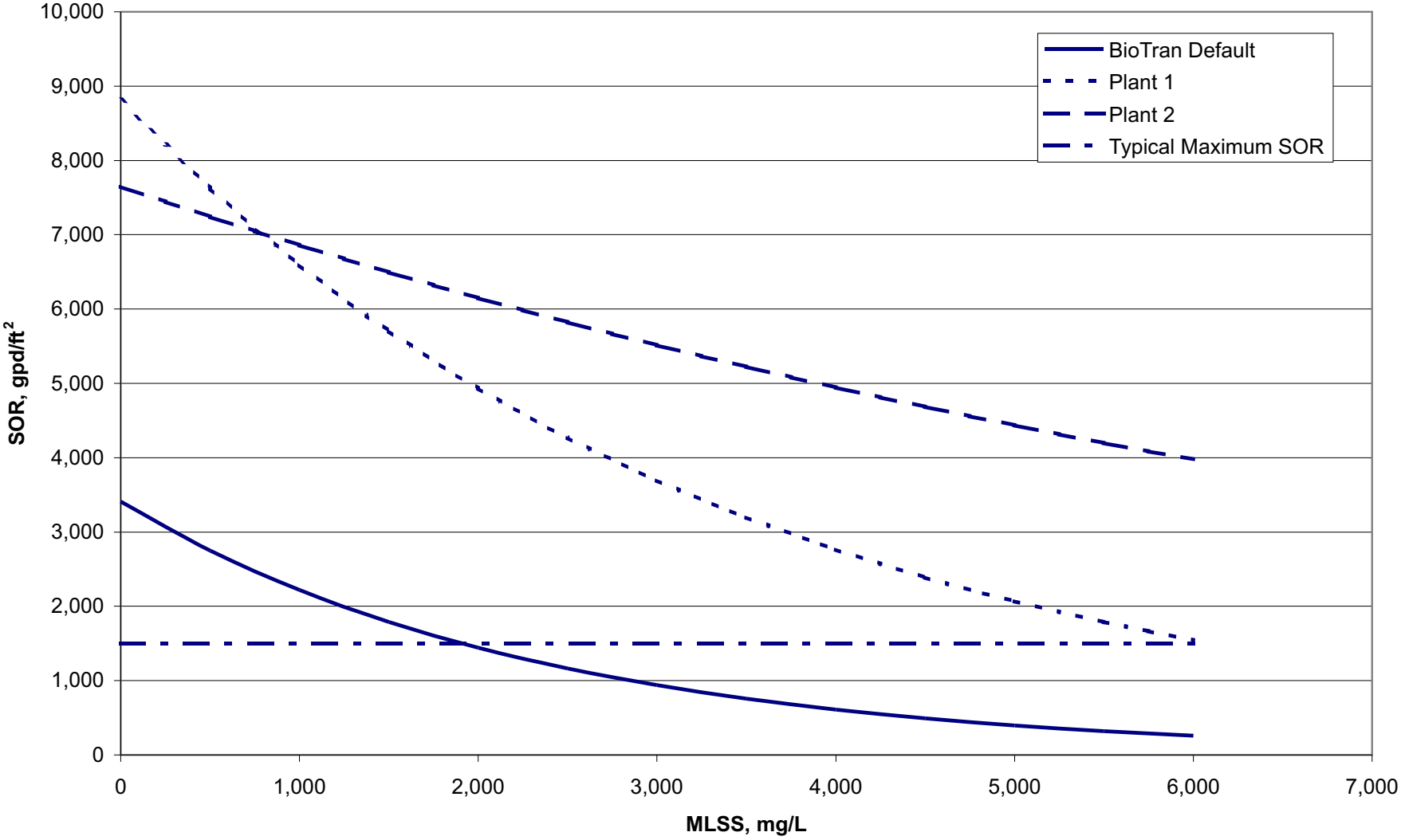
There are three different factors that could limit the capacity of a secondary treatment system (aeration basins and clarifiers):

- Aeration Basin Capacity:
  In a nitrifying system, such as at the RWQCP, the basin must be large enough to ensure full nitrification at design loads and minimum expected wastewater temperatures. Basin capacity typically increases as Mixed Liquor Suspended Solids (MLSS) concentration is increased.
- Aeration System Capacity:
  The aeration system (blowers and diffusers) must be able to supply sufficient oxygen to the aeration basin under design load conditions. Blower capacity must be assessed at maximum expected air temperatures. The oxygen transfer efficiency of the diffusers depends on air flux and process conditions, such as Sludge Retention Time (SRT), MLSS concentration, etc.
- Clarifier Capacity:
  The clarifiers must be able to produce an effluent with a low Total Suspended Solids (TSS) concentration under design loads. Typically, clarifier capacity increases with lower MLSS concentrations.

Both aeration basin capacity and aeration system capacity can be modeled to a high degree of accuracy using existing process models for the aeration system. Secondary clarifier capacity, however, depends on sludge-settling characteristics. These characteristics may be assumed or estimated based on available data such as Sludge Volume Index (SVI) data. Translating SVI data to sludge-settling characteristics does carry some risk, as the SVI test does not discriminate between sludge settling, which determines the required Surface Overflow Rater (SOR) and sludge compaction, which determines the required Return Activated Sludge (RAS) rate.

A sludge-settling test was performed to determine the sludge-settling characteristics of the mixed liquor for both Plants 1 and 2. A sample of mixed liquor from the aeration basin effluent was collected and settling tests were performed, in duplicate, in a 6-foot sludge-settling column. The test was repeated with increasingly dilute mixed liquor samples (diluted with secondary effluent) to obtain initial sludge settling velocity as a function of MLSS concentration. These results were then used to estimate the settling properties of sludge for both Plant 1 and Plant 2.

Rate of settling data for various solids concentrations was collected and compared with typical settling rates. Figure 7.2 shows a summary of the results of the settling tests. The figure shows the effect of MLSS concentrations on the settling rates (i.e., SOR). From the figure, it is apparent that the mixed liquor settles very fast in the secondary clarifiers at both Plants 1 and 2.



SECONDARY SLUDGE SETTLING TEST RESULTS

FIGURE 7.2

The figure suggests that at a typical MLSS operating concentration range of 2,500 to 3,500 mg/L, the clarifiers can be loaded at a much higher SOR ranging from 3,000 to 4,500 gpd/ft^2. This indicates that sludge-settling characteristics are not the limiting factor for the RWQCP secondary clarifiers. Experience and clarifier stress testing at other plants indicate that where SOR exceeds 1,500 gpd/ft^2 hydraulic effects begin to dominate, causing an increase in effluent TSS concentration, regardless of sludge-settling characteristics. Therefore, the loading of the secondary clarifiers should be limited to 1,500 gpd/ft^2 under all conditions.

Hence, in order to increase the capacity at the RWQCP, the clarifiers can be operated at higher SOR, which would enable the operators to maintain a higher MLSS concentration (i.e., higher capacity) in the aeration basins. Table 7.2 summarizes the existing and proposed clarifier operating conditions.

Table 7.2 Summary of Secondary Sludge-Settling Tests
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Plant 1	Plant 2
Current Operation		
Average Influent Flow, mgd	11	20.1
MLSS, mg/L	2,858	3,173
SOR at Average Flow, gpd/ft^2	386	494
Design for 40 mgd		
Average Influent Flow, mgd	20	20
MLSS, mg/L	3,500	2,500
SOR at Average Flow, gpd/ft^2	645	631

Previously during the secondary system upgrades project, done by Carollo Engineers (Carollo) in 2002, the Biotran showed that the plant capacity was approximately 36 mgd. At the time of that project, a settling test was not conducted for the evaluation of the performance of the secondary clarifiers and sludge-settling characteristics were assumed. The settling test results as discussed above indicate that the sludge-settling characteristics at both Plants 1 and 2 are very good, and better than assumed. Due to the good sludge-settling characteristics, the aeration basins can be operated at a higher MLSS to achieve higher treatment capacity. Only the MLSS in Plant 1 can be increased to 3,500 mg/L to increase capacity. The MLSS concentration in Plant 2 should not be increased beyond 2,500 mg/L, as the capacity of Plant 2 is limited by the capacity of the aeration system and not the performance of the secondary clarifiers. Making these adjustments, the combined capacity of the secondary system for Plant 1 and Plant 2 is 40 mgd, based on the Biotran model.

7.4 IDENTIFICATION OF SECONDARY TREATMENT EXPANSION ALTERNATIVES FOR THE RWQCP

Based on the current and expected future treated effluent discharge requirements, and also keeping in mind the City's requirements for future treatment goals and operational flexibility, the following four secondary treatment alternatives were identified:

1. Using EPT to increase secondary treatment capacity.
2. Expand the existing CAS system at Plant 1.
3. Convert the existing Plant 1 secondary treatment facility into a MBR plant capable of treating the 32.2 mgd of plant flow.
4. Convert the existing Plant 1 secondary treatment facility into an IFAS facility.

In addition to the above four processes, the Waste Activated Sludge Anaerobic Contact (WASAC) process was also considered for secondary treatment expansion. The WASAC is a proprietary process developed by Carollo that uses phosphorus-harboring organisms to remove BOD from wastewater in an anaerobic environment. The WASAC process would be inserted between the primary clarifiers and the aeration basins. This process would supplement the secondary treatment process such that the secondary expansion could be delayed. The WASAC process can potentially provide the City significant cost and energy savings. Since at this time the WASAC process has not been proven, it was not evaluated further or recommended to the City. However, in the future, if proven successful through pilot testing, the WASAC process could be a viable alternative for the City, since it could make best use of the existing facilities. Appropriate design considerations were made in this Master Plan to leave room for the potential implementation of the WASAC process.

For this project only the four alternatives listed above were evaluated. The four alternatives are described and discussed in the following subsections.

7.4.1 Enhanced Primary Treatment

EPT doses ferric iron and polymer (typically anionic polymer) to the primary influent to increase flocculation and settling, hence improving primary clarifier performance, specifically TSS and BOD removal. This reduces the load on the secondary treatment plant. The reduced load translates into reduced operating costs (mostly due to lower aeration air requirements and lower secondary solids production). In some cases, the secondary treatment capacity can also be increased. Carollo investigated whether EPT would significantly increase primary clarifier performance by performing a bench test. The effect of EPT on secondary treatment was also considered.

For the test, a sample of primary influent from each plant was taken. The sample was divided into six samples that were dosed with 0.5 mg/L of anionic polymer and different concentrations of ferric chloride: 5, 10, 15, 20, and 25 mg/L. The control received neither ferric nor polymer. All the samples were thoroughly mixed and allowed to settle in Imhoff cones. After about half an hour the settled solids were drained from the Imhoff cone and a

sample of the supernatant was collected and submitted to the RWQCP laboratory for analysis. The test results are summarized on Figure 7.3. As shown in the figure, EPT did increase primary clarifier performance. The key results from the experiment are summarized in Table 7.3.

Table 7.3 Enhanced Primary Treatment Bench Test Results
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Plant 1	Plant 2
Control		
COD Removal	32%	24%
TSS Removal	59%	54%
Optimum Dose		
Dose, mg/L as $FeCl_3$	10	15
COD Removal	46%	45%
TSS Removal	68%	71%
Maximum Dose Tested		
COD Removal	50%	49%
TSS Removal	76%	72%

The optimum ferric chloride dose at Plant 1 appeared to be approximately 10 mg/L and 15 mg/L at Plant 2.

The effect of EPT on secondary treatment is summarized in Table 7.4.

Table 7.4 Summary of Enhanced Primary Treatment Testing Results
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Conventional	EPT
Aeration Basin Influent		
BOD, mg/L	160	112
TSS, mg/L	101	61
NH_4-N, mg/L	29	28
TKN, mg/L	38	35
Soluble BOD, mg/L	64	60
BOD: TKN Ratio	4.2	3.2
Aeration Basin Operating Conditions		
SRT, days	5.3	8.9
MLSS, mg/L	3,500	3,500
Anoxic Fraction	25%	50%
Primary Sludge, lb/d	63,250	82,900
WAS, lb/d	43,200	25,400
Digester Feed Flow, mgd	0.50	0.49
Aeration Basin Air, scfm	27,600	21,500

Table 7.4 Summary of Enhanced Primary Treatment Testing Results Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Parameter	**Conventional**	**EPT**
Secondary Effluent Quality		
NH_4-N, mg/L	0.7	0.5
Total Organic Nitrogen, mg/L	2.7	2.7
NO_3-N, mg/L	6.9	7.5
Total Inorganic Nitrogen, mg/L	7.6	7.9
Total Nitrogen, mg/L	10.3	10.6

The table confirms that EPT has the potential to reduce the operating costs of the secondary treatment (approximately 22-percent savings in aeration air and 41-percent savings in WAS mass, while primary sludge production increases by 31 percent). However, it should be noted that EPT reduces the BOD to Total Kjeldahl Nitrogen (TKN) ratio in the aeration basin influent from 4.2 to 3.2.

Typically, when this ratio drops below 4.0, special measures are required to achieve a high level of denitrification. In this case, the anoxic fraction in the aeration basin needs to be increased to 50 percent. This means that there is no capacity increase as the reduced aerobic volume requirement with EPT is taken up by the increased anoxic volume. Operating the basin at such a high anoxic fraction may also increase the SVI. Should that happen, secondary clarifier performances would be affected and the secondary treatment capacity could be reduced.

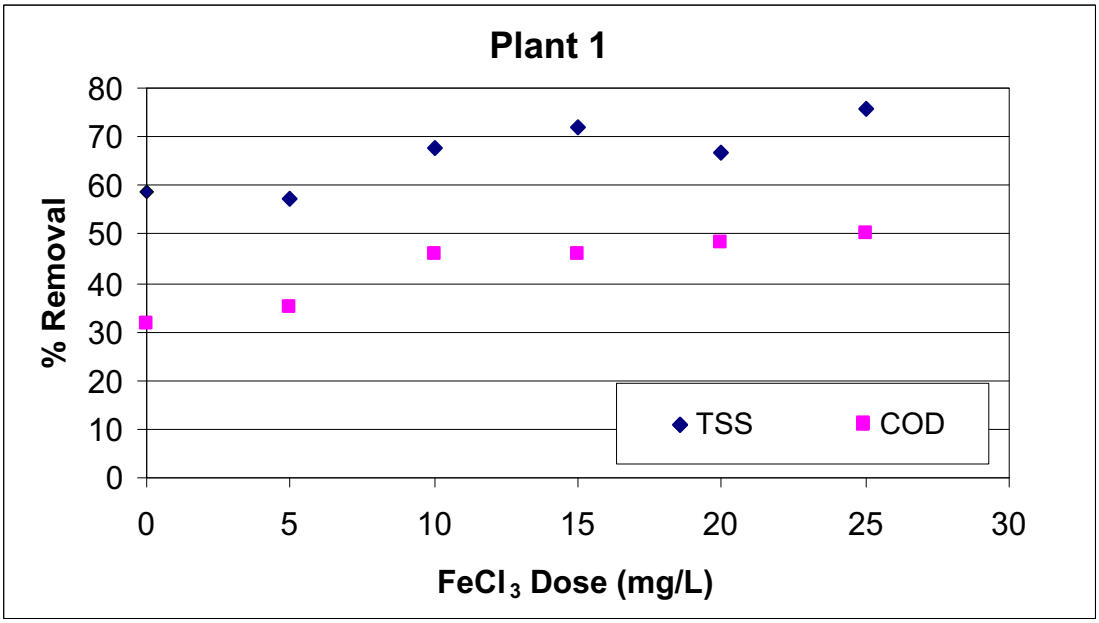
For these reasons, EPT is not recommended for the RWQCP and is not discussed further.

7.4.2 Conventional Activated Sludge Process

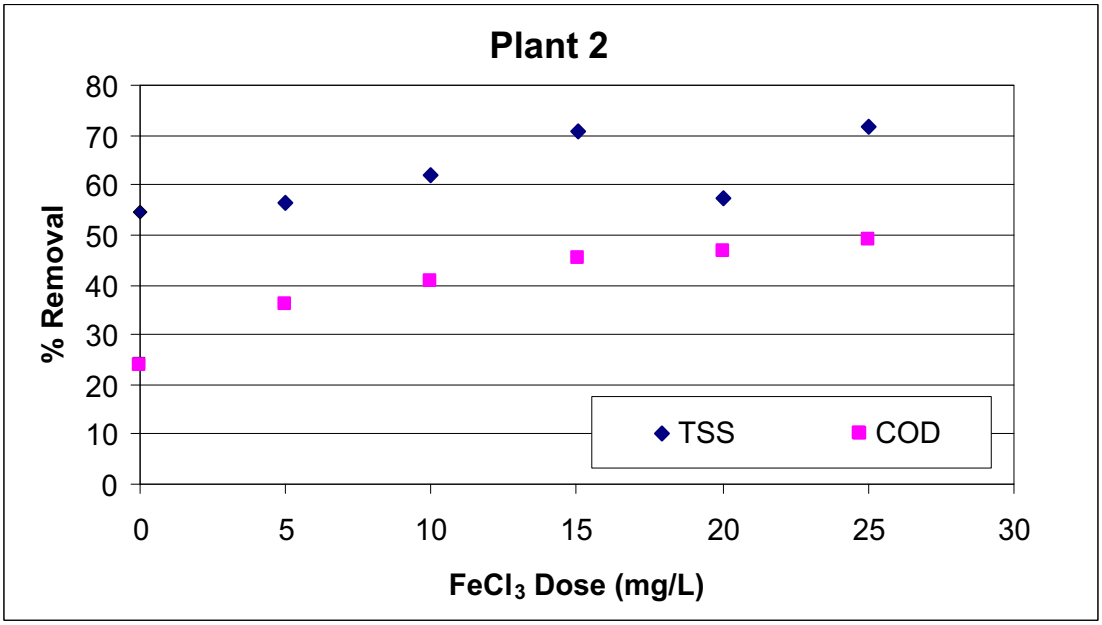
The City operates two separate trains of CAS process. The secondary treatment processes at Plant 1 and Plant 2 are rated at 20-mgd AA each. For future increase in capacity, Plant 1 will be expanded since some of the process units in Plant 1 have aged and there is enough room for future units in Plant 1, whereas Plant 2 has limited room for future expansions. The expansion would increase Plant 1 capacity to 32.2-mgd AA and the total RWQCP treatment capacity to 52.2-mgd AA.

The CAS process is a proven wastewater treatment method and the City has had good experience with the process. Additionally, the operators at the RWQCP are well versed with the operation and maintenance of the facilities involved in a CAS process. Hence, for the next expansion, the CAS process was chosen as a secondary treatment alternative for further evaluation. For the comparison of the treatment alternatives, the CAS alternative was used as a base case scenario. A process schematic of the CAS process is shown on Figure 7.4.

The process requirements for the CAS process are summarized in Section 7.5.



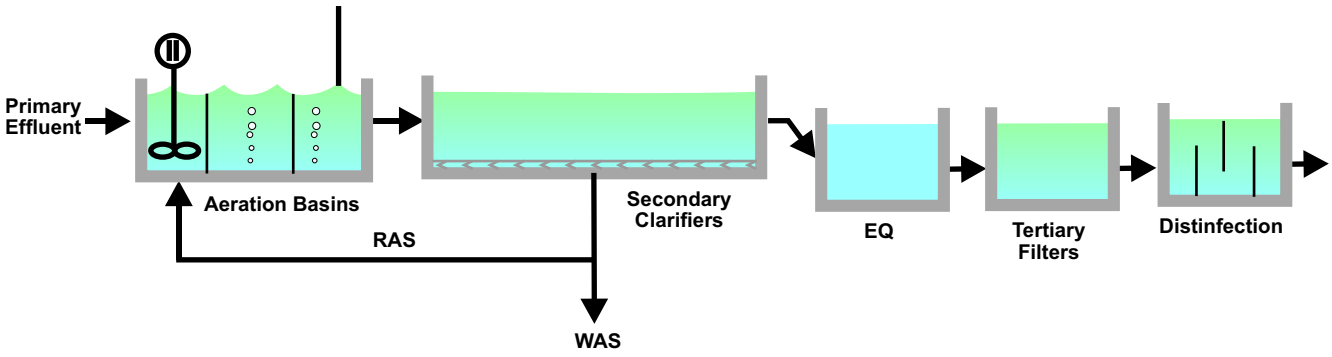
(A)



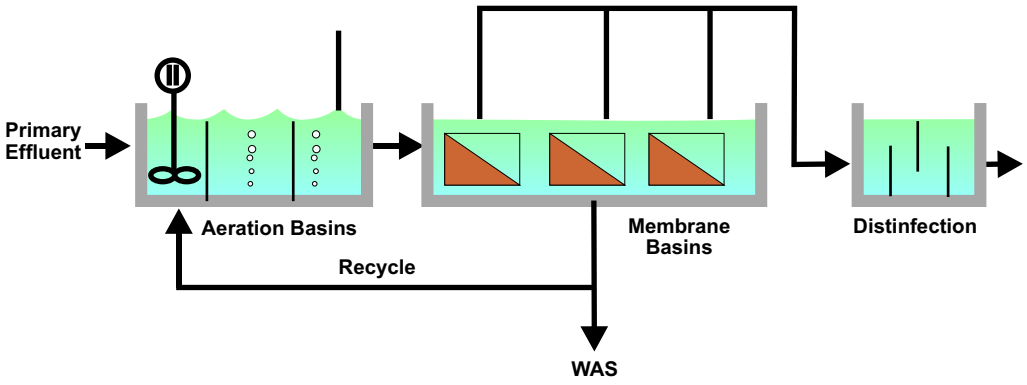
(B)

EPT TEST RESULTS

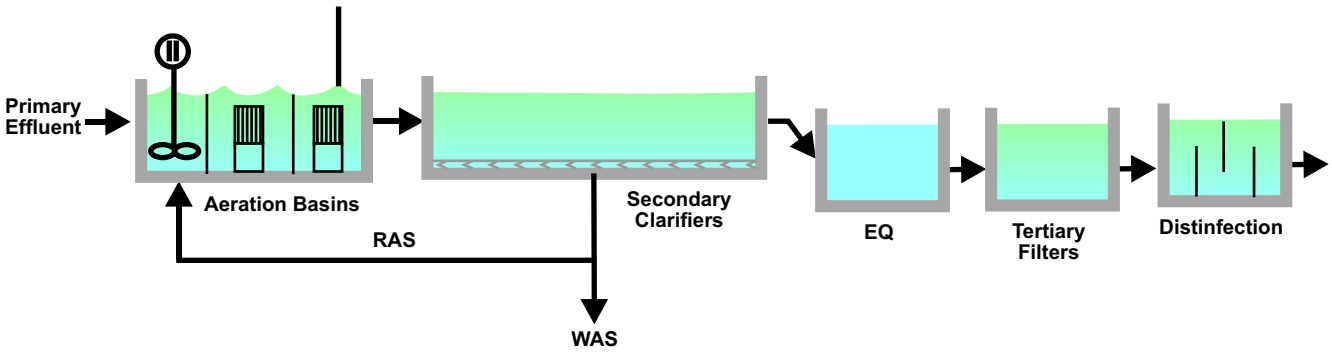
FIGURE 7.3



(A) CAS Schematic



(B) MBR Schematic



(C) IFAS Schematic

PROCESS SCHEMATICS

FIGURE 7.4

7.4.3 Membrane Bioreactor Process

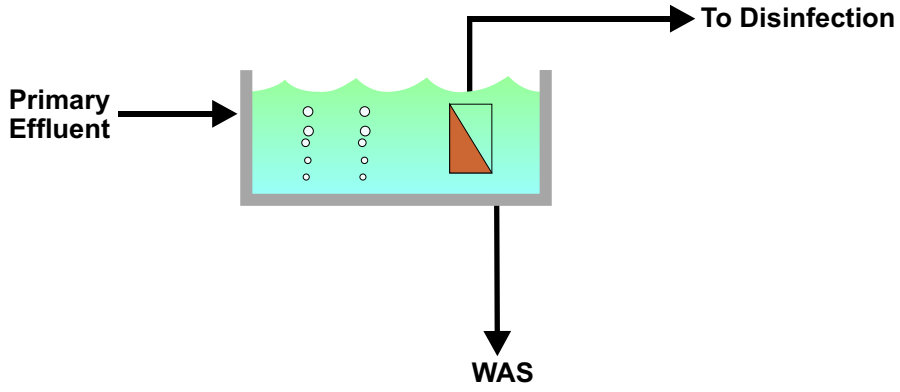
The MBR combines conventional biological treatment with the use of membranes for the separation of the solid and liquid phases. The MBR treatment train is similar to the existing secondary processes except that membranes replace the secondary clarifiers and tertiary filters. In the MBR process, the MLSS can be increased beyond that which is possible in CAS systems. Figure 7.4 includes a process schematic for the MBR alternative.

Typically, MBR systems operate at MLSS concentrations in the range of 8,000 to 10,000 mg/L, compared with a value of around 2,500 to 3,000 mg/L in the CAS. The higher MLSS provides the benefit of a greater treatment capacity per unit volume of aeration basin. In order to minimize the solids buildup near the membrane surface, which would reduce the flow of water through the membranes, membrane agitation air is introduced to scour the membrane surface. This air is usually in addition to the biological process air requirements, although at least one manufacturer combines both air needs as shown on Figure 7.5, part (A).

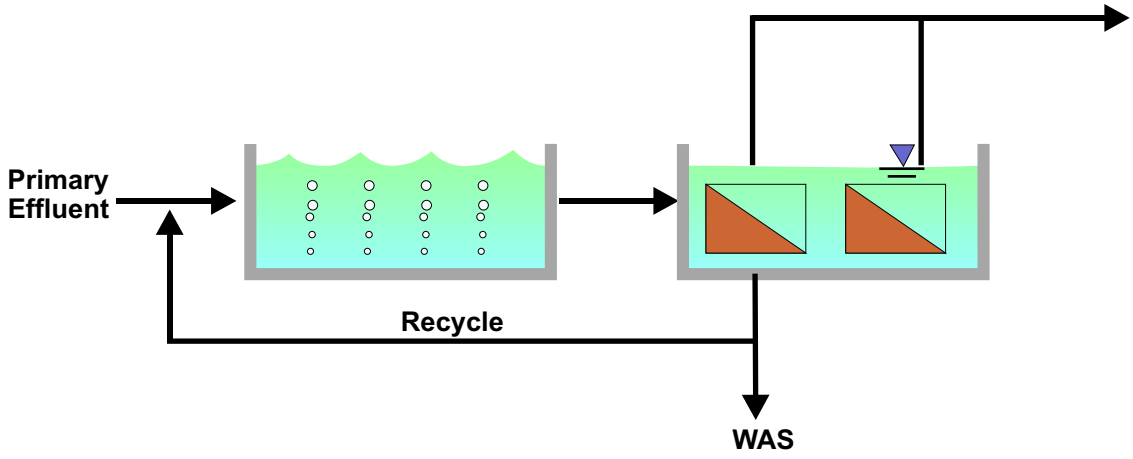
Because the process incorporates a membrane barrier, it produces a low turbidity effluent that is not impacted by quality changes in the feed water. Another benefit is that the effluent TSS concentration is low enough that tertiary filtration is not required. In addition, the treated effluent consistently has a low turbidity, which means process reliability is good. Finally, because the MBR system would operate at a longer SRT, there would be some endogenous destruction of the biomass within the process. Therefore, total sludge production from the facility be would reduced by about 10 to 15 percent, compared with operating a CAS plant.

The higher SRT also has benefits related to future regulatory requirements. At the Inland Empire Utilities Agency Regional Plant 5, it was shown that operating a CAS at a very high SRT (40 days) the effluent was able to perform much better in the WET test. Operating at a high SRT also improves the destruction of recalcitrant compounds including EDCs. The consistently low TSS concentration in the MBR effluent also means that disinfection is easier to achieve and that more disinfection process options are available. The MBR effluent would also be most compatible with using an advanced oxidation process (such as ozone) to destroy remaining organic compounds. All these factors make MBR the process that could most easily be combined with advanced tertiary treatment options to meet future effluent limits (Volume 2, Chapter 2 - Regulatory Requirements).

All MBR systems require screening of the influent to protect the membranes. In systems that incorporate hollow-fiber membranes (most systems), it is important that abrasive solids and hair be removed. To accomplish this, MBR systems require fine screening of the feed water in the range of 1 mm. Abrasive solids can wear through the membrane fibers and cause failures, while hair wraps around the fibers, causes clumping of the mixed liquor and is very difficult to remove. Ideally, fine screens are installed upstream of the aeration basins, but they can also be installed in the sludge recycle line between the aeration basins and the membrane tanks depending on the site layout.



(A) Combined Membrane-Aeration Tank



(B) Separate Membrane Tank

MBR PROCESS CONFIGURATION

FIGURE 7.5

One MBR supplier has a flat sheet membrane configuration, which is less susceptible to issues with hair, but is still subject to abrasion. This system can be used with 3-mm screens.

Even with air agitation, membranes lose their water permeability (flux rate) with time and require cleaning. Most MBR systems include regular relaxing (zero flux) or back pulsing (using permeate to dislodge accumulated solids). Depending on operating conditions, a chemical clean may be required every 3 to 6 months. Chemical cleaning typically involves submerging the membranes in a solution of either sodium hypochlorite (to remove biological fouling) or citric acid (to remove lime scale).

There are different ways to configure an MBR system as shown on Figure 7.5. In the original plants that were built (around 1 mgd or less), the membranes (in the form of cassettes) were simply installed directly into the aeration basins creating a combined membrane-aeration tank. When it is time for chemical cleaning, the membrane cassettes are lifted out of the aeration basins (by crane) and dipped into a cleaning tank. Cleaning could require 4 to 6 hours of soaking before the cassette is returned to the aeration basin. Alternatively, at least one manufacturer operates by cleaning the membranes in place in the aeration basin.

The other approach to designing MBR systems, as shown on Figure 7.5, part (B), is to construct a separate membrane tank to house the membranes. The mixed liquor is circulated from the aeration basin to the membrane tank and back to the aeration basin. In this configuration, the membrane tank can be divided into cells that can be taken off-line and cleaned. A potential disadvantage of this approach is that a separate tank is required. For the RWQCB, the secondary clarifiers could be modified to become the membrane tanks.

A comparison of the separate membrane tank approaches is presented in Table 7.5.

Table 7.5 Comparison of Combined and Separate Membrane Tank Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Combined Membrane-Aeration	Separate Membrane Tank
Removing membranes, placing them in a small cleaning tank and then returning them to the aeration basins is operator intensive.	Removal of membrane cassettes for cleaning is not needed, as individual cells can be taken off-line.
Without individual flow control on each cassette, the clean membrane, when returned to operation, would take most of the load compared to the other membrane cassettes. This leads to uneven distribution of flow through the membrane cassettes and inefficient use of the available membrane area.	A complete train of membranes can be cleaned simultaneously, so the flow through the membranes can be controlled (relative to the other trains) when the clean membranes are brought back online.
	Major modifications to the aeration basins are not required.

Table 7.5 Comparison of Combined and Separate Membrane Tank Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Combined Membrane-Aeration	**Separate Membrane Tank**
Aeration basins tend to be much deeper than required to house the membranes, so complex systems are required to support the membranes and associated piping.	The activated sludge biological system can be designed, configured, and operated independently of the membrane tanks. The separate membrane tank approach is well suited to larger installations where the number of membrane cassettes is high.

The main disadvantage of the separate membrane tank configuration is that a high rate mixed liquor recycle system must be installed and operated. Typically, a recycle rate of 400 percent is used to maintain the aeration tank MLSS concentration at 80 percent of the membrane tank MLSS concentration.

Based on the above discussion, the combined membrane-aeration tank option is not considered further. For the preliminary evaluation of expansion of Plant 1, the separate membrane tank approach will be used.

The process requirements for converting the Plant 1 CAS system to an MBR system are summarized in Section 7.5.

7.4.4 Attached Growth Processes

Attached growth processes use biomass attached to media to perform the required biological transformations. In these applications, the attached growth forms a film on the media; this is referred to as biofilm. The differences between suspended and attached growth processes are summarized in Table 7.6.

Table 7.6 Comparison of Suspended and Attached Growth Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Suspended Growth	**Attached Growth**
No gradient for soluble compounds under typical conditions.	A significant gradient that drives diffusion of soluble compounds.
Biomass moves with effluent through bioreactor.	Biomass stationary while effluent passes through.
Bioreactor effluent has a high TSS concentration.	Bioreactor effluent TSS is low.
Clarifier design must take both solids and hydraulic loads into account.	Clarifier design based on hydraulic loading only.
Produces more WAS.	Produces less WAS.
Process parameters (such as SRT, aeration MLSS concentration) can be controlled.	Limited process control options.

Table 7.6 Comparison of Suspended and Attached Growth Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Suspended Growth	**Attached Growth**
Provides contact time between biomass and effluent of several hours.	Contact time of minutes.
Can be designed to perform Biological Nutrient Removal (BNR).	Limited ability to perform BNR.
Superior effluent quality.	Inferior effluent quality.

Some modern attached growth processes differ from the more traditional processes in that in the modern process the media is submerged below the water surface. This means that, as for suspended growth processes, aeration air must be introduced at pressure (related to the diffuser submergence depth). This also allows for increased contact times, but still does not allow the operator to completely control the solids inventory.

There are two versions of the modern attached growth processes:

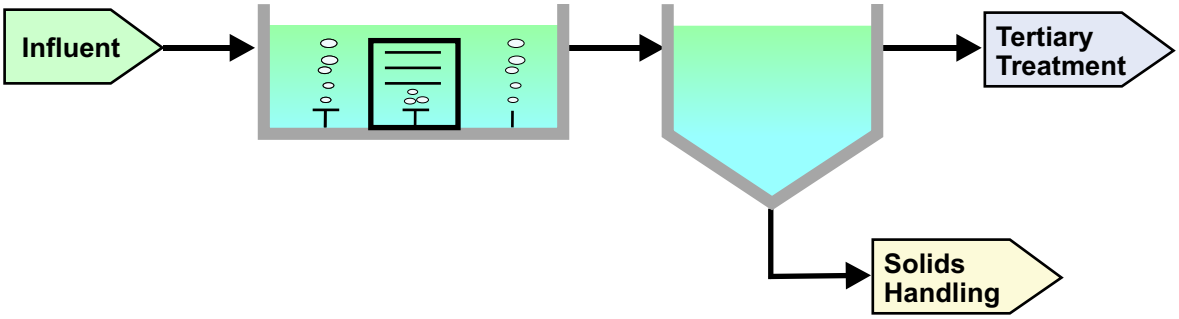
- Moving Bed Bioreactor (MBBR) or Submerged Fixed Film (SFF).
- IFAS.

The process schematic for each process is shown on Figure 7.6. Primary effluent enters the basin that contains the media and the attached biomass. The effluent from the basin passes through a clarifier before proceeding to tertiary treatment. Settled sludge goes to sludge handling. For MBBR/SFF, as with trickling filter effluent, the TSS concentration in the bioreactor effluent is low.

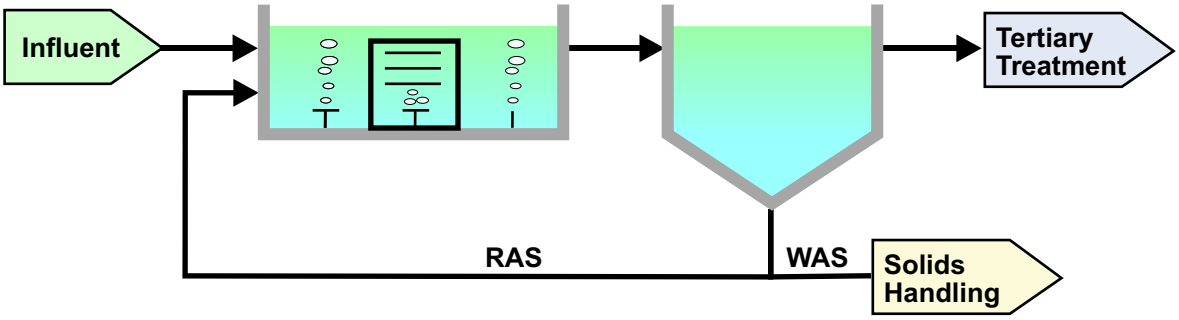
The IFAS process schematic is similar to the MBBR/SFF flow diagram. The main difference is the presence of a RAS line that allows the cultivation of suspended biomass in addition to the attached biomass. The bioreactor effluent has a high TSS concentration, similar to suspended growth processes.

The two processes are compared in Table 7.7.

Table 7.7 Comparison of IFAS and MBBR Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
MBBR/SFF	**IFAS**
Attached biomass only	Attached and suspended biomass
No RAS line	RAS to a CAS process
Biomass inventory cannot be controlled	Biomass inventory can be partially controlled
Pin floc due to low TSS in basin effluent	Typically have low SVI
No control over solids inventory	Solids inventory can be controlled



MBBR/SFF



IFAS

ATTACHED GROWTH PROCESS SCHEMATIC

FIGURE 7.6

The IFAS system has some important advantages, especially the ability to partially control biomass inventory (or SRT). Since the activated sludge process at the RWQCP already includes RAS pumps and provisions to handle high bioreactor TSS concentrations, there is no additional investment for selecting IFAS above MBBR. In addition, the suspended biomass does not have to be attached to media, which means that the total surface area of the required media is reduced. For these reasons, further evaluation of attached growth processes is based on an IFAS system.

There are two different kinds of media that can be used with the IFAS system, free floating or fixed, as shown on Figure 7.7. The free-floating media consist of small plastic elements that have positive buoyancy. Fixed media is typically attached to a frame that can be lowered to the floor of the basin. Fixed media can consist of either rigid media (like structured packing used in trickling filters) or pliable media (typically attached to a frame that allows for limited media movement). Free-floating and fixed media are compared in Table 7.8.

Table 7.8 Comparison of Fixed Film Process Media
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

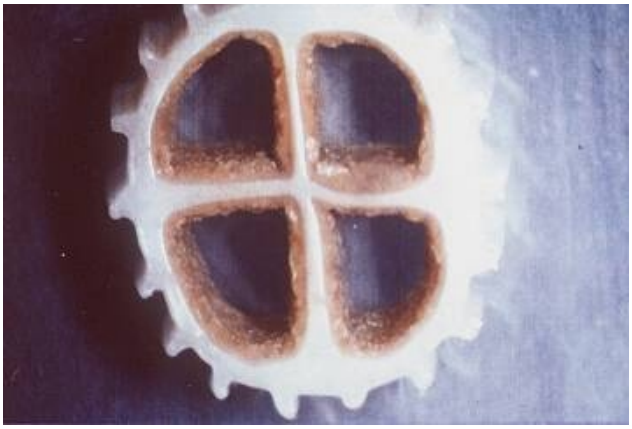
Free-Floating Media	Fixed Media
Influent: Fine Screens and Primary Treatment are required	Influent: Fine Screens not required
Coarse Bubble Aeration only	Fine or Coarse Bubble Aeration
Screens required in Basin to Retain Media(1)	No Screens required in basin
Large area per unit volume	Smaller area per unit volume

Notes:
(1) Screens typically produce 2 to 6 inches of water column head loss, per screen.

Free-floating media require fine screens upstream of the basin to prevent plugging of the screens in the basin itself. Coarse bubble aeration is required to achieve enough turbulence to ensure a good distribution of the media throughout the basin depth. The coarse air also helps to prevent plugging of the basin's screens. The free-floating media allows greater treatment capacity for a given basin volume, due to its greater surface area.

Due to the facts that the City has recently installed new fine bubble diffusers and that plant hydraulics are already a limiting factor, it was decided to concentrate on fixed media for this evaluation. The evaluation specifically considered pliable media, as it allows more biomass attachment per unit area. Should IFAS be selected, a comparison of rigid and pliable media alternatives can be made during preliminary design.

To increase the treatment capacity at the RWQCP to 52.2 mgd, both Plant 1 and Plant 2 CAS processes would have to be converted to the IFAS process. The process requirements for the conversion are summarized in Section 7.5.



Free Floating Media

Rigid Media

Pliable Media

Fixed Media

ATTACHED GROWTH MEDIA OPTIONS

FIGURE 7.7

7.5 PROCESS MODELING OF TREATMENT ALTERNATIVES

7.5.1 Conventional Activated Sludge Alternative

Expansion using CAS would entail adding aeration basins and secondary clarifiers to the Plant 1 system. The primary effluent piping from the new Plant 1 primary clarifiers would need to be expanded. Mixed liquor piping between the Plant 1 aeration basins and secondary clarifiers would also need to be expanded. Secondary effluent piping to transfer secondary effluent to the equalization basins would also need to be expanded. The diffuser count in the existing basins would be increased from the current 588 to 694 units.

7.5.2 Membrane Bioreactor Alternative

One additional aeration basin would be required. The recycle from the membrane tank will have a high Dissolved Oxygen (DO) concentration and would inhibit denitrification if returned to the anoxic zone of the aeration basins. Instead, the membrane tank recycle will be discharged in the aerobic zone of the aeration basin. The existing mixed liquor return system in the aeration basins would be expanded from the existing 7,000 gpm to 17,000 gpm. The diffuser count in the existing basins would be increased to 1,096 units. Two of the existing secondary clarifiers would be retrofitted into membrane tanks. There would be nine trains in total. The plant would be able to operate at full capacity even with one membrane train out of service.

The MBR system in Plant 1 would treat 32.2 mgd, to give a total capacity of 52.2 mgd for the whole plant. Treated effluent would be pumped through the membrane by permeate pumps and the solids would be returned to the aeration basin by recycle pumps. WAS would be withdrawn from the return line where the MLSS concentration is at its highest.

In order to implement this alternative, fine screens (about 1-mm openings) would need to be installed. Based on the existing site configuration it is proposed that the screens would be installed to treat the primary effluent upstream of the Plant 1 aeration basins. A new pipe would be needed to convey primary effluent from the new Plant 1 primary clarifiers (Volume 4, Chapter 6 - Primary Treatment). In addition, the Plant 1 aeration basin influent channel would need to be extended for the new aeration basin. By further extending this channel, a channel is created that could house the new fine screens. However, due to the high head loss at the fine screens, there might be a need to pump the primary effluent to accommodate the screens. The hydraulic requirements should be determined during the preliminary design.

7.5.3 Integrated Fixed Film Activated Sludge Alternative

Implementing the IFAS process would mean increasing the secondary treatment capacity of both Plants 1 and 2. It is estimated that a total media surface area of 1,360,000 feet^2 would need to be installed in Plant 1 and 1,836,000 feet^2 in Plant 2. The increased biomass in the aeration basins would increase the oxygen demand, increasing required blower capacity as

well as diffusers. The diffuser count in Plant 1 would increase to 896 units per basin and to 818 units per basin in Plant 2.

7.5.4 Process Modeling

A Biotran process model was set up for the three secondary treatment alternatives for the RWQCP. A copy of the Biotran model is included in Appendix A. The modeled plant performance characteristics are summarized in Table 7.9. Figures 7.8, 7.9, and 7.10 show the proposed layout for the CAS, MBR, and IFAS alternatives, respectively.

Table 7.9 Modeling of Secondary Treatment Alternatives for Plant 1 Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

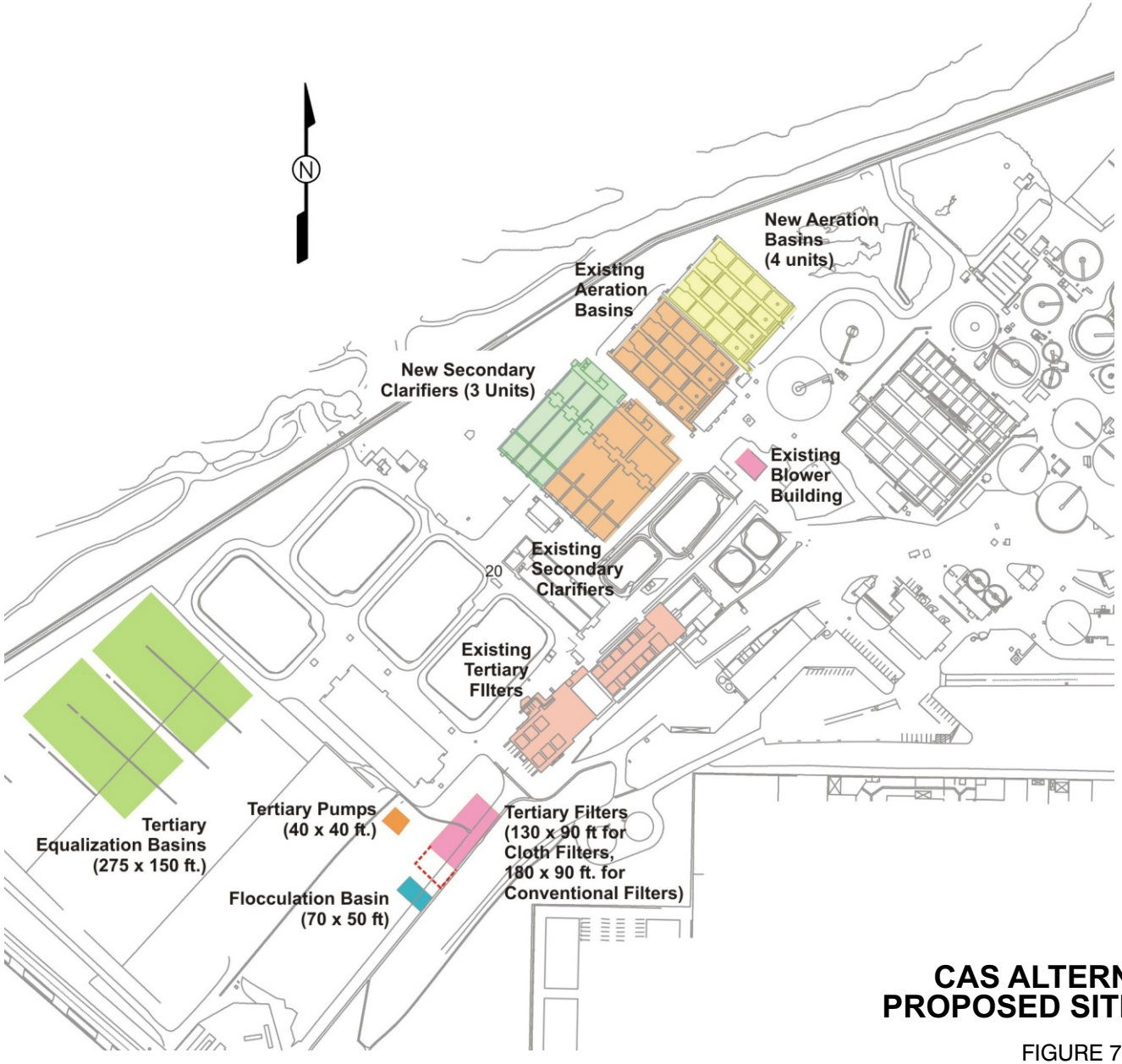
Parameter	CAS	MBR	IFAS Plant 1[1]	IFAS Plant 2[1]
Aeration Basin Influent[2]				
Average Flow, mgd	32.2	32.2	22.1	30.1
BOD, mg/L	160	169	164	176
TSS, mg/L	101	106	104	130
VSS, %	86	90	88	109
NH_3-N, mg/L	29.2	32.5	27.8	30.3
Organic-N, mg/L	8.7	8.9	8.8	9.8
NO_3-N, mg/L	0.6	0.3	0.4	0.7
Alkalinity, mg/L as $CaCO_3$	266	279	262	270
Filterable ("soluble") BOD, mg/L	64	67	66	63
Process Requirements				
No. of Fine Screens	N/A	4	N/A	N/A
Clear Screen Opening, mm	N/A	~1	N/A	N/A
New Aeration Basins	4	1	0	0
New Secondary Clarifiers	3	0	0	0
Membrane Tanks	N/A	2[3]	N/A	N/A
Tertiary Equalization Requirement	Yes	No	Yes	Yes
New Tertiary Filters[4]	10	0	10	10
Aeration Basin Operating Conditions				
SRT, days	5.3	9.6	6.5	5.6
MLSS, mg/L	3,500	10,000	5,500[5]	4,500[5]

Table 7.9 Modeling of Secondary Treatment Alternatives for Plant 1 Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Parameter	CAS	MBR	IFAS Plant 1[(1)]	IFAS Plant 2[(1)]
WAS, lb/day	43,200	40,500	28,000	55,150
Aeration Basin Air, scfm	29,500	35,200	22,400	32,300
Scour Air, scfm	N/A	25,000[(6)]	N/A	N/A
Sludge Disposal, wet tons/day	206	198	207	
Expected Secondary Effluent Quality				
BOD, mg/L	3	1	3	3
TSS (nominal), mg/L	5	0	5	5
Ammonia, mg/L as N	0.7	0.3	0.5	0.5
Total Organic Nitrogen, mg/L as N	2.7	2.3	2.6	2.6
NO_3-N, mg/L as N	6.9	7.3	5.4	5.4
Total Inorganic Nitrogen, mg/L	7.6	7.6	5.9	5.9
Total Nitrogen, mg/L	10.3	9.9	8.5	8.5
Turbidity, NTU	<1.0	<0.2	<1.0	<1.0

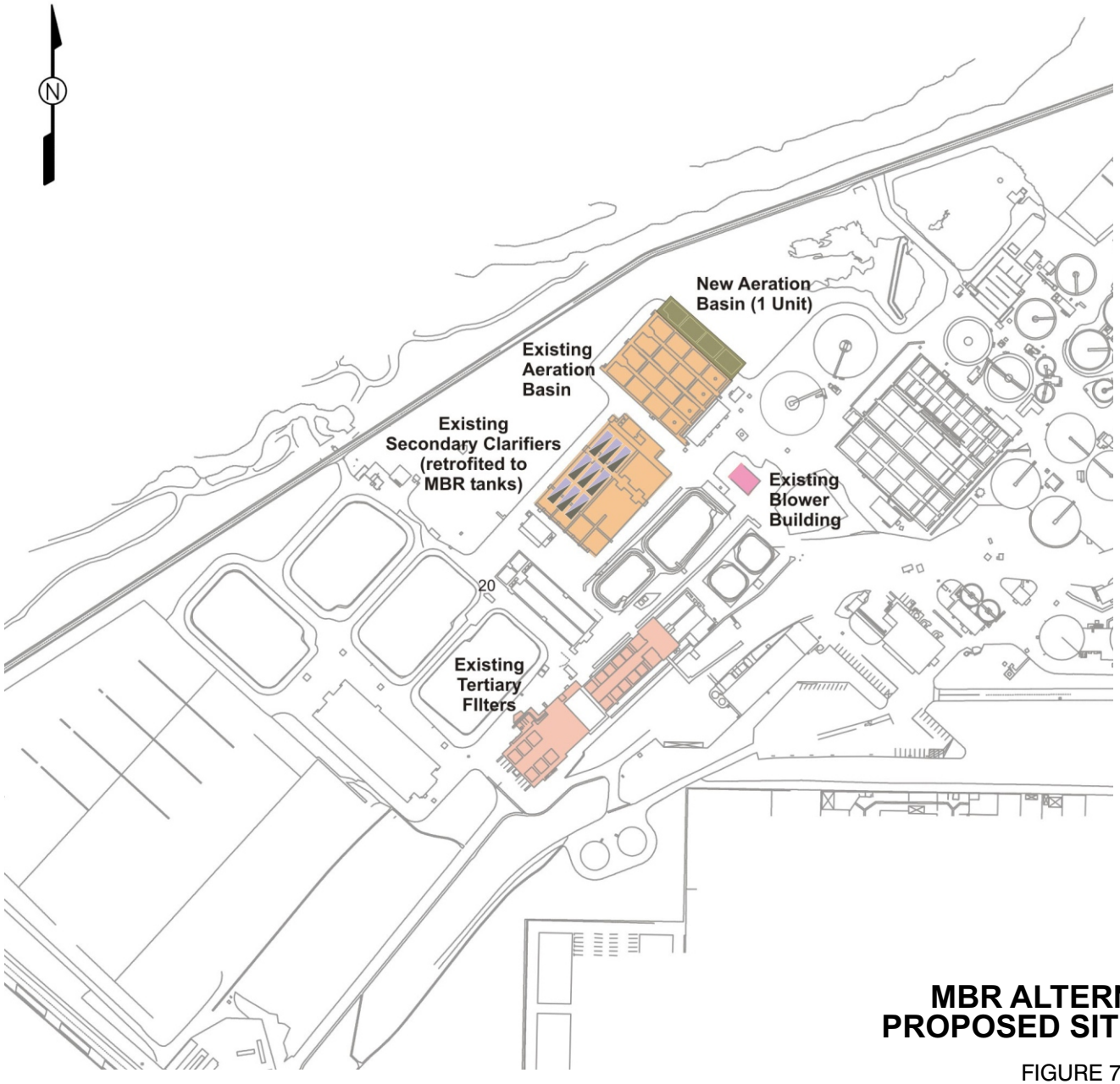
Notes:
(1) For the IFAS alternative, it is assumed that both Plants 1 and 2 would be converted to IFAS from CAS.
(2) The aeration basin influent quality varies for the three processes because of the effects of the different quality of the recycle streams.
(3) Two Plant 1 secondary clarifiers would be retrofitted into membrane tanks.
(4) For this analysis, it is assumed that if the City decides to expand the tertiary filtration facility, the new filter would be a cloth-media filter (for details refer to Volume 4, Chapter 8 - Tertiary Treatment).
(5) The MLSS concentrations for the IFAS systems are effective biomass concentration values (including attached growth) and not the actual MLSS concentration.
(6) The scour air is required only for 15 seconds per minute during normal operation. Under high loads, the scour aeration rate can be doubled to 30 seconds per minute.

MBR effluent quality is better than the other alternatives, particularly for TSS and turbidity. Tertiary filtration is not required for this alternative. In the future, if the City has to use Reverse Osmosis (RO) treatment to meet lower dissolved salt limits or is required to have higher quality recycle water, the MBR alternative provides a distinct advantage.



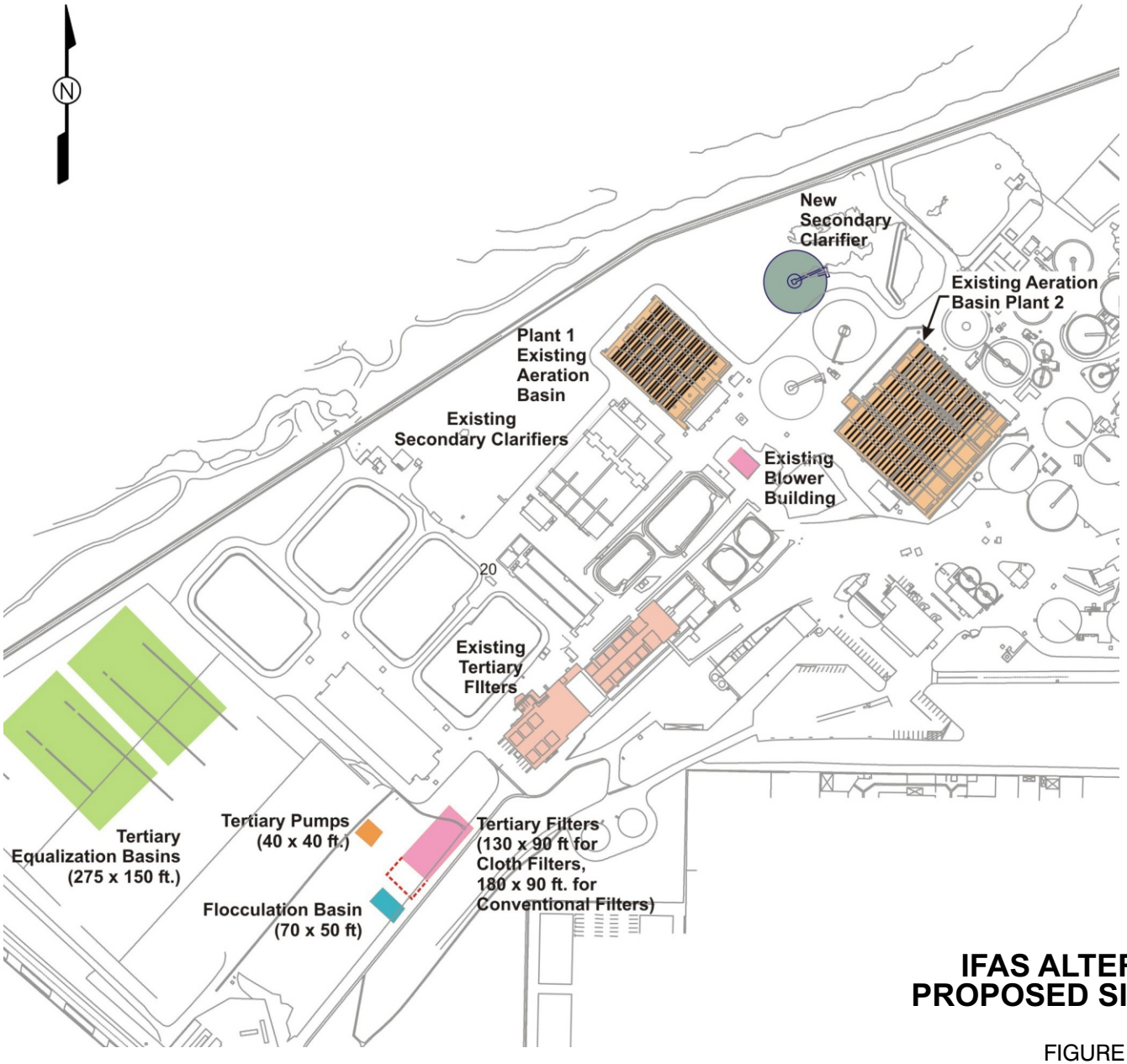
CAS ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.8



MBR ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.9



IFAS ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.10

7.6 COMPARISON OF SECONDARY TREATMENT ALTERNATIVES

7.6.1 Non-Economic Comparison

Table 7.10 lists some advantages and disadvantages for the three alternatives discussed above.

Table 7.10 Advantages and Disadvantages of Secondary Treatment Alternatives Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Advantages	Disadvantages
Alternative 1 - CAS	
• Proven system with long operational history. • Relatively easy to control and operate.	• Large volume and footprint requirements. • Limited to MLSS concentrations in the 1,000- to 5,000-mg/L (max.) range.
Alternative 2 - MBR	
• Longer SRTs increase the potential for complete nitrification. • Longer SRTs enhance the oxidation of recalcitrant toxic compounds, which may be regulated in the future. • Stable process operation due to higher MLSS. • Longer SRTs lead to lower sludge production. • High-quality effluent irrespective of fluctuation of influent water quality. No tertiary filtration required. • Small footprint.	• High MLSS and SRT means higher aeration cost. • High operating costs due to scour air requirement. • High membrane replacement costs. • Most membrane units available in the market are proprietary and the units are not interchangeable.
Alternative 3 - IFAS	
• Higher effective MLSS translates to higher aeration basin capacity. • Improved sludge settleability increases capacity of secondary clarifiers. • Small footprint.	• New technology with limited operational history. • Treatment performance deteriorates at peak flow conditions. • Most existing installations are small plants with limited operational/performance data. • Media for attached growth is proprietary. • Process models are still under development.

Table 7.11 summarizes a comparison of the three different secondary stream treatment alternatives discussed above.

Table 7.11 Comparison of Recycle Treatment Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Toxics Removal	0	+	0
EDCs Removal	0	+	0
Sludge Settleability	0	0	+
Sludge Thickenability	+	0	+
Tertiary Filters Required	YES	NO	YES
Disinfectability	0	+	0
Reliability	0	+	0
Constructability	–	0	0
Maintenance Requirements	0	–	+
Energy Input	+	–	+
Operating Experience	+	0	–
Process Complexity	0	–	0
Recovery from Upset	–	0	+

Legend:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

7.6.2 Economic Evaluation

A life-cycle cost analysis was performed for the three process alternatives. Costs were estimated for the following three different conditions:

1. Treatment train with primary effluent equalization.
2. Treatment train without primary effluent equalization but with secondary effluent equalization.
3. Secondary treatment with high SRT.

A summary of the costs for the treatment train alternative with primary equalization is shown in Table 7.12.

Table 7.12 Life-Cycle Cost of Secondary Treatment Alternatives - With Primary Effluent Equalization
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Project Cost	$103,105,000	$118,190,000	$104,970,000
Annual O&M Cost	$1,150,000	$1,800,000	$1,120,000
Membrane/Media Replacement Cost(1)	N/A	$6,610,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$122,890,000**	**$158,800,000**	**$135,500,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

The table shows that CAS is the most cost effective, with IFAS the next most cost effective. To show the effect of primary effluent equalization the cost estimates for all three options without primary effluent equalization are summarized in Table 7.13.

Table 7.13 Life-Cycle Cost of Secondary Treatment Alternatives - Without Primary Effluent Equalization
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Project Cost	$95,824,000	$126,992,000	$98,370,000
Annual O&M Cost	$1,152,000	$1,624,000	$1,120,000
Membrane/Media Replacement Cost(1)	N/A	$ 6,600,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$115,610,000**	**$166,740,000**	**$128,880,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

A comparison of these two tables shows that without primary effluent equalization there is an even bigger difference between MBR and the other two options. This is due to the fact that without equalization, more membrane cassettes must be installed to allow the system to handle the higher diurnal peaks. Hence, the primary effluent equalization benefits the economics of the MBR alternative. However, the costs presented above do not account for the benefits of an MBR system regarding WET. Drury et al. (1999) postulated that both high SRT and high MLSS concentration were helpful in improving effluent WET results. High SRT would enable slow growing biomass, capable of toxic compound destruction, to survive in the aeration basin. High MLSS concentrations would improve adsorption of the toxic compounds onto the biomass. As indicated in Table 7.9, the MBR alternative would have both higher SRT and MLSS concentration than the other two alternatives. The high MLSS concentration is unique to the MBR process. This means that if the Drury hypothesis is correct, the MBR process will have unique advantages regarding WET. It is assumed that EDCs would respond the same way as toxic compounds to an increase in both MLSS concentration and SRT. If the CAS and IFAS systems were to be designed for a higher SRT, the process would require additional aeration basins and secondary clarifiers. Table 7.14 shows a cost estimate that assumes operating all three processes at a high SRT.

Table 7.14 Life-Cycle Cost of Secondary Treatment Alternatives - High SRT (Without Primary Effluent Equalization)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Project Cost	$139,730,000	$126,922,000	$137,720,000
Annual O&M Cost	$1,095,000	$1,624,000	$1,053,000
Membrane/Media Replacement Cost(1)	N/A	$6,600,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$159,082,000**	**$166,740,000**	**$167,120,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

The table shows that increasing the SRT for the CAS and IFAS systems increases the capital cost for the alternative to more that that of the MBR system. The annual operating and maintenance cost is still higher for the MBR alternative. The result is that the life-cycle cost for all three alternatives are with the range of uncertainty for the cost estimates. Under these conditions life-cycle costs do not strongly favor any of the three options. Based on the

ability to achieve better effluent quality and do so more consistently, the City chose the MBR alternative for future expansion.

7.7 EXPANSION PROJECT PHASING

Current flows of approximately 33 mgd (80 percent of rated capacity) and 30-day running averages as high as 35 mgd would indicate that the RWQCP needs additional capacity. The City has no control over how fast the CSDs and the Highgrove area increase their flows into the RWQCP. And, based on housing activity in the summer of 2006, there was concern that residential development would grow faster than was currently predicted. If these occurred there was a good chance that RWQCP flows would tend toward the high-growth scenario. In addition, for a master planning process it is more prudent to plan based on conservative assumptions about future growth. For these reasons, the City chose to use the high-growth scenario (52.2 mgd and an annual growth rate of 1.5 percent) as the basis of the process alternative evaluations for the Integrated Master Plan. This decision was made at a meeting on August 31, 2006. Since that time, a slow down in the housing market has occurred, which caused the City to reevaluate the potential RWQCP influent flows for the master plan planning period. Based on the reevaluation, the City, at a meeting on September 20, 2007, decided that the lower end of the 90-percent confidence interval would be more appropriate as the basis for 2025 RWQCP flow projections. This results in an average daily flow of 47.3 mgd, which corresponds to an annual growth rate of 0.75 percent (low-growth scenario). The City therefore decided to expand the secondary treatment facilities in two phases. The first phase will expand the treatment capacity of Plant 1 from 20 mgd to 26.1 mgd and the second phase to 32.2 mgd. The capacity of Plant 2 will remain at 20 mgd.

For such a phased expansion, the City has decided to purchase MBR equipment to construct an MBR facility of 26.1 mgd. However, the Plant 1 structures will be modified to handle the final expanded flow capacity of 32.2 mgd during the first phase and the additional aeration basin would be constructed. The MBR equipment for the full capacity will be procured when actual influent flow to the RWQCP starts approaching the 46.1-mgd capacity of the first phase.

7.8 CONTROL OF EFFLUENT ORGANICS

The City presently owns and operates constructed wetlands in the Hidden Valley area. Originally developed to aid in nutrient removal, such wetlands may also be useful for reducing trace metals, complex organics, and providing a carbon matrix in the final effluent that is more similar to that found in natural streams. Due to the present regulatory environment, it is unlikely that the wetlands can be expanded at this time. However, the City plans to continue to use the existing wetlands as an effluent polishing treatment process.

7.9 ODOR CONTROL

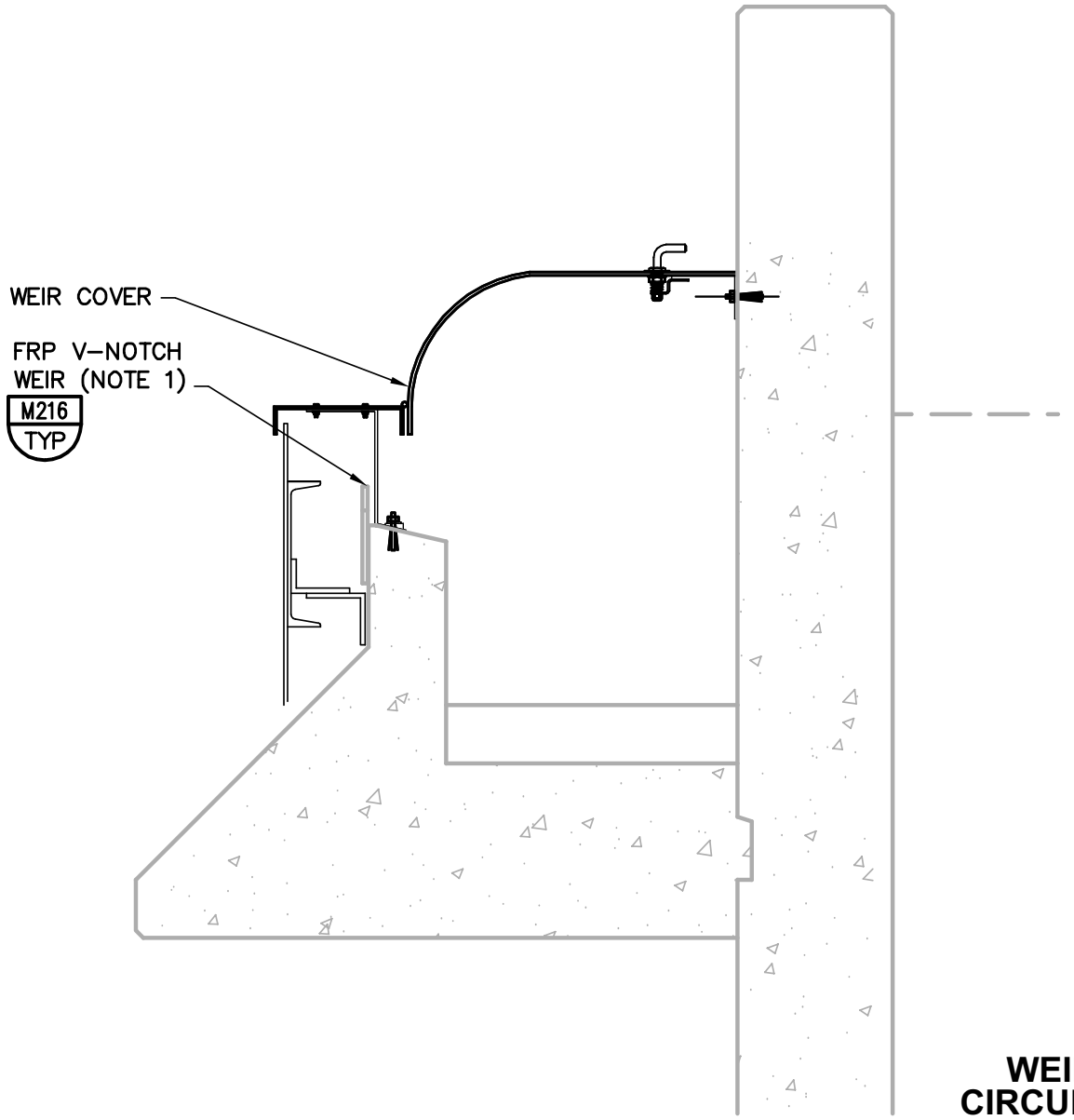
The City requested that Carollo investigate covering of secondary clarifiers for odor concerns. While secondary clarifiers are not typically prime sources of odor in a wastewater treatment plant, some owners choose to cover the clarifiers for aesthetic reasons. For this evaluation, it was assumed that only the effluent weirs would be covered, as the hydraulic conditions at the weirs would promote the bulk of any released odor. A typical weir cover is shown on Figure 7.11 for a circular clarifier. The weir cover for a rectangular clarifier would require some additional elements to support it above the weir, as shown on Figure 7.12. In addition to the weir covers, the odor control system would include blowers to collect the headspace air, some form of odor control system such as a biofilter, and the required ducting. Additional evaluation of secondary clarifier odor control would be done during preliminary design if the City decides to pursue it further.

7.10 RETURN ACTIVATED SLUDGE/WASTE ACTIVATED SLUDGE PUMPING

Selection of RAS/WAS pumps is based on the flow and head characteristics of the RAS/WAS. Final selection of the pump types will be determined during preliminary design when the flow and head characteristics are known.

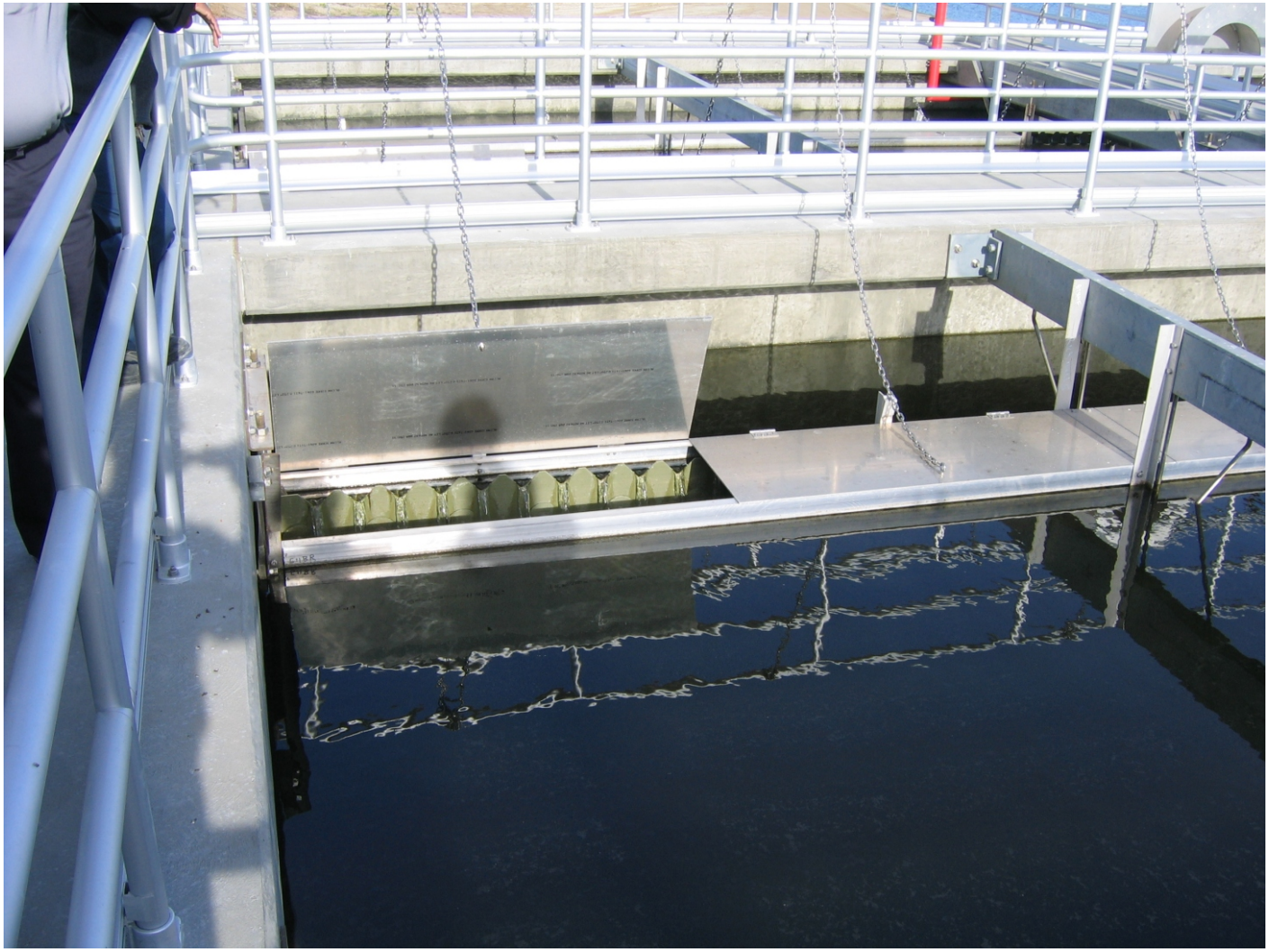
7.11 REFERENCE

Drury D, Clifton N., Todd A.C., Buhr H.O. and Moore T. Operating and Designing Municipal Wastewater Treatment Plants to Treat Toxicity, WEFTEC (October 1999), New Orleans, LA.



WEIR COVER FOR CIRCULAR CLARIFIERS

FIGURE 7.11



TYPICAL WEIR COVER FOR RECTANGULAR CLARIFIERS

FIGURE 7.12

Appendix A

BIOTRAN MODEL

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
NOTES regarding this application:		With Better Sludge Settleability 60:40 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			MBR With Better Sludge Settleability 80:20 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			With Better Sludge Settleability 60:40 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			With Better Sludge Settleability 30:70 Recycle Split Based on aeration capacity APAD Centrifuge, not BP				
SUMMARY:															
FLOW RATES, mgd:															
- Raw WW Flow		35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
- Flow to Primaries		40.6	25.6		39.3	23.2		41.0	25.9		26.9	39.0			
- Flow to Activated Sludge		39.2	25.3		37.8	23.0		39.1	25.0		26.0	38.4			
SECONDARY EFFLUENT QUALITY, mg/L:															
- BOD (est.), mg/L		2	2		1	2		2	2		2	2			
- TSS (nominal), mg/L		5	4		0	4		5	4		5	4			
- NH3-N, mg/L	[Note]	0.26	0.40		0.24	0.29		0.46	0.87		0.19	0.42			
- NO3/NO2-N, mg/L		6.7	7.4		7.4	6.6		7.5	7.7		5.4	7.2			
- T.I.N., mg/L		7.0	7.8		7.6	6.9		8.0	8.6		5.6	7.7			
PRIMARY CLARIFIERS															
- # of Clarifiers		4	4		4	4		4	4		4	4			
- # in Service		4	4		4	4		4	4		4	4			
- Surface Overflow Rate, gpd/sf		897	902		869	817		907	913		948	1,376			
AERATION BASINS															
- # of Basins		12	6		13	6		8	6		6	6			
- # in Service		11	6		13	6		8	6		6	6			
- Hydraulic Deten. Time, hr		6.8	7.5		3.6	8.2		5.0	7.5		5.6	4.9			
- Operating Last-Pass MLSS, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Design Temperature, deg C		20.0	20.0		20.0	20.0		20.0	20.0		20.0	20.0			
- Unaerated Volume Fraction		0.25	0.40		0.45	0.40		0.50	0.60		0.25	0.40			Selected
- Aerobic SRT, days		5.95	3.52		5.23	4.08		4.41	3.93		8.13	3.39			
-- Min. Aerobic SRT for Nitrification		5.46	4.41		5.03	4.41		4.68	5.38		5.76	4.41			
- Total SRT, days		7.93	5.87		8.37	6.80		8.83	9.84		10.84	5.64			
-- Recommended Min. Total SRT for Nitrification		7.28	7.35		8.04	7.35		9.36	13.46		7.68	7.35			
- F/M, lb BOD Appl./lb MLSS-day		0.21	0.33		0.24	0.31		0.31	0.35		0.17	0.31			
- Aer. BOD Loading, lb BOD/1000 cf-day		47	52		127	49		67	55		58	88			
- ML Recirculation Ratio		2.5	2.0		3.2	2.2		2.5	2.0		2.3	2.0			Selected
- Process Air (est.), scfm		19,300	12,910		25,000	11,350		15,530	8,780		13,910	23,600			
MEMBRANE BIO-REACTOR															
- # of Membrane Zones (Basins)					8										
- # of Membrane Cassettes per Zone					18										
- Total Membrane Modules (Elements)					7,022										
- Total Membrane Area, sf					2,387,383										
- Average Operating Flux, gfd					15.6										
- Normal Daily Peak Flux, gfd					20.1										
-- One Membrane Zone Out of Service, gfd					23.0										
- Scrubbing Air Blowers Installed (1 standby)					9										
- Blower Capacity, each, scfm					1,200										
- Blower Motor Size, each, hp					60										

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
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Calc by: CFP,NV | Date Time: 02/27/2008 1:50 PM | Chk by/Date: | FileName: Ch07-AppA.xls

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
SECONDARY CLARIFIERS															
- # of Basins		7	4			4		7	4		4	5			
- # in Service		6	4			4		6	4		4	5			
- Sec. Clarifier SOR, gpd/sf		735	589			537		737	587		731	683			
- Sec. Clar. Solids Loading, lb/day-sf		29	16			15		29	16		54	37			
- Clarifier Safety Factor (CSF)		2.4	3.0			3.3		2.4	3.1		1.6	2.1			
-- CSF Target		2.3	2.3			2.3		2.3	2.3		2.3	2.3			
DETAILED CALCULATIONS:															
RAW WASTEWATER (excluding Recycles)															
o Plant Flow Rate, mgd		35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
o Flow Characteristic Ratios															
- Max Month/Annual Avg	*	1.11	1.11		1.11	1.11		1.11	1.11		1.11	1.11			Default
- Peak 4-hr Wet-W Flow/Annual Avg	*	**2.2**	**2.2**		**2.2**	**2.2**		**2.2**	**2.2**		**2.2**	**2.2**			Default
- Typical 4-hr Diurnal Peak/Daily Avg	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
o Wastewater Characteristics															
- BOD, mg/L, Annual Average	*	**250**	**250**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective BOD, mg/L		282	282		282	282		282	282		282	282			
"Effective" concentrations correspond to Peak Mass Loads with the flow rate used in the calculation															
- TSS, mg/L, Annual Average	*	**250**	**250**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective TSS, mg/L		282	282		282	282		282	282		282	282			
- Fpv, VSS fraction	*	0.83	0.83		0.83	0.83		0.83	0.83		0.83	0.83			Default
-- Effective VSS, mg/L		234	234		234	234		234	234		234	234			
- NH3-N, mg/L, Annual Average	*	21.0	21.0		21.0	21.0		21.0	21.0		21.0	21.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective NH3-N, mg/L		23.6	23.6		23.6	23.6		23.6	23.6		23.6	23.6			
Organic-N, mg/L, Annual Average	*	14.5	14.5		14.5	14.5		14.5	14.5		14.5	14.5			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Org-N, mg/L		16.3	16.3		16.3	16.3		16.3	16.3		16.3	16.3			
- NO3-N, mg/L, Annual Average	*	0	0		0	0		0	0		0	0			Default
- Alkalinity, mg/L, Annual Average	*	250	250		250	250		250	250		250	250			Default
- Filterable ("soluble") BOD															
-- fraction, Fbf	*	0.25	0.25		0.25	0.25		0.25	0.25		0.25	0.25			Default
-- mg/L		70	70		70	70		70	70		70	70			
- Fvu, Fraction VSS that is Unbiodeg	*	0.600	0.600		0.600	0.600		0.600	0.600		0.600	0.600			Estimated
- Total Phosphorus, mg/L, Annual Average	*	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Total-P, mg/L		12.4	12.4		12.4	12.4		12.4	12.4		12.4	12.4			
-- Fraction filterable ("soluble")	*	0.32	0.32		0.32	0.32		0.32	0.32		0.32	0.32			Default
-- Filterable P, mg/L		3.94	3.94		3.94	3.94		3.94	3.94		3.94	3.94			
o Design Temperature, deg. C															
- Minimum (Winter)	*	20	20		20	20		20	20		20	20			Default
- Maximum (Summer)	*	29	29		29	29		29	29		29	29			Default
- Design	*	20	20		20	20		20	20		20	20			Winter
RECYCLE TO HEADWORKS/PRIM CLAR.S															
o Flow Rate, mgd															
- Filter Backwash	*	3.440	2.293	5.733	1.632	0.408	2.041	3.442	2.295	5.736	1.719	4.012	5.731		
- Dewatering Filterate + Washwater/Centrate	*	0.163	0.108	0.271	0.216	0.054	0.269	0.166	0.110	0.276	0.080	0.187	0.268		

* Input Data

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		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Primary Sludge Thickener Supernatant	*	1.450	0.967	2.417	1.954	0.488	2.442	1.902	1.268	3.170	0.646	1.508	2.154		
- Total		5.052	3.368		3.802	0.950		5.509	3.673		2.446	5.707			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		173	173		308	308		222	222		162	162			
-- TSS		301	301		510	510		342	342		288	288			
-- VSS		237	237		399	399		260	260		226	226			
-- NH3-N		66	66		116	116		57	57		66	66			
-- Organic-N		15	15		23	23		16	16		15	15			
-- NO3/NO2-N		5	5		3	3		5	5		5	5			
-- Alkalinity		378	378		559	559		343	343		378	378			
-- Filterable ("soluble") BOD		26.5	26.5		48.3	48.3		28.1	28.1		25.4	25.4			
-- Total soluble Organic N		3.0	3.0		3.5	3.5		3.1	3.1		3.0	3.0			
-- Fpv, VSS fraction		0.79	0.79		0.78	0.78		0.76	0.76		0.78	0.78			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default
PRIMARY TREATMENT		In Service	In Service		In Service	In Service		In Service	In Service		In Service	In Service			
o Flow Rate, mgd															
- Raw Wastewater		35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
- Recycle stream		5.05	3.37		3.80	0.95		5.51	3.67		2.45	5.71			
- Total Influent		40.6	25.6		39.3	23.2		41.0	25.9		26.9	39.0			
o Wastewater Characteristics, mg/L															
- BOD		268	267		284	283		274	273		271	264			
- TSS		284	284		304	291		290	290		282	282			
- VSS		234	234		250	240		237	237		233	232			
- NH3-N		29	29		33	27		28	28		28	30			
- Organic-N		16	16		17	17		16	16		16	16			
- NO3-N		1	1		0	0		1	1		0	1			
- Alkalinity		266	267		280	263		262	263		262	269			
- Filterable ("soluble") BOD		65	65		68	69		65	64		66	64			
- Fpv, VSS fraction		0.82	0.82		0.82	0.83		0.82	0.82		0.83	0.82			
o Basin dimensions (inside)															
- Basins Set - 1,2,3,4															
- Number of Basins	*	4	4		4	4		4	4		4	4			
- Number of Units in Service	*	4	4		4	4		4	4		4	4			
- Diameter, ft	*	120	95		120	95		120	95		95	95			
- Side Water Depth, ft	*	12	9		12	9		12	9		12	9			
- Surface Area per Basin, sf		11,310	7,088		11,310	7,088		11,310	7,088		7,088	7,088			
- Surface Area in Service, sf		45,239	28,353		45,239	28,353		45,239	28,353		28,353	28,353			
- Basins Set - 5,6															
- Number of Basins	*	0	0		0	0		0	0		0	0			
- Number of Units in Service	*	0	0		0	0		0	0		0	0			
- Diameter, ft	*	0	0		0	0		0	0		0	0			
- Side Water Depth, ft	*	9	0		9	0		9	0		9	0			
- Surface Area per Basin, sf		6,050	0		6,050	0		6,050	0		6,050	0			
- Surface Area in Service, sf		0	0		0	0		0	0		0	0			
- Total Surface Area in Service, sf		45,239	28,353		45,239	28,353		45,239	28,353		28,353	28,353			
o Surface Overflow Rate, gpd/sf															
- At Design Flow		897	902		869	817		907	913		948	1,376			
- At Diurnal Peak Flow		1,050	1,056		1,018	956		1,062	1,069		1,110	1,611			
- At Peak WW Flow		1,778	1,787		1,723	1,618		1,798	1,809		1,878	2,727			
o Detention Time, hr		2.4	1.8		2.5	2.0		2.4	1.8		2.3	1.2			
o Chemically Enhanced Primary Treatment															
- CEPT applied? [Y=1; N=0]	*	0	0		0	0		1	1		0	0			Default

* Input Data

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		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Ferric Chloride dosage, mg/L as FeCl3	*	10	10		10	10		10	10		10	10			Default
-- FeCl3 used, lb/d		0	0		0	0		3,422	2,158		0	0			
- Polymer dosage, mg/L	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			Default
-- Polymer used, lb/d		0	0		0	0		0	0		0	0			
- Chem Sludge Generated, lb/d															
-- Total, lb/d		0	0		0	0		3,483	2,197		0	0			
- Alkalinity Reduction, mg/L		0	0		0	0		6	6		0	0			
o Removal Efficiency, %															
- BOD Removal, %		**40.3**	**40.3**		**40.7**	**41.5**		**59.0**	**58.9**		**39.6**	**33.5**			
- TSS Removal, %		**64.4**	**64.3**		**65.0**	**66.1**		**79.0**	**78.8**		**63.3**	**53.9**			
- Non-volatile SS %, Rpn		69.6	69.5		70.3	71.4		80.7	80.5		68.5	58.4			
- Organic-N Removal, %		46.5	46.4		47.4	47.6		56.7	56.6		45.6	39.2			
o Primary Sludge															
- Solids removed, lb/d															
-- Non-chemical primary solids		63,163	39,762		66,122	37,882		79,326	49,991		40,860	50,873			
-- Chemical solids from CEPT		0	0		0	0		3,483	2,197		0	0			
-- Total solids removed		63,163	39,762	102,925	66,122	37,882	104,003	82,809	52,188	134,997	40,860	50,873	91,734		
- Concentration, %	*	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5			Default
- Flow Rate, mgd		1.515	0.954		1.586	0.908		1.986	1.252		0.980	1.220			
- Organic N removed, lb/d		2,654	1,670		2,757	1,592		3,263	2,054		1,723	2,150			
o Primary Effluent Flow, mgd		39.1	24.6		37.7	22.2		39.0	24.6		25.9	37.8			
o Primary Effluent, mg/L															
- BOD		160	160		168	165		112	112		163	175			
- TSS		101	101		106	99		61	61		104	130			
- VSS		86	86		90	84		51	51		88	109			
- NH3-N		29.0	29.3		32.6	27.4		28.1	28.3		27.5	29.8			
- Organic-N		8.66	8.66		8.93	8.70		7.03	7.04		8.81	9.78			
- NO3-N		0.6	0.7		0.3	0.1		0.7	0.7		0.4	0.7			
- Alkalinity		266	267		280	263		262	263		262	269			
- Filterable ("soluble") BOD		65	65		68	69		61	60		66	64			
RECYCLE TO ACTIVATED SLUDGE															
o Flow Rate, mgd															
- DAF Underflow	*	0.000	0.585	0.585	0.000	0.693	0.693	0.000	0.352	0.352	0.000	0.517	0.517		
- Stream 2	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Stream 3	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Spray Water to Basins	*	0.096	0.060		0.096	0.060		0.096	0.060		0.066	0.090			Default
- Total		0.096	0.645		0.096	0.753		0.096	0.412		0.066	0.607			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		0	191		0	156		0	174		0	217			
-- TSS		0	654		0	546		0	632		0	792			
-- VSS		0	553		0	461		0	531		0	664			
-- NH3-N		0	0		0	0		0	1		0	0			
-- Organic-N		0	44		0	36		0	42		0	51			
-- NO3-N		0	6		0	6		0	7		0	6			
-- Alkalinity		0	127		0	130		0	119		0	121			
-- Filterable ("soluble") BOD		0.0	1.0		0.0	1.0		0.0	0.9		0.0	1.0			
-- Total soluble Organic N		0.0	2.2		0.0	2.1		0.0	2.0		0.0	2.0			
-- Fpv, VSS fraction		0.00	0.85		0.84	0.84		0.00	0.84		0.00	0.84			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default
ACTIVATED SLUDGE PROCESS															

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
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Calc by: CFP,NV | Date Time: 02/27/2008 1:50 PM | Chk by/Date: | FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
o Flow Rate, mgd															
- Main-Stream Influent		39.06	24.61		37.74	22.24		39.04	24.62		25.89	37.79			
- Recycle directly to AS		0.10	0.65		0.10	0.75		0.10	0.41		0.07	0.61			
- Total to Activated Sludge		39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39			
o Influent Characteristics, mg/L															
- Total BOD		160	161		168	165		112	113		163	176			
- TSS		101	116		106	113		61	71		103	141			
- VSS		86	98		90	97		51	59		88	118			
- NH3-N		29	29		32	27		28	28		27	29			
- Organic-N		9	10		9	10		7	8		9	10			
- NO3-N		1	1		0	0		1	1		0	1			
- Alkalinity		265	263		279	258		262	261		261	266			
- Filterable ("soluble") BOD		65	63		68	67		61	59		66	63			
- Fpv, VSS fraction		0.85	0.85		0.85	0.85		0.83	0.83		0.85	0.84			
- AB Influent D.O. Concentration, mg/L		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0			
o Basin dimensions															
- Main Basins					MBR									For MBR,	MBR
-- No. of Basins	*	12	6		5	6		8	6		6	6		enter	0
-- Number of Units in Service	*	11	6		5	6		8	6		6	6		Basin	0
-- Length, ft (inside)	*	200	250		200	250		200	250		200	250		dimen.s	0
-- Width, ft (inside)	*	40	40		40	40		40	40		40	40		in the	0
-- Side Water Depth, ft	*	16.9	17.5		16.9	17.5		16.9	17.5		16.9	17.5		MBR	0
.. Recomm inside Wall height, incl. Freeboard, ft		19.9	20.5		22.9	20.5		19.9	20.5		19.9	20.5		section	3
-- Liquid Volume per Basin, mil gal		1.01	1.31		1.01	1.31		1.01	1.31		1.01	1.31		(not HERE)	0.00
- Supplemental Basins or Sections															
-- Identification	*				Membrn Zn									calcs	Membrn Zn
-- No. of Basins	*	0	0		8	0		0	0		0	0			0
-- Number of Units in Service	*	0	0		8	0		0	0		0	0		into	0
-- Length, ft (inside)	*	200	200		19.5	200		200	200		200	200		< - - these	0
-- Width, ft (inside)	*	40	100		75	100		40	100		40	100		columns	0
-- Side Water Depth, ft	*	16.9	17		11.9	17		16.9	17		16.9	17			0
-- Volume per Basin, mil gal		1.01	2.54		0.13	2.54		1.01	2.54		1.01	2.54			0.00
o Total Volume of Basins, mil gal															
- Total Basin volume in service		11.12	7.85		6.10	7.85		8.09	7.85		6.07	7.85			
-- Reduction for MBR cassettes		0.00	0.00		0.41	0.00		0.00	0.00		0.00	0.00			
- Biological Reaction Volume		11.12	7.85		5.69	7.85		8.09	7.85		6.07	7.85			
o Aerated Zone BOD Loading, lb/1,000 cf-day		46.5	52.0		126.8	48.7		67.3	54.9		57.6	87.8			
o Hydraulic Detention Time, hr		6.82	7.46		3.61	8.20		4.96	7.53		5.61	4.91			
o Selected Operating L-P MLSS, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
PROCESS LAYOUT															
o Zone Sizes (Fraction of Total Volume)															Selected
- Zone 1	*	0.125	0.186		0.225	0.186		0.125	0.186		0.125	0.186		For MBR,	0.000
- Zone 2	*	0.125	0.214		0.225	0.214		0.125	0.214		0.125	0.214		*Copy*	0.000
- Zone 3	*	0.000	0.000		0.225	0.000		0.000	0.000		0.000	0.000		*& Paste*	0.000
- Zone 4	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000		these - - >	0.000
- Zone 5	*	0.250	0.200		0.000	0.200		0.250	0.200		0.250	0.200		calcs into	0.000
- Zone 6	*	0.250	0.200		**0.225**	0.200		0.250	0.200		0.250	0.200		< - - these	0.000
- Zone 7 (by difference)		0.250	0.200		0.100	0.200		0.250	0.200		0.250	0.200		columns	0.000
-- Total		1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			0.000
o DO in each Zone (Unaerated, Set = 0), mg/L															
- Zone 1	*	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		For MBR,	0.0
- Zone 2	*	0.0	**0.0**		0.0	**0.0**		0.0	**0.0**		0.0	**0.0**		Adjust	2.0
- Zone 3	*	0.0	2.0		**0.5**	2.0		0.0	0.0		0.0	2.0		D.O. as	2.0

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Zone 4	*	0.0	2.0		2.0	2.0		0.0	0.0		0.0	2.0		needed,	2.0	
- Zone 5	*	**0.2**	2.0		2.0	2.0		**0.0**	**0.0**		**0.1**	2.0		**except** for	2.0	
- Zone 6	*	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0		Zone 7	2.0	
- Zone 7	*	2.0	2.0		***1.5***	2.0		2.0	2.0		2.0	2.0		< - - copy	***0.0***	
o Aerated/Unaerated Fractions																
- Total Unaerated Volume Fraction		0.25	0.40		0.45	0.40		0.50	0.60		0.25	0.40				
-- Total Unaerated Volume, mil gal		2.78	3.14		2.56	3.14		4.05	4.71		1.52	3.14				
- Total Aerated Volume Fraction		0.75	0.60		0.55	0.60		0.50	0.40		0.75	0.60				
-- Total Aerated Volume, mil gal		8.34	4.71		3.13	4.71		4.05	3.14		4.55	4.71				
- Total Aerated Mass Fraction		0.75	0.60		0.63	0.60		0.50	0.40		0.75	0.60				
o Plant Influent Flow Routing																
- Fraction to Zone 1	*	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 3	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 4	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 5	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 6		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
o Return Sludge Routing																
- Fraction to Zone 1	*	1.00	1.00		0.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 3		0.00	0.00		1.00	0.00		0.00	0.00		0.00	0.00				
o Mixed-Liquor Recirculation Routing																
- MLR Taken from Zone (3, 4, 5, 6, 7)	*	7	7		6	7		7	7		7	7				Default
- MLR Returned to Zone (1, 2, 3, 4, 5)	*	1	1		1	1		1	1		1	1				Default
- MLR Flow, mgd		96.00	50.00		120.00	50.00		96.00	50.00		60.00	75.00				
- MLR Ratio		2.45	1.98		3.17	2.17		2.45	2.00		2.31	1.95				
o Sludge Wasting Method														**For MBR,**		
- Wasting from RAS (1) or ML (0)	*	1	1		***0***	1		1	1		1	1		< - - copy	***0***	Default
-- If ML, Waste taken from Zone # (1, 2, - - 7)	*	(RAS)	(RAS)		*7*	(RAS)		(RAS)	(RAS)		(RAS)	(RAS)		< - - copy	*7*	Default
LOADING CRITERIA																
o BOD Applied, lb/d																
- Total Influent		52,109	33,813		53,012	31,643		36,531	23,652		35,290	56,403				
- (-) WAS Recycled		228	1,028		0	980		159	598		225	1,100				
- Net BOD Load		51,881	32,785		53,012	30,663		36,373	23,054		35,065	55,303				
o MLSS under aeration, lb		243,533	98,205		218,609	98,225		118,074	65,491		208,756	176,793				
- F/M, lb BOD Appl./lb MLSS-day		0.21	0.33		0.24	0.31		0.31	0.35		0.17	0.31				
o Organic Loading, Based on Aerated Zone																
- Aerated Volume in Service, 1,000 cf		1,115	630		418	630		541	420		608	630				
- Aer. BOD Loading, lb BOD/1000 cf-day		46.5	52.0		126.8	48.7		67.3	54.9		57.6	87.8				
o Unaerated Zone																
- Actual HRT (Throughflow), hr		0.45	0.91		0.39	0.94		0.66	1.36		0.36	0.58				
- Mixing Power, total																
-- Total BHP, all Unaerated Zones	*	97.3	110.0		89.6	110.0		141.6	164.9		53.1	110.0				
-- Mixing, hp/mil gal		35	35		35	35		35	35		35	35				
ACTIVATED SLUDGE - ZONE 1		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer				
o Zone Volume, mil gal	1	1.391	1.461		1.280	1.461		1.011	1.461		0.758	1.461				
o Flows Entering, mgd	1															
- Plant Influent Flow	1	39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39				
- RAS Stream	1	13.01	7.99		0.00	7.27		13.01	7.91		15.66	16.87				
- Centrate	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
- ML Recirculation	1	96.00	50.00		120.00	50.00		96.00	50.00		60.00	75.00				

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Flow to this Zone	1	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	1														
- ML Recirculated to Other Zones	1	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	1	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	1	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	1														
- Hydraulic Detention time, Actual, hr	1	0.23	0.42		0.19	0.44		0.16	0.42		0.18	0.27			
o Effluent from this Zone	1														
-- MLSS, mg/L	1	3,500	2,498		6,134	2,499		3,501	2,502		5,502	4,497			
-- NH3-N, mg/L	1	7.67	8.83		8.43	7.73		7.51	8.85		7.03	8.88			
-- NO3-N, mg/L	1	2.12	1.34		1.74	0.78		3.24	1.96		1.13	1.25			
-- D.O., mg/L	1	0.01	0.00		0.00	0.00		0.01	0.00		0.01	0.00			
o Biological Growth Summary	1														
- Increase in VSS, lb/d	1	5,943	3,690		5,537	3,568		5,713	3,672		3,974	5,455			
- Increase in ISS, lb/d	1	533	354		528	338		498	336		354	531			
ACTIVATED SLUDGE - ZONE 2		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer			
o Zone Volume, mil gal	2	1.391	1.681		1.280	1.681		1.011	1.681		0.758	1.681			
o Flows Entering, mgd	2														
- Throughflow	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	2														
- ML Recirculated to Other Zones	2	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	2														
- Hydraulic Detention time, Actual, hr	2	0.23	0.48		0.19	0.50		0.16	0.49		0.18	0.31			
o Effluent from this Zone	2														
-- MLSS, mg/L	2	3,500	2,495		6,133	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	2	7.92	9.26		8.74	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	2	0.81	0.04		0.29	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	2														
- Increase in VSS, lb/d	2	-480	-1,857		-2,178	-2,752		505	-845		-943	-3,546			
- Increase in ISS, lb/d	2	-4	-88		-118	-144		63	-33		-52	-177			
ACTIVATED SLUDGE - ZONE 3		N.I.S.	N.I.S.		Aerated	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	3	0.000	0.000		1.280	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	3														
- Throughflow	3	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	3	0.00	0.00		151.33	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	3	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	3														
- ML Recirculated to Other Zones	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	3	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 02/27/2008 1:50 PM | Chk by/Date: | FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
o HRT in this Zone	3														
- Hydraulic Detention time, Actual, hr	3	0.00	0.00		0.10	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	3														
-- MLSS, mg/L	3	3,500	2,495		8,026	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	3	7.92	9.26		2.72	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	3	0.81	0.04		5.26	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	3	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	3														
- Increase in VSS, lb/d	3	0	0		211	0		0	0		0	0			
- Increase in ISS, lb/d	3	0	0		426	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 4		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	4	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	4														
- Throughflow	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	4														
- ML Recirculated to Other Zones	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	4														
- Hydraulic Detention time, Actual, hr	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	4														
-- MLSS, mg/L	4	3,500	2,495		8,026	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	4	7.92	9.26		2.72	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	4	0.81	0.04		5.26	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	4	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	4														
- Increase in VSS, lb/d	4	0	0		0	0		0	0		0	0			
- Increase in ISS, lb/d	4	0	0		0	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 5		Aerated	Aerated		N.I.S.	Aerated		Un-Aer	Un-Aer		Aerated	Aerated			
o Zone Volume, mil gal	5	2.781	1.571		0.000	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	5														
- Throughflow	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	5														
- ML Recirculated to Other Zones	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	5														
- Hydraulic Detention time, Actual, hr	5	0.45	0.45		0.00	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	5														
-- MLSS, mg/L	5	3,500	2,497		8,026	2,498		3,499	2,497		5,500	4,497			
-- NH3-N, mg/L	5	5.71	5.24		2.72	4.37		7.98	9.52		5.56	5.34			
-- NO3-N, mg/L	5	1.88	3.32		5.26	3.12		0.68	0.01		0.63	3.23			
-- D.O., mg/L	5	0.15	2.00		0.50	2.00		0.00	0.00		0.10	2.00			
o Biological Growth Summary	5														
- Increase in VSS, lb/d	5	-548	1,283		0	1,960		-2,260	-2,440		-857	2,399			

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Increase in ISS, lb/d	5	318	341		0	372		-130	-128		158	596			
ACTIVATED SLUDGE - ZONE 6		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil gal	6	2.781	1.571		1.280	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	6														
- Throughflow	6	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	6	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	6														
- ML Recirculated to Other Zones	6	0.00	0.00		120.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	6	148.17	83.25		189.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	6														
- Hydraulic Detention time, Actual, hr	6	0.45	0.45		0.10	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	6														
-- MLSS, mg/L	6	3,500	2,499		8,026	2,500		3,500	2,499		5,501	4,499			
-- NH3-N, mg/L	6	1.71	2.00		0.94	1.50		2.91	4.17		1.44	2.08			
-- NO3-N, mg/L	6	5.45	6.08		6.83	5.57		5.30	4.70		4.33	5.94			
-- D.O., mg/L	6	2.00	2.00		2.00	2.00		2.00	2.00		2.00	2.00			
o Biological Growth Summary	6														
- Increase in VSS, lb/d	6	437	902		661	626		496	1,499		38	1,654			
- Increase in ISS, lb/d	6	417	295		482	248		302	272		270	522			
ACTIVATED SLUDGE - ZONE 7		Aerated	Aerated		MBR	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil gal	7	2.781	1.571		0.567	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	7														
- Throughflow	7	148.17	83.25		189.16	80.26		148.15	82.95		101.62	130.26			
- (-) Removed as MBR Filtrate [Note]	7	0.00	0.00		-37.33	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	7	148.17	83.25		151.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone (excl.MBR Filtr)	7														
- ML Recirculated to Other Zones	7	96.00	50.00		0.00	50.00		96.00	50.00		60.00	75.00			
- ML Wasted from this Zone	7	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net Flow to Next Zone, mgd	7	52.17	33.25		151.33	30.26		52.15	32.95		41.62	55.26			
o HRT in this Zone	7														
- Hydraulic Detention time, Actual, hr	7	0.45	0.45		0.09	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	7														
-- MLSS, mg/L	7	3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
-- NH3-N, mg/L	7	0.26	0.40		0.24	0.29		0.46	0.87		0.19	0.42			
-- NO3-N, mg/L	7	6.72	7.39		7.37	6.57		7.51	7.72		5.41	7.24			
-- D.O., mg/L	7	2.00	2.00		1.50	2.00		2.00	2.00		2.00	2.00			
o Biological Growth Summary	7														
- Increase in VSS, lb/d	7	-620	439		90	86		96	411		-671	1,066			
- Increase in ISS, lb/d	7	317	249		254	194		281	181		211	472			
WAS SOLIDS PRODUCTION															
o P-Removal															
- Include P-Removal in Calc? (Y=1, N=0)	*	0	0		0	0		0	0		0	0			
o Solids Production, TSS, lb/d															
- TSS Entering in Feed, lb/d		35,193	25,785		35,882	22,988		21,534	15,894		23,794	47,222			
- VSS Change in A.B. Zones		4,732	4,456		4,321	3,489		4,551	2,297		1,542	7,028			
- ISS Change in A.B. Zones		1,581	1,151		1,572	1,008		1,014	629		941	1,944			
- ISS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			
- Unbiodeg VSS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Solids Production, lb/d		**41,506**	**31,392**		**41,775**	**27,485**		**27,098**	**18,820**		**26,277**	**56,195**			
MLSS CHARACTERISTICS															
o Mixed Liquor Components, mg TSS/L															
- Solids, mg TSS/L															
-- Slowly Biodegradable		26	28		86	23		28	21		34	51			
-- Active Biomass		1,261	996		3,526	977		1,238	838		1,723	1,661			
-- Endogenous Biomass		415	206		1,180	230		406	255		758	345			
-- Nitrifiers		59	44		182	41		91	63		81	67			
-- Unbiodegradable VSS (Influent + Bio-P)		1,196	881		3,443	887		1,185	947		2,020	1,686			
-- Inorganic SS (influent + Biogrowth)		550	384		1,585	383		557	410		897	732			
-- Inorganic SS due to Bio-P (est.)		0	0		0	0		0	0		0	0			
-- Total Last-Pass MLSS		3,506	2,539		10,002	2,542		3,506	2,535		5,514	4,541			
-- Total Soluble Organic N (SolOrgN)		2.3	2.4		2.3	2.3		2.3	2.4		2.3	2.4			
-- Alkalinity, mg/L as CaCO3		141.2	139.2		138.6	142.2		139.0	139.7		145.8	139.8			
o Org N fraction of MLVSS (NinVSS)		0.079	0.081		0.078	0.081		0.079	0.079		0.077	0.078			
o MLVSS Fraction		0.84	0.85		0.84	0.85		0.84	0.84		0.84	0.84			
o BOD of AS Solids															
- BOD/TSS ratio		0.28	0.31		0.28	0.30		0.28	0.26		0.24	0.29			
SOLIDS RETENTION TIME, SRT															
o Total Solids Wasted, lb/d		41,506	31,392		41,775	27,485		27,098	18,820		26,277	56,195			
- Recycled WAS Solids, lb/d		582	3,522		0	3,425		343	2,173		600	4,007			
- Net lb Solids Yield/day		40,924	27,870		41,775	24,060		26,755	16,646		25,677	52,188			
o Total BOD Load, lb/d		51,881	32,785		53,012	30,663		36,373	23,054		35,065	55,303			
- Recycled BOD, lb/d		228	1,028		0	980		159	598		225	1,100			
- Net BOD Load, lb/d		51,653	31,757		53,012	29,684		36,214	22,456		34,841	54,203			
o Solids Production															
- lb Dry SS/lb BOD Applied		0.792	0.878		0.788	0.811		0.739	0.741		0.737	0.963			
o Total Mass TSS in System, lb		324,711	163,609		349,539	163,644		236,149	163,723		278,358	294,577			
- **Total SRT (Rs), days**		**7.93**	**5.87**	**7.24**	**8.37**	**6.80**	**7.87**	**8.83**	**9.84**	**9.24**	**10.84**	**5.64**	**8.17**		
- lb/mgd		8,293	6,477		9,239	7,117		6,034	6,540		10,726	7,673			
o Total Mass TSS in Aerated Zones, lb		243,533	98,205		218,609	98,225		118,074	65,491		208,756	176,793			
- Nominal Aerated Mass Fraction		0.750	0.600		0.625	0.600		0.500	0.400		0.750	0.600			
- **Nominal Aerobic SRT, days**		**5.95**	**3.52**		**5.23**	**4.08**		**4.41**	**3.93**		**8.13**	**3.39**			
o Mass Fraction in Each Zone															
- Zone 1		0.125	0.186		0.187	0.186		0.125	0.186		0.125	0.186			
- Zone 2		0.125	0.214		0.187	0.214		0.125	0.214		0.125	0.214			
- Zone 3		0.000	0.000		0.245	0.000		0.000	0.000		0.000	0.000			
- Zone 4		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Zone 5		0.250	0.200		0.000	0.200		0.250	0.200		0.250	0.200			
- Zone 6		0.250	0.200		0.245	0.200		0.250	0.200		0.250	0.200			
- Zone 7		0.250	0.200		0.135	0.200		0.250	0.200		0.250	0.200			
		1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			
o Min. Aer. SRT recommended for nitrification, days		5.5	4.4		5.0	4.4		4.7	5.4		5.8	4.4			
- Washout SRT(total)															
-- Rwashout = 1/(Ua*DOsw - ba)		3.16	3.20		3.56	3.20		4.28	6.52		3.37	3.20			
- Recommended Aerobic SRT															
-- Max slope criterion, dNH3/dSRT, mg/L-d	*	0.20	0.20		0.20	0.20		0.20	0.20		0.20	0.20			
-- Recomm. Min. Operating SRT(total)		7.3	7.4		8.0	7.4		9.4	13.5		7.7	7.4			
-- Recomm. Min. Operating SRT(Nominal aerobic)		5.5	4.4		5.0	4.4		4.7	5.4		5.8	4.4			
-- Nitrification Safety Factor		2.31	2.30		2.26	2.30		2.19	2.06		2.28	2.30			

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
AERATION REQUIREMENTS															
o Oxygen Required, lb/d															
- Net Oxygen Demand in Zone 1		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 2		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 3		0	0		32,850	0		0	0		0	0			
- Net Oxygen Demand in Zone 4		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 5		21,855	19,647		0	18,910		257	331		13,151	31,512			
- Net Oxygen Demand in Zone 6		37,129	16,293		38,026	14,599		38,401	22,395		26,548	26,362			
- Net Oxygen Demand in Zone 7		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- (-) Oxygen provided by MBR Scouring		0	0		-10,220	0		0	0		0	0			
- Total Oxygen required lb/d		**80,794**	**47,522**		**72,838**	**43,458**		**61,641**	**37,911**		**54,651**	**77,212**			
o Diffuser Analysis		**42,715**	**58,144**					**42,715**	**58,144**		**42,715**	**58,144**			
Note:															
All values of air and blower requirements given below are preliminary estimates, to be refined during detailed design															
o Oxygen Transfer Efficiency															
- Diffuser Type		[EDI] Mini-Panel	[EDI] Mini-Panel		[EDI] Mini-Panel	[EDI] Mini-Panel		[EDI] Mini-Panel	[EDI] Mini-Panel		[EDI] Mini-Panel	[EDI] Mini-Panel			
- Aeration Basin D.O. (Avg), mg/L		1.4	2.0		1.3	2.0		2.0	2.0		1.4	2.0			
- Design Water Temperature, C		29	29		29	29		29	29		29	29			Summer
- Diffuser submergence, ft		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
- Air loading, scfm/unit	[Note]	1.25 scfm/sf	1.25 scfm/sf		1.25 scfm/sf	1.25 scfm/sf		1.25 scfm/sf	1.25 scfm/sf		1.25 scfm/sf	1.25 scfm/sf			
- Floor Coverage		23.4 %Actv A	28.7 %Actv A		70.3 %Actv A	25.2 %Actv A		38.8 %Actv A	29.3 %Actv A		30.9 %Actv A	52.4 %Actv A			
- Clean Water SOTE	*	36.2	37.1		36.2	37.1		36.2	37.1		36.2	37.1			Mfr. lit.
- Site Conditions Adjustment Factor F = Actual / Standard OTE															
-- Alpha factor, including fouling		0.54	0.50		0.37	0.52		0.56	0.59		0.50	0.45			Estimate
-- Theta factor	*	1.024	1.024		1.024	1.024		1.024	1.024		1.024	1.024			Default
-- Temp. correction, Tau		0.85	0.85		0.85	0.85		0.85	0.85		0.85	0.85			
-- Elevation above MSL, ft	*	695	695		695	695		695	695		695	695			Site
-- ..Pressure correction, Omega		0.97	0.97		0.97	0.97		0.97	0.97		0.97	0.97			
-- Beta factor	*	0.99	0.99		0.99	0.99		0.99	0.99		0.99	0.99			Default
-- Equilibrium C*20		10.64	10.70		10.64	10.70		10.64	10.70		10.64	10.70			
..Depth Adjustment Factor	*	0.37	0.37		0.37	0.37		0.37	0.37		0.37	0.37			Default
- F = Alpha x [Theta ^(T-20)] x (Tau Beta Omega C*20 - C)/C*20		0.46	0.39		0.32	0.41		0.43	0.46		0.43	0.35			
- Oxygen Transfer Efficiency OTE = F x SOTE		16.57 Percent	14.57 Percent		11.53 Percent	15.16 Percent		15.71 Percent	17.09 Percent		15.55 Percent	12.95 Percent			
Preliminary Estimate															
o Surface Aerators		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A			
- Oxygen to be transferred, lb/hr															
- Aerator hp required [Ox. Requ.d/Eff.]															
- Peaking factor	*														
- Aerator hp Installed															
o SOTR Required															
- Average Day @ Design flow															
-- Actual Ox Tr Requd, AOTR, lb/d		80,794	47,522		72,838	43,458		61,641	37,911		54,651	77,212			
-- Site Conditions Adjustment, F		0.46	0.39		0.32	0.41		0.43	0.46		0.43	0.35			
-- Standard Ox Tr Rate, SOTR, lb/d SOTR = AOTR / F		176,639	121,066		228,813	106,388		142,119	82,336		127,308	221,242			

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
o Air Supply Required															
- Average Day @ Design flow															
-- Ox Transfer Rate, AOTR, lb/d		80,794	47,522		72,838	43,458		61,641	37,911		54,651	77,212			
-- Oxygen Supplied, lb/min		338.6	226.5		438.6	199.1		272.4	154.1		244.0	414.0			
-- cf Air/lb Oxygen		57.0	57.0		57.0	57.0		57.0	57.0		57.0	57.0			
[23.3 lb O2/100 lb Air]															
[0.0753 lb Air/scf]															
-- Process Air, scfm		19,300	12,910		25,000	11,350		15,530	8,780		13,910	23,600			
..scfm per lb/d Oxygen		0.239	0.272		0.343	0.261		0.252	0.232		0.255	0.306			
..scf/lb BOD Applied		536	567		679	533		615	548		571	615			
-- Other Uses, e.g. Channel Air	*	1,500	1,200		1,500	1,200		1,500	1,200		1,200	1,400			Default
-- Total Blower Air, scfm		20,800	14,110		26,500	12,550		17,030	9,980		15,110	25,000			
- Peak Day @ Design Flow															
-- Peaking factor	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
-- Process Air, scfm		25,100	16,800		32,500	14,800		20,200	11,400		18,100	30,700			
-- Total Blower Air, scfm		26,600	18,000		34,000	16,000		21,700	12,600		19,300	32,100			
o Diffusers															
- Expressed as active sq ft or # diffusers		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft			
- Recommended															
-- Air Loading, scfm/(sf or dfr)		1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Number recommended per Basin		1,403	1,722		4,000	1,513		1,553	1,171		1,854	3,146			
- Actual Installed, per basin															
-- Main Basin	*	1,403	1,722		4,000	1,513		1,553	1,171		1,854	3,146			
-- Additional Basin	*	0	0		0	0		0	0		0	0			
- Total Installed, sf or dfr		15,438	10,330		19,998	9,078		12,421	7,025		11,126	18,878			
- Air Loading, scfm/sf or dfr															
-- Daily Average		1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
- Floor Coverage															
-- Total Basin Floor Area in Service, sf		88,000	60,000		51,700	60,000		64,000	60,000		48,000	60,000			
-- Total Aerated Floor Area in service		66,000	36,000		28,427	36,000		32,000	24,000		36,000	36,000			
-- Coverage		23.4	28.7		70.3	25.2		38.8	29.3		30.9	52.4			
.. Expressed as		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A			
- Active sf/diffuser, or 1		2.54	2.54		2.54	2.54		2.54	2.54		2.54	2.54			
- Number of diffuser units		6,078	4,067		7,873	3,574		4,890	2,766		4,380	7,432			
o Blower Discharge pressure															
- Head, ft water															
-- Submergence		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
-- Freeboard above normal op level		0.0	0.0		4.0	0.0		0.0	0.0		0.0	0.0			
-- Diffuser head loss		1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5			
-- Pipe & Valve friction		2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5			
-- Total Head, ft		19.9	20.5		23.9	20.5		19.9	20.5		19.9	20.5			
- Discharge pressure, psig		8.6	8.9		10.4	8.9		8.6	8.9		8.6	8.9			
o Delivered Horsepower															
- Max Operating Air Temp, C	*	34	34		34	34		34	34		34	34			Default
- Barometric Pressure, psia		14.3	14.3		14.3	14.3		14.3	14.3		14.3	14.3			
- Blower Suction Pressure, psia		14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0			
- Daily Average Total Air, scfm		20,800	14,110		26,500	12,550		17,030	9,980		15,110	25,000			
- Avg Delivered Horsepower, hp		738	513		1,091	456		604	363		536	909			
- Peak Day Delivered hp		944	655		1,400	582		770	458		685	1,167			
o Wire power required															
- Energy Efficiency, %	*	61.0	61.0		61.0	61.0		61.0	61.0		61.0	61.0			Default
- Wire power required, hp															
-- Daily Average		1,210	840		1,790	750		990	590		880	1,490			
-- Firm Installed		1,550	1,070		2,290	950		1,260	750		1,120	1,910			

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
SECONDARY SEDIMENTATION BASINS															
o Flow Rates, mgd															
- AS Influent, Q		39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39			
- Net Sed. Basin Inflow (excl. RAS), Qci		39.15	25.26		37.33	22.99		39.14	25.03		25.95	38.39			
- Return Sludge Flow, Qr (not including waste sludge flow)		13.01	7.99		151.33	7.27		13.01	7.91		15.66	16.87			
- Total Sed Basin Inflow		52.17	33.25		188.66	30.26		52.15	32.95		41.62	55.26			
- Total Sed. Basin Underflow		13.36	8.35		151.33	7.59		13.23	8.13		15.87	17.33			
- Net Sec. Effluent, Qe		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
o Basin dimensions															
- Group 1	*														
-- No. of Basins	*	7	2		8	2		7	2		4		**3**	1 more for	
-- Number of Units in Service	*	6	2		7	2		6	2		4		**3**	hydraulics	
-- Diameter, ft (inside)	*	0	130		0	130		0	130		0	130			
-- Side Water Depth, ft	*	11.9	14.0		11.9	14.0		11.9	14.0		11.9	14.0			
-- Surface Area per Basin, sf		8,800	13,273		8,800	13,273		8,800	13,273		8,800	13,273			
-- Volume per Basin, cf		104,720	185,825		104,720	185,825		104,720	185,825		104,720	185,825			
- Group 2	*														
-- No. of Basins	*	0	2		0	2		0	2		0	2			
-- Number of Units in Service	*	0	2		0	2		0	2		0	2			
-- Diameter, ft (inside)	*	120	100		120	100		120	100		120	100			
-- Side Water Depth, ft	*	14.0	10.3		14.0	10.3		14.0	10.3		14.0	10.3			
-- Surface Area per Basin, sf		11,310	7,854		11,310	7,854		11,310	7,854		11,310	7,854			
-- Volume per Basin, cf		158,336	80,503		158,336	80,503		158,336	80,503		158,336	80,503			
o Flow Split															
- Fraction of ML Flow to Group 1:															
-- Fraction based on Surface Area		1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.72			
-- Fraction selected	*	1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.72			
- Effective (Flow-weighted) SWD, ft		11.90	12.61		11.90	12.61		11.90	12.61		11.90	12.94			
o Surface Overflow Rate															
- Group 1															
-- Surface Area in service, sf		52,800	26,546		61,600	26,546		52,800	26,546		35,200	39,820			
-- Surface Overflow Rate, gpd/sf		735	589		606	537		737	587		731	683			
- Group 2															
-- Surface Area in service, sf		0	15,708		0	15,708		0	15,708		0	15,708			
-- Surface Overflow Rate, gpd/sf		0	589		0	537		0	587		0	683			
o Solids Loading Rate, lb/day-sf															
- Group 1		29	16		255	15		29	16		54	37			
- Group 2		0	16		0	15		0	16		0	37			
o Volume in service, mil gal															
- Group 1		4.70	2.78		5.48	2.78		4.70	2.78		3.13	4.17			
- Group 2		0.00	1.20		0.00	1.20		0.00	1.20		0.00	1.20			
o Hydraulic Detention Time, hr (based on Q)															
- Group 1		2.9	4.2		N.A.	4.6		2.9	4.2		2.9	3.6			
- Group 2		N.A.	3.1		N.A.	3.4		N.A.	3.1		N.A.	2.7			
o Weir Loading															
- Group 1															
-- Actual weir length per unit, ft	*	808	745		667	745		811	745		804	745			Default
-- Weir loading, gpd/ft		8,000	10,502		8,000	9,566		8,000	10,472		8,000	12,179			
- Group 2															
-- Actual weir length per unit, ft	*	0	556		0	556		0	556		0	556			Default
-- Weir loading, gpd/ft		0	8,320		0	7,579		0	8,297		0	9,649			
o Sludge Settling Characteristics															

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Design Max. SVI, ml/g	*	150	150		150	150		150	150		150	150			Default
ISV = a x exp(-b MLSS), ft/h															
- "a" Value, ft/hr	*	21.3	21.3		21.3	21.3		21.3	21.3		21.3	21.3			
- "b" Value [x 1,000,000]	*	218	218		218	218		218	218		218	218			
o Target Settling Values															
- Effluent rise rate (SOR), ft/hr															
-- Group 1		4.09	3.28		3.38	2.99		4.11	3.27		4.07	3.81			
-- Group 2		N.A.	3.28		N.A.	2.99		N.A.	3.27		N.A.	3.81			
-- Average		4.09	3.28		3.38	2.99		4.11	3.27		4.07	3.81			
- Clarifier Safety Factor, CSF	*	2.3	2.3		2.3	2.3		2.3	2.3		2.3	2.3			Default
- Initial Settling Velocity, ISV, ft/hr		9.3	7.5		7.7	6.8		9.4	7.5		9.3	8.7			
- Preferred Max. Last-Pass MLSS, mg/L		3,786	4,801		4,671	5,229		3,773	4,814		3,809	4,121			
o Selected Settling Values															
- Operating L-P MLSS conc, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Operating ISV, ft/h		9.9	12.4		2.4	12.4		9.9	12.4		6.4	8.0			
- Operating CSF															
-- Group 1		2.4	3.0		0.7	3.3		2.4	3.1		1.6	2.1			
-- Group 2		N.A.	3.0		N.A.	3.3		N.A.	3.1		N.A.	2.1			
MEMBRANE BIO-REACTOR (MBR)															
o MBR System in Service? (Y=1; N=0)	*	0	0		1	0		0	0		0	0			
into column B) but DO NOT DELETE the section															
o Flow Rates, mgd															
- Nominal Plant Flow Rate, mgd															
-- Daily Average		35.52	22.20		35.52	22.20		35.52	22.20		24.42	33.30			
-- 4-Hour Diurnal Peak Flow, mgd		46.18	28.86		46.18	28.86		46.18	28.86		31.75	43.29			
-- Max Instantaneous Flow, mgd		70.40	44.00		70.40	44.00		70.40	44.00		48.40	66.00			
- Actual Secondary Effluent, mgd															
-- Daily Average		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
-- 4-Hour Diurnal Peak Flow, mgd		49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
-- Max Instantaneous Flow, mgd		73.68	46.69		72.21	44.47		73.80	46.62		49.72	70.63			
- Design Flow through Membranes															
-- Daily Average		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
-- Peak Flow (Short Term)	*	49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
o Reaction Zone dimensions															
- (NOT INCLUDING the membrane zones)															
- No. of Units (parallel trains)	*	2	2		**5**	2		2	2		2	2			
- Number of Units in Service	*	2	2		**5**	2		2	2		2	2			
- Length, ft (inside)	*	200	200		200	200		200	200		200	200			
- Width, ft (inside)	*	100	100		40	100		100	100		100	100			
- Side Water Depth, ft	*	17	17		16.9	17		17	17		17	17			
- Volume per Basin, mil gal		2.54	2.54		1.01	2.54		2.54	2.54		2.54	2.54			
o Membrane System Characteristics															
- Membrane identification		ZW-500b	ZW-500b		ZW-500d	ZW-500b		ZW-500b	ZW-500b		ZW-500b	ZW-500b			
- Average Operating Flux, gfd	*	14	14		15.44	14		14	14		14	14			
- Stressed Operating Flux (4 hours), gfd	*	18.2	18.2		27.35	18.2		18.2	18.2		18.2	18.2			
- Membrane area per module (element), sf	*	650	650		340	650		650	650		650	650			
- Modules (Elements) per Cassette	*	8	8		48	8		8	8		8	8			
- Cassette dimensions, ft															
-- Length	*	6	6		7.1	6		6	6		6	6			
-- Width	*	2.39	2.39		5.7	2.39		2.39	2.39		2.39	2.39			
-- Depth (Height)	*	6.73	6.73		8.3	6.73		6.73	6.73		6.73	6.73			
Scrubbing air, acfm per sf membrane	*	0.0192	0.0192		0.0128	0.0192		0.0192	0.0192		0.0192	0.0192			
-- acfm per module		12.48	12.48		4.35	12.48		12.48	12.48		12.48	12.48			

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PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
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Calc by: CFP,NV | Date Time: 02/27/2008 1:50 PM | Chk by/Date: | FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Percent of time that air is ON	*	100	100		25	100		100	100		100	100			
-- Net scfm per module		14.7	14.7		1.3	14.7		14.7	14.7		14.7	14.7			
o Est.Membrane Units Required (*In Service*)															
- Membrane Area, sf															
-- Based on Avg Flux		2,771,653	1,777,953		2,072,197	1,619,488		2,779,845	1,772,894		1,838,726	2,709,590			
-- Based on Max Flux		2,717,536	1,733,590		1,754,586	1,611,694		2,723,837	1,729,699		1,816,932	2,633,201			
-- Membrane area in service, sf		2,771,653	1,777,953		2,072,197	1,619,488		2,779,845	1,772,894		1,838,726	2,709,590			
- Number of Modules (Elements)		4,264	2,735		6,095	2,492		4,277	2,728		2,829	4,169			
- Number of Cassettes in service (typ.)		533	342		127	312		535	341		354	522			
o Membrane Zone Configuration															
- Total Number of Membrane Zones	*	2	2		8	2		2	2		2	2			
- Cassettes Required per Zone															
-- All units in service		267	171		16	156		268	171		177	261			
-- Allowing for one unit out of service		534	342		18	312		536	342		354	522			
- Cassettes Installed per Zone	*	534	342		18	312		536	342		354	522			
-- Cassettes spaces provided, incl. Spares	*	534	342		22	312	Per Zenon	536	342		354	522			
- Total Membrane Area, all Zones, sf		5,553,600	3,556,800		2,387,383	3,244,800		5,574,400	3,556,800		3,681,600	5,428,800			
- Flux @ Daily Avg Flow, gfd															
-- One Zone OOS		14.0	14.0		17.9	14.0		14.0	14.0		14.0	14.0			
-- All Zones in Service		7.0	7.0		15.6	7.0		7.0	7.0		7.0	7.0			
- Flux @ Peak Flow, gfd															
-- One Zone OOS		17.8	17.7		23.0	18.1		17.8	17.7		18.0	17.7			
-- All Zones in Service		8.9	8.9		20.1	9.0		8.9	8.9		9.0	8.8			
- Freeboard Check (from FB Check section below)															
-- At Peak Flow (AB ***or*** MZ OOS)		OK	OK		OK	OK		OK	OK		OK	OK			
.. 1 AB ***and*** 1 MZ OOS		OK	OK		OK	OK		OK	OK		OK	OK			
-- At Inst. Max Flow (AB or MZ OOS)		Overload	Overload		Overload	Overload		Overload	Overload		Overload	Overload			
.. 1 AB ***and*** 1 MZ OOS		Overload	Overload		Overload	Overload		Overload	Overload		Overload	Overload			
o Membrane Zone Dimensions - per Zone															
- Number of cassettes accommodated		534	342		22	312		536	342		354	522			
- Dimensions Along Length of Cassette:															
-- Zone inside dimension, ft	*	134.4	109.2		19.5	100.8		134.4	109.2		109.2	134.4			
-- Number of Cassette positions	*	17	13		2	12		17	13		13	17			
-- Free space provided [30-50]		32%	40%		37%	40%		32%	40%		40%	32%			
- Dimensions Along Width of Cassette:															
-- Zone inside dimension, ft	*	107.072	90.342		75	86.996		107.072	90.342		93.688	103.726			
-- Number of Cassette positions	*	32	27		11	26		32	27		28	31			
-- Free space provided [30-50]		40%	40%		20%	40%		40%	40%		40%	40%			
- Total Cassette Spaces per Membrane Zone		544	351		22	312		544	351		364	527			
- Side Water Depth at min. flow, ft	*	8.7	8.7		11.9	8.7		8.7	8.7		8.7	8.7			
-- Minimum cassette water cover	*	1	1		1	1		1	1		1	1			
-- Cassette submergence		7.73	7.73		9.3	7.73		7.73	7.73		7.73	7.73			
-- Free depth below cassettes, ft		1	1		2.6	1		1	1		1	1			
o Net Biological Reaction Volume															
- Cassette volume per Zone, cf		59,193	37,910		6,882	34,585		59,415	37,910		39,240	57,863			
- Total membrane zone volume, mil gal		1.88	1.29		1.04	1.15		1.88	1.29		1.34	1.82			
- Total volume occupied by cassettes, mil gal		0.89	0.57		0.41	0.52		0.89	0.57		0.59	0.87			
- Nominal Aer. Basin volume, mil gal		11.12	7.85		5.69	7.85		8.09	7.85		6.07	7.85			
- Available Biological Reaction Volume		10.24	7.29		6.32	7.34		7.20	7.29		5.48	6.99			
o MLSS Relationships															
- Target MLSS in Membrane Zone, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Target MLSS in Reaction Zones, mg/L		7,000	7,000		8,000	7,000		7,000	7,000		7,000	7,000			
- Total Recycle Ratio required leaving Zone 7		0.29	0.29		4.00	0.29		0.29	0.29		0.29	0.29			
-- MLR from Zone 7 (only if from Z7)		2.45	1.98		0.00	2.17		2.45	2.00		2.31	1.95			

* Input Data

CAROLLO ENGINEERS, PC

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Qr/Q		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
- Actual MLSS in Zone 6, mg/L		3,500	2,499		8,026	2,500		3,500	2,499		5,501	4,499			
o Freeboard Check (Uses Main AB only)															
- Number of Basins that provide Freeboard		12	6		5	6		8	6		6	6			
- Basin surface area, each, sf		8,000	10,000		8,000	10,000		8,000	10,000		8,000	10,000			
- Total Freeboard provided, ft	*	6	6		6	6		6	6		6	6			
-- Min. liquid clearance below top of wall	*	1	1		1	1		1	1		1	1			
-- Freeboard used for control	*	1	1		1	1		1	1		1	1			
-- Freeboard available for accumulation		4	4		4	4		4	4		4	4			
- Freeboard volume available, mil gal															
-- All Aeration Basins in service		2.872	1.795		1.197	1.795		1.915	1.795		1.436	1.795			
-- One Aeration Basin OOS		2.633	1.496		0.957	1.496		1.676	1.496		1.197	1.496			
- Membrane capacity at peak flux, mgd															
-- All membranes in Service		101.08	64.73		65.29	59.06		101.45	64.73		67.01	98.80			
-- One cassette in cleaning		100.98	64.64		64.85	58.96		101.36	64.64		66.91	98.71			
-- One Membrane Zone OOS		50.54	32.37		57.13	29.53		50.73	32.37		33.50	49.40			
o Peak Accumulation at Diurnal Peak Flow															
- Peak Influent Flow, mgd		49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
- Peak Flow duration, h	*	4	4		4	4		4	4		4	4			
- All membranes in Service, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
- One cassette in cleaning, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
- One Membrane Zone OOS, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
o Peak Accumulation at Max Instantaneous Flow															
- Peak Influent Flow, mgd		73.68	46.69		72.21	44.47		73.80	46.62		49.72	70.63			
- Peak Flow duration, h	*	4	4		4	4		4	4		4	4			
- All membranes in Service, Accum. mil gal		0.000	0.000		1.153	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		3.85	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		195,443	0		0	0		0	0			
- One cassette in cleaning, Accum. mil gal		0.000	0.000		1.227	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		30,474	0		0	0		0	0			

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		269,834	0		0	0		0	0			
- One Membrane Zone OOS, Accum. mil gal		3.858	2.387		2.513	2.491		3.845	2.376		2.703	3.539			
-- & All Aeration Basins in service															
.. Freeboard used, ft		4.00	4.00		4.00	4.00		4.00	4.00		4.00	4.00			
.. Excess flow to be diverted, gal/d		985,244	592,210		1,316,371	695,658		1,930,252	580,406		1,267,106	1,743,497			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		4.00	4.00		4.00	4.00		4.00	4.00		4.00	4.00			
.. Excess flow to be diverted, gal/d		1,224,604	891,410		1,555,731	994,858		2,169,612	879,606		1,506,466	2,042,697			
o Scrubbing Air Requirements															
- Applied air per module, scfm		14.7	14.7		1.3	14.7		14.7	14.7		14.7	14.7			
-- Sufficient for Oxygen Demand? (>)					More Ox reqd										
- Number of modules - all Zones in serv		8,544	5,472		7,022	4,992		8,576	5,472		5,664	8,352			
- Air supply - all Zones in service, scfm		125,986	80,688		9,373	73,610		126,458	80,688		83,519	123,155			
- Air supply - one Zone OOS, scfm		62,993	40,344		8,202	36,805		63,229	40,344		41,760	61,578			
o Oxygen Transfer Efficiency (Coarse Bubble)															
- Diffuser submergence, ft		7.7	7.7		9.3	7.7		7.7	7.7		7.7	7.7			
- Clean Water SOTE, est.		6.3	6.3		7.6	6.3		6.3	6.3		6.3	6.3			
- Equilibrium C*20		9.69	9.69		9.82	9.69		9.69	9.69		9.69	9.69			
-- Adjusted C*20		7.91	7.91		8.01	7.91		7.91	7.91		7.91	7.91			
- OTE Multiplier		0.112	0.116		0.087	0.116		0.112	0.116		0.104	0.108			
- Minimum DO required, mg/L	*	2.00	2.00		1.50	2.00		2.00	2.00		2.00	2.00			
- Membrane Zone D.O., mg/L		**6.93**	**7.13**		**1.50**	**7.17**		**6.88**	**6.89**		**6.82**	**6.99**			
- Site Conditions Adjustment Factor, F		0.11	0.09		0.57	0.09		0.11	0.12		0.11	0.10			
= OTEMult x (C*20adj - C)															
- Est. Oxygen Transfer Efficiency, %		0.69	0.57		4.32	0.54		0.72	0.75		0.71	0.62			
o D.O. Concentration without Air Supplement															
- Ox.Transfer=Biological Demand, lb/d		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- Resulting DO conc, mg/L		6.93	7.13		0.25	7.17		6.88	6.89		6.82	6.99			
(All Zones in service)					More Ox rqd!										
o Supplemental Oxygen required															
- Max. (Biological) Ox. Demand, lb/d		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- Ox.Transferred from Mem. air, lb/d		21,814	11,584		10,220	9,950		22,987	15,188		14,955	19,342			
- Supplemental Ox requd in Membr zone, lb/d		0	0		1,962	0		0	0		0	0			
o Aeration Diffusers in Membrane Zones															
- Total Floor Area in Membrane Zones, sf		28,781	19,731		11,700	17,538		28,781	19,731		20,461	27,882			
- Floor Area reserved for Cassettes		15,602	10,067		7,123	8,948		15,602	10,067		10,440	15,114			
- Available Free Floor Area, sf		13,179	9,664		4,577	8,590		13,179	9,664		10,022	12,767			
- Total MZ Floor Area fitted with Diffusers, sf	*	0	0		0	0		0	0		0	0			
o Scrubbing Blower Discharge pressure															
- Head, ft water															
-- Submergence (min water level)		7.7	7.7		9.3	7.7		7.7	7.7		7.7	7.7			
-- Freeboard above min. op. level		5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0			
-- Diffuser head loss	*	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5			
-- Pipe & Valve friction	*	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0			
-- Total Head, ft		14.2	14.2		15.8	14.2		14.2	14.2		14.2	14.2			
Discharge pressure @ min. op. level, psig		4.0	4.0		4.7	4.0		4.0	4.0		4.0	4.0			
- Discharge pressure @ pk freeboard, psig		6.2	6.2		6.8	6.2		6.2	6.2		6.2	6.2			
o Delivered Horsepower															
- Max Operating Air Temp, C	*	34	34		34	34		34	34		34	34			
- Barometric Pressure, psia		14.3	14.3		14.3	14.3		14.3	14.3		14.3	14.3			
- Blower Suction Pressure, psia		14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0			
- Daily Average Total Air, scfm		125,986	80,688		9,373	73,610		126,458	80,688		83,519	123,155			

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		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Avg Delivered Horsepower, hp		2,351	1,506		200	1,374		2,360	1,506		1,558	2,298			
- Peak Freeboard Delivered hp		3,387	2,169		275	1,979		3,400	2,169		2,245	3,311			
o Wire power required															
- Energy Efficiency, %	*	61.0	61.0		61.0	61.0		61.0	61.0		61.0	61.0			Default
- Wire power required, hp															
-- Daily Average		3850	2470		330	2250		3870	2470		2550	3770			
-- Firm Installed		5550	3560		450	3240		5570	3560		3680	5430			
-- Daily Average, kW		2870	1840		240	1680		2880	1840		1900	2810			
-- Firm Installed, kW		4140	2650		340	2420		4150	2650		2740	4040			
o Scrubbing Air Blowers Required															
- Number of Blowers (1 standby)	*	3	3		9	3		3	3		3	3			
- Capacity, each, scfm		63,000	40,400		1,200	36,900		63,300	40,400		41,800	61,600			
- Firm Capacity (duty blowers), scfm		126,000	80,800		9,600	73,800		126,600	80,800		83,600	123,200			
- Blower Motor Size, each, hp		2780	1780		60	1630		2790	1780		1850	2720			
SLUDGE RETURN AND WASTAGE															
o Wasting Method (see Process Layout)															
- Waste Flow from RAS, Qw		0.350	0.369		0.000	0.322		0.222	0.213		0.210	0.459			
- Waste Flow from MLSS, Zone 7, Qmw		0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Return Sludge															
- Qr/Q, fraction	*	0.33	0.32		4.00	0.32		0.33	0.32		0.60	0.44			
- RAS flow to Aer Basin, Qr, mgd Average		13.01	7.99		151.33	7.27		13.01	7.91		15.66	16.87			
- RAS concentration, mg/L		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
o Sludge Wastage															
- Total Solids Wasted, lb/d		41,506	31,392		41,775	27,485		27,098	18,820		26,277	56,195			
- Adjustment for ESS:															
-- Solids in Effluent, lb/d		1,618	830		0	756		1,623	828		1,073	1,265			
-- Solids in WAS, lb/d		39,888	30,562	70,449	41,775	26,728	68,503	25,476	17,992	43,467	25,204	54,929	80,133		
- Concentration, mg/L		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
- Organic N, lb/d		2,648	2,102		2,755	1,837		1,703	1,199		1,623	3,621			
- Flow Rate, mgd Average		0.350	0.369	0.719	0.501	0.322	0.823	0.222	0.213	0.435	0.210	0.459	0.669		
o WAS Characteristics, mg/L															
- Wasting from -		RAS	RAS		Zone 7	RAS		RAS	RAS		RAS	RAS			
- BOD		3,781	3,059		2,758	2,964		3,863	2,677		3,462	4,137			
- TSS		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
- VSS		11,508	8,432		8,415	8,454		11,590	8,484		12,066	12,031			
- NH3-N		0.3	0.4		0.2	0.3		0.5	0.9		0.2	0.4			
- Organic-N		906.1	683.5		659.5	684.0		921.4	674.6		927.9	945.4			
- NO3-N		6.7	7.4		7.4	6.6		7.5	7.7		5.4	7.2			
- Alkalinity		141	139		139	142		139	140		146	140			
- Filterable ("soluble") BOD		1.0	1.2		1.1	1.1		1.1	1.1		1.0	1.3			
- Total soluble Organic N		2.3	2.4		2.3	2.3		2.3	2.4		2.3	2.4			
o Recommended Installed Capacity															
- Return Sludge Pumps, gpm		27,170	17,530		69,190	15,960		27,160	17,370		18,010	26,650			
- WAS Pumps															
-- Wasting operation, hr/day	*	24	24	24	24	24	24	24	24	24	24	24	24		
-- Pump Capacity (2 x Qwas), gpm		490	520	1,000	700	450	1,150	310	300	610	300	640	930		
-- WAS Solids Peak Handling Capacity, lb/hr		3,330	2,550	5,880	3,490	2,230	5,710	2,130	1,500	3,630	2,110	4,580	6,680		
SECONDARY EFFLUENT															
o Flow Rate															
- Net Secondary Effluent, mgd		38.80	24.89	63.69	37.33	22.67	60.00	38.92	24.82	63.74	25.74	37.93	63.68		
o Secondary Effluent Quality															
- BOD, mg/L		2	2	2.0	1	2	1.6	2	2	2.0	2	2	2.0		Estimate

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- TSS (nominal), mg/L	*	5	4	4.4	0	4	2.4	5	4	4.4	5	4	4.4		Default
- VSS, mg/L		4.2	3.4	3.7	0.0	3.4	2.1	4.2	3.4	3.7	4.2	3.4	3.7		
- NH3-N, mg/L		0.3	0.4	0.3	0.2	0.3	0.3	0.5	0.9	0.7	0.2	0.4	0.3		
- Total Organic N, mg/L		2.7	2.7	2.7	2.3	2.6	2.5	2.7	2.6	2.6	2.6	2.7	2.7		
- NO3/NO2-N, mg/L		6.7	7.4	7.1	7.4	6.6	6.9	7.5	7.7	7.6	5.4	7.2	6.5		
- Alkalinity, mg/L		141	139	140	139	142	141	139	140	139	146	140	142		
- Soluble Organic N, mg/L		2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.4	2.4	2.3	2.4	2.4		
- T.I.N., mg/L		7.0	7.8	7.5	7.6	6.9	7.2	8.0	8.6	8.3	5.6	7.7	6.8		
- Total N, mg/L		9.7	10.5	10.2	9.9	9.4	9.6	10.6	11.2	11.0	8.2	10.4	9.5		
TERTIARY FILTRATION				In Service			In Service Plant 2 (conv) only			In Service			In Service		
o Tertiary Filtration in Service? (Y=1, N=0)	*			1			1			1			1		
o Influent															
- Flow, mgd															
-- Total				63.7			22.7			63.7			63.7		
- BOD, total, mg/L				2.0			2.0			2.0			2.0		
- SS, total, mg/L				4.4			4.0			4.4			4.4		
o Filter Area															
- Surface Area per Filter, sf	*			200			200			200			200		
- Backwash - Continuous (0) or Intermittent (1)?	*			0			0			0			0		
- Standby Units Provided	*			2			2			2			2		
- Number of Filters															
-- Existing	*			16			16			16			16		
-- New	*			0			0			0			0		
-- Total				16			16			16			16		
- Number of Units in Service				14			14			14			14		
o Filter Loading															
- Equalization provided? (Y=1, N=0)	*			1			1			1			1		
- Peaking factor	*			1.10			1.10			1.10			1.10		Default
- Surface Area in Service, sf				2,800			2,800			2,800			2,800		
- Loading rate, gpm/sf				17.4			6.2			17.4			17.4		
o Removal															
- SS Removal, %	*			70			70			70			70		Default
- SS removed, lb/d				1,634			529			1,635			1,634		
- BOD removed, lb/d				328			119			334			317		
o Backwash Flow															
- Percent of Flow, %	*			9			9			9			9		Cont BW
- Backwash Flow, mgd				5.73			2.04			5.74			5.73		
o Backwash Characteristics, mg/L															
- BOD				8			8			8			8		
- TSS				34			31			34			34		
- VSS				29			26			29			29		
- NH3-N				0.3			0.3			0.7			0.3		
- Organic-N				5			4			5			5		
- NO3-N				7.1			6.6			7.6			6.5		
- Alkalinity				140			142			139			142		
o Net Flow to Disinfection, mgd															
- Undisinfected Plant Water Used	*			0.00			0.00			0.00			0.00		
- To Disinfection				57.96			20.63			58.00			57.95		
o Tertiary Effluent Quality, mg/L															
- BOD				1.4			1.4			1.4			1.4		
- SS				1.3			1.2			1.3			1.3		
- VSS, mg/L				1.1			1.0			1.1			1.1		
- NH3-N, mg/L				0.3			0.3			0.7			0.3		

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Organic N, mg/L				2.5		2.4				2.4			2.5		
- NO3/NO2-N, mg/L				7.1		6.6				7.6			6.5		
- Alkalinity, mg/L				140		142				139			142		
- Filterable ("soluble") BOD				1.1		1.1				1.1			1.1		
- Soluble Organic N, mg/L				2.4		2.3				2.4			2.4		
- T.I.N., mg/L				7.5		6.9				8.3			6.8		
- Total N, mg/L				10.0		9.2				10.8			9.3		
CHLORINE CONTACT TANKS				In Service			In Service			In Service			In Service		
o Flow Rate, mgd				57.96			57.96			58.00			57.95		
- Peaking factor	*			1.1			1.1			1.1			1.1		
o Number of Tanks	*			4			4			4			4		
o Volume per Tank, mil gal	*			1.327			1.327			1.328			1.327		
o Detention Time @ peak, min.				120			120			120			120		
FINAL EFFLUENT															
o Flow Rate, mgd															
- Plant Water used	*			0.12			0.12			0.16			0.11		
- Final Effluent Flow				57.84			57.84			57.84			57.84		
RESIDUALS MANAGEMENT															
SOLIDS GENERATED															
o Total Primary Sludge															
- Flow, mgd		1.515	0.954	2.468	1.586	0.908	2.494	1.986	1.252	3.237	0.980	1.220	2.200		
- Solids, lb/d		63,163	39,762	102,925	66,122	37,882	104,003	82,809	52,188	134,997	40,860	50,873	91,734		
- Concentration, %		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
- VSS, %		81	81	81	81	81	81	78	78	78	81	81	81		
- Organic N, lb/d		2,654	1,670	4,323	2,757	1,592	4,349	3,263	2,054	5,317	1,723	2,150	3,874		
o Total Waste Activated Sludge															
- Flow, mgd		0.350	0.369	0.719	0.501	0.322	0.823	0.222	0.213	0.435	0.210	0.459	0.669		
-- Recomm Installed Capacity, gpm		490	520	1,000	700	450	1,150	310	300	610	300	640	930		
- Solids, lb/d		39,888	30,562	70,449	41,775	26,728	68,503	25,476	17,992	43,467	25,204	54,929	80,133		
-- Recomm Installed Capacity, lb/hr		3,330	2,550	5,880	3,490	2,230	5,710	2,130	1,500	3,630	2,110	4,580	6,680		
- Concentration, mg/L		13,648	9,936	11,745	10,000	9,954	9,982	13,781	10,122	11,988	14,411	14,342	14,364		
- VSS, %		84	85	85	84	85	84	84	84	84	84	84	84		
- Organic N, lb/d		2,648	2,102	4,750	2,755	1,837	4,592	1,703	1,199	2,902	1,623	3,621	5,244		
- BOD/TSS ratio		0.28	0.31	0.29	0.28	0.30	0.28	0.28	0.26	0.27	0.24	0.29	0.27		
WAS THICKENING				In Service			In Service			In Service			In Service		
o Sludge Feed															
- Flow, mgd				0.719			0.823			0.435			0.669		
- Solids, lb/d				70,449			68,503			43,467			80,133		
- Concentration, mg/L				11,745			9,982			11,988			14,364		
- VSS, %				85			84			84			84		
- Organic N, lb/d				4,750			4,592			2,902			5,244		
- Solids BOD, lb/d				20,452			19,470			11,895			21,894		
- NH3-N, mg/L				0.3			0.3			0.7			0.3		
- NO3-N, mg/L				7.1			6.9			7.6			6.5		
- Alkalinity				140			141			139			142		
- Filterable ("soluble") BOD, mg/L				1.1			1.1			1.1			1.1		
- Soluble OrgN, mg/L				2.4			2.3			2.4			2.4		
-- N/VSS ratio for solids				0.080			0.079			0.080			0.078		
o Number of Units	*			4			4			4			4		
- Number of Units in Service	*			4			4			4			4		

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Diameter, ft	*			37			37			37			37		
- Effective Area in Service, sf				3,959			3,959			3,959			3,959		
- Operating cycle, hr/week	*			168			168			168			168		Default
o Hydraulic loading, gpm/sf				0.29			0.30			0.18			0.30		
o Solids Loading, lb/d-sf				17.8			17.3			11.0			20.2		
o Thickened Sludge															
- Solids Capture, %	*			95			95			95			95		
- Solids, lb/d				66,927			65,078			41,294			76,126		
- Percent Solids, %	*			6.0 GBT			6.0 GBT			6.0 GBT			6.0 GBT		
- Volume, mgd				0.134			0.130			0.083			0.152		
- Volatile Solids, lb/d				56,588			54,960			34,681			63,820		
- Organic N, lb/d				4,516			4,365			2,759			4,985		
o Underflow															
- Underflow solids, lb/d				3,522			3,425			2,173			4,007		
- Flow, mgd				0.585			0.693			0.352			0.517		
- Characteristics, mg/L															
-- BOD				211			170			204			255		
-- TSS				721			593			740			930		
-- VSS				610			501			621			779		
-- NH3-N				0.3			0.3			0.7			0.3		
-- Organic-N				48			39			49			60		
-- NO3-N				7.1			6.9			7.6			6.5		
-- Alkalinity				140			141			139			142		
ANAEROBIC DIGESTION				In Service			In Service			In Service			In Service		
o Digester Feed															
- Flow, total, mgd				0.309			0.307			0.312			0.308		
- Solids, total, lb/d				154,413			153,481			156,042			154,100		
- Volatile Solids, total, lb/d				127,422			126,530			124,238			126,950		
- Organic N, total, lb/d				8,190			8,061			7,278			8,277		
o - Anaerobic Digestion Type															
o Acid Phased Anaerobic Digestion				In-Service			In-Service			In-Service			In-Service		
o FIRST SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			60			60			60			60		
-- SWD, ft	*			28.5			28.5			28.5			28.5		
-- Volume per Digester, kcf				80.6			80.6			80.6			80.6		
-- Volume per Digester, mg				0.60			0.60			0.60			0.60		
- Larger Size Units															
-- Number	*			0			0			0			0		
-- Diameter, ft	*			70			70			70			70		
-- SWD, ft	*			29			29			29			29		
-- Volume per Digester, kcf				111.6			111.6			111.6			111.6		
-- Volume per Digester, mg				0.83			0.83			0.83			0.83		
- Gross Volume, kcf															
-- All Units in Service				80.6			80.6			80.6			80.6		
...Largest digester				80.6			80.6			80.6			80.6		
-- One Unit OOS				0.0			0.0			0.0			0.0		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- All Units in Service				77			77			77			77		
-- One Unit OOS				0			0			0			0		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				1.7			1.7			1.6			1.7		
-- One Unit OOS				#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!		
- Detention Time, days															
-- All Units in Service				1.86			1.87			1.84			1.86		
-- One Unit OOS				0.0			0.0			0.0			0.0		
o SECOND SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			2			2			2			2		
-- Diameter, ft	*			90			90			90			90		
-- SWD, ft	*			32			32			32			32		
-- Volume per Digester, kcf				203.6			203.6			203.6			203.6		
-- Volume per Digester, mg				1.52			1.52			1.52			1.52		
- Larger Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			88			88			88			88		
-- SWD, ft	*			38			38			38			38		
-- Volume per Digester, kcf				231.1			231.1			231.1			231.1		
-- Volume per Digester, mg				1.73			1.73			1.73			1.73		
- Gross Volume, kcf															
-- All Units in Service				638.3			638.3			638.3			638.3		
...Largest digester				231.1			231.1			231.1			231.1		
-- One Unit OOS				407.2			407.2			407.2			407.2		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															
-- All Units in Service				606			606			606			606		
-- One Unit OOS				387			387			387			387		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				0.21			0.2			0.2			0.2		
-- One Unit OOS				0.33			0.3			0.3			0.3		
- Detention Time, days															
-- All Units in Service				14.70			14.79			14.54			14.73		
-- One Unit OOS				9.4			9.4			9.3			9.4		
o Temperature, deg C	*			35			35			35			35		
o THIRD SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			75			75			75			75		
-- SWD, ft	*			32			32			32			32		
-- Volume per Digester, kcf				141.4			141.4			141.4			141.4		
-- Volume per Digester, mg				1.06			1.06			1.06			1.06		
- Larger Size Units															
-- Number	*			0			0			0			0		
-- Diameter, ft	*			90			70			70			70		
-- SWD, ft	*			29			29			29			29		
-- Volume per Digester, kcf				184.5			111.6			111.6			111.6		
-- Volume per Digester, mg				1.38			0.83			0.83			0.83		
- Gross Volume, kcf															

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- All Units in Service				141.4			141.4			141.4			141.4		
...Largest digester				141.4			141.4			141.4			141.4		
-- One Unit OOS				0.0			0.0			0.0			0.0		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															
-- All Units in Service				134			134			134			134		
-- One Unit OOS				134			134			134			134		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				0.949			0.942			0.925			0.945		
-- One Unit OOS				0.949			0.942			0.925			0.945		
- Detention Time, days															
-- All Units in Service				3.26			3.28			3.22			3.26		
-- One Unit OOS				3.3			3.3			3.2			3.3		
o Digestion Summary															
- Temperature, deg C	*			35			35			35			35		
- All units in service															
-- Total Volume, mg				6.1			6.1			6.1			6.1		
-- Combined SRT, days				19.8			19.9			19.6			19.8		
- Largest Unit out of service															
-- Largest Digester, mg				1.64			1.64			1.64			1.64		
-- Combined SRT, days				14.5			14.6			14.3			14.5		
o Acid Phase Assumptions															
- Acid Phase Cut Off, days	*			5			5			5			5		
- Additoinal biodegradability of WAS, %	*			0			0			0			0		
o VS Reduction for the First Set of Digests In Series															
- Acid Phase or Methane Phase?				acid			acid			acid			acid		
- Primary Sludge VSS, ppd				70,834			71,570			89,557			63,130		
-- % Degradable	*			71			71			67			71		
-- Inerts, ppd				20,224			20,441			29,491			18,027		
-- Degradable Solids, ppd				50,610			51,129			60,066			45,103		
-- VSS destruction %				27			27			25			27		
-- VS Destroyed, ppd				19,076			19,344			22,493			17,022		
- WAS VSS, ppd				56,588			54,960			34,681			63,820		
-- Aeration Basin Aerobic SRT, days				7.2			7.9			9.2			8.2		
-- % Degradable				56			55			54			55		
-- Inerts, ppd				24,789			24,486			16,007			28,660		
-- Degradable Solids, ppd				31,799			30,474			18,674			35,160		
-- VSS destruction %				21			21			20			21		
-- VS Destroyed				11,986			11,530			6,993			13,269		
- Total VSS destruction, %				24			24			24			24		
-- T * SRT (deg C*days)				65			65			64			65		
-- VSR check, %				NA			NA			NA			NA		
- VSS destroyed, lb/d				26,989			26,544			25,050			26,395		
- Discharge Total Solids, lb/d				127,424			126,936			130,992			127,705		
- Discharge Volatile Solids, lb/d				100,433			99,986			99,188			100,555		
-- TSS, %				5.0			5.0			5.0			5.0		
-- VSS, %				78.8			78.8			75.7			78.7		
o Gas Production															
- cf/lb VSS destroyed	*			4			4			4			4		
- Gas Production, kcf/d				108			106			100			106		
- BTU/cf	*			130			130			130			130		
- MMBTU/hr				0.6			0.6			0.5			0.6		
o VS Reduction for the Second Set of Digests In Series															

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Acid Phase or Methane Phase?				methane			methane			methane			methane		
- Remaining Primary Sludge VSS, ppd				51,758			52,226			67,064			46,108		
-- % Degradable				61			61			56			61		
-- VSS destruction %				50			50			46			50		
-- VS Destroyed				26,089			26,324			31,030			23,241		
- Remaining WAS VSS, ppd				44,602			43,430			27,688			50,551		
-- % Degradable				44			44			42			43		
-- VSS destruction %				37			36			35			36		
-- VS Destroyed				16,392			15,690			9,647			18,117		
- Total VSS destruction, %				42			42			41			41		
- VSS destroyed, lb/d				42,482			42,014			40,676			41,358		
- Discharge Total Solids, lb/d				84,942			84,923			90,316			86,347		
- Discharge Volatile Solids, lb/d				57,951			57,973			58,512			59,197		
-- TSS, %				3.3			3.3			3.5			3.4		
-- VSS, %				68.2			68.3			64.8			68.6		
o Gas Production															
- cf/lb VSS destroyed	*			22			22			22			22		
- Gas Production, kcf/d				935			924			895			910		
- BTU/cf	*			670			670			670			670		
- MMBTU/hr				26.1			25.8			25.0			25.4		
o VS Reduction for the Third Set of Digests In Series															
- Acid Phase or Methane Phase?				methane			methane			methane			methane		
- Remaining Primary Sludge VSS, ppd				25,669			25,902			36,035			22,867		
-- % Degradable				21			21			18			21		
-- VSS destruction %				11			11			9			11		
-- VS Destroyed				2,803			2,820			3,352			2,495		
- Remaining WAS VSS, ppd				28210			27741			18042			32434		
-- % Degradable				12			12			11			12		
-- VSS destruction %				6			6			6			6		
-- VS Destroyed				175			171			194			150		
- Total VSS destruction, %				5			5			6			4		
- VSS destroyed, lb/d				2,978			2,991			3,546			2,644		
- Discharge Total Solids, lb/d				81,964			81,932			86,770			83,703		
- Discharge Volatile Solids, lb/d				54,973			54,982			54,966			56,553		
-- TSS, %				3.2			3.2			3.3			3.3		
-- VSS, %				67.1			67.1			63.3			67.6		
o Gas Production															
- cf/lb VSS destroyed	*			15			15			15			15		
- Gas Production, kcf/d				45			45			53			40		
- BTU/cf	*			615			615			615			615		
- MMBTU/hr				1.1			1.1			1.4			1.0		
o Digestion Summary															
- Total VSS destroyed, lb/day				72,449			71,548			69,272			70,397		
- Total VSS destruction, %		37		**57**	37		**57**	37		**56**	37		**55**		
- Temp * SRT				693			698			686			695		
- Total Gas Production, kcf/d				1087			1075			1048			1055		
-- Overall rate, cf/lb VSS destroyed				15.0			15.0			15.1			15.0		
- Total Energy Production, mmBTU/hr				28			28			27			27		
-- Overall rate, BTU/cf				614			614			616			614		
o Nitrogen in Dig Sludge Filtrate															
- Assumed Sol OrgN in Digester effl, mg/L				5			5			5			5		
-- lb/d				12.9			12.79			13.00			12.84		
- Org N/VSS (VSS of digester feed) in Digester Solids				0.064			0.064			0.058			0.065		
- VSS destroyed, lb/d				72,449			71,548			69,272			70,397		

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Ammonia generated (organic N released), lb/d				4,650			4,551			4,051			4,583		
- Organic N taken up by struvite, lb/d				0			0			0			0		
- NH3 Concentration, mg/L				1,807			1,779			1,558			1,784		
- Alkalinity, mg/L				6,452			6,354			5,563			6,373		
DEWATERING (Belt Presses)				N.I.S.			N.I.S.			N.I.S.			N.I.S.		
o Sludge Feed															
- Flow rate, mgd	*			0.309			0.307			0.312			0.308		
- Total Solids, lb/d	*			81,964			81,932			86,770			83,703		
- Total VSS, lb/d	*			54,973			54,982			54,966			56,553		
o Number of Belt Presses (2m)	*			0			0			0			0		
- Number of Units in Service	*			0			0			0			0		
- Feed Rate, gpm per unit	*			110			110			110			110		Default
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				0.0			0.0			0.0			0.0		
o Sludge Cake															
- Capture, %	*			90			90			90			90		Default
- Concentration, %	*			16.23			16.38			19.24			15.25		Default
- Cake Solids, lb/d															
-- Dry Solids, lb/d				81,964			81,932			86,770			83,703		
-- Wet Cake, tons/d				N.I.S.			N.I.S.			N.I.S.			N.I.S.		
- Flow, mgd				0.309			0.307			0.312			0.308		
o Filtrate															
- Filtrate Flow, mgd				0.000			0.000			0.000			0.000		
- Characteristics, mg/L															
-- BOD	*			700			700			700			700		Default
-- TSS	*			250			250			250			250		Default
-- VSS				168			168			158			169		
-- NH3-N				1,807			1,779			1,558			1,784		
-- Organic-N				16			16			14			16		
-- NO3-N				0			0			0			0		
-- Alkalinity				5,414			5,394			5,196			5,303		
o Wash Water															
- Wash water, mgd/mgd feed	*			1.00			1.00			1.00			1.00		Default
-- Wash Water flow, mgd				0.000			0.000			0.000			0.000		
- Solids in Wash Water															
-- Unrecovered Solids, lb/d				0			0			0			0		
-- Solids in Filtrate				0			0			0			0		
-- Solids in Wash Water, lb/d				0			0			0			0		
-- TSS in Wash Water, mg/L				0			0			0			0		
- Characteristics, mg/L															
-- BOD				2			2			2			2		
-- TSS				0			0			0			0		
-- VSS				0			0			0			0		
-- NH3-N				0.0			0.0			0.2			0.0		
-- Organic-N				2			2			2			2		
-- NO3-N				7.1			6.9			7.6			6.5		
-- Alkalinity				140			141			139			142		
-- Filterable ("soluble") BOD				1.1			1.1			1.1			1.1		
-- Total soluble Organic N				2.4			2.3			2.4			2.4		
o Combined Filtrate & Wash Water															
- Flow, mgd															
-- Filtrate				0.000			0.000			0.000			0.000		

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Wash Water				0.000			0.000			0.000			0.000		
-- Total				0.000			0.000			0.000			0.000		
- Characteristics, mg/L															
-- BOD				0			0			0			0		
-- TSS				0			0			0			0		
-- VSS				0			0			0			0		
-- NH3-N				0			0			0			0		
-- Organic-N				0			0			0			0		
-- NO3-N				0			0			0			0		
-- Alkalinity				0			0			0			0		
-- Filterable ("soluble") BOD				0			0			0			0		
-- Total soluble Organic N				0.0			0.0			0.0			0.0		
CENTRIFUGE DEWATERING/THICKENING															
o Application				In Service Anaerobic Dig Dewat			In Service Anaerobic Dig Dewat			In Service Anaerobic Dig Dewat			In Service Anaerobic Dig Dewat		
o Sludge Feed															
- Flow Rate, mgd				0.309			0.307			0.312			0.308		
- TSS, %				3.18			3.20			3.34			3.26		
- Solids, lb/d				81,964			81,932			86,770			83,703		
-- VSS fraction				0.67			0.67			0.63			0.68		
o Number of Centrifuges	*			3			3			3			3		
- Number of Units in Service				2			2			2			2		
- Feed Rate, gpm per unit	*			250			250			250			250		
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				12.0			11.9			12.1			12.0		
o Chemical Dose															
- Ferric chloride, lb/ton	*			0			0			0			0		
- Ferric chloride, lb/day				0			0			0			0		
- Polymer, lb/ton	*			16			16			16			16		
- Polymer, lb/day				635			635			672			649		
- Chemical Sludge generated, lb/d				0			0			0			0		
o Sludge Cake															
- Capture, %	*			95			95			95			95		Default
- Cake Solids, lb/d				77,866			77,836			82,432			79,518		
- Concentration, %	*			24.9			25.0			27.5			23.6		Default
- Flow, mgd				0.0374			0.0373			0.0360			0.0405		
o Filtrate															
- Filtrate Flow, mgd				0.271			0.269			0.276			0.268		
- Characteristics, mg/L															
-- BOD	*			500			500			500			500	230	Default
-- TSS				1,812			1,823			1,886			1,876	250	
-- VSS				1,215			1,224			1,195			1,267	208	
-- NH3-N	*			1,807			1,779			1,558			1,784	23	
-- Organic-N	*			83			83			75			88	14	
-- NO3-N	*			0			0			0			0	0	
-- Alkalinity	*			6,452			6,354			5,563			6,373	250	
-- Fpv, VSS fraction				0.67			0.67			0.63			0.68	0.83	
-- Fvu, Fraction VSS that is Unbiodeg				**0.70**			**0.70**			**0.70**			**0.70**	0.350	
-- D.O. Concentration, mg/L				0			0			0			0	1.0	

* Input Data

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 8: TERTIARY TREATMENT

FINAL
February 2008

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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TERTIARY TREATMENT

8.1 PURPOSE

The purpose of this chapter is to analyze the tertiary influent equalization requirement, to evaluate the existing tertiary filters and future expansion alternatives, and to develop tertiary facility layouts that will meet the expansion needs at the Regional Water Quality Control Plant (RWQCP) for a total capacity of 52.2 mgd on an average daily basis.

8.2 CONCLUSIONS AND RECOMMENDATIONS

- The volume of the existing tertiary influent equalization basins is 6.0 MG. It is estimated that an additional equalization volume of 6.1 MG will be required based on the simulated Riverside wet-weather diurnal curves. The additional equalization basins can be built either as tertiary influent equalization basins or as primary effluent equalization basins.
- The existing filters are rated to have a capacity of 28.2 mgd on an average daily flow basis. If Membrane Bioreactors (MBRs) are used for secondary expansion, no tertiary facility expansion is needed. If MBRs are not used, an additional tertiary capacity of 24.0 mgd will be required to meet the 52.2-mgd average influent flow.
- Cloth-disk filters are recommended over conventional dual-media filters because of their lower life-cycle cost and ease of operation.
- The total project cost for the new tertiary filters is estimated to be $29.9 million for cloth-disk filters.

8.3 BACKGROUND

In Volume 4, Chapter 7 - Secondary Treatment, the alternative of MBRs for secondary treatment is discussed. MBRs of capacity 32 mgd for Plant 1 were chosen for future expansion at the project meeting on November 17, 2006. Because high-quality filtrate from MBRs does not require tertiary filtration, and the existing filters have a capacity of more than 20 mgd, no tertiary expansion is needed for the MBR alternative. Additional tertiary filters and flocculation basins are evaluated for non-MBR secondary treatment alternatives.

8.4 EXISTING TERTIARY TREATMENT FACILITIES

Table 8.1 presents the design information for the existing tertiary treatment facilities. The tertiary influent is equalized in four equalization basins. Flocculation basins are located upstream of Filters 11 through 16. There are 16 dual-media filters, each of which has a 24-inch anthracite layer and a 15-inch silica sand layer. Filters 1 through 10 have a smaller

surface area than Filters 11 through 16. Filters 9 and 10 were built together with Filters 11 through 16 in the early 1990s. They have an air scour blower to improve backwash performance, while Filters 1 through 8 only have water backwash.

Table 8.1 Existing Tertiary Treatment Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value	
TERTIARY INFLUENT EQUALIZATION		
Number of Equalization Basins	4	
Length	240 feet	
Width	140 feet	
Side Water Depth	7.2 feet	
Volume Each	1.5 MG	
Total Existing Volume	6.0 MG	
TERTIARY INFLUENT FLOCCULATION (FOR FILTERS 11 THROUGH 16 ONLY)		
Number of Flocculation Basins		10
Number of Stages		2 each
Volume Each		178,000 gallons
Average Alumer Dosage		0.2 mg/L
TERTIARY INFLUENT PUMPS		
Pump Stations	Plant 1	Plant 2
Number	2 duty + 1 standby	2 duty + 1 standby
Capacity	3 @ 13,050 gpm	3 @ 8,000 gpm
TERTIARY BACKWASH		
Number of Pumps	2 duty + 1 standby	
Capacity Each	3,200 gpm	
Quantity of Storage Tanks	2	
Volume Each	660,000 gallons	
TERTIARY FILTRATION		
Dual-Media Filters	Filters 1-10	Filters 11-16
Number	10	6
Surface Area Each	552 ft^2	650 ft^2
Total Surface Area	5,520 ft^2	3,900 ft^2

8.5 DESIGN CRITERIA

The tertiary peaking factor is 1.5. The maximum and the average loading rate for the tertiary filters is 5.0 gpm/ft^2 and 3.33 gpm/ft^2 at the tertiary peak flow and average flow rates, respectively. For cloth filters, the Title 22 maximum allowance is 6.0 gpm/ft^2. However, for this analysis, 5.0 gpm/ft^2 is used, the same as conventional dual-media filters, based on recent experience with cloth-filter loading rates at other plants.

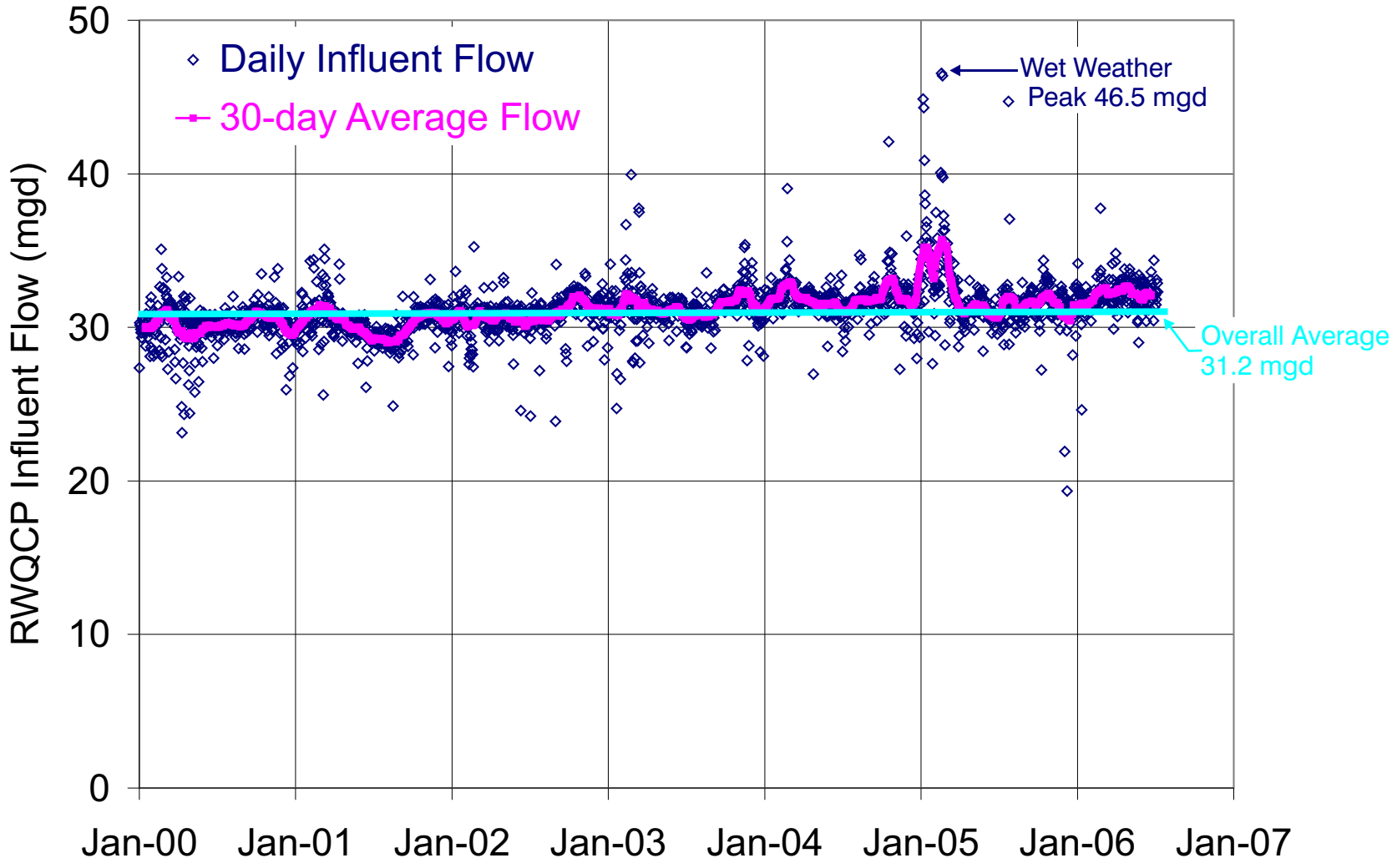
The detention time for the tertiary flocculation basins is 15 minutes at the average daily flow, including the filter backwash flow.

8.6 TERTIARY INFLUENT EQUALIZATION SYSTEM

The purpose of the equalization system is to balance fluctuating flows from upstream, and reduce the surface area requirements for tertiary filters. Assuming the equalization basins are emptied every day, the necessary volume should be the accumulated volume above the capacity of the tertiary filters during a wet-weather peak day. The filter capacity will match or exceed the average influent flow in a wet weather day.

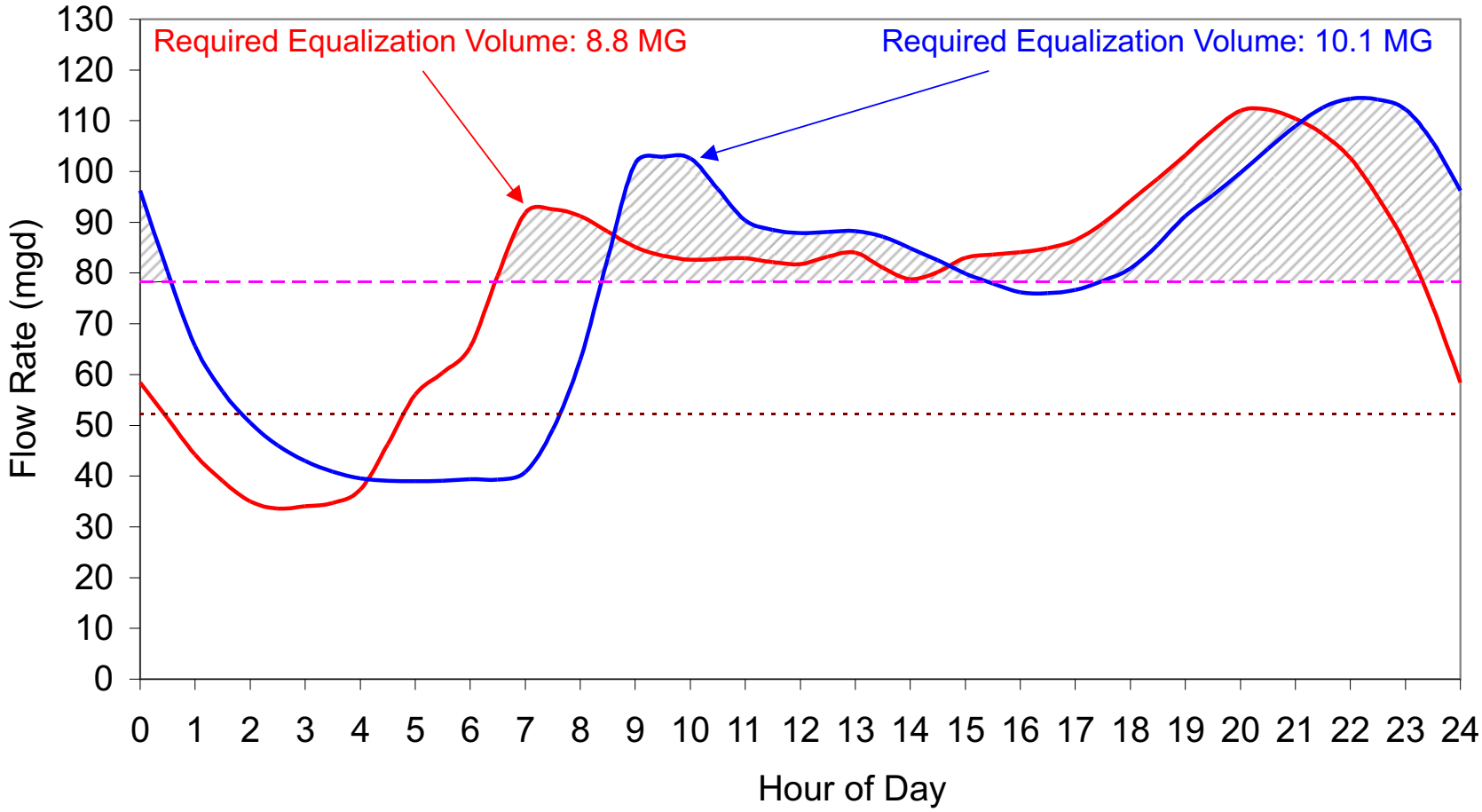
To determine the average daily influent flow during a wet-weather peak day, the RWQCP influent flow data for the last 6 years was used as presented on Figure 8.1. The figure shows that the average daily flow for the highest peak day occurred in February 2005, at 46.5 mgd. During the entire 6-year data timeframe, the average daily flow was 31.2 mgd. The ratio of the maximum average daily flow (46.5 mgd) to the overall average daily flow (31.2 mgd) is approximately 1.5. Applying the 1.5 ratio to the projected 2025 annual average daily flow of 52.2 mgd results in a peak wet-weather average daily flow of 78.0 mgd. The accumulated volume above this value in a diurnal flow curve is used to calculate the maximum necessary volume of the equalization basins.

Since there is no diurnal flow curve available for the RWQCP, the diurnal curves from the City's Collection System Master Plan were used. Data from the two flowmeters (Meters 7 and 8), located close to the RWQCP, as discussed in Volume 4, Chapter 12 - Primary Effluent Equalization, were used to simulate the RWQCP diurnal curve, as shown on Figure 8.2. The equalization volume is equal to the area below the simulated diurnal flow curves and above the peak wet-weather average daily flow line (78.0 mgd). The required volumes are 10.1 MG and 8.8 MG for the two curves, respectively. Using the larger required volume from the adopted curves and including a 20-percent safety factor as an operational contingency, the total designed equalization volume is 12.1 MG. This total volume can be built as either tertiary influent equalization or primary effluent equalization.



DAILY INFLUENT FLOW AT RWQCP

FIGURE 8.1



SIMULATED RWQCP
WET WEATHER DIURNAL FLOW

FIGURE 8.2

If primary effluent equalization basins are not used, two new tertiary influent equalization basins would be needed for the additional volume of 6.1 MG, as presented in Table 8.2. The final design of the equalization basins should use the actual diurnal curve for the RWQCP, which will be available after completion of the influent metering project. The dimensions of the new basins should be determined during the preliminary design based on a geotechnical investigation. A cursory review of the existing geotechnical boring logs from past geotechnical reports completed for the adjacent area indicates a groundwater level of approximately 15 feet below ground level. For this reason, the depth of the equalization basins is limited to 8 feet for this Integrated Master Plan.

Table 8.2 Tertiary Influent Equalization Basin Volume
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Quantity	Size	Total Volume
Required Volume			10.1 MG
Total Volume(1)			12.1 MG
Existing Basins	4	240 x 140 x 7.2 ft. (1.5 MG)	6.0 MG
New Basins(2)	2	330 x 250 x 8 ft. (4.4 MG)	6.1 MG

Notes:
(1) Includes 20-percent operational safety factor.
(2) Assume 2:1 sloped side; dimensions depended on geotechnical conditions.

8.7 TERTIARY FILTERS

For this Integrated Master Plan, two expansion alternatives, conventional dual-media filters and cloth-disk filters, are evaluated for tertiary filtration. They are assessed based on a life-cycle cost analysis as well as other non-economic factors.

8.7.1 Alternative 1 – Conventional Dual-Media Filters

The conventional filters are designed to filter water by gravity and the filters are removed from service intermittently for backwash, which usually uses water accompanied by air from the bottom to loosen particles adhering to the sand grains. Based on one backwash filter for each filter system and one standby filter for every six filters, Table 8.3 lists the existing capacity and the required tertiary treatment capacity for non-MBR expansion alternatives for both conventional and cloth filters.

Table 8.3 Tertiary Filters Capacity (Tertiary Peaking Factor = 1.5)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

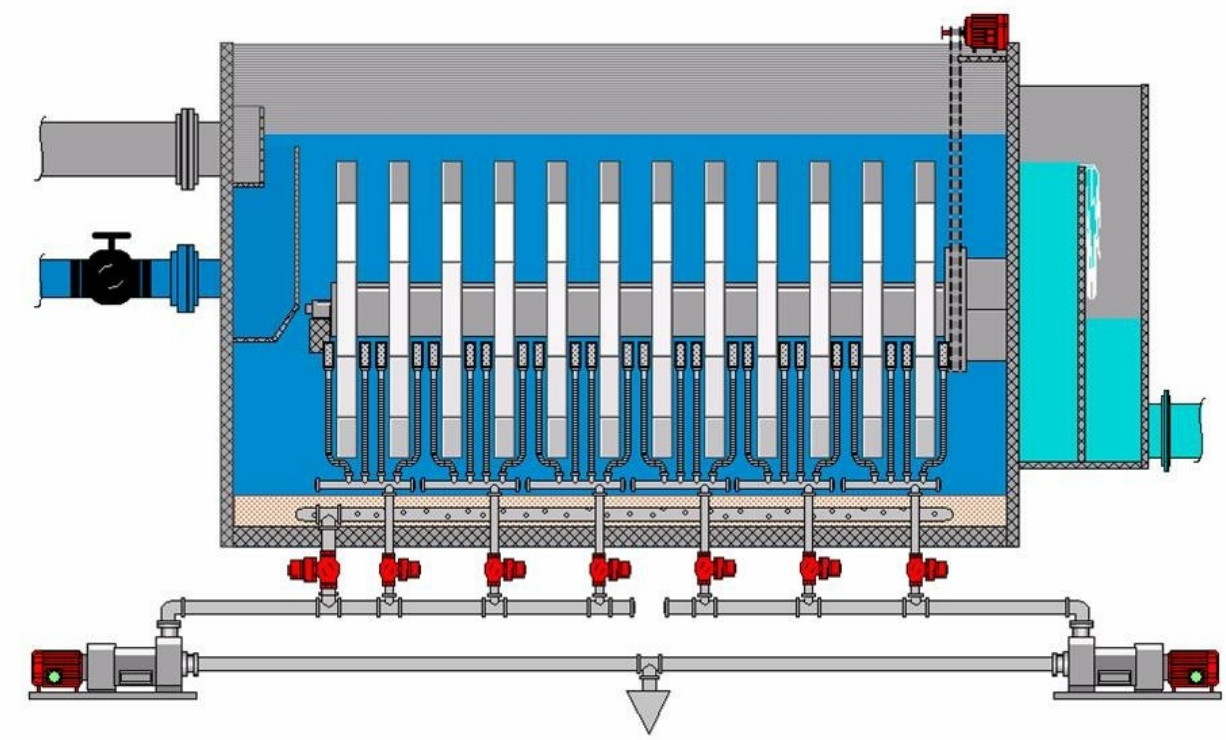
Existing Dual-Media Filters	Filters 1-10	Filters 11-16
Designed Loading Rate	3.3 gpm/ft^2	3.3 gpm/ft^2
Wet-Weather Peak Loading(1)	5.0 gpm/ft^2	5.0 gpm/ft^2

Table 8.3 Tertiary Filters Capacity (Tertiary Peaking Factor = 1.5) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Quantity	10 (7 duty, 2 standby, 1 backwash)	6 (4 duty, 1 standby, 1 backwash)
Surface Area for Each Filter	552 ft^2	650 ft^2
Total Area	5,520 ft^2	3,900 ft^2
Total Effective Area	3,864 ft^2	2,600 ft^2
Tertiary Flow Including Backwash(2)	31.0 mgd	
Existing Capacity	28.2 mgd	
New Filters	**Alternative 1: Conventional (Dual-Media)**	**Alternative 2: Cloth-Disk (AquaDisk®)**
Designed Loading Rate	3.3 gpm/ft^2	3.3 gpm/ft^2
Wet-Weather Peak Loading(1)	5.0 gpm/ft^2	5.0 gpm/ft^2
Quantity	12 (9 duty, 2 standby, 1 backwash)	10 (8 duty, 2 standby)
Surface Area for Each Filter	620 ft^2	646 ft^2
Total Area	7,440 ft^2	6,460 ft^2
Total Effective Area	5,580 ft^2	5,168 ft^2
Tertiary Flow Including Backwash(2)	26.4 mgd	24.7 mgd
Expansion Capacity	24.0 mgd	24.0 mgd
Total Capacity (Existing + Expansion)	52.2 mgd	52.2 mgd

Notes:
(1) Maximum Title 22 Loading Rate: 5.0 gpm/ft^2 for conventional filters, 6.0 gpm/ft^2 for cloth-disk filters.
(2) Backwash for dual-media filters: 10 percent; backwash for cloth-disk filters: 3 percent.

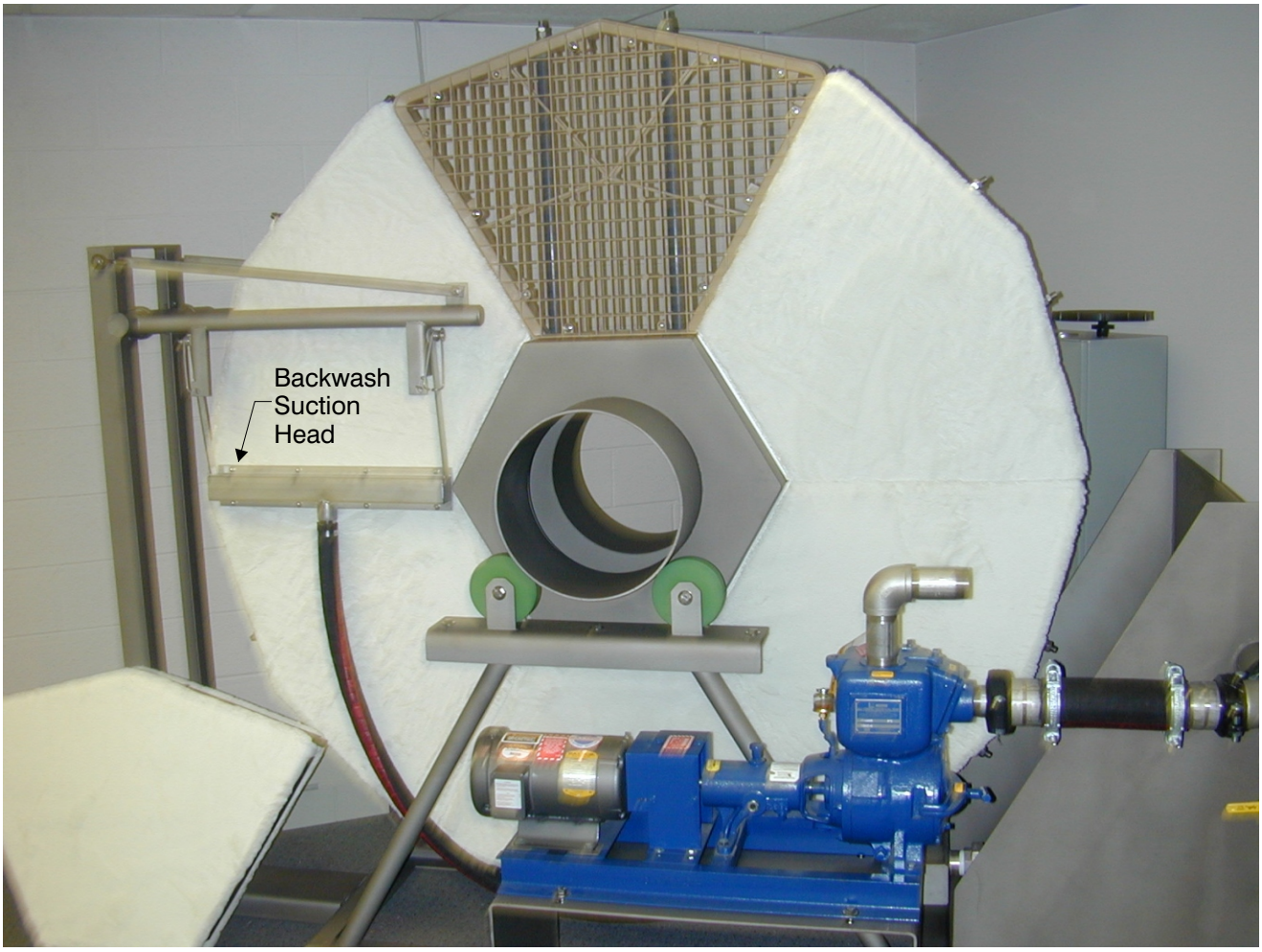
8.7.2 Alternative 2 – Cloth-Disk Filters

Figure 8.3 shows a section of a typical AquaDisk® cloth-disk filter unit. Each AquaDisk® unit has 12 cloth-disk filters that are completely submerged. By gravity, liquid passes through the cloth media with an outside-in mode. The backwash cycle is initiated at a predetermined level or time, and the solids are removed by a stationary backwash suction head, as shown on Figure 8.4. The suction head behaves similar to a vacuum cleaner, through a manifold that creates suction to force filtrate back through a small portion of the filter panels from both sides of each disk. The disks rotate at 1 rpm to allow the entire surface of the filter panels to be cleaned. The disks are cleaned in multiples of two, and one backwash cycle takes 6 minutes. During the backwash cycles, filtration is continuous. The cloth disks are stationary except during the backwash cycle. There are two 2-hp backwash pumps and one 0.75-hp shaft driver for each unit, and the backwash valves and motors are automatically controlled.



AQUADISK® UNIT CONFIGURATION

FIGURE 8.3



AQUADISK® CLOTH DISK SECTION

FIGURE 8.4

8.7.3 Non-Economic Comparison

A comparison of non-economic factors for the two alternatives is presented in Table 8.4. In general, cloth-disk filters have a simpler mechanism and require less maintenance, but cloth media have a lower resistance to chemicals. If chlorine is used to control algae and slime, the concentration should not exceed 1 mg/L for the cloth-disk filters. The cloth media are also sensitive to polymer concentrations. Therefore, polymer dosage needs to be carefully controlled to avoid blinding the filters.

Table 8.4 Non-Economic Comparison of Conventional and Cloth-Disk Filters Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Alternative 1: Conventional (Dual-Media)	Alternative 2: Cloth-Disk (AquaDisk®)
Operating Filter Head Loss	10 feet	3 feet
Long-Term Equipment Reliability	+	0
Resistance to Chemical Addition	+	–
Flocculation Basin Required	0	0
Backwash Downtime	–	+
Backwash Horsepower Requirement	–	+
Maintenance Requirement	–	+
Air Scour Blower Requirement	–	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

8.7.4 Flocculation Basins

Based on experience from other installations, flocculation basins may be needed to meet Title 22 standards consistently. For this evaluation, it is assumed that flocculation basins are required. Pilot or bench-scale testing can help determine this. The dosage requirement for the alumer (or alum and polymer) would be affected by the particle distribution of the tertiary influent, and the dosage should be determined based on pilot or bench-scale testing. The capacity and costs of the flocculation basins are based on the average tertiary flow for the new filters, including the filter backwash at a detention time of 15 minutes.

8.7.5 Site Layout

A proposed layout for a tertiary influent pump station, new flocculation basins, and new filters is shown on Figure 8.5, near the existing filters and chlorine contact basins. The footprint for the filters on Figure 8.5 includes room for either the cloth-media or the dual-media filter alternatives.

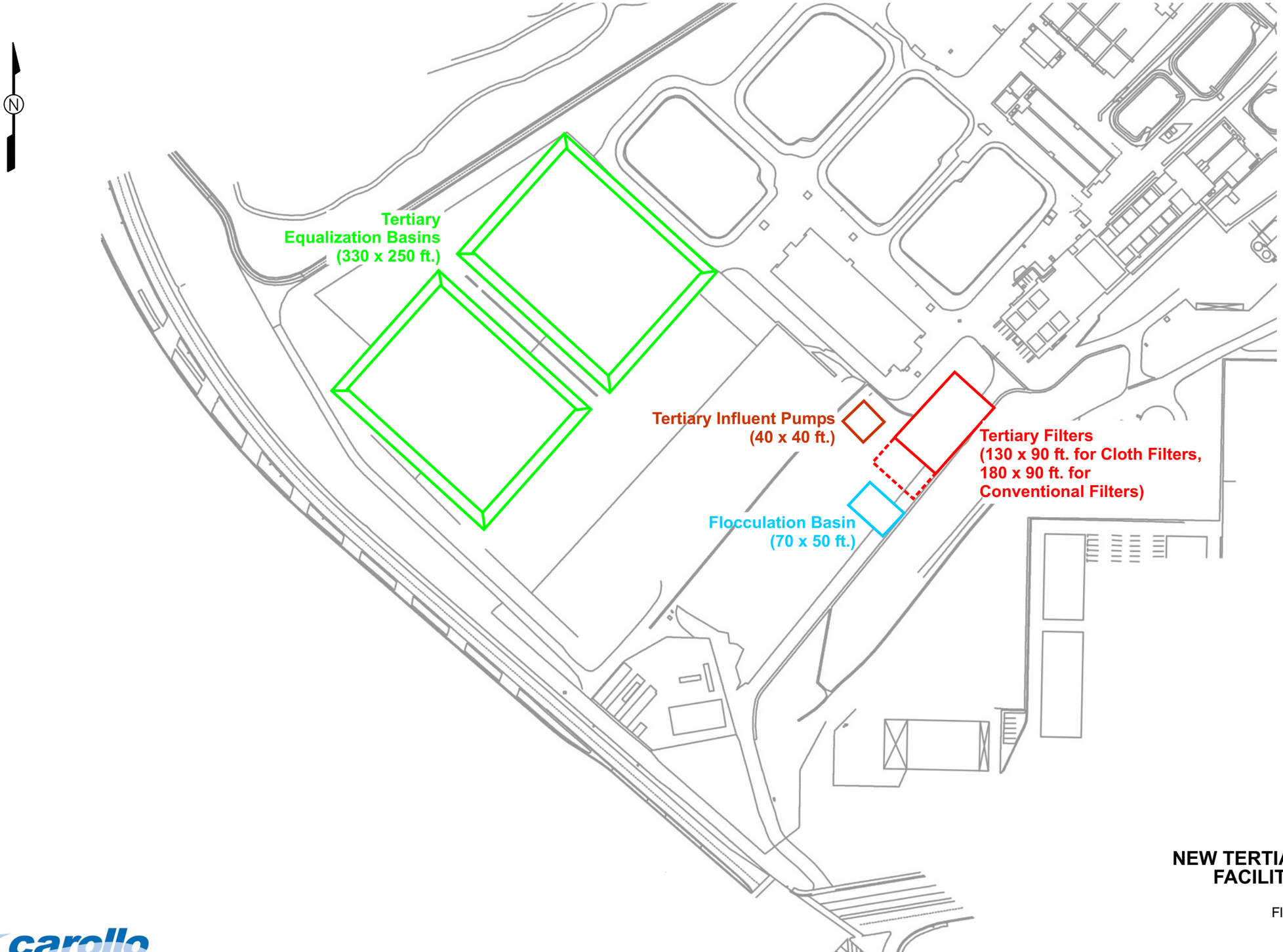
8.7.6 Life-Cycle Cost Analysis

The total project costs are $40.0 and $29.9 million for conventional filters and cloth-disk filters, respectively. The Operations and Maintenance (O&M) costs for conventional filters are also higher than the cloth-disk filters. Life-cycle costs for the two alternatives are shown in Table 8.5. At the project meeting on November 17, 2006, it was decided to use cloth-disk filters because of the lower life-cycle cost and simplicity of operation.

Table 8.5 Life-Cycle Cost of Conventional and Cloth-Disk Filters Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Alternative 1: Conventional (Dual-Media)	Alternative 2: Cloth-Disk (AquaDisk®)
Filter Facility(1)	$10,390,000	$7,300,000
Flocculation Basins(1)	$1,090,000	$1,020,000
Tertiary Influent Pump Station(1)	$1,160,000	$1,110,000
Total Project Cost	$40,000,000	$29,900,000
Yearly O&M Cost(2)	$153,000	$86,000
Replacement Cost(3)	$199,000	$91,000
Life-Cycle Cost(4)	$42,800,000	$31,500,000

Notes:
(1) Total direct costs.
(2) Includes the chemical cost and backwash pumping cost. The required media refill and the influent pumping power cost for the 7-foot head loss difference is also included for conventional filters (see the first item in Table 8.4).
(3) Conventional dual media will be replaced every 10 years, and cloth media will be replaced every 5 years.
(4) As present value, assuming a life-cycle period of 19 years, a discount rate of 6 percent, and an escalation rate of 6 percent for the first 5 years and 4 percent thereafter.



NEW TERTIARY TREATMENT FACILITIES LAYOUT

FIGURE 8.5

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 9: DISINFECTION

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 9: DISINFECTION

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DISINFECTION

9.1 PURPOSE

The purpose of this chapter is to evaluate expansion alternatives for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) disinfection system that will meet California Title 22 standards. Ultraviolet (UV) and/or ozone disinfection are compared with the existing sodium hypochlorite (NaOCl) chlorination and dechlorination system.

9.2 CONCLUSIONS AND RECOMMENDATIONS

- Existing NaOCl should continue to be used as the disinfection method unless future regulations require removal of pollutants that only advanced disinfection systems can provide.
- Ozone or ozone plus UV should be considered for disinfection if removal of Endocrine Disrupting Compounds (EDCs) is required by future regulations. These alternatives will be developed as alternate treatment scenarios for the Master Plan Manager™ (MPM™).
- UV alone will not be used as the disinfection method because it is incapable of removing EDCs.
- A tracer test should be performed for each existing chlorine contact basin in order to determine the size requirement for new basins.

9.3 DESIGN CRITERIA

The average and maximum daily flows to the disinfection facilities are 52 mgd and 78 mgd, respectively.

California Title 22 standards are used for the evaluation in this Chapter. Title 22 requires disinfected tertiary recycled water to meet the following criteria:

1. The filtered wastewater has been disinfected by either:
    a. A chlorine disinfection process following filtration that provides a CT (the product of total chlorine residual and modal contact time measured at the same point) value of not less than 450 milligram-minutes per liter at all times with a modal contact time of at least 90 minutes, based on peak dry weather design flow; or
    b. A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999 percent of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration.

2. The median concentration of total coliform bacteria measured in the disinfected effluent does not exceed an MPN of 2.2 per 100 milliliters utilizing the bacteriological results of the last 7 days for which analyses have been completed and the number of total coliform bacteria does not exceed an MPN of 23 per 100 milliliters in more than one sample in any 30-day period. No sample shall exceed an MPN of 240 total coliform bacteria per 100 milliliters.

For the Integrated Master Plan, the dose and contact time of each disinfection alternative to meet the above requirements are listed in Table 9.1.

Table 9.1 Design Criteria for Disinfection Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Disinfection	Dose	Contact Time
NaOCl	450 mg-min/L	106 min(1)
UV(2)	100/80 mJ/cm^2(3)	-
Ozone(4)	5 mg/L	15 min
Ozone and UV(5)	Ozone: 3 mg/L	-
	UV: 100/80 mJ/cm^2(3)	

Notes:
(1) Modal contact time equals 90 minutes, based on an assumed ratio of modal contact time to theoretical contact time of 0.85.
(2) UV as the only disinfection method, using open-channel reactors.
(3) Dose for tertiary filtrate/membrane bioreactor (MBR) effluent. Total dose includes fouling and aging factors.
(4) Ozone as the only disinfection method, using contact basins for MBR effluent only.
(5) Ozone in-pipe contactor followed by in-vessel UV reactor. Without published studies quantifying the disinfection credit of ozone pretreatment, the UV dose is assumed the same as without ozone pretreatment. This could be lowered upon pilot testing.

9.4 EXISTING DISINFECTION FACILITIES

The existing disinfection facilities are listed in Table 9.2. As discussed in Volume 4, Chapter 1 - Existing Facilities, the RWQCP has three Chlorine Contact Basins (CCBs) for chlorination. Water from CCB1 discharges into CCB2 or CCB3. CCB2 is currently out of service. Part of the CCB1 effluent is used as recycled water for the Van Buren Golf Course and RWQCP utility water needs. The remaining portion of the CCB1 effluent goes through CCB3 for either urban forest irrigation or river discharge. Sodium bisulfite is used to dechlorinate the flow that is discharged to the river.

Table 9.2 Existing Disinfection Facilities Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside			
Description	**Value**		
Chlorination			
Disinfection Chemical	Sodium Hypochlorite (NaOCl)		
Current Chemical Dose	5 to 8 mg/L		
Chlorine Contact Basins	CCB 1	CCB 2	CCB 3
Length to Width Ratio	18.5:1	63.5:1	48:1
Volume	448,320 gal	1,426,470 gal	3,022,960 gal
Total Volume	4.90 MG		
Theoretical Contact Time	106 min		
Modal Contact Time	90 min		
Existing Capacity	44 mgd (Average Daily Flow)		
Dechlorination			
Dechlorination Chemical	Sodium Bisulfite ($NaHSO_3$)		

To evaluate the capacity of the existing CCBs, a modal contact time of 90 minutes is used to meet Title 22 standards. Ideally, water entering a basin will travel from the inlet to the outlet for a period equal to the reactor volume divided by the flow rate, which is termed as theoretical contact time. However, because of back-mixing and velocity currents, along with short-circuiting and dead zones, the modal contact time is shorter than the theoretical contact time. The modal contact time corresponds to the maximum concentration in a tracer curve for a pulse-input tracer test.

Because no tracer tests have been performed on the three CCBs, the ratio of modal contact time to the theoretical contact time is assumed to be 0.85 to calculate the maximum basin capacity. Applying a tertiary peaking factor of 1.5, the current disinfection capacity is 44 mgd on an average daily basis. An additional facility with a capacity of 8 mgd is needed for expansion to 52 mgd. If tracer tests are performed for the three CCBs and the results show that the modal contact time is close to the theoretical contact time for all CCBs, then a small capacity may be needed. Also, it may be possible to modify the basins to improve modal contact time. Therefore, it is recommended that the City perform tracer tests on each of the existing CCBs.

The chemical systems for chlorination and dechlorination, including the feed equipment and chlorine storage facilities, will be evaluated as needed for the 52-mgd expansion during preliminary design.

9.5 EXPANSION ALTERNATIVES

Increased understanding of chlorine-based disinfection shortcomings on pathogens and rising public and regulatory concerns on Disinfection By-Products (DBPs) such as Trihalomethanes (THMs) and Haloacetic Acids (HAA5), have pushed the wastewater treatment industry to look for alternative disinfectants to chlorine. Advances in analytical methods coupled with toxicity research on humans and wildlife may result in the regulation of constituents that are not currently regulated at wastewater treatment plants. These constituents may include nitrosamines, (e.g., N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), N-nitrosodi-n-propylamine (NDPA)), and EDCs.

For the Master Plan, UV and ozone are considered as alternatives to the existing hypochlorite disinfection. UV disinfection is considered because it is a well-proven and cost-effective disinfection technology. Ozone is a much less common wastewater treatment technology than UV, and it is currently not accepted by the California Department of Health Services (CDHS) as an approved technology for the production of recycled water. However, there are several full-scale ozone installations for water treatment disinfection. In addition, there are studies that suggest that ozone is an effective disinfectant with a strong potential for EDC destruction.

9.5.1 Sodium Hypochlorite

While chlorine-based disinfection is predicted to be phased out gradually, it is likely to maintain some presence until other treatment methods capable of leaving a measurable disinfection residual are developed. For recycle and reuse, even with advanced disinfection such as ozone and UV, a 2-mg/L chlorine residual is recommended in distribution systems to control bacterial regrowth. The advantages and disadvantages of NaOCl disinfection are as follows:

9.5.1.1 Advantages

- Existing disinfectant at the RWQCP, so operating experience exists.
- Most economical.
- Provides disinfection residual for recycled water.

9.5.1.2 Disadvantages

- Disinfection by-product formation.
- Risk of transporting and storing a hazardous chemical.
- Potential lower capability of virus and protozoa removal when compared to ozone and UV.
- Higher Total Dissolved Solids (TDS) in the effluent.
- Requires dechlorination for river discharge.

9.5.2 Ultraviolet

UV disinfection is a well-proven and robust process when the reactor design is optimized and particles do not shield pathogens or interfere with light transmission. A low-pressure high-intensity UV channel is shown on Figure 9.1. UV radiation at a wavelength of 254 nm is an effective agent to inactivate microorganisms by damaging their DNA. The inactivation of microorganisms is proportional to the intensity multiplied by the time of exposure to UV, termed as UV dose. The actual UV dose reaching the microorganism depends on factors such as the UV transmittance (UVT), flow rate, the geometry of the UV reactor, and the hydraulics of the system. The advantages and disadvantages of UV disinfection are as follows:

9.5.2.1 Advantages

- Physical process: No disinfection by-products.
- Higher virus and protozoan pathogen inactivation than chlorine-based disinfection.
- Fast reaction time and small footprint.
- Compatible with chlorination to provide a multiple barrier. Pre-UV chlorination provides algal growth control.

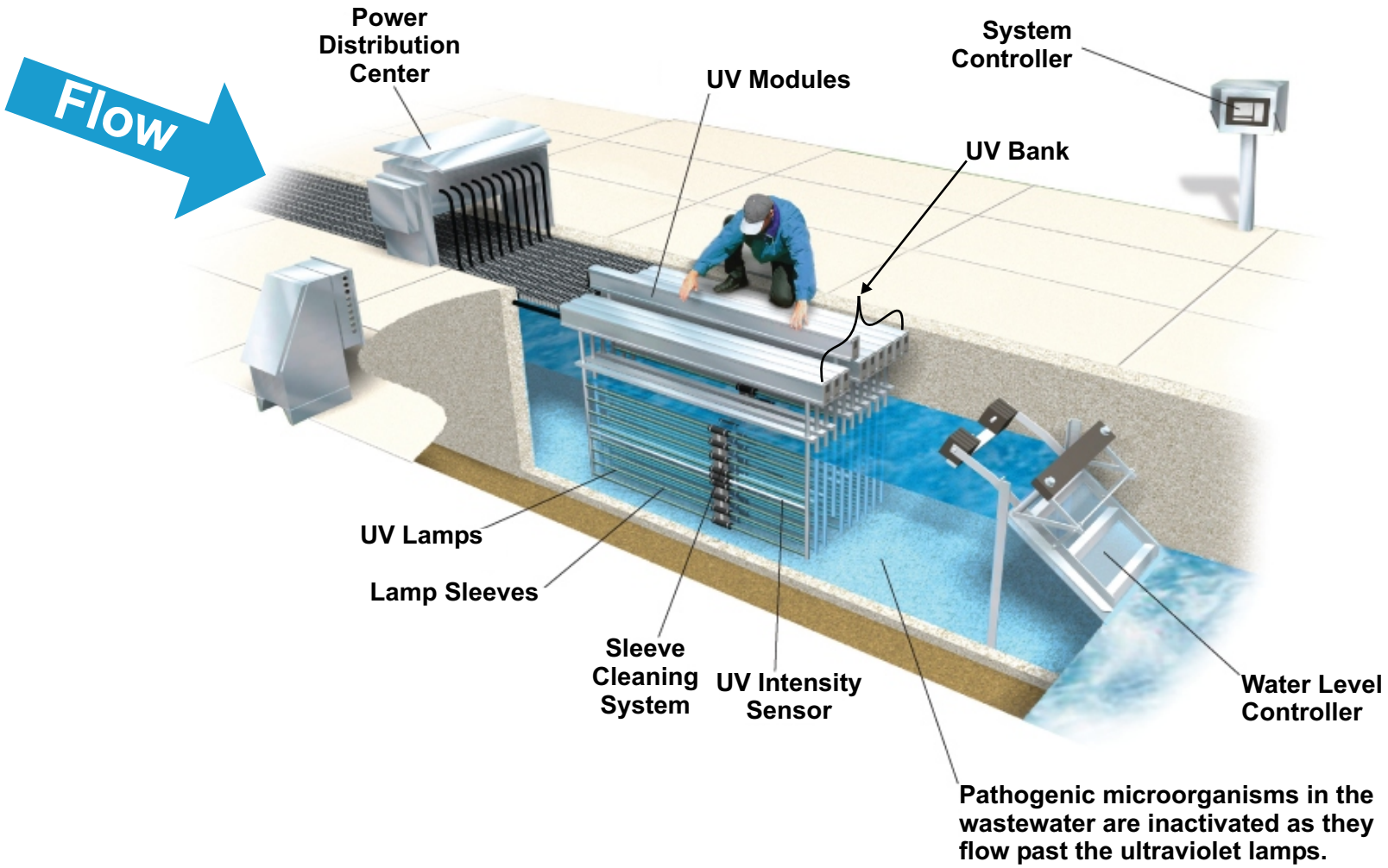
9.5.2.2 Disadvantages

- Not effective on EDCs.
- Higher cost than chlorine-based disinfection.
- Performance can be negatively affected by the presence of particle-associated organisms: It is expected that the RWQCP tertiary effluent has low turbidity and small particles. Therefore, UV is expected to be effective at the designed dose for this project.

9.5.3 Ozone

Ozone disinfects by oxidizing the cell walls of the microorganisms, causing them to disintegrate. This is a different mechanism from chlorine, which diffuses though the cell wall, making the cell susceptible to enzymatic attack. For this reason, ozone disinfects more effectively and much faster. Ozone was originally used in potable water treatment. The use of ozone for wastewater disinfection has not increased comparably to its use in drinking water disinfection, due to its high cost for a high dose. A typical ozone process schematic is shown on Figure 9.2.

Because recent research has shown that EDCs may cause gender deformities in fish around ocean outfalls and surface water discharges, it is predicted that EDCs will be regulated in the future.

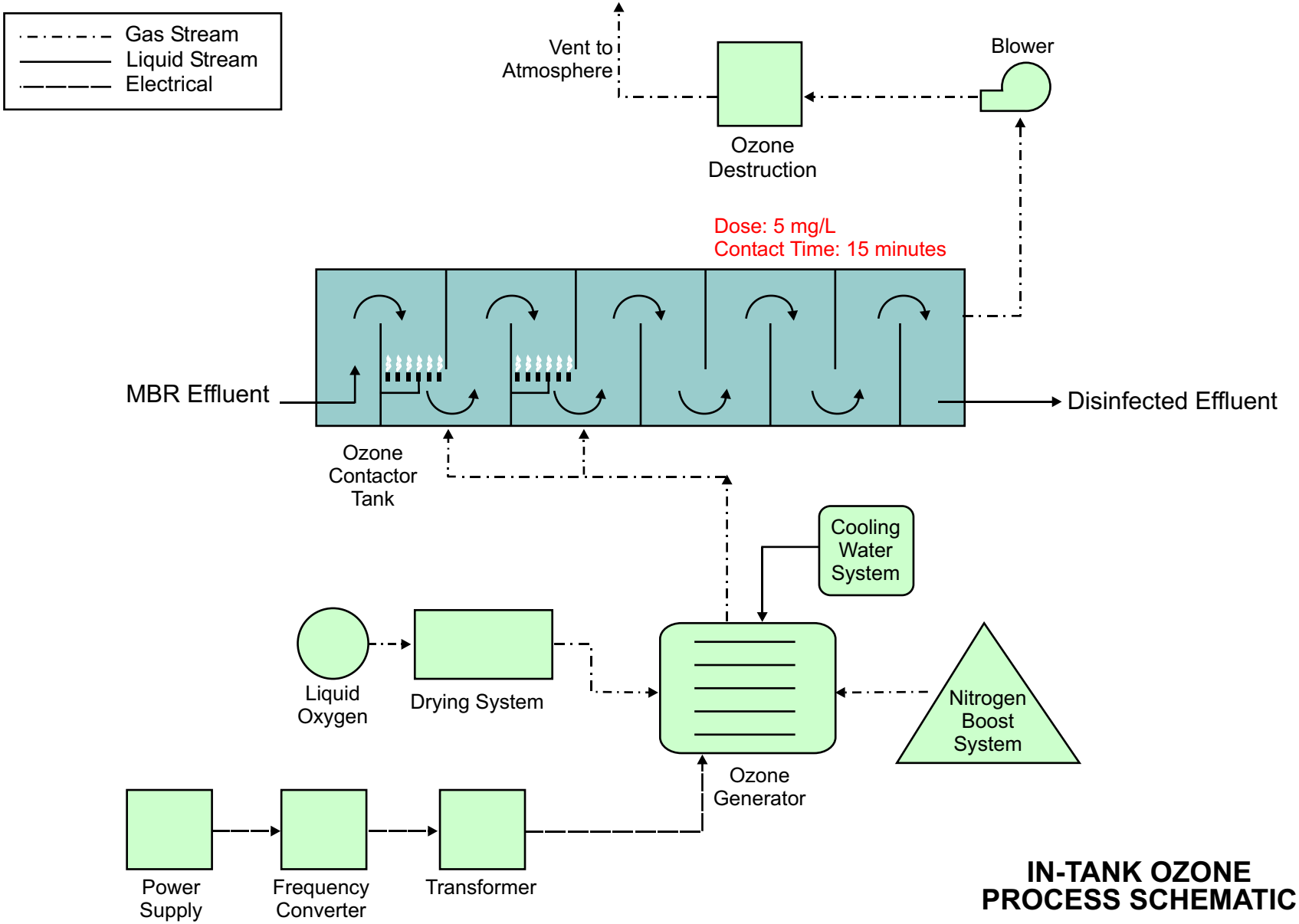


Note:

UV systems usually consist of multiple banks in series per channel.

OPEN-CHANNEL UV SYSTEM: TROJAN UV3000PLUS™

FIGURE 9.1



IN-TANK OZONE PROCESS SCHEMATIC

FIGURE 9.2

Research also shows that ozone is the most effective method to destroy EDCs compared to NaOCl and UV. The advantages and disadvantages of ozone disinfection are as follows:

9.5.3.1 Advantages

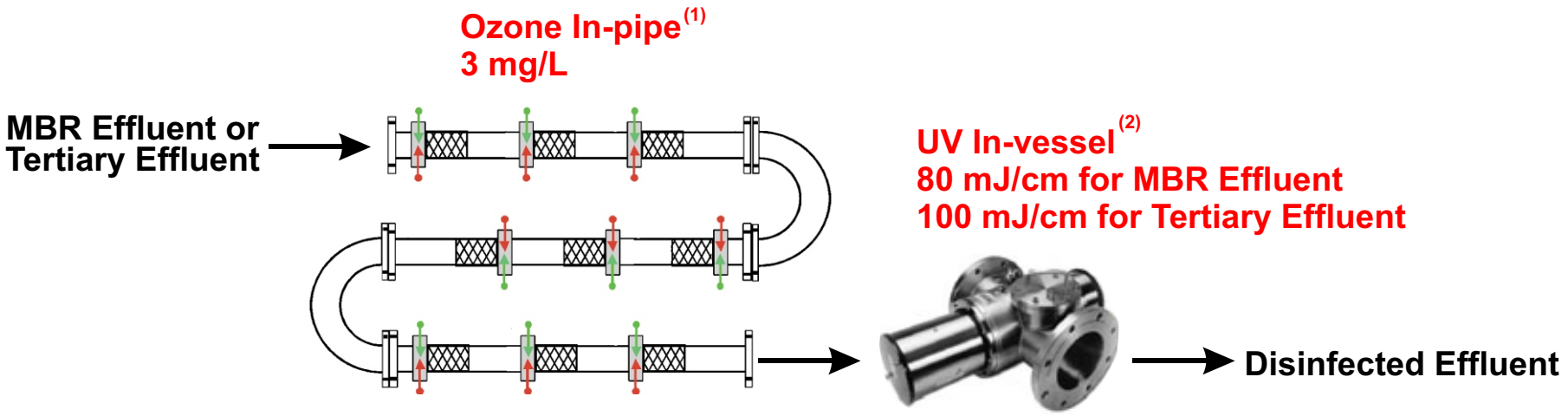
- Effective on bacteria, viruses, and micro-pollutants.
- Strong oxidant: Eliminates color, odor, and taste by oxidizing organic and inorganic matter (primarily potable water advantages).
- Increases the dissolved oxygen content of the effluent for river discharges.

9.5.3.2 Disadvantages

- Currently it is not approved by the CDHS as an accepted disinfection technology for the production of recycled water.
- High cost is related to the high dose and low efficiency of ozone generation equipment. Therefore, it is not cost effective without MBRs upstream.
- Possibility of bromate/bromine formation at high ozone doses (higher than 10 mg/L). Therefore, it is not applicable for conventional tertiary effluent, which requires high doses.
- Complexity of the ozone system: Ozone has to be generated on-site and the equipment includes an ozone generator, power supply unit, ozone dissolution system, ozone contactor, ozone destruction unit, nitrogen boosting system, cooling unit, Liquid Oxygen (LOX) storage, LOX filters, dryers and vaporizers, valves, and controls.
- Ozone is corrosive and toxic.
- Off-gas requires destruction.
- Organic disinfection by-products may be formed in the process, such as aldehydes, ketones, and acetaldehydes.

9.5.4 Ozone and Ultraviolet

Because low dose ozone can increase UV transmittance, the disinfection costs using low dose ozone followed by UV are potentially equivalent to UV only costs. Additionally, because of the concern of EDCs and the infeasibility of ozone as a disinfection method for non-MBR applications, a combined ozone and UV process, as shown on Figure 9.3, is evaluated for the Master Plan. To obtain a higher ozone contact efficiency and improve hydraulics, an in-pipe ozone contactor (Applied Process Technology Inc., Pleasant Hill, California) is used for this alternative. In addition, an in-vessel UV reactor is used in this process for better dose distribution.



Notes:

1. Ozone in-pipe contactor (Applied Process Technology, Pleasant Hill, CA) provides 1 minute contact time for mixing.
2. UV dose includes fouling and aging factors.

OZONE IN-PIPE AND UV IN-VESSEL PROCESS SCHEMATIC

FIGURE 9.3

The advantages and disadvantages of the combination of ozone and UV disinfection are as follows:

9.5.4.1 Advantages

- Low dose ozone will increase UV transmittance and provide partial disinfection and micro-pollutant destruction with less possibility of bromate/bromine formation. Shorter ozone contact time.
- No requirement for residual ozone destruction.
- An Advanced Oxidation Process (AOP) in which secondary oxidants are formed to oxidize organic and inorganic compounds including EDCs.

9.5.4.2 Disadvantages

- No experience in a wastewater application.
- The combined low dose ozone and UV process has currently not been approved by CDHS for water recycling applications.

9.6 NON-ECONOMIC COMPARISON OF ALTERNATIVES

A non-economic comparison of the alternatives is summarized in Table 9.3.

Table 9.3 Non-Economic Comparisons of Disinfection Alternatives Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	NaOCl	UV	Ozone	Ozone+UV
Microorganism Inactivation	0	+	0	+
EDC Destruction	0	–	+	+
Contact Time	–	+	+	+
Disinfection By-Products	–	+	0	+
TDS	–	+	+	+
Safety Concerns	–	+	–	–
Operating Experience	+	0	–	–
Ease of Operation	+	0	–	–
Ease of Maintenance	+	–	–	–
Disinfection Residual	Yes	No	No	No

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

9.7 LIFE-CYCLE COST

Life-cycle costs for the alternatives are shown in Tables 9.4 through 9.6.

Table 9.4 presents a comparison of the alternatives for disinfection facilities sized for 8 mgd. In this comparison, all of the disinfection alternatives are assumed for conventional tertiary effluent. In addition, in this comparison, the existing NaOCl disinfection system would continue to be used for 44 mgd and an additional 8 mgd of disinfection would be provided by one of the three alternatives for disinfection. This would increase the total disinfection system capacity from 44 mgd to 52 mgd.

Table 9.4 Life-Cycle Costs of Disinfection Alternatives: 8-mgd Conventional Effluent
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Disinfection	NaOCl(1)	UV	Ozone+UV(2)
Total Project Cost	$4,070,000	$10,100,000	$22,230,000
Yearly O&M Cost	$151,000	$228,000	$381,000
Life-Cycle Cost(3)	**$6,670,000**	**$14,010,000**	**$28,770,000**

Notes:
(1) Yearly operation and maintenance (O&M) cost and life-cycle cost for NaOCl disinfection include the costs for dechlorination with sodium bisulfite.
(2) Cost based on UV dose of 100 mJ/cm^2 for conventional tertiary effluent. The dose, and thus the cost, may be lowered upon the completion of pilot testing.
(3) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

Table 9.5 presents a comparison of the alternatives for disinfection facilities sized for 52 mgd. Similar to the comparison in Table 9.5, all of the disinfection alternatives in this comparison are assumed for conventional tertiary effluent. In this comparison, for the NaOCl alternative, the existing NaOCl disinfection system would continue to be used for 44 mgd and an additional 8-mgd CCB would provide the remaining disinfection capacity. For the UV and ozone alternatives, new facilities with a capacity of 52 mgd would be required, because either of these alternatives would replace the existing NaOCl facilities if selected.

Table 9.5 Life-Cycle Costs of Disinfection Alternatives: 52-mgd Conventional Effluent
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Disinfection	NaOCl(1)	UV	Ozone+UV(2)
Total Project Cost	$4,070,000	$47,000,000	$70,410,000
Yearly O&M Cost	$980,000	$1,279,000	$1,579,000

Table 9.5 Life-Cycle Costs of Disinfection Alternatives: 52-mgd Conventional Effluent
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Disinfection	NaOCl[1]	UV	Ozone+UV[2]
Life-Cycle Cost[3]	**$20,900,000**	**$68,950,000**	**$97,520,000**

Notes:
(1) The project cost for NaOCl disinfection only includes the additional 8-mgd CCB. Yearly O&M cost and life-cycle cost include chlorination and dechlorination for both existing and new facilities for 52 mgd.
(2) Cost based on UV dose of 100 mJ/cm^2 for conventional tertiary effluent. The dose, and thus the cost, may be lowered upon the completion of pilot testing.
(3) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

Table 9.6 also presents a comparison of the alternatives for disinfection facilities sized for 52 mgd. However, in this comparison, it is assumed that the disinfection alternatives will be for 20 mgd of conventional tertiary effluent and 32 mgd of MBR effluent. In this comparison, for the NaOCl alternative, the existing NaOCl disinfection system would continue to be used for 44 mgd and an additional 8-mgd CCB would provide the remaining disinfection capacity. For the UV and/or ozone alternatives, new facilities with a capacity of 52 mgd would be required, because either of these alternatives would replace the existing NaOCl facilities if selected. However, there are several different combinations of UV and ozone treatment that can be applied to the 52 mgd, depending upon whether the influent to the disinfection system is from conventional tertiary or MBR systems. These combinations follow the general rule that ozone is only used in series with UV for disinfection of conventional tertiary effluent, but can be used by itself for disinfection of MBR effluent. As described previously, this is due to the potential for bromate/bromine formation when high doses of ozone are applied to conventional tertiary effluent, and it is not a problem for MBR effluent because lower ozone doses are required.

At the project meeting on December 20, 2006, it was decided to continue the use of NaOCl as the only disinfection method until regulatory changes require a method to remove additional pollutants, such as EDCs. The decision was based on the high cost to implement ozone or ozone plus UV. Under the current regulatory conditions, minimal additional expenditures would be required to continue using NaOCl. In addition, when regulatory changes do require an advanced disinfection method, it will likely be ozone or a combination of ozone and UV. The final method would be determined during preliminary design. Alternative treatment scenarios for the MPM™ will be established that include ozone and a combination of ozone and UV.

It was also decided that the City should perform tracer tests to determine the actual requirement for additional chlorine contact basins.

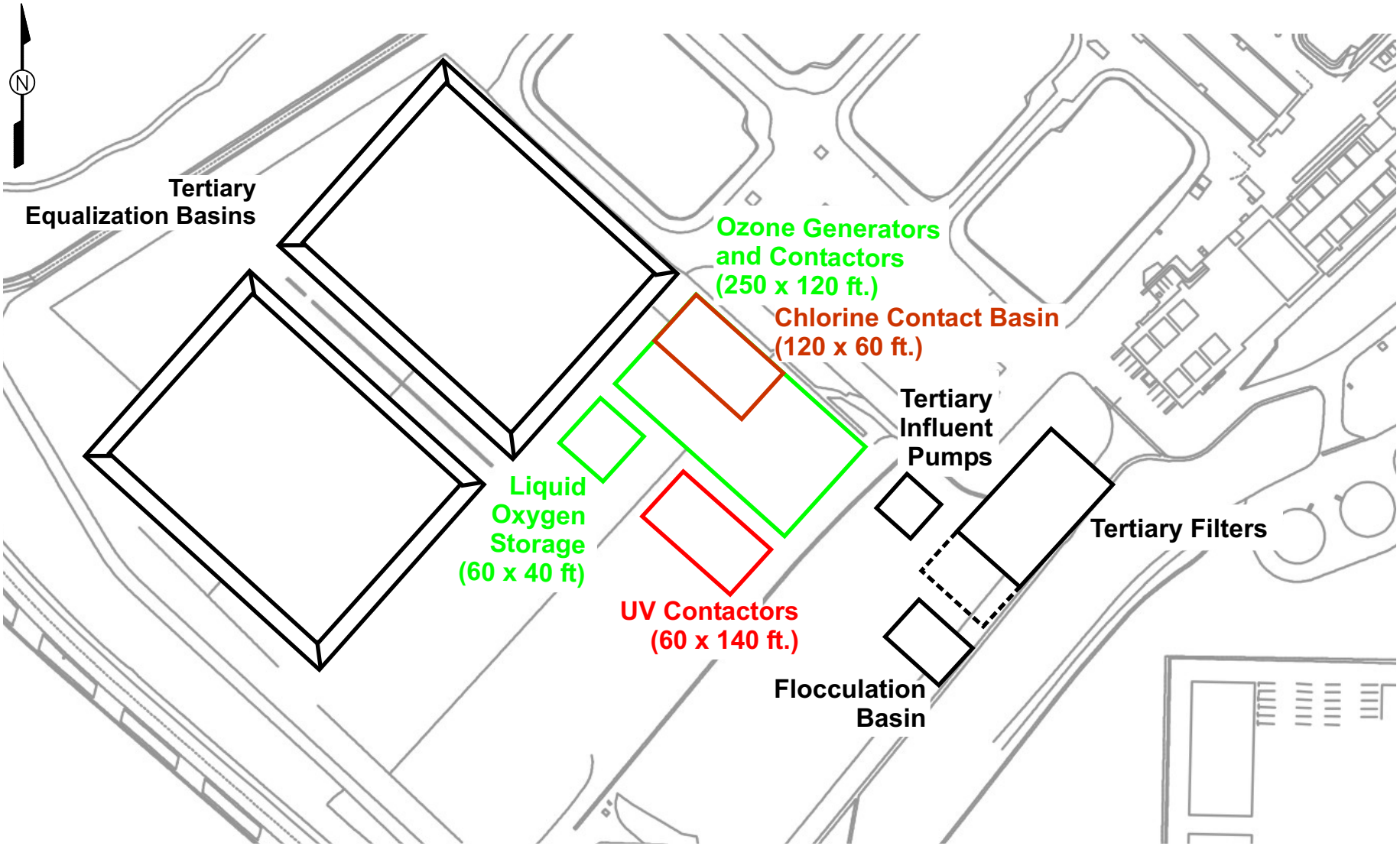
Table 9.6 Life-Cycle Costs of Disinfection Alternatives: 20-mgd Conventional Effluent and 32-mgd MBR Effluent
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Disinfection for Conventional	**NaOCl[(1)]**	**UV**	**Ozone +UV[(2)]**	**UV**	**Ozone +UV[(2,3)]**	**Ozone +UV[(2)]**
Disinfection for MBR	**NaOCl[(1)]**	**UV**	**UV**	**Ozone**	**Ozone[(3)]**	**Ozone +UV[(4)]**
Total Project Cost	$4,070,000	$34,000,000	$52,540,000	$53,980,000	$72,520,000	$64,370,000
Yearly O&M Cost	$980,000	$880,000	$1,106,000	$1,677,000	$1,902,000	$1,347,000
Life-Cycle Cost[(5)]	**$20,900,000**	**$49,100,000**	**$71,530,000**	**$82,760,000**	**$105,180,000**	**$87,500,000**

Notes:
(1) The project cost for NaOCl disinfection only includes the additional 8-mgd CCB. Yearly O&M cost and life-cycle costs include chlorination and dechlorination for both existing and new facilities for 52 mgd.
(2) Cost based on UV dose of 100 mJ/cm^2 for conventional tertiary effluent. The dose, and thus the cost, may be lowered upon the completion of pilot testing.
(3) Cost based on in-pipe ozone contactor for 32 mgd, and in-tank ozone contactor for 20 mgd. In-tank ozone contactor can be used for both streams to lower the cost if hydraulically feasible.
(4) Cost based on UV dose of 80 mJ/cm^2 for MBR effluent. The dose, and thus the cost, may be lowered upon the completion of pilot testing.
(5) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter. Includes chlorination and dechlorination O&M costs for the existing 44-mgd facilities.

9.8 DISINFECTION FACILITY LAYOUT

Figure 9.4 shows the proposed layout of the UV and ozone facilities as an alternative treatment strategy in the MPM™. After the tracer test, if it is determined that an additional chlorine contact basin is needed instead of advanced disinfection, it will be located where the ozone facilities are shown on Figure 9.4.



NEW DISINFECTION FACILITIES LAYOUT

FIGURE 9.4

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 10: RECYCLE STREAM MANAGEMENT

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 10: RECYCLE STREAM MANAGEMENT

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Chapter 10

RECYCLE STREAM MANAGEMENT

10.1 PURPOSE

The purpose of this chapter is to describe the evaluation of alternatives for handling the recycle flows from dewatering at the Regional Water Quality Control Plant (RWQCP). The aim was to identify a project that could be used to improve secondary treatment operation as well as secondary effluent quality before expanding secondary treatment capacity. This chapter focuses on the treatment and management of the recycle flows from dewatering; it does not consider treatment options for other in-plant recycles such as filter backwash and Dissolved Air Flotation (DAF) underflow, which would not contain significant pollutant loads.

10.2 RECOMMENDATIONS AND CONCLUSIONS

- Both the Single Reactor High-Activity Ammonia Removal Over Nitrite (SHARON) Alternative and the SHARON combined with Anaerobic Ammonia Oxidation (ANAMMOX) Alternative require precise process control. There are only a few SHARON full-scale facilities and no known full-scale SHARON combined with ANAMMOX systems in operation in this country. The ANAMMOX biomass also has a very low growth rate, which means that it would take months to recover from process upsets. Based on these factors, neither the SHARON Alternative nor the SHARON combined with ANAMMOX Alternative appear to be feasible at this time.
- The Centrate and Return Activated Sludge (RAS) Re-Aeration Basin (CaRRB) system uses RAS from secondary treatment to supply biomass and alkalinity for recycle treatment. In this case, the CaRRB system could be housed in the old Chlorine Contact Basin and receive RAS from the two small Plant 2 secondary clarifiers. Analysis showed that this system could increase the capacity of the Plant 2 secondary treatment by approximately 2 mgd, but it could not treat the full recycle stream without exceeding the future effluent Total Inorganic Nitrogen (TIN) limits (10 mg/L). It would also be necessary to pump twice (clarifiers to CaRRB and CaRRB to Plant 2 Aeration Basins). Life-cycle cost for this option is more than twice as high as that of an equivalent capacity secondary treatment plant. Hence, CaRRB is not feasible.
- The Equalization (EQ) Basin Alternative would ensure an even nitrogen load throughout the week and will lead to improved process control. However, the cost of constructing and operating a new EQ basin is high and the benefits of having an EQ basin do not justify the costs. Operating the dewatering system 7 days a week and using the existing 24-hour EQ would achieve the same benefits for a fraction of the cost. Hence, no interim project is recommended. Expansion to 52 mgd, as described

in the remainder of this volume, would make recycle treatment obsolete as the recycle load has been included in the design.

- The City of Riverside (City) should proceed with a 7-days-per-week dewatering operation, in order to achieve lower average TIN concentration load into the aeration basins.

10.3 DESCRIPTION OF EXISTING FACILITIES

At the RWQCP, recycle streams are generated from thickening of Waste Activated Sludge (WAS) from the activated sludge process, backwash of tertiary filters, and the digested sludge dewatering process. Each of the recycle streams has different properties and it is important to account for the impacts these streams have on the wastewater treatment process.

Currently, the tertiary filter backwash water, centrate (from dewatering centrifuge), and filtrate (from dewatering belt filter presses) are combined in waste ponds where they are equalized over a 24-hour period. The combined recycle stream from the waste ponds is pumped into the screened influent upstream of the primary clarifiers. In the past, all flow was recycled to Plant 1 only, causing Plant 1 secondary effluent TIN concentrations to be consistently higher than those in the Plant 2 effluent. Since March 17, 2006, the recycle flows are split between Plant 1 and Plant 2 (with approximately 20 percent to Plant 1 and 80 percent to Plant 2). However, the flow split is not measured and the actual split may differ from this estimate. It may also change over time. It is recommended that these flows be metered in the future, so that the flow split can be quantified and controlled.

The recycle stream from the dewatering units (belt filter press and centrifuge) has a very high ammonia concentration that significantly increases the nitrogen load entering the secondary treatment process. Currently, the centrifuge at the RWQCP is operated continuously and is typically taken off-line for regular maintenance and operation work on Wednesdays. The belt filter presses are operated to dewater sludge when the centrifuge is out of service and/or when there is a need for extra dewatering capacity.

The DAF subnatant (from WAS thickening) is mixed with the RAS and is recycled to the Plant 2 aeration basins.

For a detailed description of the existing facilities, refer to Volume 4, Chapter 1 - Existing Facilities. The description of facilities for handling waste solids generated during the wastewater treatment process is discussed separately. The basis of design for the various solids handling processes is discussed in Volume 8, Chapter 3 - Design Criteria.

10.3.1 Recycle Characteristics

Using the influent quality and operating data, a Biotran model was calibrated (refer to Volume 8, Chapter 3 - Design Criteria). The calibrated model was used to project the future

plant performance at an annual average influent flow of 40 mgd. The recycle flow was increased proportionally to account for future annual average flows of 52.2 mgd. An estimate for future recycle stream flows and characteristics was developed. Table 10.1 summarizes the estimated flow and water quality data for the recycle stream from the dewatering process. It was assumed that two-phase digestion would be used. Two-phase digestion allows for higher volatile solids reduction and consequently converts more of the organic nitrogen in the solids into ammonia-nitrogen. Thus, in terms of recycle nitrogen load, two-phase digestion presents the worst-case condition.

Table 10.1 Summary of the Dewatering Recycle Stream Characteristics Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Parameter	Units	Dilute	Average	Thick
Digester Feed Condition				
Primary Sludge Concentration	%	3.5	4.0	5.0
TWAS Concentration	%	3.0	3.5	5.0
Belt Filter Press(1)				
Filtrate Flow	mgd	0.61	0.52	0.37
Washwater Flow	mgd	0.66	0.57	0.42
Recycle Flow	mgd	1.27	1.09	0.79
TSS	mg/L	768	894	1,225
NH_4-N	mg/L	580	667	884
Amount of N Recycled	lbs/day	6,125	6,049	5,853
Centrifuge(2)				
Centrate Flow	mgd	0.62	0.53	0.38
TSS	mg/L	784	915	1,265
Ammonia as N	mg/L	1,207	1,396	1,883
Amount of N Recycled	lbs/day	6,241	6,183	6,034

Notes:
(1) Recycle stream parameters when only belt filter presses are used for dewatering.
(2) Recycle stream parameters when only centrifuge is used for dewatering.

In Table 10.1, three conditions are presented: dilute, average, and thick. These conditions were derived based on different assumptions (see Table 10.1) for the feed solids content. Feed solids content directly impacts the digester performance and recycle characteristics entering the anaerobic digesters.

The data show that using the belt presses creates much more recycle flow than centrifuges due to the addition of wash water. However, it must be noted that the nitrogen load remains approximately equal. Future projects to thicken primary sludge and WAS using gravity belt thickeners would reduce the recycle volumes below what is shown in the table. As

indicated, recycle solids and nitrogen loads would essentially remain constant. Table 10.2 summarizes the estimated impact of the recycle flow from the dewatering process on the organic and nitrogen loads to the secondary process.

Table 10.2 Summary of Impact of Recycle Stream on Wastewater Quality Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Parameter	Units	Concentration	Load (Pounds per Day)
Influent Characteristics			
Daily Average Flow	mgd	52.2	-
BOD	mg/L	250	108,850
TSS	mg/L	250	108,850
TKN as N	mg/L	35.5	15,455
Ammonia as N	mg/L	21	9,142
Recycle Stream Characteristics(1)			
Daily Average Flow	mgd	0.53	-
BOD	mg/L	500	2,210
TSS	mg/L	915	4,045
TKN as N(2)	mg/L	1,396	6,170

Notes:
(1) Recycle stream parameters when only centrifuge is used for dewatering for average flow condition. For design purposes, this is considered the worst-case scenario.
(2) The main component will be NH_4-N, with organic-N is contributing only a small part to the Total Kjeldahl Nitrogen (TKN).

As shown, the impact of the recycle flow from the dewatering process on Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) loads are nominal. However, the impact on the total nitrogen load from the recycle stream is significant. Based on the estimates provided, the recycle contributes approximately 40 percent of the total nitrogen that the RWQCP treats. The additional nitrogen load increases the oxygen demand in the aeration basins. The recycle also lowers the BOD:TKN ratio in the aeration basin influent, making denitrification more challenging. This is one of the contributing factors to why Plant 1 effluent has historically had a much higher NO_3-N concentration than Plant 2, and also illustrates how an adjustable recycle flow split between the two plants can be used to optimize denitrification efficiency.

10.4 RECYCLE STREAM HANDLING ALTERNATIVES

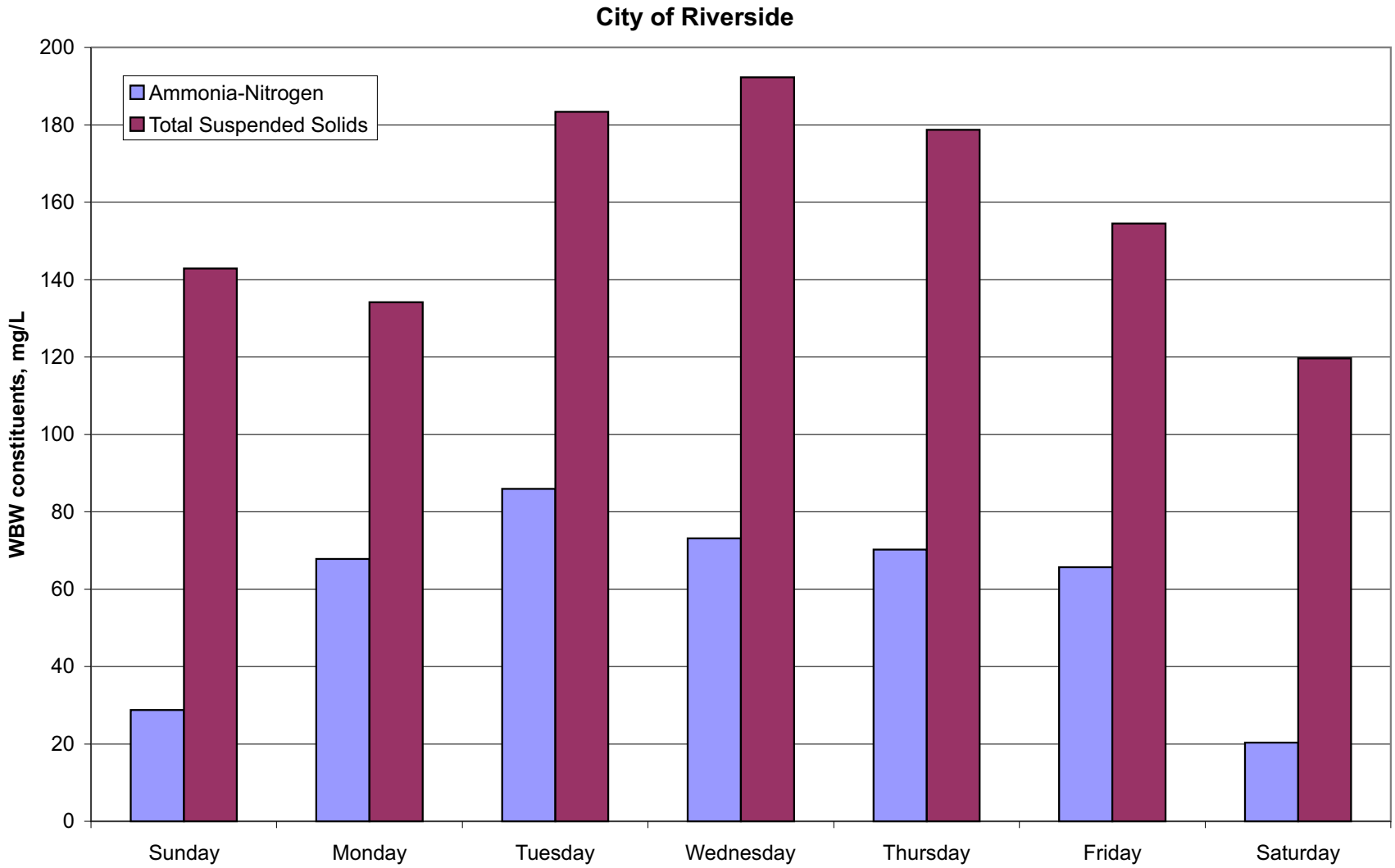
The filtrate from the dewatering belt presses and centrate from centrifuges are currently combined with the filter backwash water. The combined flow is stored in backwash lagoons and is then pumped upstream of the primary clarifiers, which provides sufficient EQ to

handle diurnal flow peaks. Since dewatering is only operated during the first few days of the week, the nitrogen load in the recycle stream tends to vary according to the day of the week. Figure 10.1 shows how both ammonia-nitrogen (NH_4-N) and TSS concentrations differ in the combined recycle stream according to the day of the week. On average, the NH_4-N concentration peaks at 86 mg/L on Tuesday, while dropping to 20 mg/L on Saturday. Figure 10.2 demonstrates that the effect of this weekday variation causes a variation of effluent nitrate nitrogen (NO_3-N) concentration. Plant 1 effluent NO_3-N, which used to receive the full combined recycle flow, varies from an average of 16 mg/L on Sunday to 24 mg/L on Wednesday. The result is that the combined effluent NO_3-N (not including NH_4-N) from Plants 1 and 2 exceed the TIN limit of 13 mg/L on average Wednesdays and Fridays, and is right at the limit on Thursdays. These findings agree with operator observations. If the recycle stream from the dewatering process were managed and treated separately, then the secondary treatment processes could be better controlled, resulting in reduced operational difficulties.

The high ammonia concentration in the recycle stream impacts the nitrification and denitrification of the liquid-stream process. The additional ammonia added via the recycle stream leads to a carbon-limited condition; which in turn leads to a reduced denitrification capacity. Either additional liquid-stream treatment capacity or a separate recycle stream treatment process is necessary to mitigate these influences.

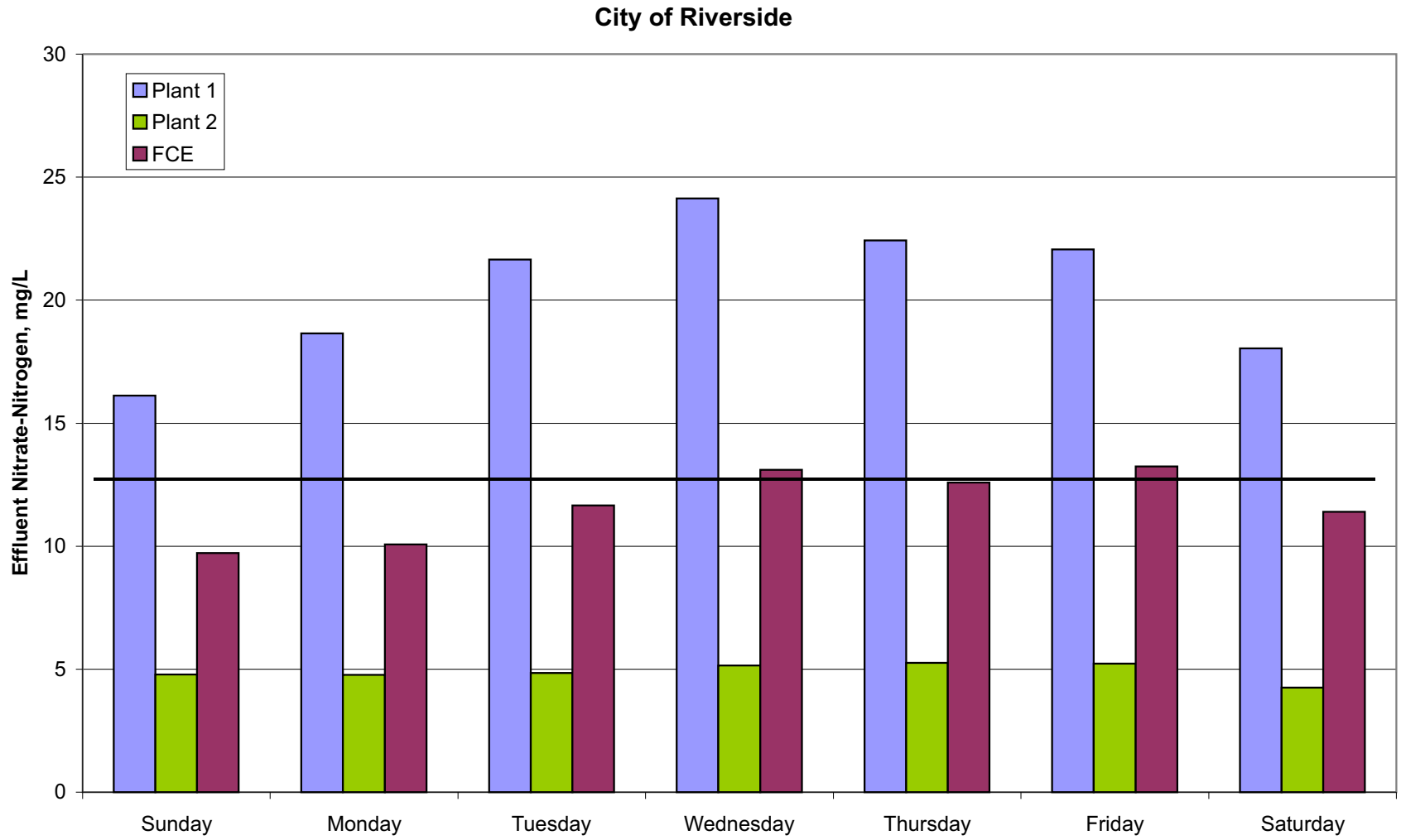
Four alternatives, described in the following subsections, were considered for separate recycle stream treatment:

1. Alternative 1:
   EQ of recycle flow.
2. Alternative 2:
   Treatment of recycle flow using the SHARON process.
3. Alternative 3:
   Treatment of recycle flow using a combination of the SHARON and ANAMMOX processes.
4. Alternative 4:
   Treatment of recycle flow in the old Chlorine Contact Chamber (1958) using the CaRRB process.



WEEKDAY VARIATION IN NH_4-N AND TSS

FIGURE 10.1



WEEKDAY VARIATION IN EFFLUENT NITRATE - NITROGEN

FIGURE 10.2

10.4.1 Alternative 1 - Equalization of Recycle Flow

This alternative considers EQ of the recycle stream (dewatering recycle only). Table 10.3 summarizes the estimated recycle flows and the EQ basin design information. The basin is sized for 7-day EQ. Currently, dewatering is performed only 4 days a week, depending on process requirements. For the analysis, it was therefore assumed that the dewatering recycle would be produced only 4 days a week, while equalized flow would be recycled 7 days a week.

Table 10.3 Equalization Basin Design
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Value
Recycle Flows	
Average Daily Recycle Flow(1) (A)	0.8 mgd
Weekly Recycle Volume (B)	5.6 mil gal
Dewatering Days Per Week (C)	4 days
Recycle Produced on Dewatering Days (D)	1.4 mgd
Centrate Returned on Dewatering Days (E)	3.2 mil gal
Equalization Basin Requirements	
EQ Volume Required = C x (D – A) = B - E	2.4 mil gal
SWD	24 feet
Length	170 feet
Width	130 feet

Notes:
(1) A conservative flow estimate was used to provide a margin of safety if continued use of belt filter presses is required. This is the constant rate at which recycle is ideally returned to the process.

Plant staff intends to switch entirely to centrifuges for dewatering because of higher cake solids concentration and other benefits. The belt presses would remain as a standby dewatering capacity. A recycle flow of 0.8 mgd was selected for this alternative to enable treatment of recycles when part of the digested solids are dewatered using belt presses. Figure 10.3 shows the area that would be required for an EQ basin. The location has not been set aside for this unit for reasons that will become apparent later.

As can be seen in Table 10.3, the volume required for 7-day EQ is significant. The EQ basin would also require aeration (to prevent odors from developing), mixing to prevent solids from accumulating, and effluent pumping. The odor potential of the recycle would

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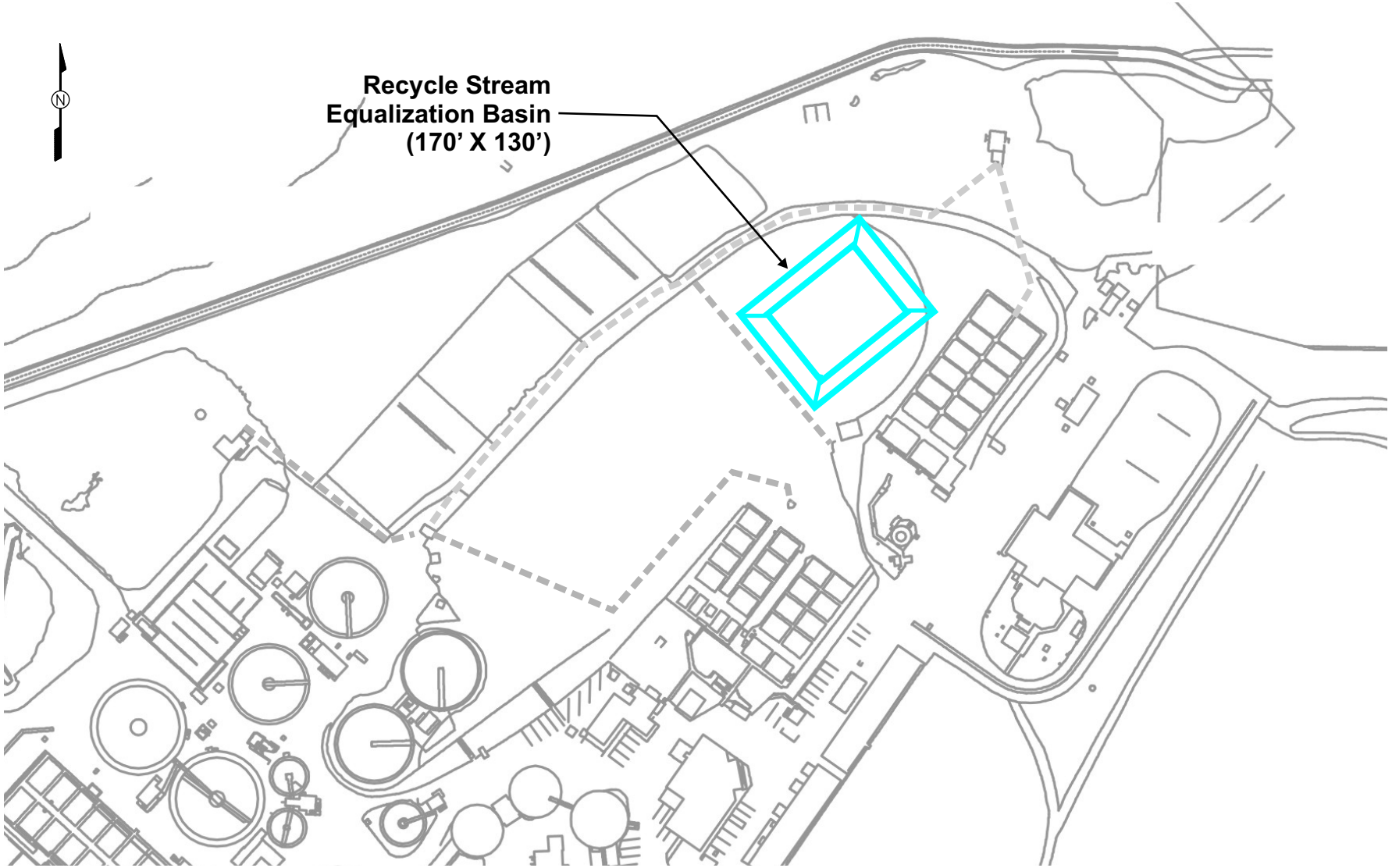


EQUALIZATION BASIN
PROPOSED SITE LOCATION

FIGURE 10.3

depend on how well the anaerobic digesters were performing. For example, an overloaded digester might turn acid and would result in high concentrations of volatile fatty acids in the recycle, which would produce significant odors. Likewise, the recycle suspended solids concentration would depend on solids capture during dewatering. In other words, some variation in recycle quality is probably unavoidable and could potentially make operation of an EQ tank very challenging.

The existing system, which allows for 24-hour EQ of filtrate (combined with filter backwash) would be adequate, if the sludge dewatering was operated 7 days a week, even if that would mean dewatering for only a couple of hours per day. From our discussions with City staff, it appears that this would be feasible. We recommend that the City proceed with a 7-days-per-week dewatering operation. This would ensure more stable operation and achieve a lower average TIN concentration in the plant effluent.

10.4.2 Alternative 2 - Single Reactor High-Activity Ammonia Removal Over Nitrite

The SHARON system has been used for the treatment of sidestreams from the dewatering process to achieve high total overall nitrogen removal. Figure 10.4 shows a process schematic of the SHARON process.

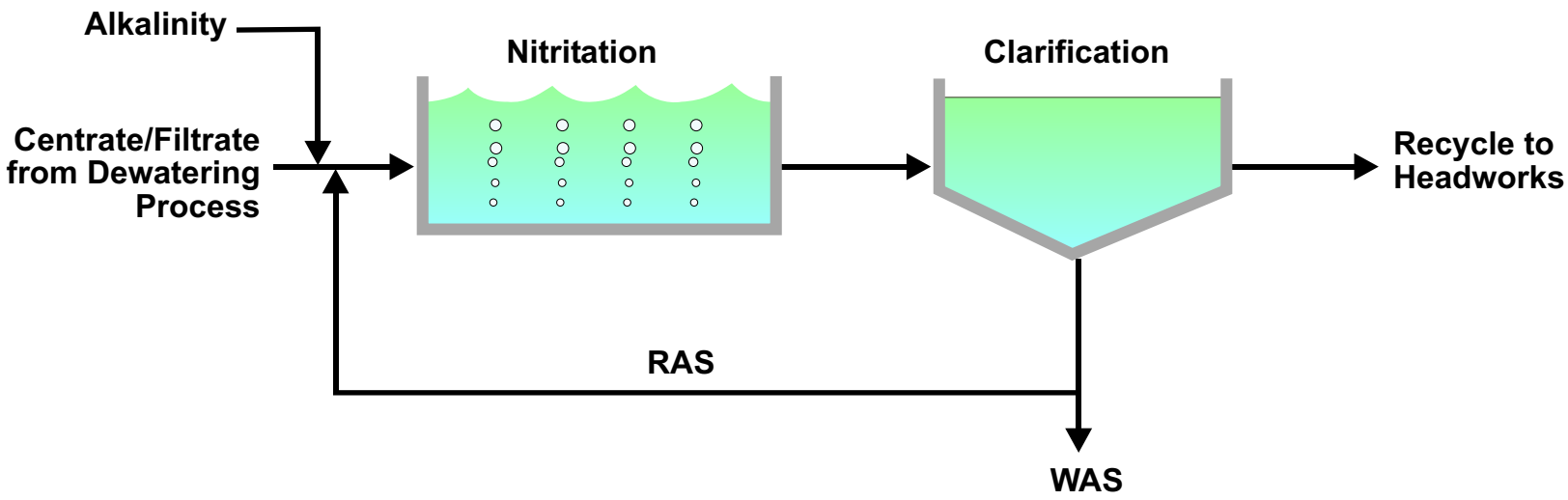
Conversion of ammonia to nitrate in wastewater treatment occurs as a two-step process, where ammonia is first oxidized to nitrite by Ammonia Oxidizing Bacteria (AOB). The nitrite is then oxidized to nitrate by Nitrite Oxidizing Bacteria (NOB). The two steps can be summarized by the two chemical reactions, excluding the production of biomass:

$$2\ NH_4^+ + 3\ O_2 + 4\ HCO_3^- \rightarrow 2\ NO_2^- + 6\ H_2O + 4\ CO_2 \text{ (Nitritation)} \qquad (1)$$

$$2NO_2^- + O_2 \rightarrow 2NO_3^- \text{ (Nitratation)} \qquad (2)$$

SHARON is a high-rate process for the removal of total nitrogen operating with minimal Solids Retention Time (SRT). Due to differences in growth rates of the AOB and NOB at the process design temperature (30 degrees to 40 degrees Celsius, which conveniently coincides with the operating temperature for anaerobic digestion), a selection can be made wherein the NOB can be washed out of the system, while AOB are retained. In other words, the system is manipulated so that only the nitrite reaction (1) is allowed to take place.

The digested sludge would be at the required temperature. Contact with air, however, allows cooling due to evaporation. In a dry climate, such as is typical in Southern California, evaporation rates are higher, leading to more cooling. Should the sludge be dewatered using the belt presses (worst-case scenario), cooling would start during dewatering. Cooling would also take place during equalization. Due to the high capacity of the dewatering equipment, 24-hour equalization would still be required, as mentioned in Section 10.4.1. Some of the recycle would remain in the EQ basin for close to 24 hours, which would allow



SHARON PROCESS SCHEMATIC

FIGURE 10.4

ample time for cooling. Hence, it would be necessary to reheat the recycle upstream of the SHARON process. It was assumed the recycle would cool to the same temperature as the influent flow. In reality, the recycle temperature would vary during the day and may, under certain conditions (low air temperature, humidity, and high wind speed), be much cooler than influent flow. The long retention time in the SHARON basin makes significant further cooling very likely.

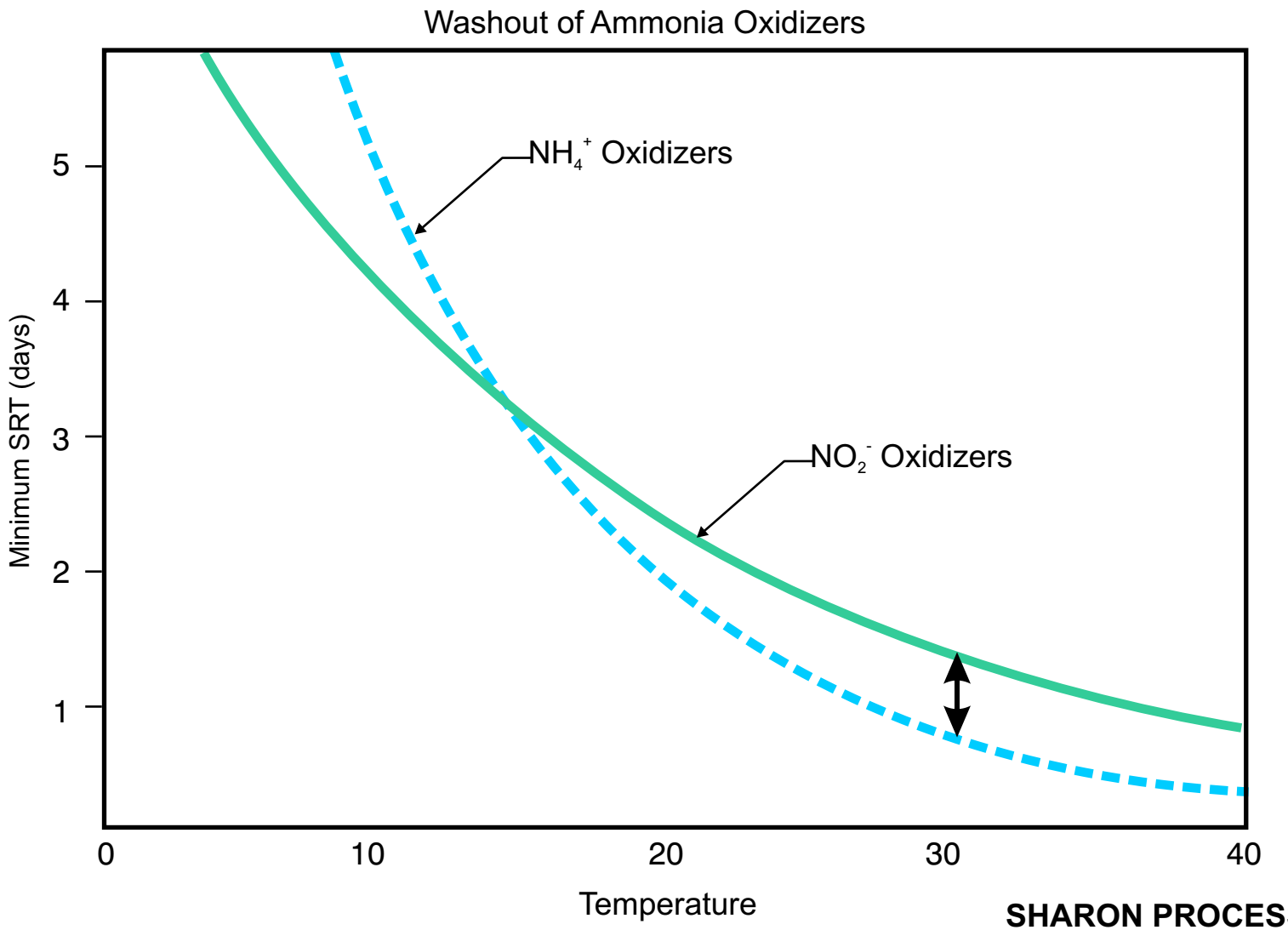
Figure 10.5 illustrates that a narrow range for SRT (and temperature) must be maintained for the SHARON process to work. Due to this narrow range, very precise process control is required for this alternative. The SHARON process can be designed so that SRT equals Hydraulic Residence Times (HRT) in a temperature ranging from 30 to 35 degrees Celsius, thereby eliminating the need for a clarifier. However, this means that it is not possible to control SRT and that SRT would fluctuate (as HRT does) with flow. It was therefore decided to include clarifiers in the analysis. Also illustrated in Figure 10.5, the temperature range at a given SRT, is equally narrow. This means that heating would need precise control. However, the inherent inertia in thermal systems would help stabilize variations in heat requirements. Using this mode of operation allows for a 25 percent reduction in oxygen demand, as indicated by comparing reaction (1) to the complete oxidation, reactions (1) and (2). This results in a similar reduction in the aeration energy required. Once the oxidation product (nitrite or nitrate) must be denitrified, there is also a difference, as can be seen in the associated chemical reactions, again excluding the effect of growth:

$$3\ C_6H_{12}O_6 + 24\ NO_2^- + 6\ CO_2 \rightarrow 24\ HCO_3^- + 6\ H_2O + 12\ N_2\uparrow \qquad (3)$$

$$5\ C_6H_{12}O_6 + 24\ NO_3^- \rightarrow 6\ CO_2 + 24\ HCO_3^- + 18\ H_2O + 12\ N_2\uparrow \qquad (4)$$

As can be seen, there is a 40-percent reduction in the required BOD for denitrification.

Our analysis indicated that the high NH_4-N concentration would require an external dose of alkalinity to prevent pH from dropping to the point where nitrification is inhibited. It is assumed that lime would be the cheapest source of alkalinity. The nitrite in the SHARON effluent is recycled to the aeration basins where it is then denitrified in the anoxic zones. Unconverted nitrite remaining in the effluent from the anoxic zones would be oxidized to nitrate in the downstream aerobic zone. Additionally, mainstream reactor cost savings are achieved, since this process reduces the ammonia-nitrogen load. Our analysis indicates that the capacity of the existing facilities would increase by 10 percent (to 44 mgd) if this alternative is used to treat the recycle. In order to function properly, the SHARON process would require an equalized feed. Therefore, the facilities required for SHARON are in addition to those shown in Table 10.3.



SHARON PROCESS SELECTIVE WASHOUT OF AMMONIA OXIDIZERS

FIGURE 10.5

Table 10.4 summarizes the design of the SHARON process for treating recycle at the RWQCP.

Table 10.4 SHARON Process Design
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Value
Average Daily Recycle Flow(1)	0.8 mgd
MLSS	2,500 mg/L
SRT	1.5 days
Volume	465,800 gallons
Tank Dimensions	
SWD	15 feet
Length	91 feet
Width	45.5 feet
Process Requirement	
Oxygen Requirement	12,000 lbs/day
Lime Requirement	9,665 lbs/day
Heat Requirement (average)	5.1 MMBtu/hr
Heat Requirement (maximum)	7.5 MMBtu/hr
Projected Effluent Quality	
BOD	5 mg/L
TSS (depending on clarifier performance)	10 mg/L
NH_3-N	50 mg/L
NO_2-N	806 mg/L
NO_3-N	40 mg/L
Alkalinity	75 mg/L

Notes:
(1) A conservative flow estimate was used to provide a margin of safety if the City continues using belt filter presses.

The heat requirement represents 29 percent of the digester gas under average conditions and 42 percent under conditions of maximum demand, assuming conventional digestion.

10.4.3 Alternative 3 - Anaerobic Ammonia Oxidation Combined with Single Reactor High-Activity Ammonia Removal Over Nitrite

The ANAMMOX process is a relatively new biological process, wherein process conditions are created for a select group of microorganisms, the so-called ANAMMOX organisms, to oxidize ammonia using nitrite in place of oxygen. The ANAMMOX process can be represented by the following reaction, excluding growth:

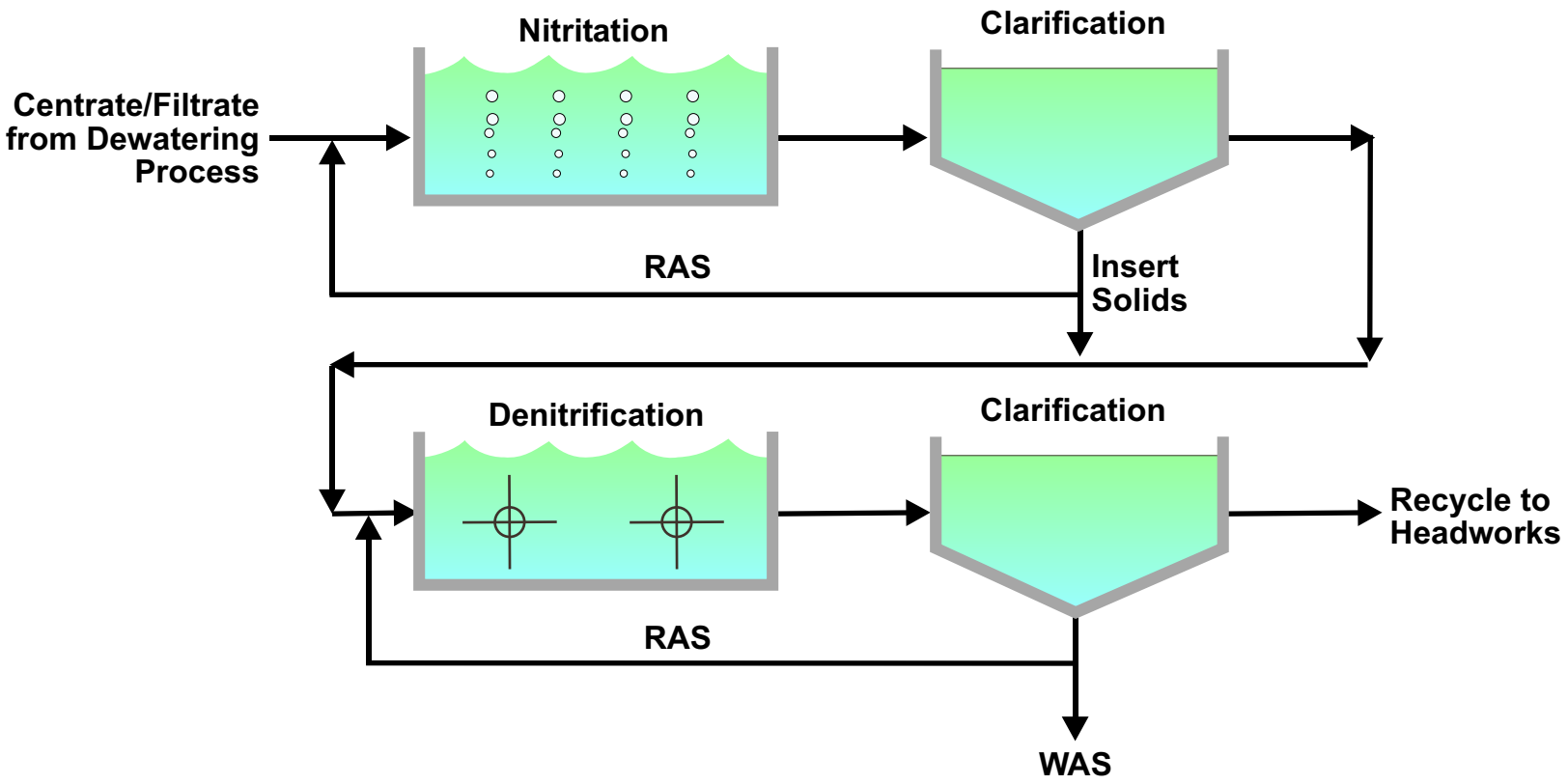
$$NH_4^+ + NO_2^- \rightarrow N_2 + 2\ H_2O \qquad (5)$$

The ANAMMOX organisms are autotrophic and are known to grow at higher temperatures (30 to 35 degrees Celsius) and have a low-growth rate (doubling time of approximately 10 days). Therefore, to cultivate a sizeable population of ANAMMOX organisms, an SRT of about 30 to 40 days, as a minimum, is required. As with the SHARON process, reheating of the recycle would be required.

Since ANAMMOX organisms use nitrite instead of oxygen, a nitrite source is necessary. Bench scale tests have shown effluent from the SHARON process, which is rich in nitrite, to be a very effective source of nitrite for the ANAMMOX organisms. Figure 10.6 shows a possible arrangement that could be effectively used for nitrogen removal using the combined SHARON and ANAMMOX processes. In order to use SHARON effluent as a feed for ANAMMOX, the SHARON system is designed to convert only 50 percent of the incoming NH_4-N to nitrite; the remainder is converted to molecular nitrogen in the ANAMMOX basin. Due to the lower conversion of ammonia to nitrite, our analysis indicates that there is no need for external alkalinity. Additionally, the air required for the SHARON process is reduced by 50 percent, compared to the full SHARON process. Process control requirements would be even greater than for a full SHARON process, as the reaction must be maintained at 50-percent conversion.

Unlike the SHARON process, the combined SHARON-ANAMMOX process would achieve full nitrogen removal, i.e., little or no denitrification of nitrite would be required in the existing aeration basins. This would allow the available BOD to be used more effectively for denitrification of nitrate produced in the aeration basins. This means that the required denitrification can be achieved in a smaller anoxic zone, which would leave a larger aerobic fraction in the aeration basin. The larger aerobic fraction allows for nitrification of a larger nitrogen mass (lb/d), which in turn translates into increased basin capacity. The SHARON-ANAMMOX process results in:

- A reduction of the required denitrification capacity in the anoxic zone.
- A 3-mgd capacity increase in the aeration basin, compared to SHARON alone.
- A 7-mgd capacity increase in the aeration basin, compared to no recycle treatment.



SHARON AND ANAMMOX PROCESS SCHEMATIC

FIGURE 10.6

The design of the ANAMMOX process for treating recycle at the RWQCP is summarized in Table 10.5.

Table 10.5 SHARON-ANAMMOX Process Design
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Value
SHARON Process	
Average Daily Recycle Flow through SHARON	0.8 mgd
MLSS	2,500 mg/L
SRT	1.5 days
Volume	232,900 gallons
Tank Dimensions	
SWD	15 feet
Length	65.0 feet
Width	32.5 feet
Process Requirement	
Oxygen Requirement	6,000 lbs/day
Heat Requirement (average)	5.1 MMBtu/hr
Heat Requirement (maximum)	7.5 MMBtu/hr
Projected Effluent Quality	
BOD	6 mg/L
TSS (depending on clarifier performance)	10 mg/L
NH_3-N	270 mg/L
NO_2-N	274 mg/L
NO_3-N	14 mg/L
Alkalinity	195 mg/L
ANAMMOX Process	
Average Daily Recycle Flow	0.8 mgd
MLSS	2,500 mg/L
SRT	37 days
Volume	867,100 gallons
Tank Dimensions	
SWD	15 feet
Length	124 feet
Width	62 feet

Table 10.5 SHARON-ANAMMOX Process Design Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Value**
Projected Effluent Quality	
BOD	6 mg/L
TSS (depending on clarifier performance)	10 mg/L
NH_3-N	25 mg/L
NO_2-N	20 mg/L
NO_3-N	2 mg/L
Alkalinity	195 mg/L

The effect of the low growth rate of the ANAMMOX biomass is reflected in the large basin requirement and the high SRT.

10.4.4 Alternative 4 - The Centrate and RAS Re-Aeration Basin Treatment Process

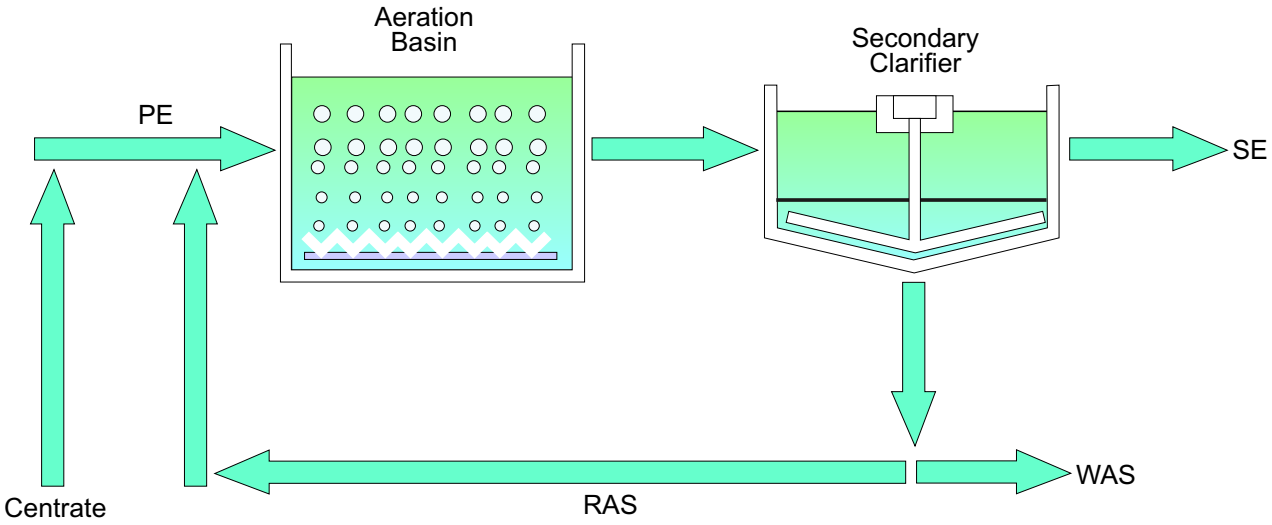
Activated sludge treatment can be used to reduce side stream centrate ammonia loads back to the main aeration basins. Conventional activated sludge systems treating side stream ammonia loads require clarifiers in order to concentrate biomass for return to the head of the process for seeding. Because the nitrifier growth rate is relatively slow, long SRTs are often required when treating high strength ammonia side streams.

Where RAS from a nitrifying system treating primary effluent is available, side stream clarifiers can be eliminated. Introducing RAS into an independent aeration basin prior to return to the main treatment plant is commonly termed sludge re-aeration. When RAS and centrate is combined in a separate basin, it is termed a CaRRB.

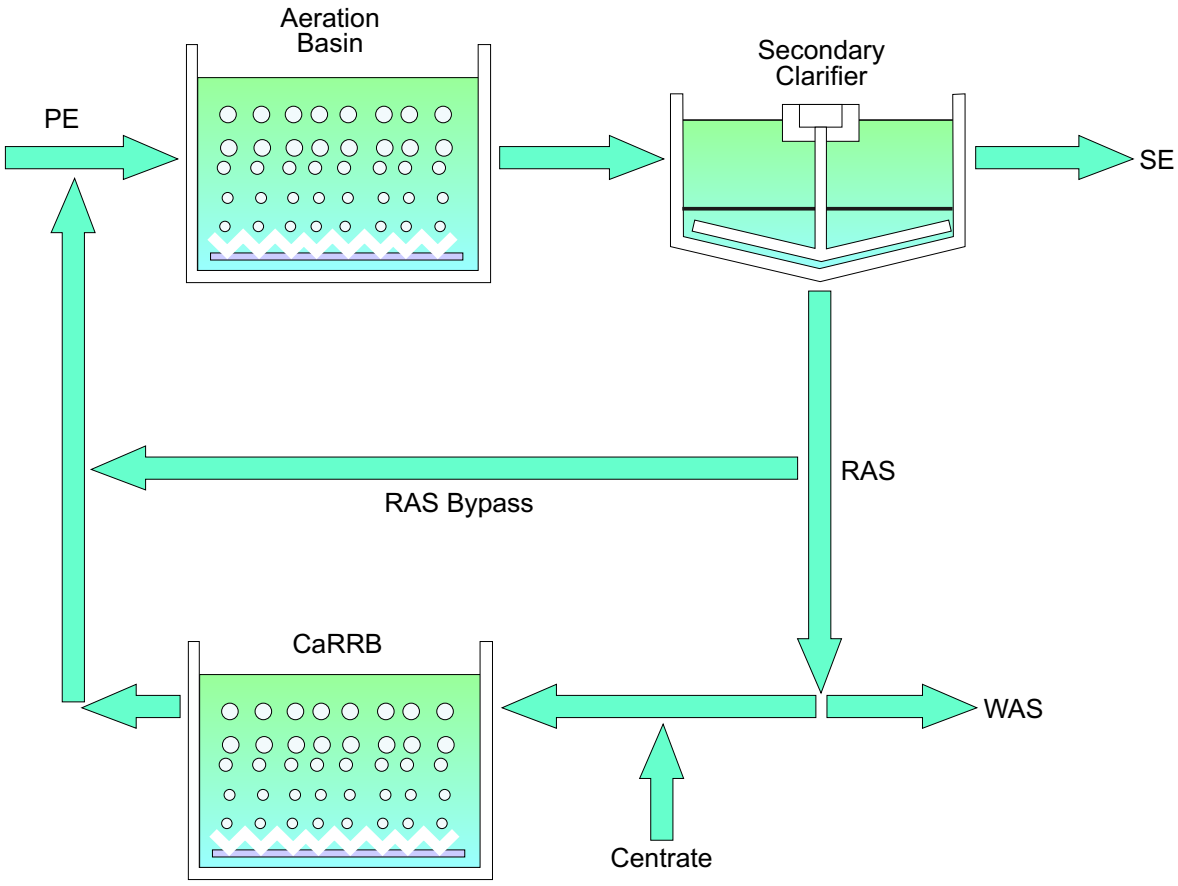
Figure 10.7 compares the CaRRB process with the conventional (existing) process. As can be seen, the main differences are the presence of the CaRRB basin and that the centrate and part of the RAS are rerouted to the CaRRB basin. After treatment, the combined stream is routed to the main aeration basins. A RAS bypass of the CaRRB basin would allow maximum flexibility and control.

The CaRRB system allows one to increase the SRT by inventorying active solids at RAS concentrations at the head of the aeration basins. This is similar to a step feed approach where solids vary from high concentrations at the head of the basin to lower concentrations at the end of the basin.

Other benefits of the CaRRB process include accelerated nitrifier growth rate in the main activated sludge aeration basins associated with nitrifier seeding from a high ammonia environment. CaRRB basins also provide a high biomass buffer to assimilate changes in



(A) Conventional Activated Sludge



(B) CaRRB

CaRRB PROCESS FLOW DIAGRAM

FIGURE 10.7

ammonia load prior to reaching the main aeration basins. Other agencies operating this process have reported reduced oxygen demand associated with incomplete conversion from nitrite to nitrate possibly due to ammonia inhibition. Where CaRRB basins are configured to allow for anoxic zones at the end of the basin, denitrification of nitrified centrate can be achieved. Nitrification/denitrification of centrate prior to feed into the main aeration basins will improve the BOD/TKN ratio.

Other agencies have successfully used centrate and RAS re-aeration for reduction of side stream ammonia loads from centrate. The Chino Basin Municipal Water District (now Inland Empire Water Reclamation District) has used this process successfully at their Carbon Canyon Wastewater Reclamation District. Successful treatment to low ammonia levels was achieved in a basin volume equivalent to 50 percent of the main aeration basins. However, they no longer use this procedure because their recycle streams are routed to another facility.

Perhaps the most significant agency to use centrate and RAS re-aeration as part of their activated sludge system to reduce return flow ammonia loads is the New York City Department of Environmental Protection (NYCDEP). NYCDEP performed a decade-long research and pilot-scale testing program to evaluate processes for reducing ammonia loads from centrate side streams. Since NYCDEP operates several regional biosolids processing centers that take solids from several plants, ammonia loads from centrate are relatively high. After years of pilot-scale and full-scale testing, the NYCDEP is moving to convert each of their 14 wastewater treatment plants (treating up to 1.8 bgd) to a centrate and RAS re-aeration design. NYCDEP is currently operating the centrate and RAS re-aeration process full-scale at their 85-mgd, 26th Ward Wastewater Treatment Plant.

The RWQCP is currently configured in a manner that allows CaRRB to be incorporated into the Plant 2 activated sludge process using the old Chlorine Contact Chamber (1958). Figure 10.8 shows a schematic of the CaRRB process and the Plant 2 activated sludge system. Table 10.6 shows the available volume in the old chlorine contact chamber.

Table 10.6 CaRRB Process Design
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Value
Average Daily Recycle Flow[(1)]	0.11 to 0.24 mgd
MLSS	4,500 to 14,000 mg/L
SRT	0.4 to 1.0 days
HRT	1.3 to 3.7 hours
Tank Dimensions	
SWD	8.0 feet
Length	79 feet

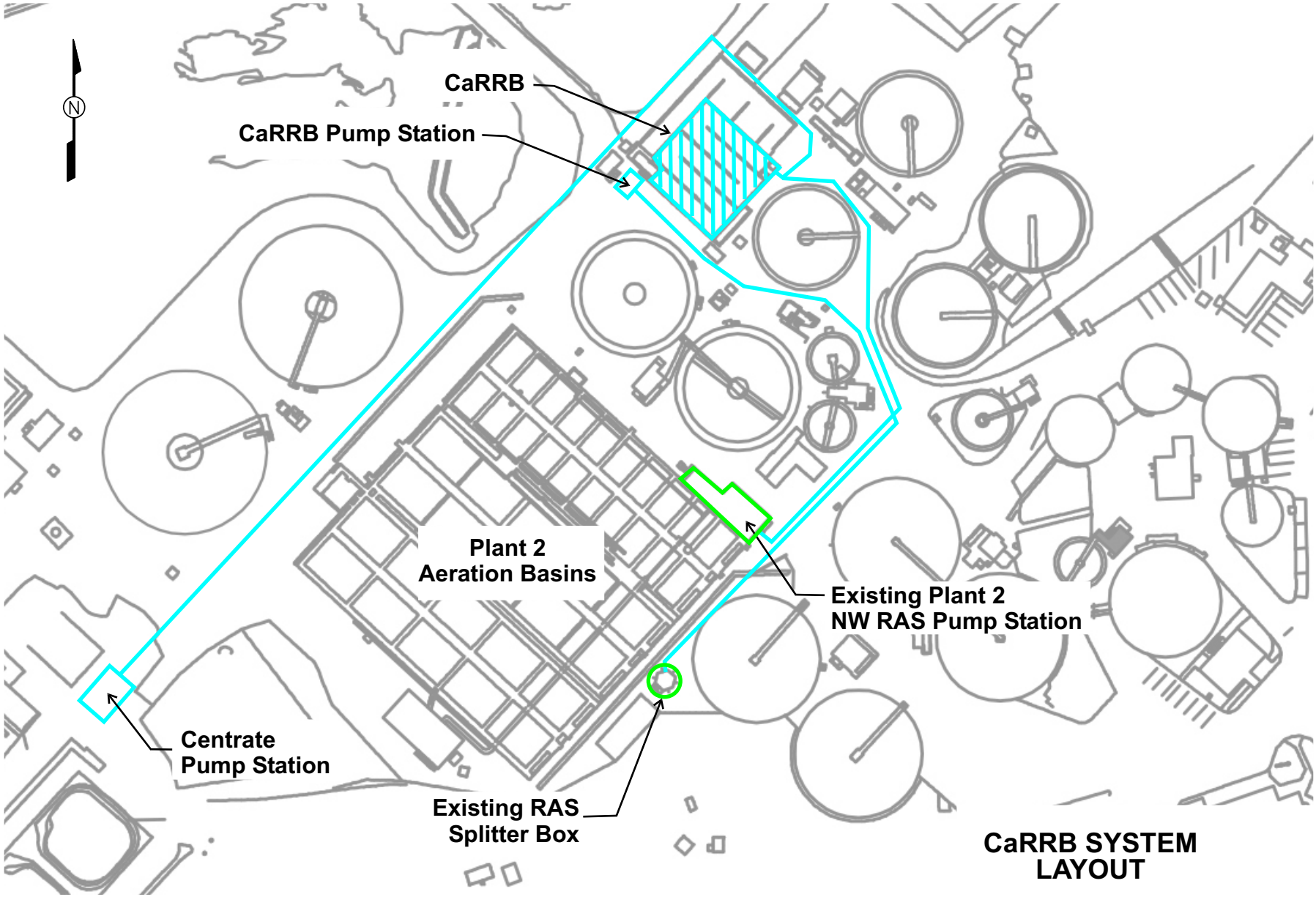
Table 10.6 CaRRB Process Design Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Value**
Width	79 feet
Channel Width	15.5 feet
Volume	373,500 gallons
Process Requirement	
Oxygen Requirement	6,200 to 9,500 lbs/day
Projected System Performance, % of centrate NH_4-N converted to(2)	
NH_3-N	38 to 41
NO_2-N	6 to 20
NO_3-N	39 to 65
Effluent pH	5.6 to 6.5
Effluent Alkalinity, mg/L as $CaCO_3$	10 to 120

Notes:
(1) Only part of the filtrate/centrate can be accommodated in the CaRRB/Plant 2 system.
(2) Reporting CaRRB effluent concentrations can be misleading as the feed and effluent concentrations are affected by dilution with RAS.

The CaRRB process is operated much like the current activated sludge process by maintaining required biomass concentrations under aeration with centrate as substrate feed. Similar to the existing activated sludge process a continuous return stream of biomass through RAS is required. The CaRRB process uses biomass captured and concentrated in the existing Plant 2 secondary clarifiers with the existing RAS pumps used to return a portion of the RAS back to the CaRRB basin. Factors that may limit the degree of centrate nitrification in the CaRRB process:

- Alkalinity:
  Alkalinity is added by both the RAS and the centrate. Centrate generally contains a significant amount of alkalinity in the form of soluble ammonia, however, that alkalinity is used up in the nitrification reaction. When alkalinity is depleted, the pH in the aeration basin will drop and inhibit nitrification. Therefore, alkalinity is sometimes the limiting parameter that controls the degree of nitrification in CaRRB. Our modeling showed that the alkalinity available in the centrate and RAS mixed liquor is not the limiting factor. Supplemental alkalinity addition would not be required.

- Kinetics:
  The conversion efficiency is limited by the available volume in the old chlorine contact chamber.



CaRRB SYSTEM LAYOUT

FIGURE 10.8

- Aeration Capacity:
  It is assumed that it would be possible to supply enough air to maintain a Dissolved Oxygen (DO) concentration of 2.0 mg/L in the CaRRB at all times. Depending on operational parameters (RAS feed rate and Mixed Liquor Suspended Solids (MLSS) concentration) and other factors (such as wastewater temperature) this may be difficult to achieve.

- Plant 2 RAS Rate:
  As the Plant 2 RAS rate is increased, the RAS MLSS concentration will decrease. This will affect the MLSS concentration in the CaRRB. As with any activated sludge process, the reaction rate in CaRRB will be directly proportional to MLSS concentration. The Plant 2 RAS rate cannot be controlled by CaRRB requirements; it is determined by the requirements of the Plant 2 secondary clarifiers.

- RAS Flow Split:
  The system can be operated with all of the RAS returned to CaRRB or some of the RAS split between CaRRB and the aeration basins. The amount of RAS returned to CaRRB is an operational decision based on balancing several parameters including: overall nitrification capacity, CaRRB hydraulic retention time, centrate dilution with adequate RAS flows to prevent ammonia toxicity, centrate dilution to minimize struvite formation, biomass seeding requirements, and process stability. In order to provide centrate ammonia dilution and avoid ammonia toxicity, a minimum RAS to centrate dilution ratio of 20 or 30:1 is recommended. Ammonia toxicity would lead to high nitrite concentrations in the CaRRB with some nitrite eventually appearing in the secondary effluent. As nitrite-nitrogen exerts a high chlorine demand (5 mg Cl_2/mg NO_2-N), this needs to be avoided.

The biggest concern with CaRRB is that it appears to make denitrification more challenging in Plant 2. This is due to the fact that much of the nitrogen is returned to the aeration basins as nitrate, while the available BOD in the recycle stream has been consumed in the CaRRB.

10.5 COMPARISON OF RECYCLE TREATMENT ALTERNATIVES

10.5.1 Non-Economic Comparison

Advantages and disadvantages for the three alternatives discussed in this chapter are shown in Table 10.7.

Table 10.7 Advantages and Disadvantages of Screening Alternatives Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Advantages	**Disadvantages**
Alternative 1 - Equalization	
• Reduces peak recycle nitrogen loads by equalizing the flows. • Provides better control of recycle and lower peak loads.	• Additional storage space required. • Advantageous only if the dewatering is not carried out 7 days a week. • Odor from the EQ basin could be a nuisance.
Alternative 2 - SHARON	
• Lower oxygen requirement. • Lower carbon requirement for denitrification. • Increases nitrification capacity. • Increases plant capacity.	• Large basin required. • Precise process control required. • No known full-scale facilities in the United States. • Recycle reheating required.
Alternative 3 - SHARON and ANAMMOX	
• Lower oxygen requirement than SHARON alone. • No carbon requirement for denitrification. • Increases TN removal capacity.	• Low growth rates of ANAMMOX organisms. • Requires numerous basins. • Very precise process control required. • No known full-scale facilities. • Recycle reheating required.
Alternative 4 - CaRRB	
• Reseeds main ABs with nitifiers. • Increases overall SRT and/or clarifier capacity. • Increases plant capacity.	• Affected by RAS rate. • Only ~50% ammonia oxidation. • Affects Plant 2 denitrification potential. • Highest oxygen demand of alternatives.

A comparison of the three different recycle stream treatment alternatives discussed in this chapter is shown in Table 10.8. The EQ Alternative does not provide a reduction in the nitrogen load going to secondary treatment; it only provides the operators with a better tool for managing recycle flow. However, the nitrogen load is reduced for all other alternatives.

Table 10.8 Comparison of Recycle Treatment Alternatives Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	Equalization	**SHARON**	**ANAMMOX**	**CaRRB**
Constructability	+	–	–	0
Maintenance Requirements	+	–	–	0

Table 10.8 Comparison of Recycle Treatment Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Equalization	SHARON	ANAMMOX	CaRRB
Aeration Energy Input	+	–	–	–
Heat Input	+	–	–	+
Operating Experience	+	–	–	0
Process Complexity	+	0	–	0
Requirement for Precise Process Control	+	–	–	–
Recovery From Upset	+	0	–	+
Reduction in Nitrogen Load	–	0	+	0
Reliability	+	0	–	+
Capital Cost	–	0	–	0
O&M Cost(1)	0	+	+	0

Notes:
(1) O&M costs refer to the overall cost of treatment, not just the cost of treating the recycle stream.

Legend:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

10.5.2 Economic Evaluation

As the precise process control requirements and significant reheating requirements make the SHARON and ANAMMOX Alternatives unfeasible, they were not included in the economic evaluation.

A life-cycle cost analysis was performed for the remaining alternatives. The resulting costs were then compared to the costs of a new 1-mgd activated sludge system. Table 10.9 displays a summary of the results found in the cost analysis performed.

Table 10.9 Life-Cycle Cost of Recycle Treatment Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	New Activated Sludge System (1 mgd)	Equalization	CaRRB
Capital Cost	$2,882,000	$2,877,000	$10,165,000
Annual O&M Cost	$230,000	$110,800(1)	$299,000
Life-Cycle Cost(2)	**$6,830,000**	**$4,780,000**	**$15,559,000**

Notes:
(1) Includes only cost for pumping, aeration, and mixing.
(2) As present value, assuming a life-cycle period of 19 years, a discount rate of 6 percent, and an escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

As shown in Table 10.9, the capital costs for a new activated sludge system and an EQ basin are comparable and the life-cycle costs are similar. As mentioned, the need for EQ can be avoided by operating the dewatering system 7 days a week, a strategy the City plans to implement. Thus, the benefits achieved from the construction of a separate EQ basin and the associated operational complexities do not justify the expenditure. The CaRRB Alternative has a much higher capital cost than the equivalent activated sludge, even when allowing for the fact that it would increase the Plant 2 capacity by 2.0 mgd. Hence, converting the 1958 chlorine chamber to CaRRB is not recommended.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 11: PLANT UTILITIES AND SUPPORT FACILITIES

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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Chapter 11

PLANT UTILITIES AND SUPPORT FACILITIES

11.1 PURPOSE

The purpose of this chapter is to identify existing plant utilities and support facilities at the Regional Water Quality Control Plant (RWQCP) and, if required, recommend new systems.

11.2 CONCLUSIONS AND RECOMMENDATIONS

- The existing potable water system can provide adequate pressure; therefore, no change is needed for the existing piping. New piping will be added as necessary as future expansions are completed.
- Utility water is pumped from Pump Station No. 21 at Chlorine Contact Basin (CCB) No. 1. The utility water system, which includes the pump station and distribution piping, is not adequate. Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) has designed an upgrade to the distribution piping and is currently designing a new pump station, which will be located in CCB No. 2. The new pump station will produce water that meets the Title 22 450 concentration and Contact Time (CT) requirement. In addition to the change that PBS&J is designing, upsizing and looping of the distribution piping in the vicinity of CCB No. 2 will be necessary to accommodate the new pump station location.
- The natural gas system includes low-pressure and high-pressure lines. No change is needed for the existing natural gas system. New piping will be connected to the existing lines as necessary as future expansions are completed.
- There is not a High-Pressure Air (HPA) piping system throughout the RWQCP. There are several small systems in individual process areas. New systems will be installed for new facilities as necessary as future expansions are completed.
- The communication system includes a phone system, plant radio system, and public address system. The public address system is old and should be upgraded.
- Based on *Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities*, published by the Water Environment Federation, the site security level should be evaluated for access control, cyber security, monitoring for flammable/toxic substances, and backup power.
- The existing storm drain system drains to a pump station and is pumped to the Plant 1 aeration basins. In the future, an option to pump upstream of primaries will be added.
- A new maintenance building will be located south of the existing maintenance building. Additional parking space will be added east of the existing parking lot.

- New buildings in excess of 5,000 square feet will meet a minimum of the Leadership in Energy and Environmental Design (LEED) standard.
- The flood protection levee may have to be raised. The total project cost will be approximately $52 million (August 2006 dollars).

11.3 POTABLE WATER

Figure 11.1 shows the piping layout for the major lines in the existing potable water system. Water is supplied by the City of Riverside (City) Public Utilities Department. City water enters the RWQCP from a 12-inch diameter pipe located in Acorn Street. Because the RWQCP potable water system is looped, it has adequate pressure. No changes are needed for the existing system. Future expansions will include new piping as necessary as future expansions are completed.

11.4 UTILITY WATER

The RWQCP utility water system layout is presented in Figure 11.2.

Table 11.1 presents anticipated 2025 on-site utility water uses. Utility water is distributed from Pump Station No. 21 at CCB No.1, except for the water cannon uses. The water cannons supply utility water through a separate booster pump. Utility water is also pumped from Pump Station No. 21 for off-site recycled water uses. These uses are described in Volume 7 – Reclamation and Reuse, of the Integrated Master Plan.

Table 11.1 Future On-Site Utility Water Demands
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

On-Site Utility Water Application	Maximum Hour Usage[(1)] (gpm)
Belt Filter Press Wash Water	350
Pump Seal Water	75
Alumer Dilution	5
Chlorine Injectors	50
Scum Sprays	50
Wash Down Hydrants (1-inch)[(2)]	40
Wash Down Hydrants (3-inch)[(2)]	100
Water Cannon[(2)(3)]	2,000
Power Plant[(4)]	560

Table 11.1 Future On-Site Utility Water Demands Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
On-Site Utility Water Application	**Maximum Hour Usage[1] (gpm)**
Miscellaneous[5]	200
Future Gravity Belt Thickeners Wash Water	1,320
TOTAL DEMAND	**4,750**

Notes:
(1) Data supplied by the City based on uses through 2025.
(2) Intermittent demand.
(3) Used for washdown of the tertiary influent equalization basins.
(4) Constant demand for industrial process.
(5) Includes on-site plant irrigation and general wash down water.

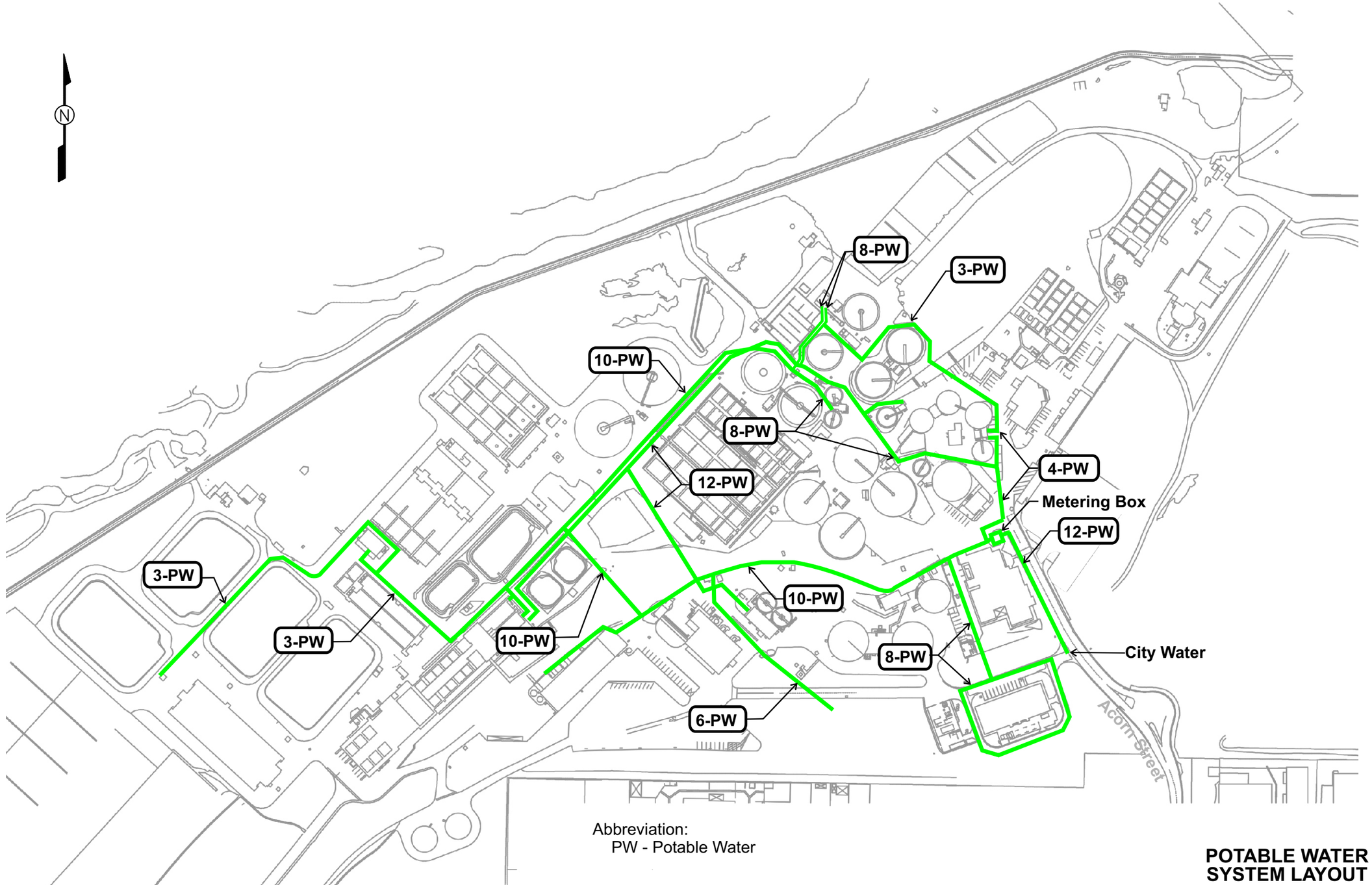
The utility water system is not adequate. There are problems with leakage in the distribution system piping. In addition, some of the lines are abandoned because of inoperable or undocumented valves. In the *Upgrade of Impure Water Piping System* designed by PBS&J, new piping will be provided for higher reliability for on-site utility water uses. Also, the pumps in Pump Station No. 21 have passed their useful life, and the water that is pumped from the pump station does not meet the Title 22 450 CT requirements. PBS&J has designed an upgrade to the distribution piping and is currently designing a new pump station, which will be located in CCB No. 2. The new pump station will produce water that meets the Title 22 450 CT requirement. In addition to the change that PBS&J is designing, upsizing and looping of the distribution piping in the vicinity of CCB No. 2 will be necessary to accommodate the new pump station location.

11.5 NATURAL GAS

There is a high-pressure natural gas service for the cogeneration facility that enters the site on Acorn Street. There is another natural gas service for low-pressure uses. The meter for this service is at the west corner of the parking lot. The major pipes from the service entrances to the points of use are shown on Figure 11.3. On-site gas uses include:

- Space heaters.
- Water heaters.
- Boilers.
- Cogeneration facility.

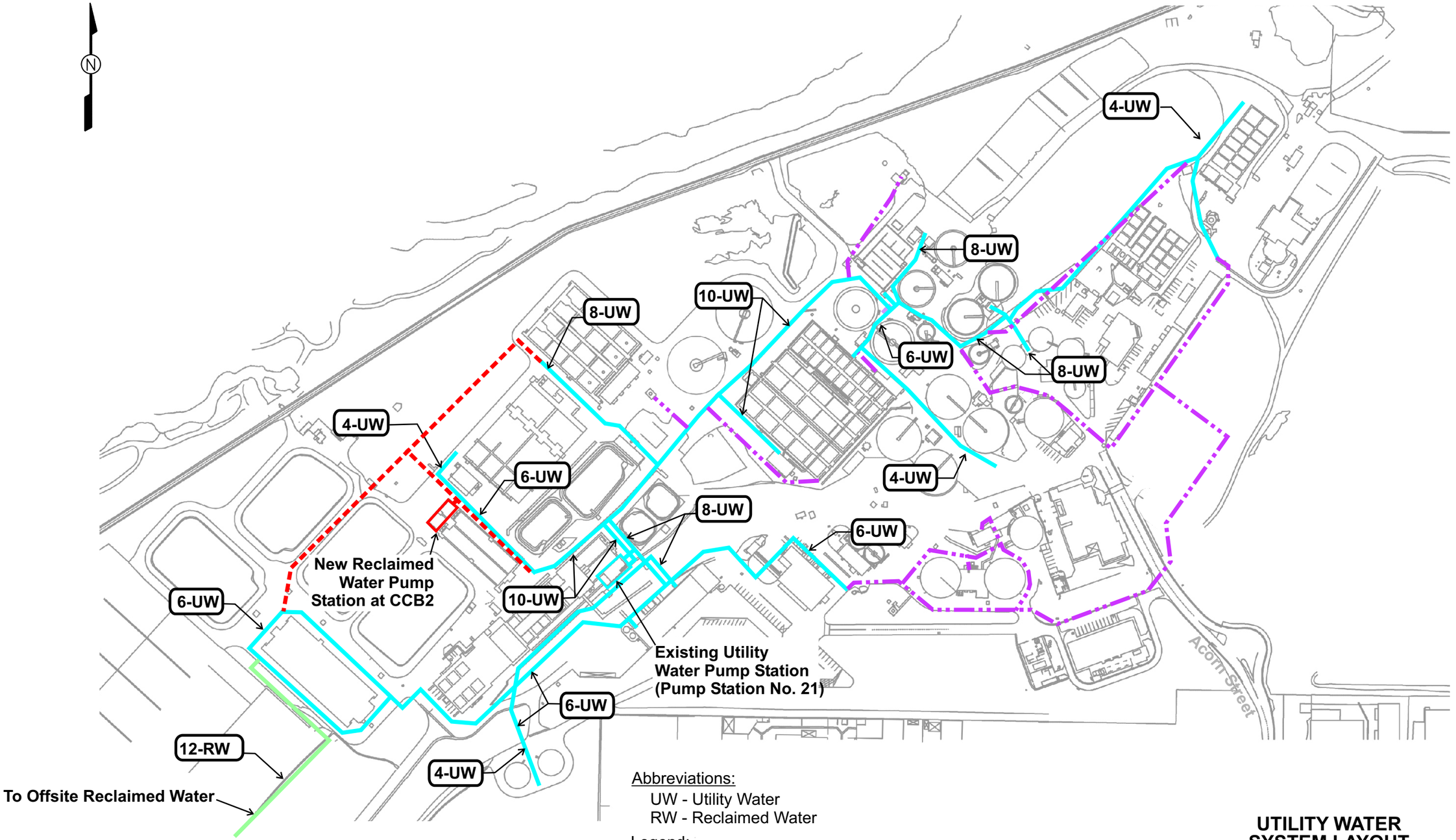
The existing system is adequate to supply gas for the existing RWQCP uses. New piping for future facilities will be connected to the existing system as necessary.



Abbreviation:
PW - Potable Water

POTABLE WATER SYSTEM LAYOUT

FIGURE 11.1



Abbreviations:

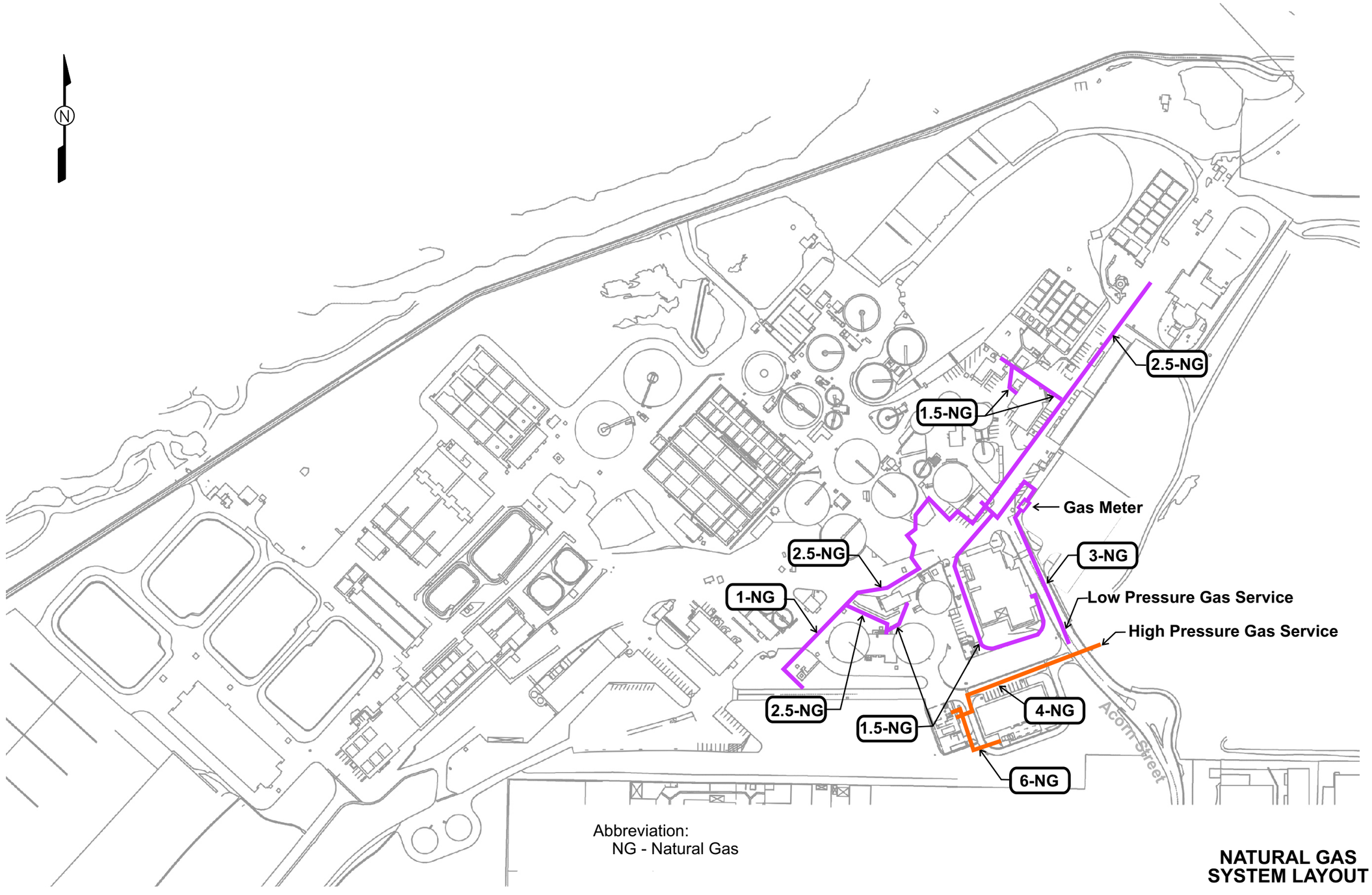
UW - Utility Water
RW - Reclaimed Water

Legend:

- Existing Piping
- Piping Upgrades by PBS&J
- Piping Upgrades for New Reclaimed Water Pump Station

UTILITY WATER SYSTEM LAYOUT

FIGURE 11.2



Abbreviation:
NG - Natural Gas

NATURAL GAS SYSTEM LAYOUT

FIGURE 11.3

11.6 HIGH-PRESSURE AIR

There is not a separate system to distribute HPA throughout the RWQCP. HPA systems are located in the following facilities for air tools and other uses:

- Headworks.
- Waste activated sludge thickening facility.
- Belt press dewatering facility.
- Tertiary filters.
- Cogeneration facility.

All of these systems are in good condition and provide adequate air for their intended purpose. New systems will be installed for new facilities as determined during preliminary design on a case-by-case basis.

11.7 COMMUNICATION SYSTEM

The existing communication system consists of the following:

- Phone System: Plant phones, cell phones, and BlackBerry handheld devices. Plant phones provide both interplant uses and public uses. The cell phones use the Nextel network with direct paging and two-way walkie-talkie communication functions. The BlackBerry handheld devices provide wireless Internet access, and they are available to staff above the manager level.
- Plant Radio System: Motorola Icom repeater system. The plant radio system is in use every day and is used for two-way communication for those who do not have Nextel cell phones or Blackberry devices.
- Public Address (PA) System: The speaker system is activated from plant phone by dialing "75." Speakers are installed in the outside walkways and plant buildings, except for pump stations. The PA system is old and has a lot of background noise. At the project meeting on January 24, 2007, it was decided that the PA system would be upgraded.

11.8 SITE SECURITY

Many major natural events, such as storms, fires, and earthquakes, which can be partially planned for, have been considered in the planning and design of the RWQCP. Since the events of September 11, 2001, malevolent acts by terrorists are also a concern. Wastewater facilities are potential targets for malevolent acts of destruction and disruption from domestic and international terrorists. Purposeful contamination of wastewater, as well

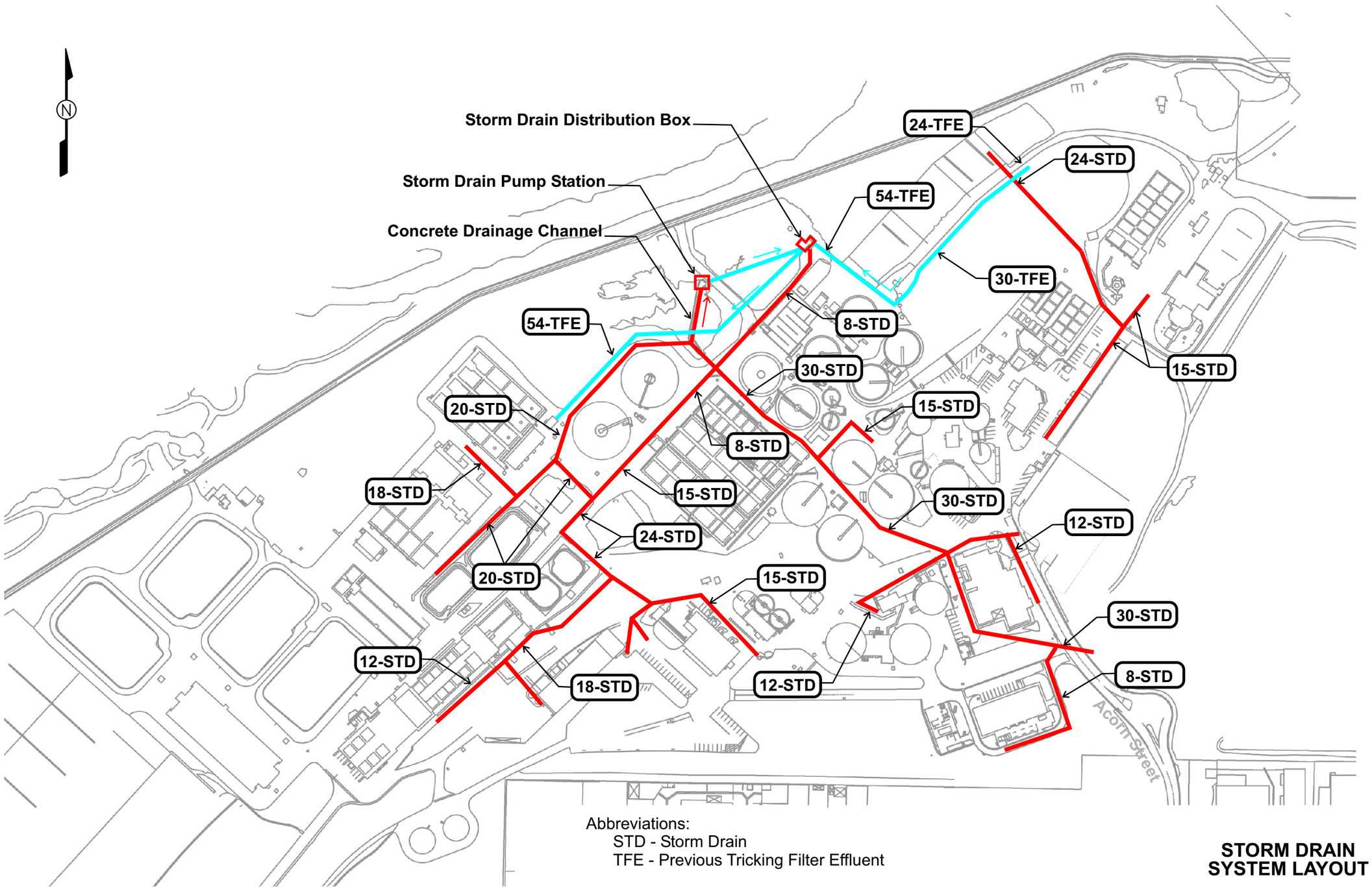
as damage to treatment or conveyance systems, can lead to widespread and long-term environmental damage and severe public health impacts. The purpose of site security planning is to reduce the risks posed by malevolent threats. Based on *Interim Voluntary Security Guidance for Wastewater/Stormwater Utilities* published by the Water Environment Federation, the following security issues should be evaluated:

- Access Control: Currently, vehicular access to the site is not limited by a gate with a card key or other type of access control. However, an identification badge is required to be worn by all RWQCP staff. In addition, all visitors are expected to check in at the Administration Building upon entering the site. Additional identification for both staff and visitors may require a vehicular access control gate, card readers, Personal Identification Numbers (PIN), and/or biometrics. Access alarms for gates and doors and camera monitoring may also be considered. The site should also be evaluated for its illumination at night.
- Cyber Security: The reliance on the automated operation increases the vulnerability to cyber attack. Access to Supervisory Control and Data Acquisition (SCADA) needs to be evaluated for cyber security vulnerability assessment.
- Continuous Sampling and/or Monitoring: Flammable substances, such as gasoline and toxic chemicals, can disrupt the collection system or debilitate the biological system. Continuous sampling for these substances is highly recommended.
- Backup Power: Uninterruptible Power Supplies (UPSs) or some method of battery backup should be considered for emergency.

11.9 STORM DRAIN

Figure 11.4 shows the existing storm drain system. The stormwater is collected by a gravity system consisting of storm drains, open channels, and over-land flow. There are two main lines: a 24-inch pipe at the east and a 30-inch pipe at the center of the RWQCP. The 24-inch pipe is connected to the storm drain distribution box by the previous trickling Filter Effluent (TFE) pipes. The stormwater collected in the 30-inch drain flows through a concrete drainage channel and then the water is pumped through submersible pumps to the storm drain distribution box, where all the stormwater flows to the Plant 1 aeration basins through the 54-inch TFE pipe. This collection system is adequate, and new piping would be added to the existing system as necessary as future expansions are completed.

One improvement to the system would be to add an option to pump stormwater upstream of primaries. This will allow flows with large amounts of sediment from large storms to be captured in the primary clarifiers. It would also lessen the impact on the secondary treatment system.



Abbreviations:
STD - Storm Drain
TFE - Previous Tricking Filter Effluent

STORM DRAIN SYSTEM LAYOUT

FIGURE 11.4

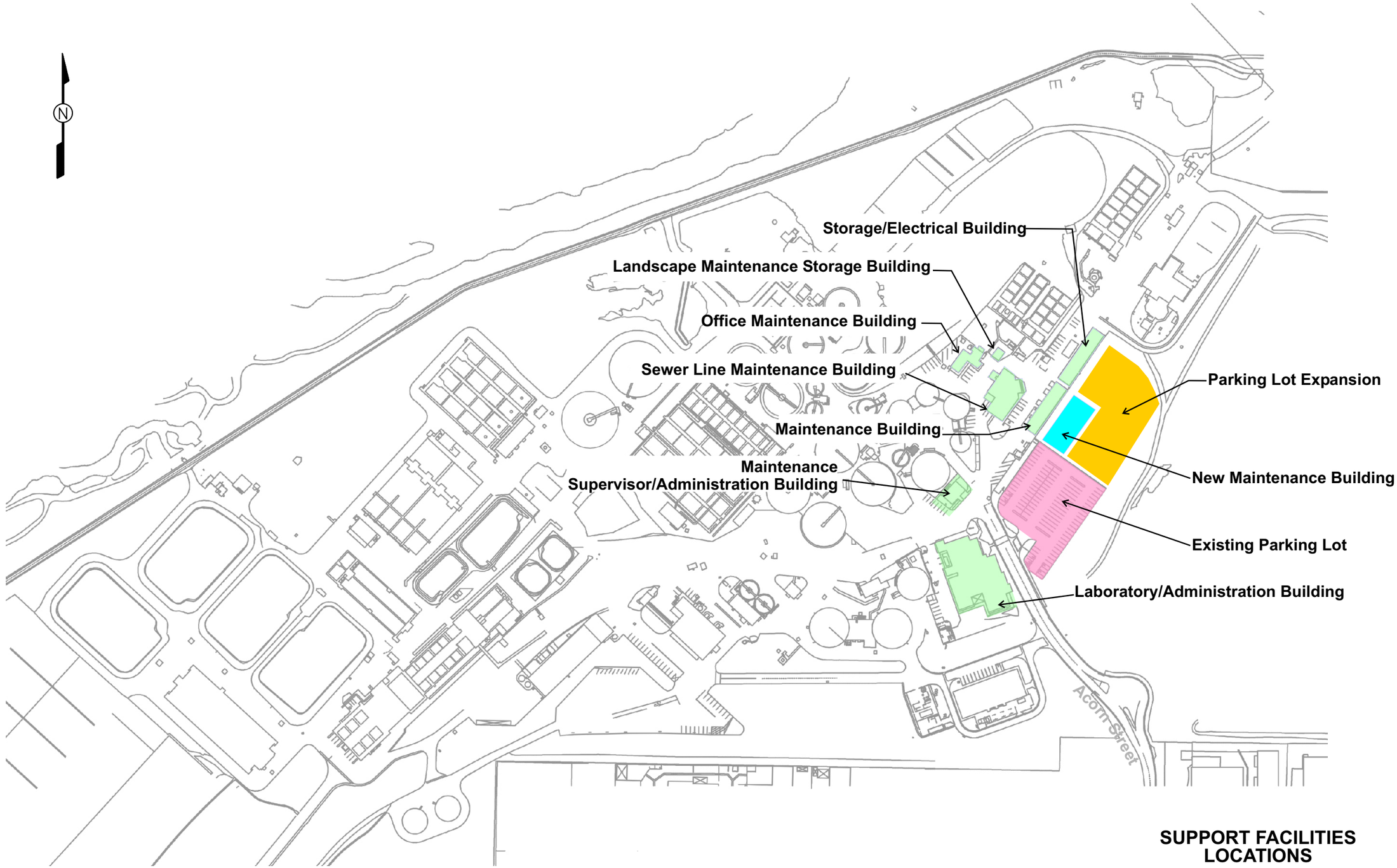
11.10 SUPPORT FACILITIES

Figure 11.5 shows the locations of the existing and future RWQCP support facilities. A new maintenance building will be located south of the existing maintenance building. The new building will be 10,000 square feet. Additional parking space will be added east of the existing parking lot.

The new maintenance building will be in accordance with the City-approved “Green Municipal Building Policy.” This policy requires that new City buildings, in excess of 5,000 square feet, meet a minimum of the LEED standard.

11.11 FLOOD PROTECTION LEVEE

Based on a preliminary analysis by the City, the existing levee that protects the RWQCP from the river may have to be raised. The City’s analysis assumes the potential new height of the levee is 8 feet higher than existing. Before the City decides that it is necessary to raise the levee, a more detailed analysis and hydrology study will be completed to confirm that the levee needs to be raised. In the meantime, a master plan level estimate of the construction cost of raising the levee has been completed. The construction cost of the levee project is estimated to be $40 million, and the total project cost will be approximately $52 million (August 2006 dollars). The schedule of the project is discussed in Volume 4, Chapter 14 – Implementation Schedule and Cost.



SUPPORT FACILITIES LOCATIONS

FIGURE 11.5

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 12: PRIMARY EFFLUENT EQUALIZATION

FINAL
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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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Chapter 12

PRIMARY EFFLUENT EQUALIZATION

12.1 PURPOSE

The purpose of this chapter is to evaluate alternatives for primary effluent equalization. This includes a comparison of equalization basin liner, cover and cleaning alternatives, and development of a basin layout that will meet the peak flow storage requirement for the Regional Water Quality Control Plant (RWQCP) at an annual average daily flow of 52.2 mgd.

12.2 CONCLUSIONS AND RECOMMENDATIONS

- Primary effluent equalization will be used to provide better control for downstream processes and a reduction in project costs for the Membrane Bioreactors (MBRs). In addition, the reduction in project costs for the MBR facility is more than the project cost of providing primary effluent equalization.
- Two equalization basins with a total volume of 12.1 MG will be required based on the Riverside wet-weather diurnal curves.
- Hypalon liners will be used for the basin liner material because of its lower cost compared to concrete and better durability than polypropylene. The total project cost for the equalization basins is estimated to be $10.4 million for the hypalon-lined basins.
- Basin covers will not be used because of cost and cleaning issues. To minimize odors, the basins will need to be dewatered and cleaned daily.

12.3 BACKGROUND

The purpose of an equalization system is to balance upstream fluctuating flows and reduce the maximum flow requirement for the downstream facilities. As described in Volume 4, Chapter 7 – Secondary Treatment, a 32-mgd capacity MBR facility was chosen for the Plant 1 secondary expansion. If primary effluent equalization is used, the size of the MBR facilities will be reduced because a lower peak flow is applied to the membranes. This reduces MBR capital costs. Because primary effluent equalization can reduce MBR capital costs and provide better process control for downstream facilities, MBR costs are included in evaluation of alternatives with equalization and without equalization.

12.4 PRIMARY EQUALIZATION ADVANTAGES/DISADVANTAGES

The primary advantage of having primary effluent equalization is to achieve better process control for both secondary and tertiary treatment. However, because primary effluent

contains more organics and suspended solids, primary effluent equalization basins need more attention for basin cleaning than tertiary influent equalization basins. In addition, primary effluent equalization basins have a potential to produce odors. The Inland Empire Utilities Agency (IEUA) Regional Plant No. 1 (RP-1) facility is located directly adjacent to a residential and commercial area and operates primary effluent equalization basins. Historically, the RP-1 facility received numerous complaints related to the equalization basins. After improved management of the basins, which included adding aeration to the basins and daily emptying and water cannon wash down, the complaints have stopped.

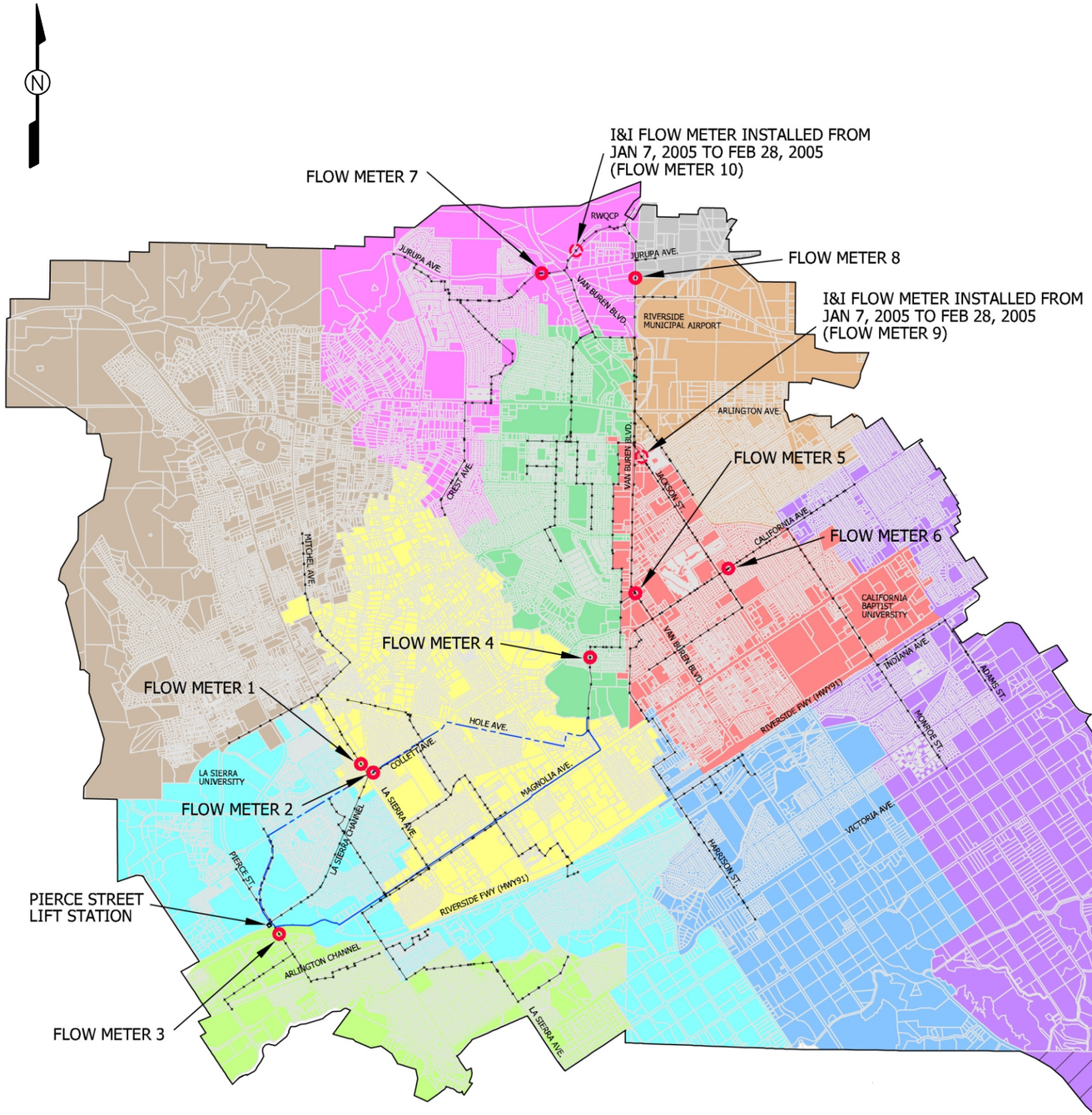
12.5 DESIGN CRITERIA

The equalization basin will be sized to limit the peak wet-weather flow downstream of the primary clarifiers to approximately 78 mgd. This is equivalent to reducing the wet-weather peaking factor from 2.2 to approximately 1.5 during storm flow conditions. Under normal operating conditions, the peaking factor will be reduced to less than 1.5. The equalization basin is sized assuming it will be completely emptied and washed down every day. The sizing also includes a 20-percent safety factor to accommodate operational contingencies.

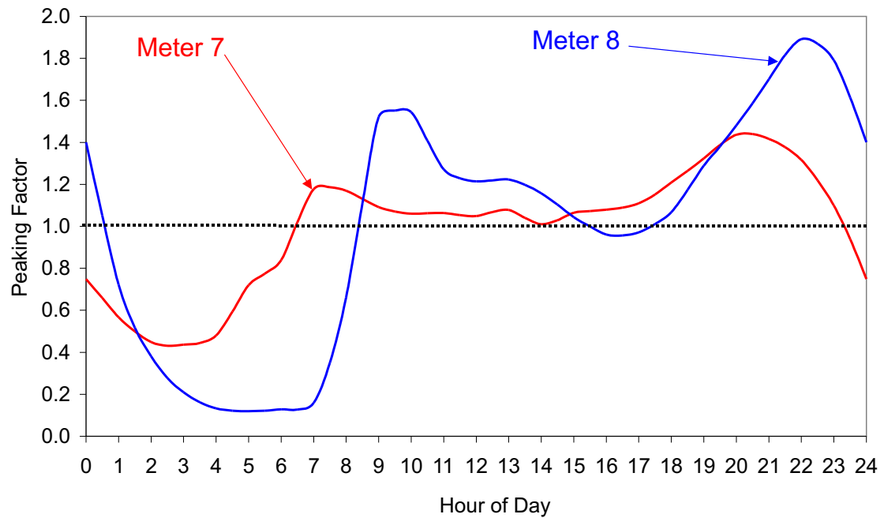
12.6 EQUALIZATION VOLUME

In Volume 4, Chapter 8 – Tertiary Treatment, tertiary influent equalization was discussed. The method to determine the equalization volume for tertiary influent, which is the accumulated volume above the wet-weather peak average daily flow, also applies for primary effluent. Because the RWQCP diurnal flow is not available, diurnal curves from the City of Riverside's (City's) Collection System Master Plan are used. During data collection for the Collection System Master Plan, two flow meters were located close to the RWQCP. The location of these meters (Meters 7 and 8) and their respective diurnal flow curves are shown on Figure 12.1. Because these curves are more representative of the RWQCP diurnal flows, they are used for the primary effluent equalization evaluation.

To determine the average daily influent flow during a wet-weather peak day, the RWQCP influent flow data for the last 6 years was used as presented on Figure 12.2. The figure shows that the average daily flow for the highest peak day occurred in February 2005, at 46.5 mgd. During the entire 6-year data timeframe, the average daily flow was 31.2 mgd. The ratio of the maximum average daily flow (46.5 mgd) to the overall average daily flow (31.2 mgd) is approximately 1.5. Applying the 1.5 ratio to the projected 2025 annual average daily flow of 52.2 mgd results in a peak wet-weather average daily flow of approximately 78 mgd. Figure 12.3 shows the simulated diurnal curves with an average daily flow of 78 mgd.



Representative Diurnal Curves for Collection System Meters

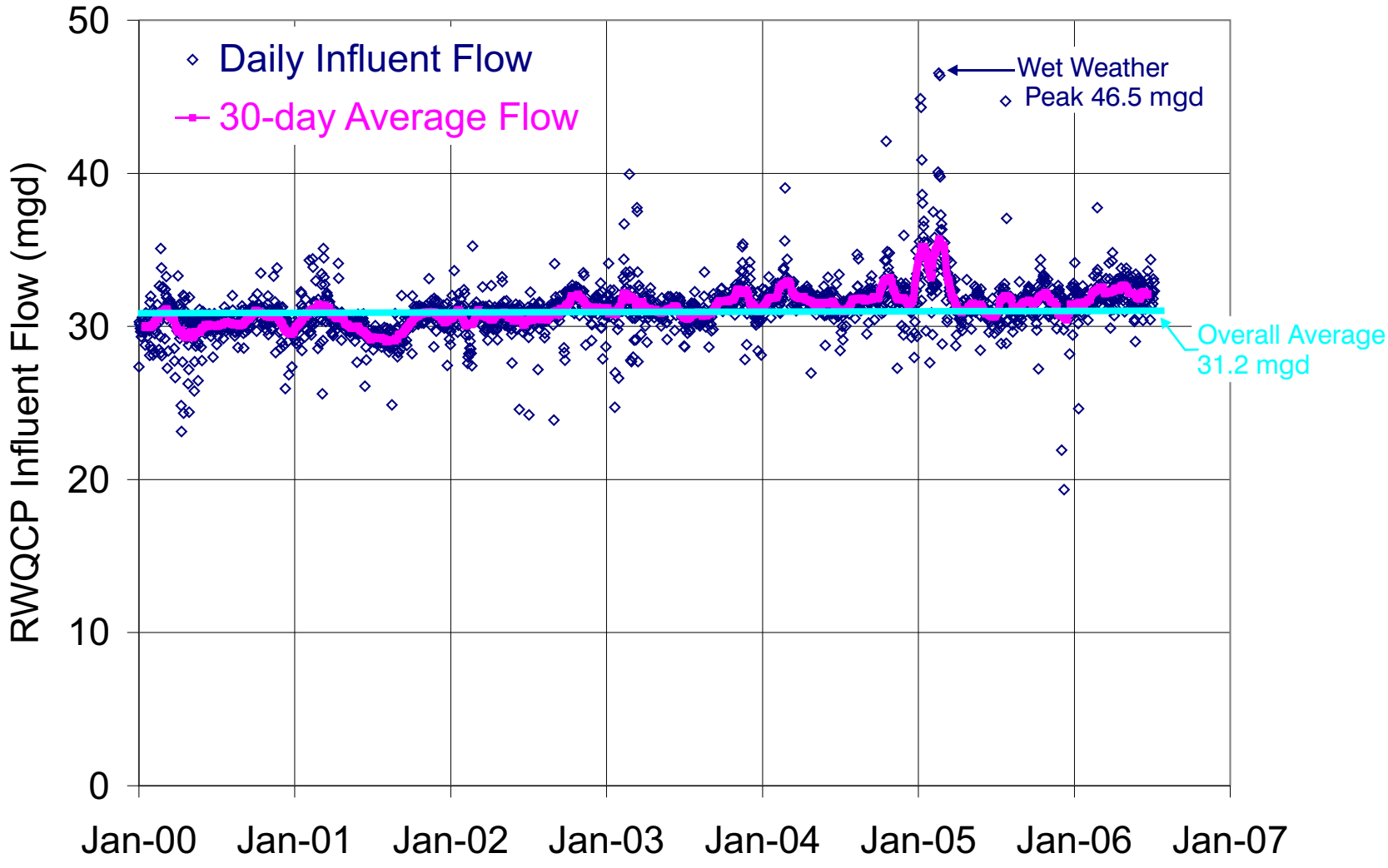


LEGEND

- STUDY MAIN AND MANHOLES
- MAGNOLIA FORCE MAIN
- LA SIERRA FORCE MAIN
- SUB AREA 01
- FLOW METER 1
- FLOW METER 2
- FLOW METER 3
- FLOW METER 4
- FLOW METER 5
- FLOW METER 6
- FLOW METER 7
- FLOW METER 8
- FLOW METER 9
- FLOW METER 10
- COUNTY AREA MAY BE SERVED BY CITY (FLOWS TO METER 6)
- FLOW METER LOCATION
- INFLOW AND INFILTRATION STUDY FLOW METER LOCATION

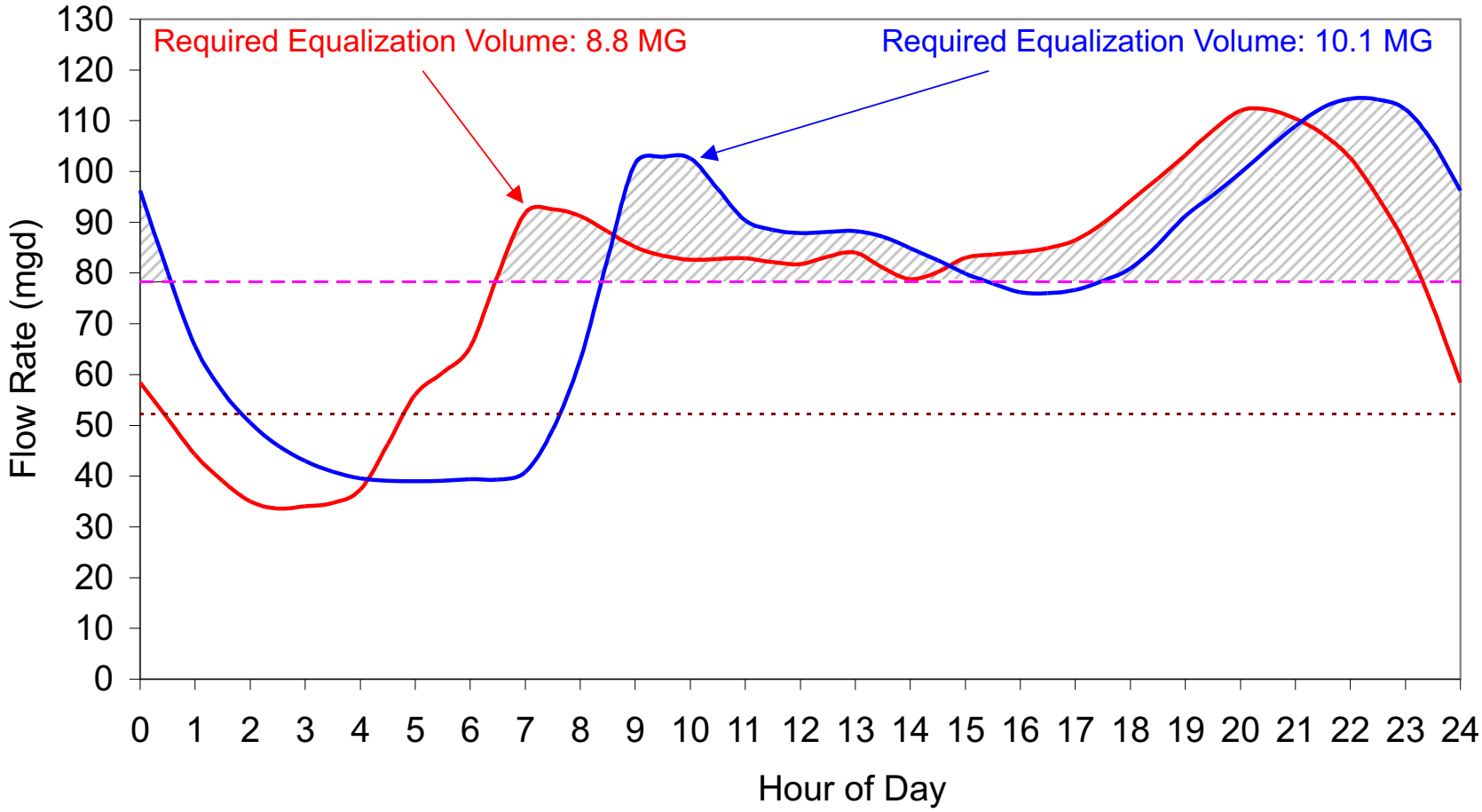
RWQCP COLLECTION SYSTEM METER LOCATIONS AND REPRESENTATIVE DIURNAL CURVES

FIGURE 12.1



DAILY INFLUENT FLOW AT RWQCP

FIGURE 12.2



SIMULATED RWQCP
WET WEATHER DIURNAL FLOW

FIGURE 12.3

Assuming the equalization basins are emptied every day, the maximum required volume should be the accumulated volume above the daily average flow of 78 mgd and below the simulated diurnal curves during a wet-weather peak day. The required volumes are 10.1 MG and 8.8 MG for the two curves, respectively. Using the larger required volume from the adopted curves and including a 20-percent safety factor as an operational contingency, the total designed equalization volume is 12.1 MG.

To provide operational flexibility, two equalization basins would be provided as presented in Table 12.1. Ideally, the basins would be roughly the same size. However, due to existing piping constraints, one basin will be larger than the other.

Table 12.1 Primary Effluent Equalization Basins
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Equalization Basin	Side Slope	Water Depth[(1)]	Basin Volume
EQ No. 1	2:1	18 feet	2.6 MG
EQ No. 2	2:1	18 feet	9.5 MG
Total Required Volume			**10.1 MG**
Total Designed Volume[(2)]			**12.1 MG**

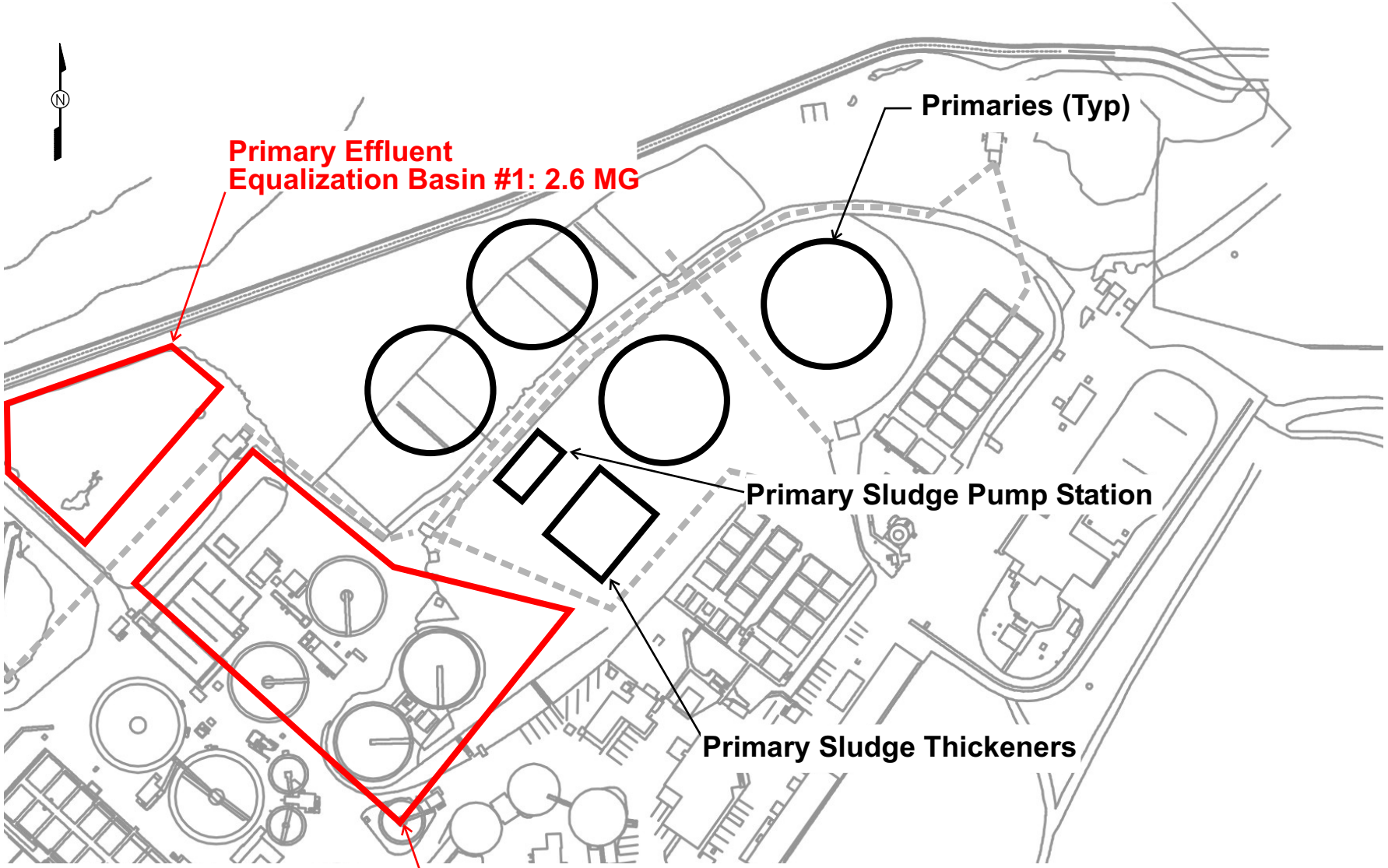
Notes:
(1) Dependent on geotechnical conditions.
(2) Includes 20-percent operational safety factor.

12.7 SITE LAYOUT

A proposed layout for two equalization basins is shown on Figure 12.4. Demolition of the abandoned Plant 1 secondary clarifiers and the abandoned chlorine contact basins is required to provide space for the basins. The dimensions of the basins should be determined during the preliminary design based on a geotechnical investigation. For this Integrated Master Plan, assuming the groundwater level is the same as the area of the existing tertiary equalization basins, and referring to the hydraulic conditions detailed in Volume 4, Chapter 13 – Proposed Expansion Plan and Site Layout, the depth for the equalization basins is limited to 18 feet.

12.8 BASIN LINERS

The primary effluent equalization basins will be lined to prevent seepage into the surrounding soil and groundwater. Basin liners can be soil cement, synthetic geomembrane, or concrete. Because soil cement lacks the ability to be high-pressure washed and has a short useful life, it is not evaluated. Among the different types of geomembrane liners, hypalon and polypropylene are considered best for this application.



PRIMARY EFFLUENT EQUALIZATION BASINS LAYOUT

FIGURE 12.4

Hypalon lasts longer and costs more than polypropylene. Concrete and shotcrete are more costly, but last longer than geomembranes. For the construction of basin walls, shotcrete is much easier to apply than concrete; therefore, shotcrete walls are much cheaper than concrete walls. Table 12.2 lists a comparison of basin liner alternatives.

Table 12.2 Comparison of Basin Liner Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

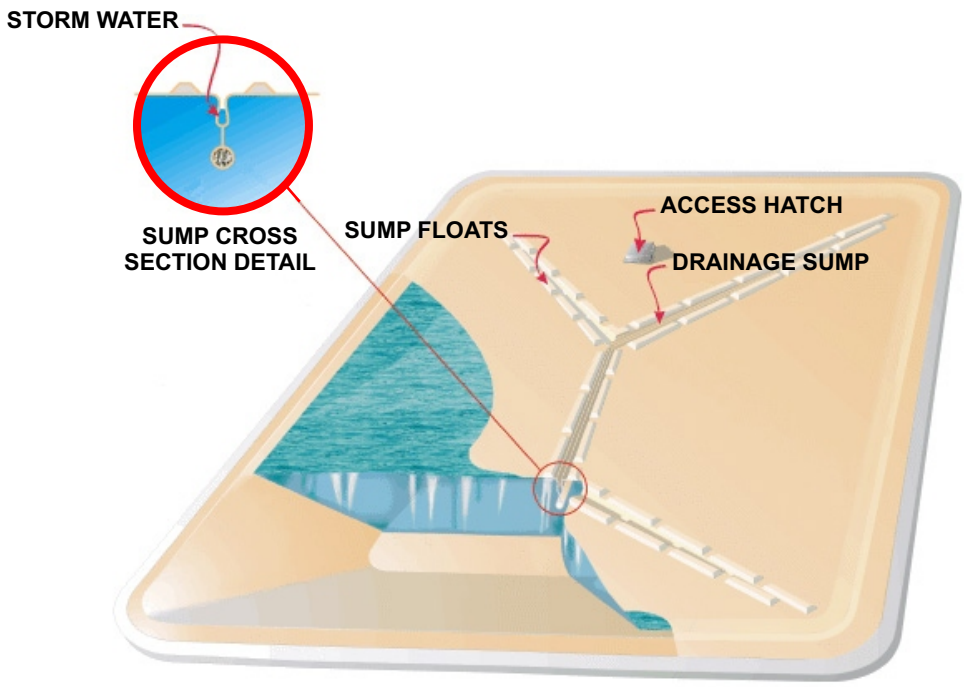
	Hypalon	Polypropylene	Concrete	Shotcrete	SWCB(1)
Ability to Support Concrete Cover	–	–	+	+	+
Ability to Drive On	–	–	+	+	+
UV Protection	0	0	+	+	+
Life Expectancy	30 years	20 years	50 years	50 years	50 years
Direct Cost(2)	$220 K	$160 K	$1,200 K	$780 K	$1,000 K
Equivalent Uniform Annual Cost(3)	$16 K	$14 K	$77 K	$ 49 K	$65 K

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

Notes:
(1) Shotcrete walls with concrete bottom.
(2) Includes material and installation costs; does not include excavation or demolition.
(3) Based on a discount rate of 6 percent per year.

12.9 BASIN COVERS

As previously stated, primary effluent equalization basins have the potential to produce odors. One method to control odors is to cover the equalization basins. If they were covered, either a concrete or floating cover would be used. A concrete cover would have to be supported by concrete columns and concrete basins. A floating cover is supported by the water and does not need extra support. Figure 12.5 shows a schematic and a photograph of a floating basin cover installation. Floating basin covers are typically made of geomembrane materials, such as hypalon or polypropylene. Hypalon is a more durable material and costs more than polypropylene.



FLOATING BASIN COVER

FIGURE 12.5

Table 12.3 presents a non-economic comparison of cover and non-cover alternatives.

Table 12.3 Non-Economic Comparison of Equalization Basin Cover
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	No Cover	Concrete Cover	Floating Cover
Surface Aeration Required	–	+	+
Odor Scrubbing Required	+	–	+
Concrete Basin Required for Cover Support	+	–	+
Water Cannon Compatibility for Cleaning	+	–	–

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

Table 12.4 presents a cost comparison of the basin cover alternatives. On an equivalent uniform annual cost basis, floating covers are much more cost effective than concrete covers.

Table 12.4 Comparison of Basin Cover Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Concrete(1)	Hypalon	Polypropylene
Unit Cost(2)	$23/sf	$5/sf	$4/sf
Life Expectancy	50 years	30 years	20 years
Direct Cost(2)	$2,840,000	$650,000	$520,000
Equivalent Uniform Annual Cost(3)	$180,000	$47,000	$45,000

Notes:
(1) Concrete cover costs do not include odor-scrubbing costs.
(2) Includes material and installation costs.
(3) Based on a discount rate of 6 percent per year.

12.10 BASIN CLEANING AND ODOR CONTROL

12.10.1 Basin Cleaning

Based on the experience at the IEUA RP-1 facility, sediment from the primary effluent is expected to accumulate at a rate of about 1/4 inch per day. Because of this, the basins must be cleaned frequently. Similar to the existing tertiary influent equalization basins, water cannons can be used to clean the basin bottom daily if the basin has no cover. If a basin is covered, an alternate cleaning method is required. Robot cleaners, as shown on Figure 12.6, with camera and remote control can be an option.

ROBOT CLEANERS FOR COVERED BASINS

FIGURE 12.6

These robot cleaners can go under water, brush the basin bottom, and suck out the sediment. The disadvantages of the robot cleaners are that they have not been used in wastewater treatment applications and more operator attention is required. The comparison of the two cleaning alternatives is presented in Table 12.5.

Table 12.5 Comparison of Basin Cleaning Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Water Cannon	Robot Cleaner
Compatibility with Basin Cover	–(1)	+
Recycled Water Requirement	–	+
Out-of-Service Requirement	–	+
Equipment Reliability	+	–
Operator Attention Requirement	+	–(2)

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

Notes:
(1) Cover must be removed to use water cannon.
(2) Would require continuous operator attention (8 hours/day).

12.10.2 Odor Control

Based on the IEUA RP-1 facility, for uncovered primary effluent equalization basins, surface aeration and daily cleaning is recommended. If the basins need to be covered, either a concrete cover or a floating cover should be considered. If a concrete cover is used, the foul air under the cover should be scrubbed before release to the atmosphere. The floating cover alternative does not require foul air treatment because the cover is in contact with the water surface.

12.11 COST COMPARISON OF EQUALIZATION BASINS

Because hypalon and polypropylene have similar properties and costs, and hypalon provides a better warranty, hypalon is used to represent the low-cost cover/liner alternative material. Similarly, because concrete and shotcrete have similar properties, but different costs, concrete is used as the liner/cover material to represent the high-cost alterative material. If other alternatives are considered, their costs will be between the hypalon and concrete costs.

Table 12.6 presents a cost comparison of the primary effluent equalization basin alternatives.

Table 12.6 Total Project Cost of Primary Effluent Equalization Basins
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Liner	Hypalon	Concrete	Hypalon	Concrete	Concrete
Cover	None[1]	None[1]	Hypalon	Hypalon	Concrete[2]
Capital Cost[3]	$8,000,000	$10,500,000	$9,800,000	$12,300,000	$44,200,000
Total Project Cost	$10,400,000	$13,600,000	$12,800,000	$15,900,000	$57,500,000
Annual O&M Cost[4]	$119,000	$119,000	$196,000	$196,000	$320,000
Equivalent Uniform Annual Cost[5]	$780,000	$980,000	$1,040,000	$1,230,000	$3,970,000

Notes:
(1) Non-cover alternative includes surface aerator and water cannon costs.
(2) Concrete cover alternative includes biofilter costs.
(3) Includes demolition, excavation, and secondary pump station construction costs.
(4) Includes basin cleaning and odor control costs.
(5) Based on a discount rate of 6 percent per year.

12.12 LIFE-CYCLE COST ANALYSIS

Because primary effluent equalization basins can reduce MBR capital costs, the total life-cycle costs for alternate MBR facilities, with and without primary effluent equalization, are compared in Table 12.7.

Table 12.7 Life-Cycle Cost for Equalization and MBR
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Without Equalization	Hypalon Basin w/o Cover	Concrete Basin w/o Cover
MBR Project Cost[1]	$132,300,000	$116,500,000	$116,500,000
MBR Annual O&M Cost	$1,620,000	$1,620,000	$1,620,000
MBR Replacement Cost [2]	$6,600,000	$5,800,000	$5,800,000
MBR Life-Cycle Cost[3]	**$172,200,000**	**$154,900,000**	**$154,900,000**
Equalization Project Cost	$0	$10,400,000	$13,600,000
Equalization Annual O&M Cost	$0	$119,000	$119,000
Equalization Life-Cycle Cost[3]	**$0**	**$12,500,000**	**$15,600,000**
Total Life-Cycle Cost[3]	**$172,200,000**	**$167,400,000**	**$170,500,000**

Notes:
(1) Includes Plant 1 aeration basin modifications, MBR tank modifications, fine screens, MBR equipment and installation, blowers retrofit, and sludge pumping upgrade (see Volume 4, Chapter 7 – Secondary Treatment for details).
(2) Membranes need to be replaced every 7 years.
(3) At present value, assuming a life-cycle period of 19 years, a discount rate of 6 percent, and an escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

As presented in Table 12.7, the reduction in project costs for the MBR facility with equalization is more than the project costs of providing primary effluent equalization for both non-cover alternatives.

12.13 SUMMARY

At the project meeting on February 21, 2007, the alternative and cost information for the various basin liner, cover, and cleaning alternatives were discussed. To help improve downstream process control and reduce the cost of the MBR secondary expansion, the City has decided to install primary effluent equalization basins. Because the City intends to operate the basins to minimize odor control by adding aeration and daily emptying and cleaning, covers will not be installed on those basins. In order to minimize life-cycle costs, the basin liner material will be hypalon. The total project cost of hypalon-lined basins is estimated to be $10.4 million.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 13: PROPOSED EXPANSION PLAN AND SITE LAYOUT

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PROPOSED EXPANSION PLAN AND SITE LAYOUT

13.1 PURPOSE

This chapter summarizes the proposed expansion plan and site layout for the Regional Water Quality Control Plant (RWQCP) liquid handling facilities to treat a flow of 52.2 mgd in 2025 on an annual average basis. The purpose of this chapter is to present the proposed site layout, flow schematic, and hydraulic profile for the liquid handling facilities. The expansion plan and layout for solids treatment facilities are discussed in detail in Volume 8 – Solids Treatment and Handling.

13.2 CONCLUSIONS AND RECOMMENDATIONS

- Based on the evaluations performed in Chapters 1 to 12 of this volume, a revised RWQCP site layout and flow schematic have been developed for expansion to 52.2 mgd on an annual average basis.
- In addition to a site layout and flow schematic, the hydraulic profile is updated with the new flow distribution, including the addition of the new structures and the new piping.

13.3 BACKGROUND

Since July 2006, several project meetings have been held to discuss process alternatives for the wastewater treatment system for the 52.2-mgd expansion. Based on the decisions at the meetings, the selected expansion for the RWQCP liquid processes is summarized as follows:

- Preliminary Treatment: A new 15-mgd annual average flow headworks facility will be built.
- Primary Treatment: Four circular primaries to treat 32 mgd on an annual average basis will be built to replace the Plant 1 primary clarifiers and expand primary capacity. Both the Plant 1 and Plant 2 primaries will be covered and a biofilter will be used for odor control.
- Primary Effluent Equalization: Two primary effluent equalization basins with a total volume of 12.1 MG will be built.
- Secondary Treatment: A 32-mgd Membrane Bioreactor (MBR) facility will be installed in two phases. The first phase will expand the Plant 1 secondary treatment facilities from 20 to 26 mgd. The second phase will expand the secondary facilities from 26 to 32 mgd.

- Tertiary Treatment: Because high-quality filtrate from MBRs does not require tertiary filtration and the existing filters have adequate capacity for the Plant 2 secondary effluent, new tertiary facilities are not required.
- Disinfection: A new Chlorine Contact Basin (CCB) of 8 mgd on annual average basis will be built.
- Plant Utilities and Support Facilities: The Public Address (PA) system will be replaced. A new maintenance building and parking lot expansion will be installed. In addition, the flood protection levee may have to be raised.

13.4 SITE LAYOUT

Based on the evaluations performed in Chapters 1 to 12 of this volume, a revised RWQCP site layout and flow schematic have been developed for expansion to 52.2 mgd, on an annual average basis. Figure 13.1 shows the proposed layout of the new liquid stream, solids, odor control, and support facilities.

The new Plant 1 primaries and primary sludge pumping and thickening facilities will be located in the area of the abandoned Plant 1 sludge beds and the demolished trickling filters. Primary effluent equalization basins will be installed where the abandoned Plant 1 secondary clarifiers and the abandoned chlorine contactor are located. The new headworks facility will be at the location of the existing Plant 1B primaries. A biofilter for the Plant 1 and Plant 2 primaries and the new headworks will be located at the site of existing Plant 1A primaries. MBR modules will be installed in the retrofitted Plant 1 secondary clarifiers. An additional basin will be added to the Plant 1 aeration basins. A new CCB will be located on the west side of CCB3. Solids treatment facilities, including sludge thickening facilities and an acid-phase digester, are described in Volume 8 - Solids Treatment and Handling.

New pipes and connections will be needed for the new facilities. Figure 13.2 shows the approximate locations of the major piping for the liquid stream processes. A primary influent splitter box for the new Plant 1 primaries will be needed. Distribution boxes will be needed to divert primary effluent to the primary effluent equalization basins for both Plant 1 and Plant 2. Primary effluent equalization pumps will be used to pump the equalized stream to either Plant 1 or Plant 2 during off-peak hours. Fine screens will be installed upstream of the Plant 1 aeration basins for the MBR. A new pipe will be provided between the aeration basins and the MBR units that will be located in the retrofitted Plant 1 secondary clarifiers. The new pipe will be installed to accommodate the increased Return Activated Sludge (RAS) flow that the MBR facility requires.

Key

1 New Headworks
2 Biofilters
3 Plant 1 New Primary Clarifiers
4 Primary Sludge Pump Station
5 Primary Effluent Equalization Basins
6 Plant 1 Aeration/Anoxic Basins Modifications
7 Plant 1 MBR
8 New Chlorine Contact Basin
9 Primary Sludge Thickeners
10 New Secondary Sludge Thickeners
11 Acid Phase Digester
12 New Maintenance Building
13 Parking Lot Expansion

Legend

Liquid Stream Treatment Facilities

Solids and Air Treatment Facilities

Support Facilities

Existing Pipes

PROPOSED LAYOUT FOR NEW FACILITIES

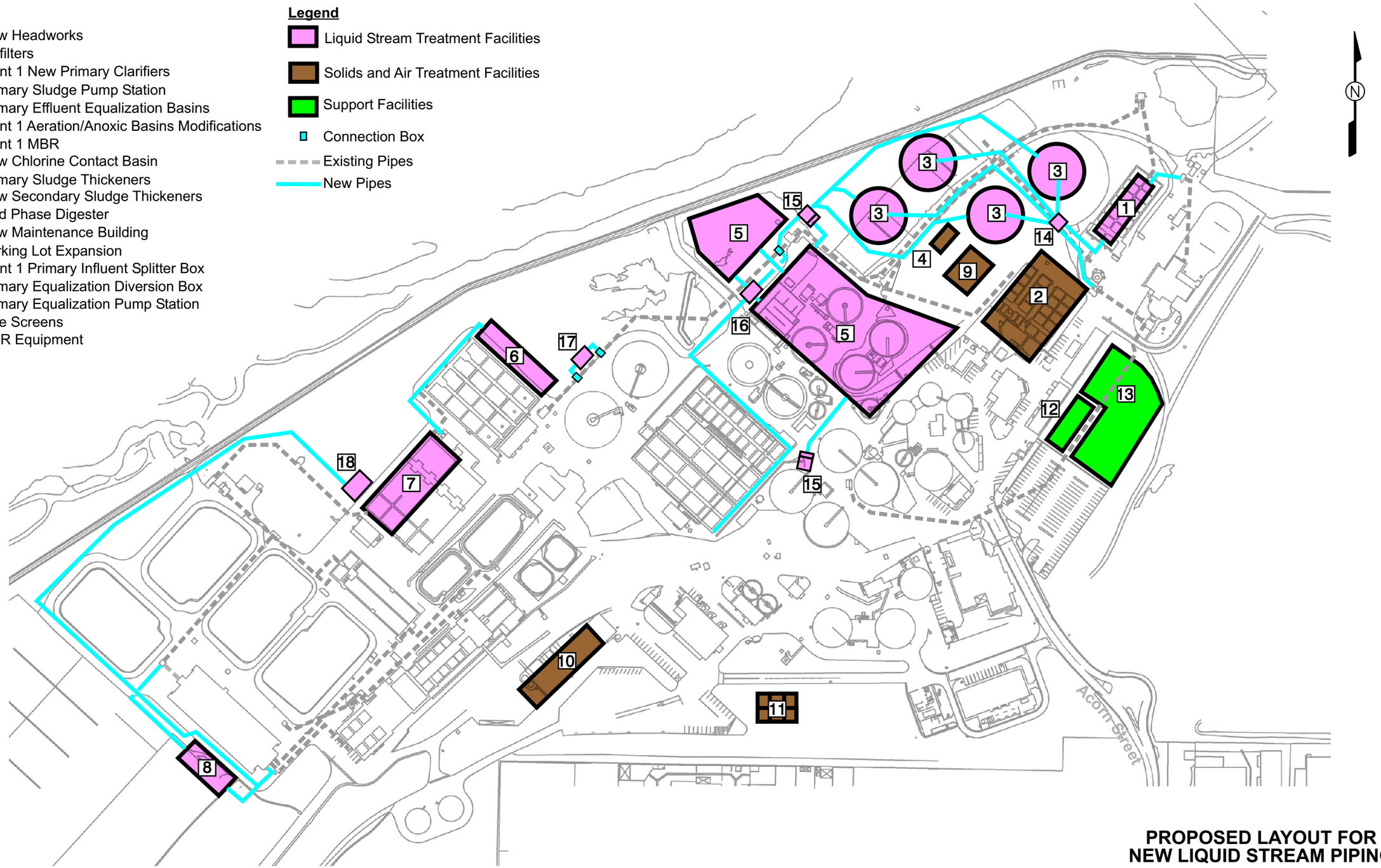
FIGURE 13.1

Key

1. New Headworks
2. Biofilters
3. Plant 1 New Primary Clarifiers
4. Primary Sludge Pump Station
5. Primary Effluent Equalization Basins
6. Plant 1 Aeration/Anoxic Basins Modifications
7. Plant 1 MBR
8. New Chlorine Contact Basin
9. Primary Sludge Thickeners
10. New Secondary Sludge Thickeners
11. Acid Phase Digester
12. New Maintenance Building
13. Parking Lot Expansion
14. Plant 1 Primary Influent Splitter Box
15. Primary Equalization Diversion Box
16. Primary Equalization Pump Station
17. Fine Screens
18. MBR Equipment

Legend

- Liquid Stream Treatment Facilities
- Solids and Air Treatment Facilities
- Support Facilities
- Connection Box
- Existing Pipes
- New Pipes



PROPOSED LAYOUT FOR NEW LIQUID STREAM PIPING

FIGURE 13.2

13.5 FLOW DISTRIBUTION

Besides changes to the structures and piping, flow distribution to the plant is also modified. Figure 13.3 shows the updated RWQCP flow schematic. It includes the new flow distributions to the different structures at the hourly peak influent flow condition.

Plant 1 and Plant 2 will have design capacities of 32.2 mgd and 20 mgd, respectively. The total design plant flow is 52.2 mgd on an average daily basis. Using a wet weather peaking factor of 2.2, the peak wet weather flow will be 114.8 mgd. In addition, there is 5.3 mgd of recycle stream flow that the plant will need to treat, which makes the total treatment flow approximately 120 mgd.

All unit processes upstream of the primary equalization basins, except the headworks, will treat the total 120 mgd, while the flow downstream of primary equalization is based on a peaking factor of 1.5, which limits the flow to approximately 80 mgd.

Since Plant 1 secondary treatment will be converted to an MBR operation, there will not be a requirement for tertiary filtration for the Plant 1 secondary effluent. With a maximum treatment capacity of 27.8 mgd, Tertiary Filters 1 through 10 can treat the majority of the Plant 2 secondary effluent. During peak flow, the remaining Plant 2 secondary effluent, approximately 3.4 mgd, can be treated by Tertiary Filters 11 through 16.

As shown in Figure 13.3, CCB1 and CCB2 will receive the flow from Filters 1 through 10 only, while CCB3 and the new CCB will receive the flows from the Plant 1 MBR effluent and part of the Plant 2 effluent from Filters 11 through 16.

13.6 HYDRAULICS

13.6.1 Hydraulic Profile

Figure 13.4 presents a hydraulic profile for the proposed facilities.

13.6.2 Changes to the Existing Structures

The hydraulic calculations show that a few modifications to the existing structures are required in order to make the hydraulics feasible. These include the following:

- Add a 24-inch flow control valve at the existing headworks.
- Increase the size of the Plant 1 aeration basin influent channel openings.
- Lower the Plant 1 aeration basin effluent weir.

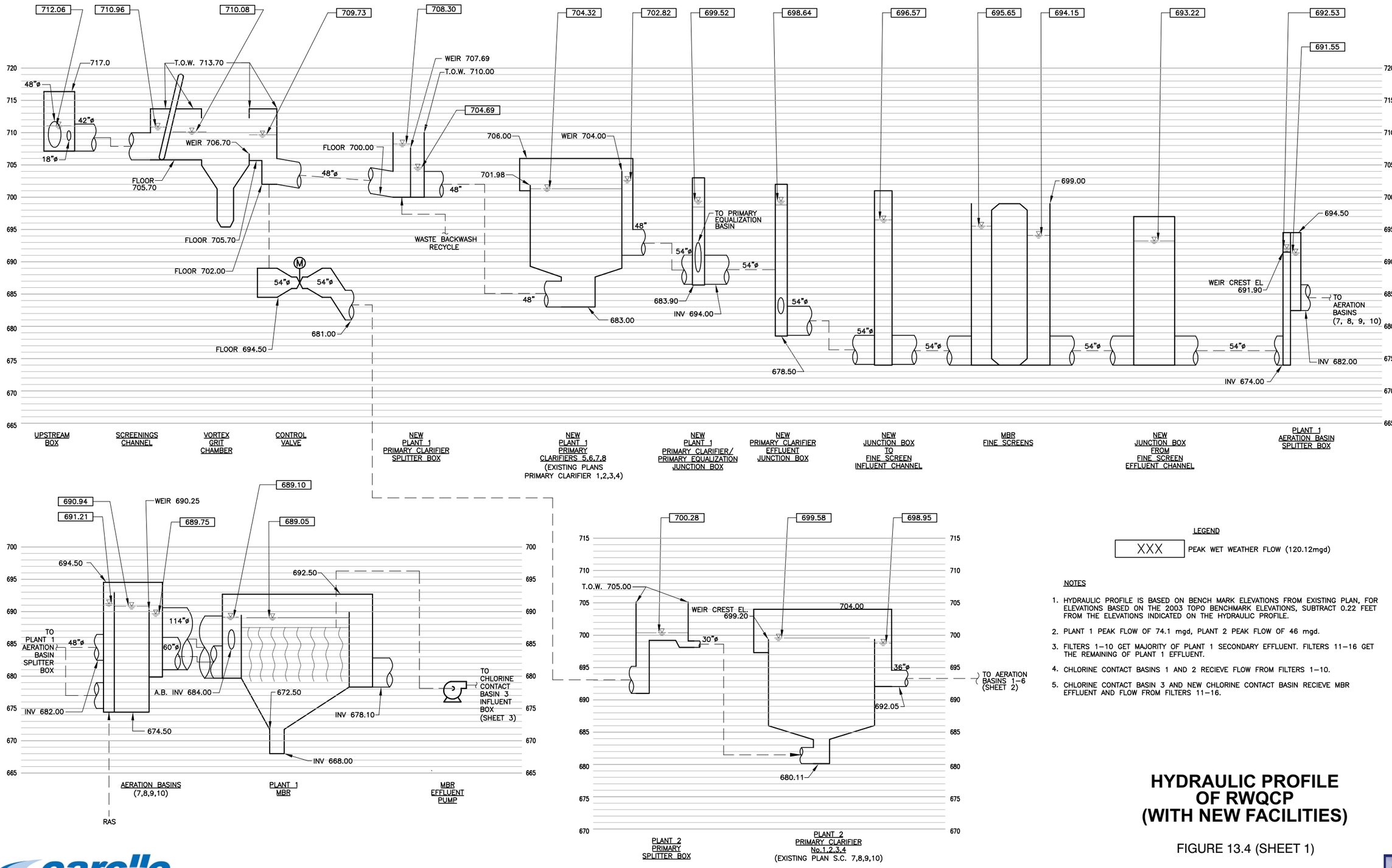
PEAK HOUR INFLUENT 114.8 MGD
RIVERSIDE/HILLSIDE
JURUPA
RUBIDOUX
ARLANZA
ACORN
HEADWORKS
33.4
BARSCREENS & VORTEX GRIT REMOVAL
PLANT 1
PLANT 2
NEW PLANT 1 PRIMARY INFLUENT SPLITTER BOX
74.1
PRIMARY CLARIFIERS (4 X 120 FT. DIAMETER)
73.6
18.4
18.5
DISTRIBUTION BOX
51.1
JUNCTION BOX
FINE SCREEN
AB SPLITTER BOX
AERATION BASIN MODIFICATIONS (5 X 200 X 40 FT)
7
8
9
10
185.5
MODIFICATIONS FOR MBR
MBR EFFLUENT PUMP STATION
50.4
RAS P/S
135.1
134.4
22.5
0
40.7
0.5
PLANT 1 PRIMARY SLUDGE
PLANT 1 PRIMARY SLUDGE PUMP STATION
WAS 0.7
PRIMARY EFFLUENT EQ BASINS
PRIMARY EQ PUMP STATION
PRIMARY CLARIFIERS (4 X 95 FT. DIAMETER)
11.4
11.5
0.15
P/S 15
P/S 4
46.0
14.0
DISTRIBUTION BOX
AERATION BASINS (6 X 250 X 40 FT.)
31.7
62.9
COMBO BOX B
31.2
RAS
WAS
0.5
SECONDARY CLARIFIERS (2 X 100 FT. DIAMETER) (2 X 130 FT. DIAMETER)
34
17
28.9
DIST. BOX 1
DIST. BOX 2
JUNCTION BOX 8
EQUALIZATION BASINS
JUNCTION BOX 9
DISTRIBUTION BOX 4
DISTRIBUTION BOX 3
JUNCTION BOX 14
JUNCTION BOX 13A
JUNCTION BOX 10
JUNCTION BOX 11
JUNCTION BOX 12
31.2
3.4
27.8
WASTE POND
5.3
0.2
B/W
FILTER PUMP STATION
FLOCCULATION
CHLORINE CONTACTOR NO. 3
41.1
37.7
12.7
JUNCTION BOX 16
53.8
NEW CHLORINE CONTACTOR
JUNCTION BOX 17
78.3
EFFLUENT METER STRUCTURE
RIVER
HIDDEN VALLEY WETLANDS
RECLAIMED WATER
FILTER PUMP STATION
1.8
2.0
27.8
DUAL MEDIA FILTRATION
CHLORINE CONTACTOR NO. 1
24.5
CHLORINE CONTACTOR NO. 2
DISTRIBUTION BOX 18
1.3
1.2
0.1
2.9
3.3
0.7
1.2
1.8
0.5
0.13
0.8
0.18
0.3
1.1
WASTE ACTIVATED SLUDGE THICKENERS
PLANT 1 & PLANT 2 PRIMARY SLUDGE
PRIMARY SLUDGE THICKENERS
DEWATERING LIQUOR
0.4
ACID PHASE DIGESTER
ANAEROBIC DIGESTERS (2 X 90 FT. DIAMETER)
DEWATERING BELT PRESSES/ CENTRIFUGES
0.3
WASH WATER
SLUDGE DISPOSAL

Legend

- —— - Liquid Stream Treatment
- - - - - Solid Stream Treatment
- —— - Backwash Stream
- ◇X - Sampling Point No. X
- ▭ - New Facilities
- XX - Wet Weather Peak/Tertiary Peak Flow, MGD
- XX - Sludge or Backwash Average Flow, MGD

RWQCP FLOW SCHEMATIC

FIGURE 13.3



LEGEND

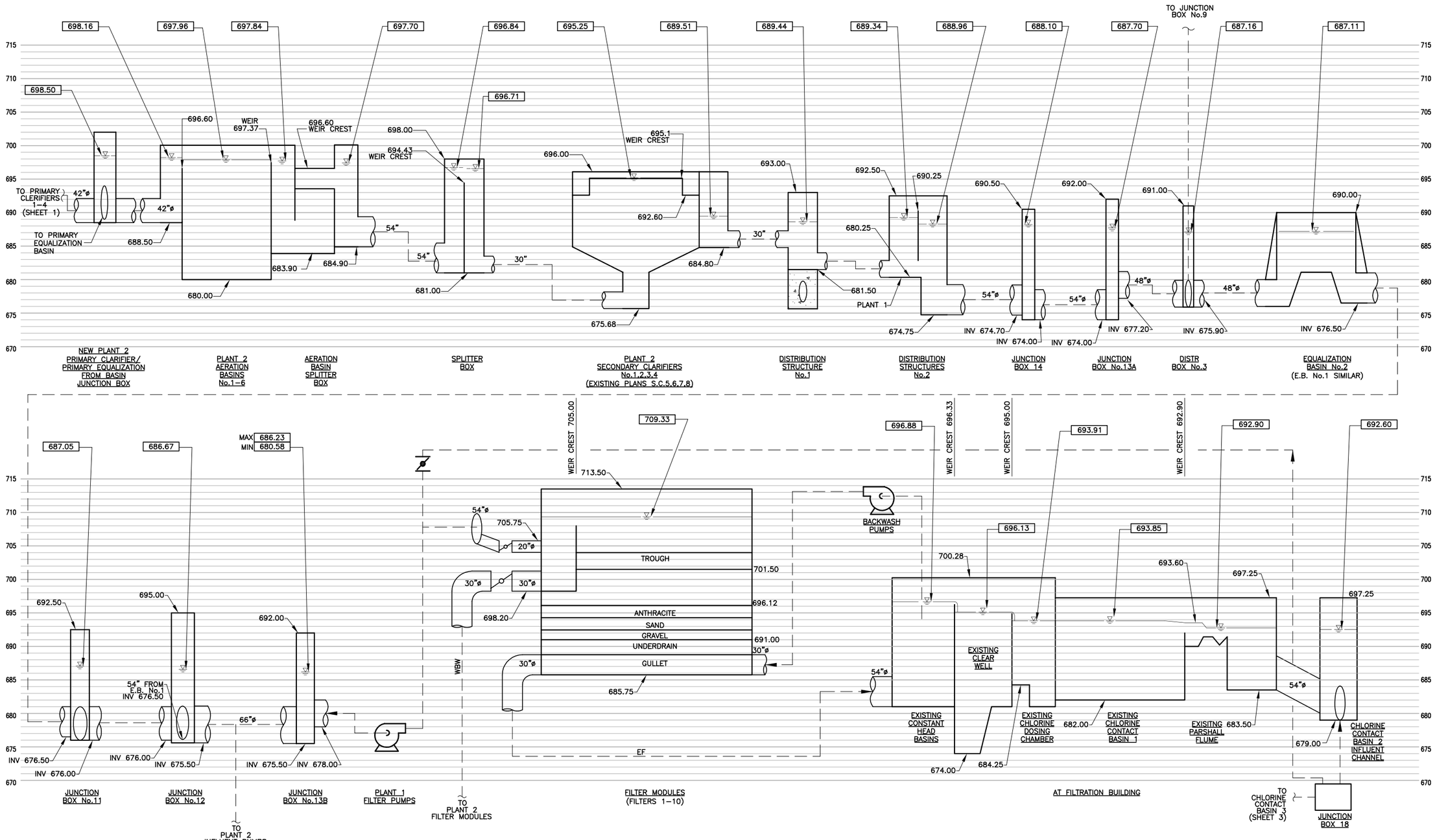
XXX — PEAK WET WEATHER FLOW (120.12mgd)

NOTES

1. HYDRAULIC PROFILE IS BASED ON BENCH MARK ELEVATIONS FROM EXISTING PLAN, FOR ELEVATIONS BASED ON THE 2003 TOPO BENCHMARK ELEVATIONS, SUBTRACT 0.22 FEET FROM THE ELEVATIONS INDICATED ON THE HYDRAULIC PROFILE.
2. PLANT 1 PEAK FLOW OF 74.1 mgd, PLANT 2 PEAK FLOW OF 46 mgd.
3. FILTERS 1–10 GET MAJORITY OF PLANT 1 SECONDARY EFFLUENT. FILTERS 11–16 GET THE REMAINING OF PLANT 1 EFFLUENT.
4. CHLORINE CONTACT BASINS 1 AND 2 RECIEVE FLOW FROM FILTERS 1–10.
5. CHLORINE CONTACT BASIN 3 AND NEW CHLORINE CONTACT BASIN RECIEVE MBR EFFLUENT AND FLOW FROM FILTERS 11–16.

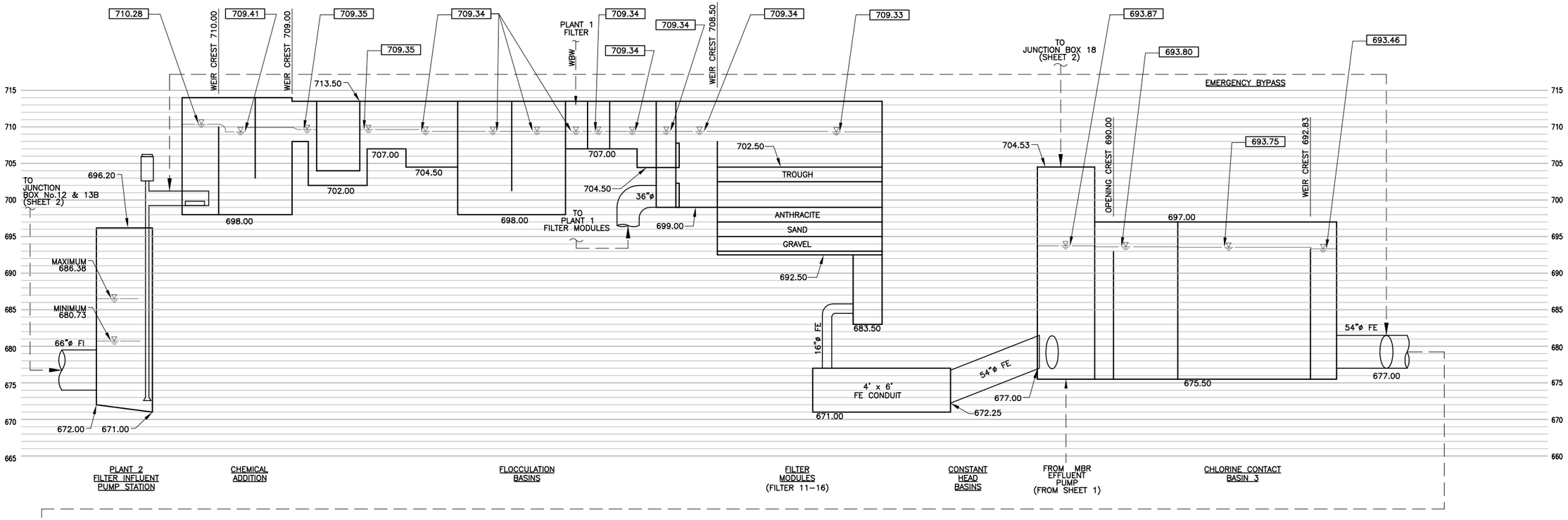
HYDRAULIC PROFILE OF RWQCP (WITH NEW FACILITIES)

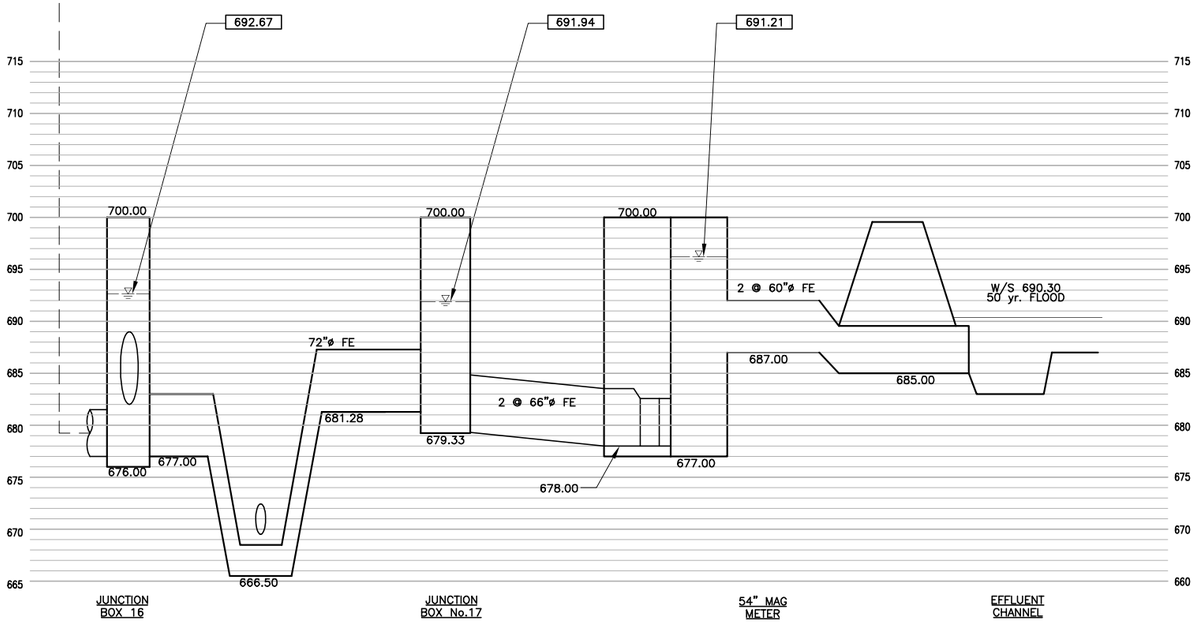
FIGURE 13.4 (SHEET 1)

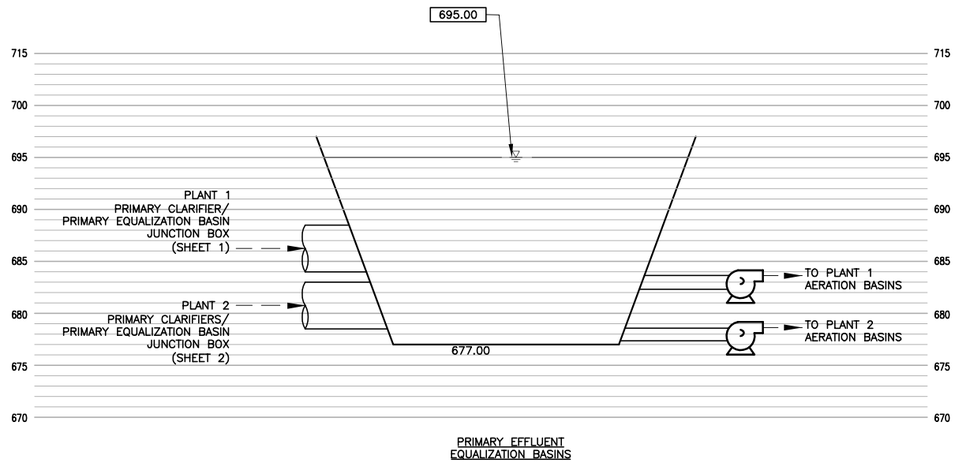


HYDRAULIC PROFILE OF RWQCP (WITH NEW FACILITIES)

FIGURE 13.4 (SHEET 2)







HYDRAULIC PROFILE OF RWQCP (WITH NEW FACILITIES)

FIGURE 13.4 (SHEET 3)

- Increase the size of the Plant 1 secondary clarifier influent channel openings (clarifiers will be converted to house the membranes for the MBR process).
- Upsize the pipe that is connecting the Plant 2 aeration basin splitter box to the Plant 2 Secondary Clarifiers 5 and 6 from 42 inches to 52 or 54 inches.

Because addition of the MBR will reduce the flow to the tertiary filters, changes will not be required to the pipe that is currently connecting Junction Box 13A and Box 14. These changes would be required if conventional activated sludge and tertiary filtration were selected instead of the MBR.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 14: IMPLEMENTATION SCHEDULE AND COST

FINAL
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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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CHAPTER 14: IMPLEMENTATION SCHEDULE AND COST

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IMPLEMENTATION SCHEDULE AND COST

14.1 PURPOSE

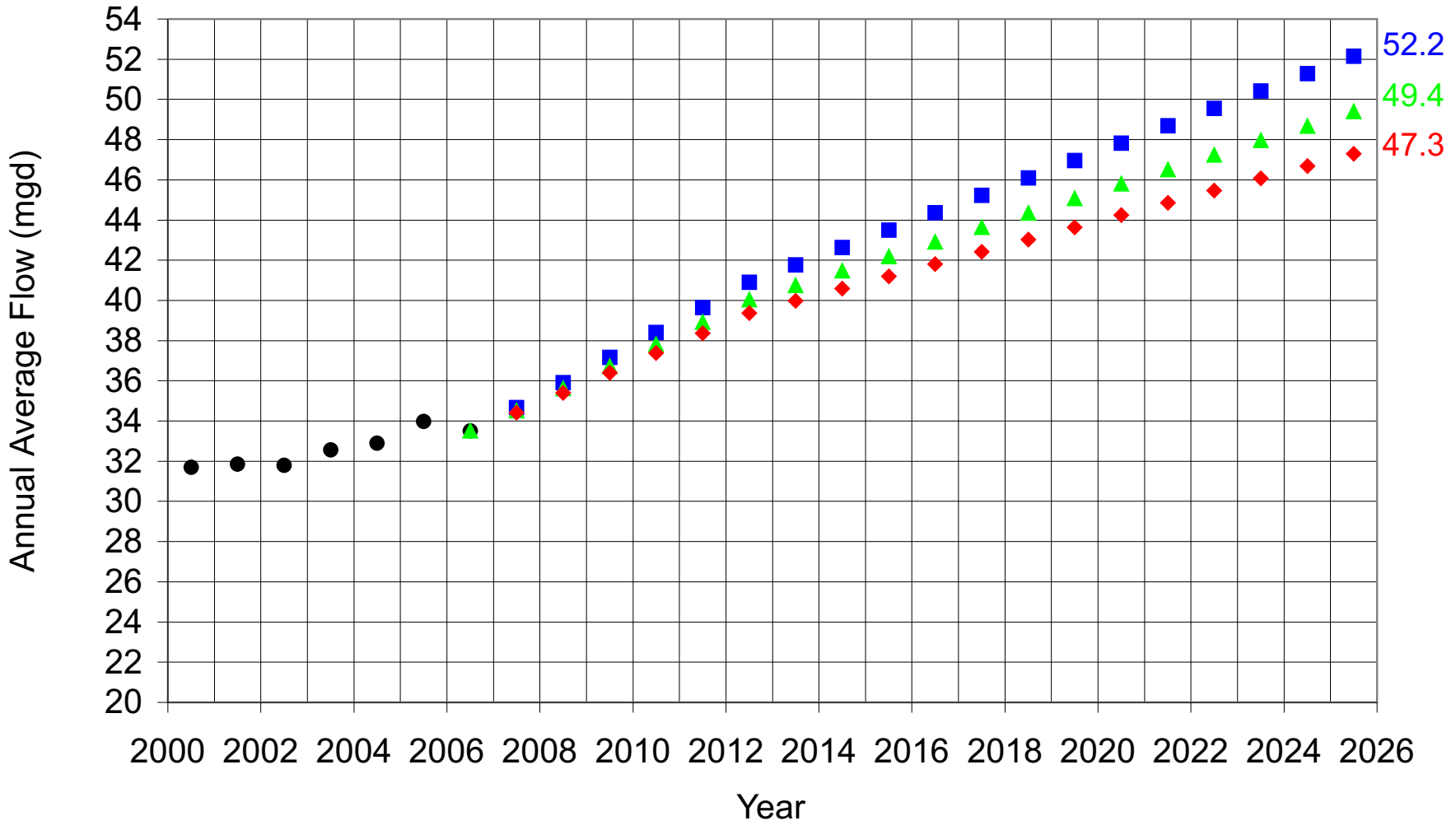
The purpose of this chapter is to present schedules and costs for the selected liquid stream process projects for the City of Riverside (City) of the Regional Water Quality Control Plant (RWQCP) Integrated Master Plan. The selected projects are derived from the analyses performed and presented in Chapters 1 through 13 of this volume of the Master Plan. This chapter is closely tied to Volume 8, Chapter 8 - Implementation Schedule and Cost for the solids stream projects.

14.2 CONCLUSIONS AND RECOMMENDATIONS

- The Plant 1 Primary Expansion, the Plant 1 Membrane Bioreactor (MBR) Facilities, and Acid-Phase Digester additions will be combined into one project.
- Based on the schedules for the low-growth scenario presented in this chapter, the combined project of Plant 1 Primary Expansion, MBR Facilities, and Acid-Phase Digester additions should start in the summer of 2008.
- The total project cost is $228 million for the liquid- and solid-stream projects described in this chapter, based on an Engineering News-Record (ENR) value of 8,570 (Los Angeles, August 2006). The mid-point of construction costs, adjusted by the schedule and phasing, are presented in Volume 10 - CIP and Overall Implementation Schedule.

14.3 BACKGROUND

In Volume 2, Chapter 3 - Population and Flow Projections, the projected average daily flow for the RWQCP is 49.4 mgd. This is based on increasing the flow at the same rate as the projected population growth, which is 1.09 percent for the City. Because population and flow projections may be different from actual values, a 90-percent confidence interval is applied to the data. This results in a high-growth scenario at 1.50 percent and low-growth scenario at 0.75 percent. Figure 14.1 shows the projected annual average influent flows for the RWQCP, along with projections using the high- and low-growth scenarios. At the beginning of the Integrated Master Plan process, the City decided that the high-growth scenario should be used as the design basis for all process alternative evaluations (August 2006). However, after the process alternative evaluations were completed (August 2007), it was determined that the slow down in the housing market would cause wastewater flows into the RWQCP to increase at a slower rate than was originally projected. Because of this slow down, the City decided that the low-growth scenario should



RWQCP FLOW PROJECTIONS

FIGURE 14.1

be used for establishing the Capital Improvement Plan (CIP). Based on the existing capacity and future flow requirements, implementation schedules for both high- and low-growth scenarios are developed for the liquid-process projects listed below:

- A new 15-mgd headworks facility (annual average basis).
- Plant 1 Primary Expansion: Four circular primaries to treat 32 mgd on an annual average basis, two primary effluent equalization basins of a total volume of 12.1 MG, primary equalization pump station, primary sludge pump station, primary sludge thickening facilities (gravity belt thickeners), and a biofilter for odor scrubbing.
- A two-phase 32-mgd MBR facility (annual average basis). The first phase will expand the Plant 1 secondary treatment facilities from 20 to 26 mgd. The second phase will expand the secondary facilities from 26 to 32 mgd.
- A new Chlorine Contact Basin (CCB) of 8 mgd on an annual average basis.

14.4 COST AND SCHEDULE CRITERIA

The implementation schedule for each project consists of a planning/design period and a construction/start-up period. A 2-year duration for the planning and design period is used for each project to include a conservative schedule at the master plan level. The construction and start-up period ranges from 1.5 to 4 years based on a general guideline of a contractor being able to perform approximately $2 million/month worth of construction. When final implementation projects are established, adjustments should be made to this schedule guideline based on experience, looking at factors such as project sequencing and equipment procurement times. For some of the projects, it may be possible to shorten the planning/design and construction/start-up schedules. However, for the Master Plan, the schedules will be presented based on the criteria described above.

The costs for these projects are based on the information presented in the previous chapters for Volume 4 - Water Treatment System. They are based on costs in August 2006 dollars. These costs will be adjusted to their midpoint of construction before placement in the CIP, which is presented in Volume 10 - CIP and Overall Implementation Schedule.

14.5 LIQUID STREAM TREATMENT FACILITIES SCHEDULE

Figure 14.2 shows the proposed layout of the new facilities including the solids treatment facilities proposed in Volume 8 - Solids Treatment and Handling. The schedules for the liquid stream treatment facilities are discussed as follows:

14.5.1 New Headworks

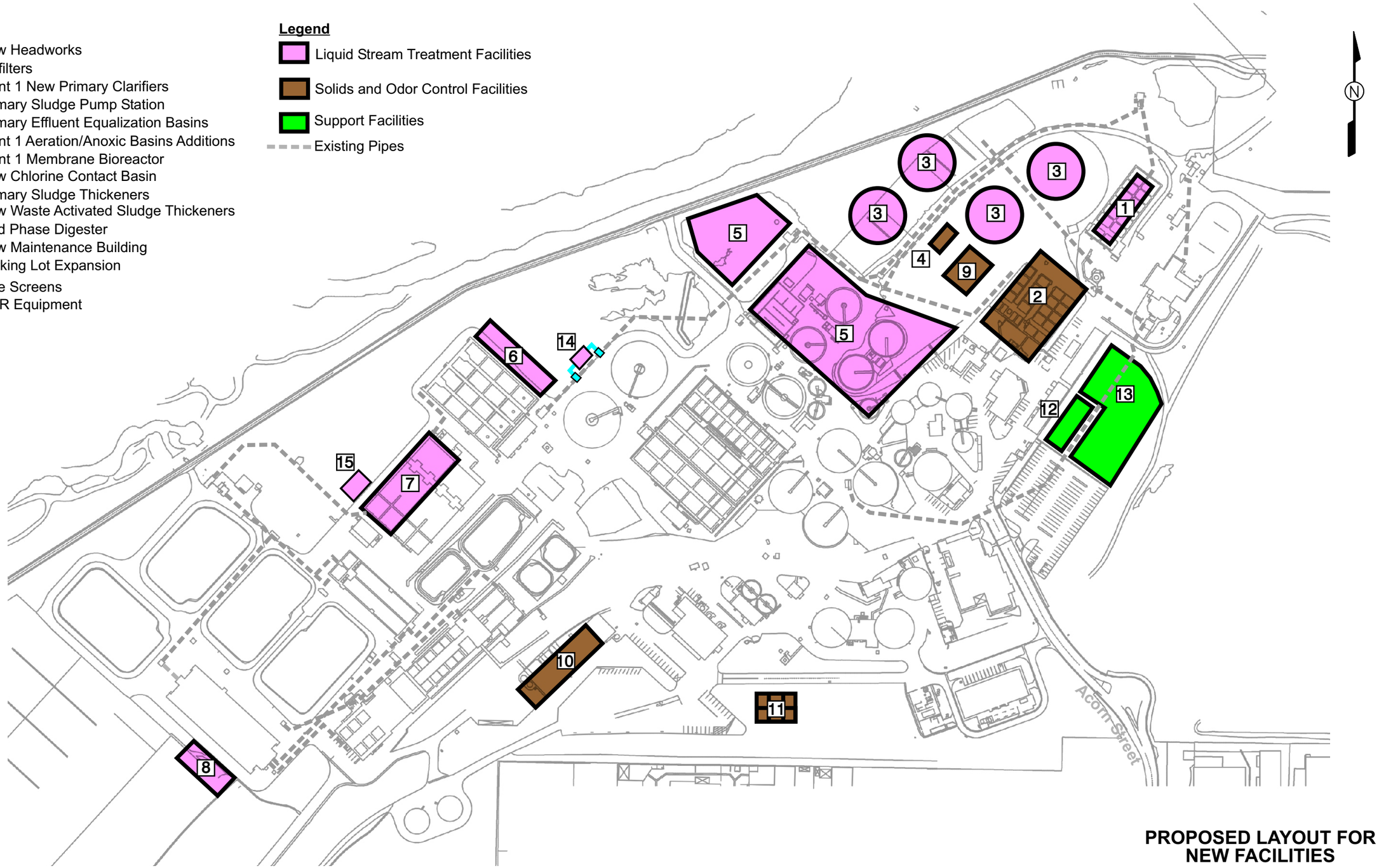
As described in Volume 4, Chapter 5 - Preliminary Treatment, the existing headworks facility is designed for a peak flow of 100 mgd. Based on a wet weather peaking factor of

Key

1 New Headworks
2 Biofilters
3 Plant 1 New Primary Clarifiers
4 Primary Sludge Pump Station
5 Primary Effluent Equalization Basins
6 Plant 1 Aeration/Anoxic Basins Additions
7 Plant 1 Membrane Bioreactor
8 New Chlorine Contact Basin
9 Primary Sludge Thickeners
10 New Waste Activated Sludge Thickeners
11 Acid Phase Digester
12 New Maintenance Building
13 Parking Lot Expansion
14 Fine Screens
15 MBR Equipment

Legend

Liquid Stream Treatment Facilities
Solids and Odor Control Facilities
Support Facilities
Existing Pipes



PROPOSED LAYOUT FOR NEW FACILITIES

FIGURE 14.2

2.2, the headworks capacity is 45 mgd on an annual average basis. Figure 14.3 shows the proposed schedule of the new headworks facility. The duration of the construction and start-up period is 1.5 years, and the duration of the planning and design period is 2 years. The project needs to start at the beginning of 2019 to be completed by the summer of 2022 for the low-growth scenario, assuming the existing headworks capacity is 45 mgd as originally designed.

As presented in Volume 4, Chapter 5 - Preliminary Treatment, the limitation of the existing headworks is the grit basins, which may be re-rated to 37 mgd on an annual average basis. Figure 14.3 also shows the schedule for the new headworks project if the grit basin capacity is 37 mgd. The project should have started in 2006 for the low-growth scenario, assuming the limitations of the grit basins. Because the limited removal efficiency of the grit basins will not cause overflows, the new headworks can be delayed so that completion is in 2022, as described in the previous paragraph, if the City is willing to accept the increased mechanical wear and tear from the grit that goes through the headworks.

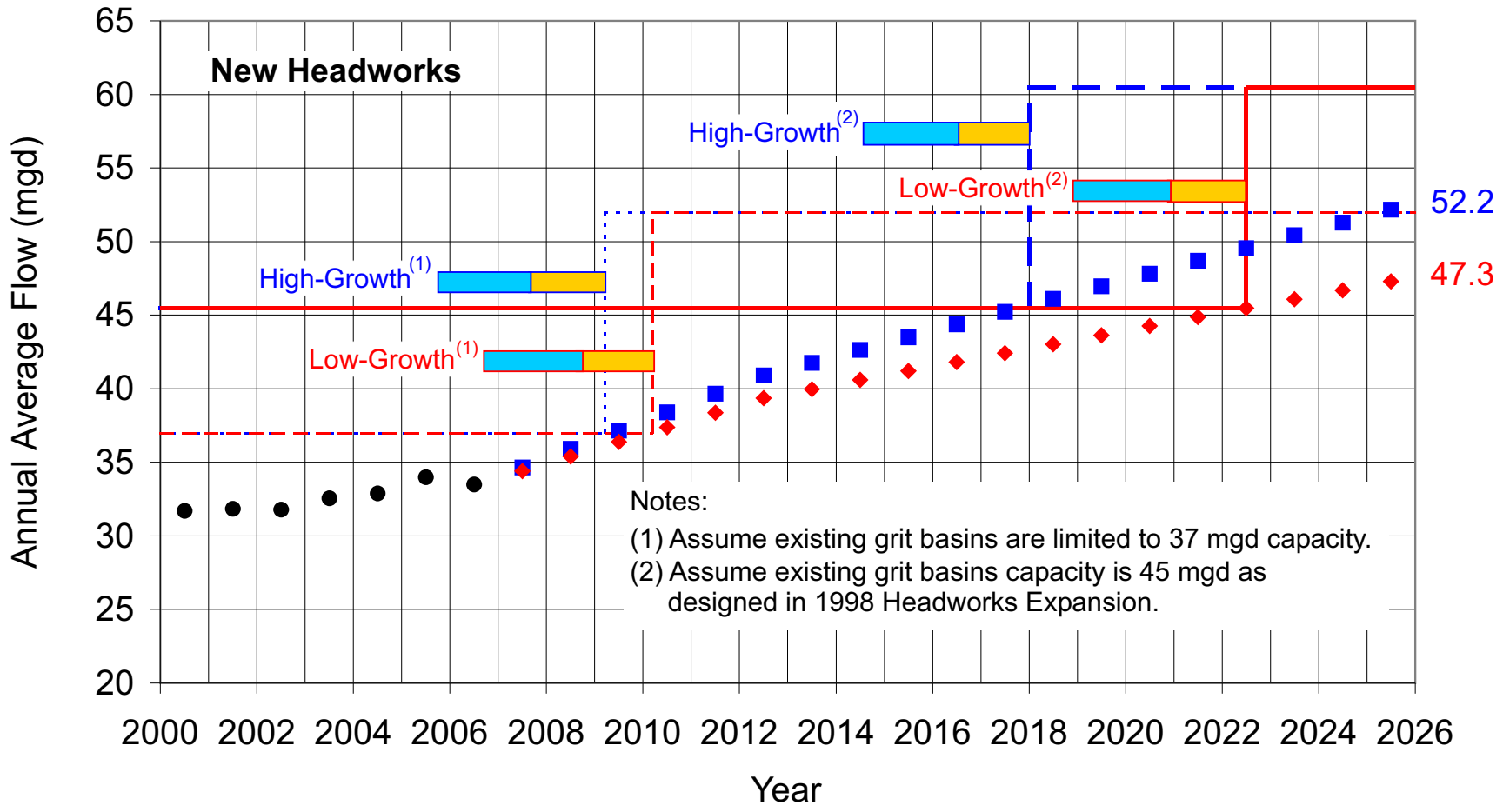
14.5.2 Plant 1 Primary Expansion

The existing capacity of the Plant 1 and Plant 2 primaries is 40 mgd. The Plant 1 Primary Expansion project includes primary clarifiers, a primary sludge pump station, primary sludge thickening facilities, primary equalization basins, a primary equalization pump station, and biofilters. These facilities are discussed in detail in Volume 4, Chapter 6 - Primary Treatment, Volume 4, Chapter 12 - Primary Effluent Equalization, and Volume 8, Chapter 4 - Solids Production and Thickening Options. Biofilter and primary sludge thickening facilities are also included in the Plant 1 Primary Expansion project, because they are needed at the same time as the other primary facilities. Figure 14.4 shows the schedule of the Plant 1 Primary Expansion. The duration of the construction and start-up period is 2.5 years, and the duration of the planning and design period is 2 years. The Plant 1 Primary Expansion project needs to start at the beginning of 2009 to be completed by the summer of 2013 for the low-growth scenario.

14.5.3 Plant 1 MBR Facilities

The existing capacity of the Plant 1 and Plant 2 secondary treatment is 40 mgd. As described in Volume 4, Chapter 7 - Secondary Treatment, the MBR project will be a two-phase project. The first phase includes installation of the following:

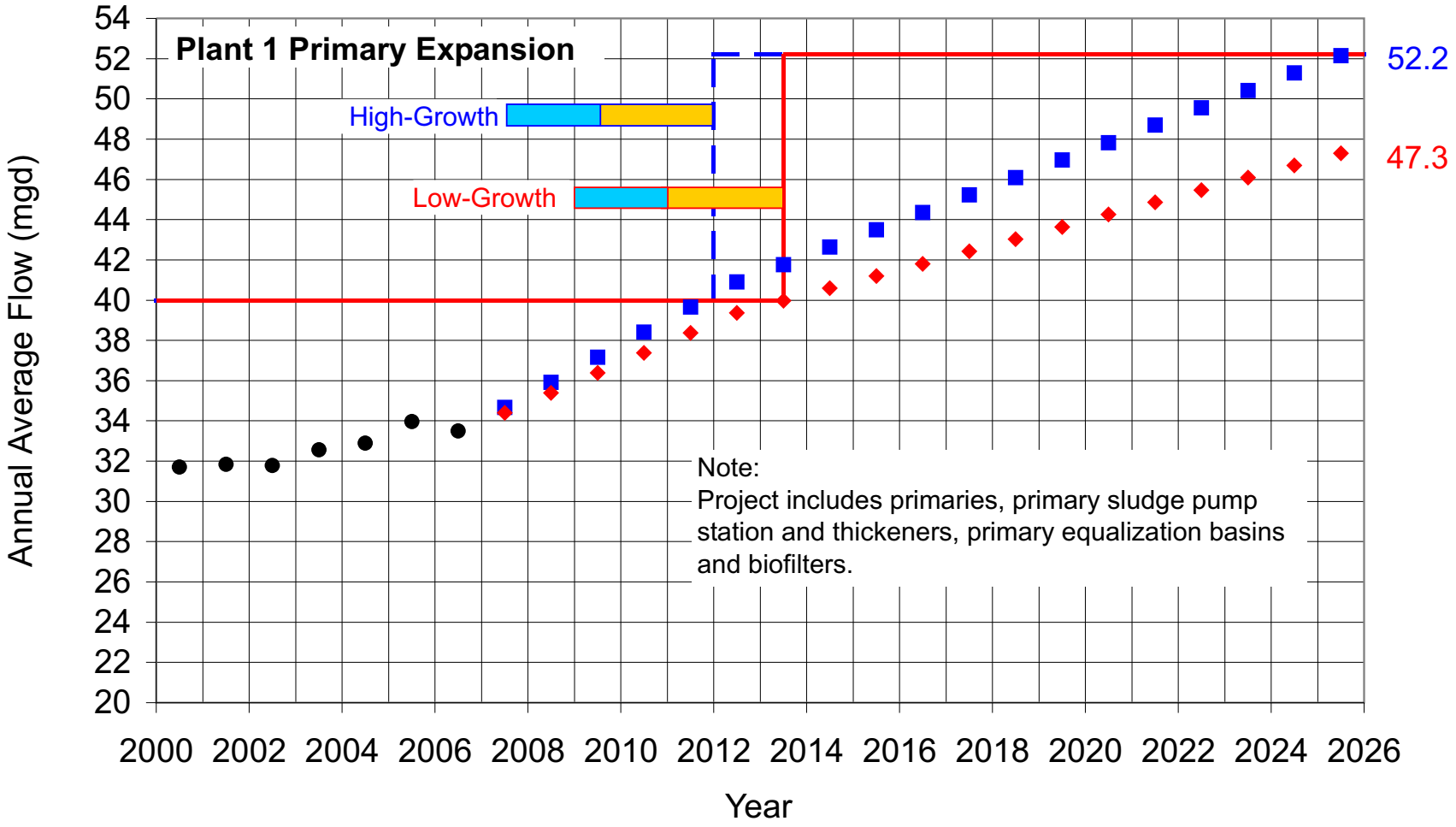
1. MBR modules of 26 mgd in the Plant 1 secondary clarifiers.
2. A 32-mgd fine screen facility.
3. Additional aeration basin channel.
4. Retrofit of the aeration basins and secondary clarifiers.



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase — High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase — Low-Growth Scenario)
- Preliminary Treatment Capacity(1) (High-Growth Scenario)
- Preliminary Treatment Capacity(1) (Low-Growth Scenario)
- Preliminary Treatment Capacity(2) (High-Growth Scenario)
- Preliminary Treatment Capacity(2) (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

NEW HEADWORKS SCHEDULE

FIGURE 14.3



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)
- Primary Treatment Capacity (High-Growth Scenario)
- Primary Treatment Capacity (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

PLANT 1 PRIMARY EXPANSION SCHEDULE

FIGURE 14.4

5. Upsizing the blowers.

6. Upsizing the Waste Activated Sludge (WAS) pumps.

The second phase includes installation of membrane modules of 6 mgd, to bring the Plant 1 capacity to 32 mgd, and the RWQCP capacity to 52 mgd. Figure 14.5 shows the schedule of the MBR project. The duration of the construction and start-up period is 2.5 years, and 1.5 years, for the first- and second-phase, respectively, and the duration of the planning and design period is 2 years. The first-phase Plant 1 MBR Facilities project needs to start at the beginning of 2009 to meet the 2013 completion schedule for the low-growth scenario. The second-phase MBR Equipment project will start at the beginning of 2020 and to be completed in the summer of 2023 for the low-growth scenario.

14.5.4 New Chlorine Contact Basin

As described in Volume 4, Chapter 9 - Disinfection, a new 8-mgd CCB will be needed. Figure 14.6 shows the schedule for the CCB project. This project would need to begin in the summer of 2016 assuming the low-growth scenario, based on a construction and start-up period of 1.5 years and a planning and design period of 2 years.

14.5.5 New Maintenance Building and Flood Protection Levee

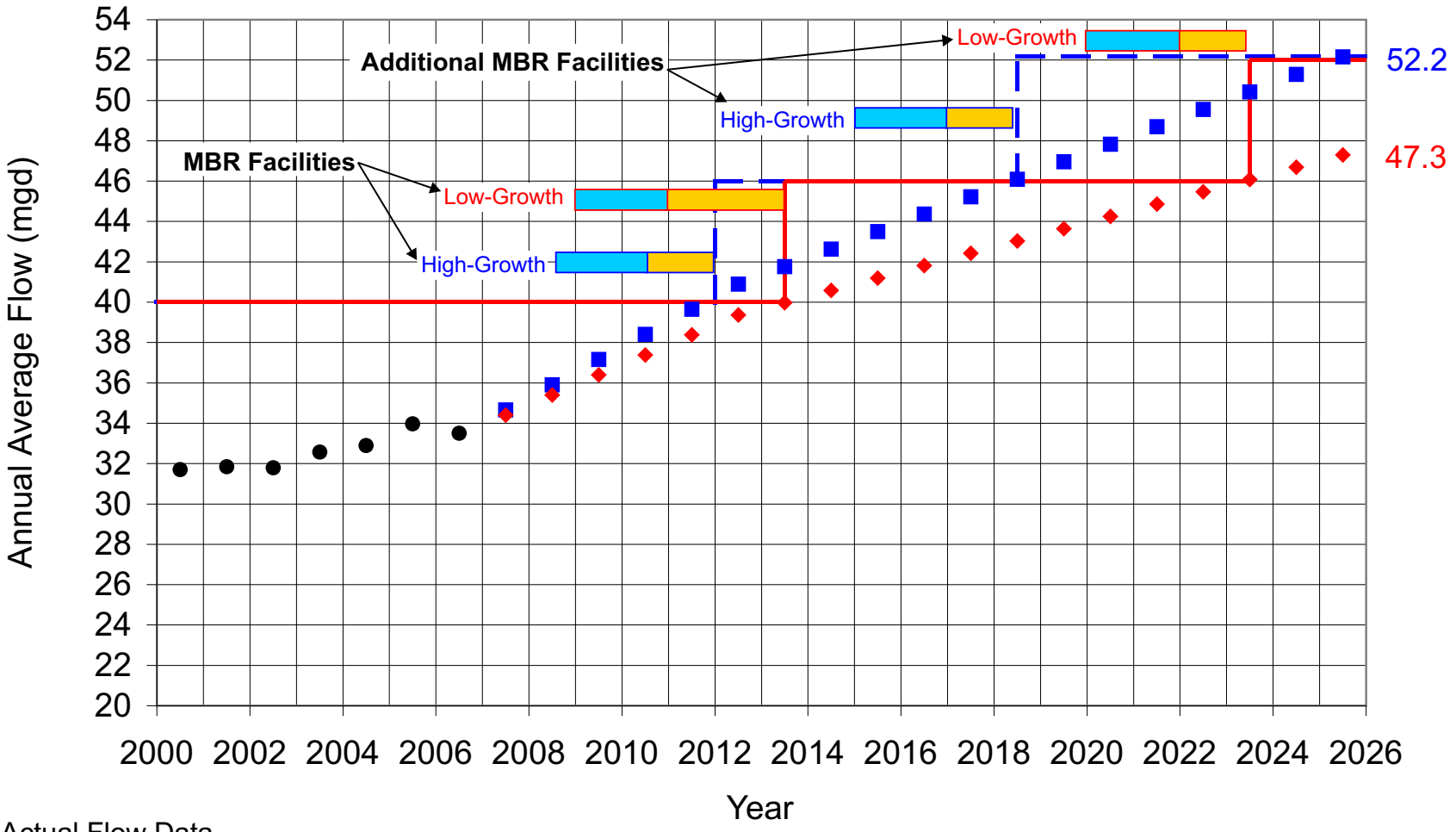
As described in Volume 4, Chapter 11 - Plant Utilities and Support Facilities, a new maintenance building, which meets a minimum of the Leadership in Energy and Environmental Design (LEED) standard, will be needed. Based on the simplicity of the project, the planning, design and construction can be shortened to 1.5 years. The project would start in the summer of 2014 to be completed by the end of 2015.

As described in Volume 4, Chapter 11 - Plant Utilities and Support Facilities, the flood protection levee may have to be raised. If the hydrology study and analysis confirms that the levee needs to be raised, this project would need to begin in the summer of 2012 to be completed in the summer of 2015, based on a construction and start-up period of 1.5 years and a planning and design period of 1.5 years.

14.5.6 Combined Project

Figure 14.7 and Figure 14.8 show the schedule for all of the projects on one graph for the high- and low-growth scenarios, respectively. The schedules for the separate projects are the same as described previously in Figures 14.3 through 14.6 in this chapter and in Figures 8.4 and 8.5 in Volume 8, Chapter 8 - Implementation Schedule and Cost.

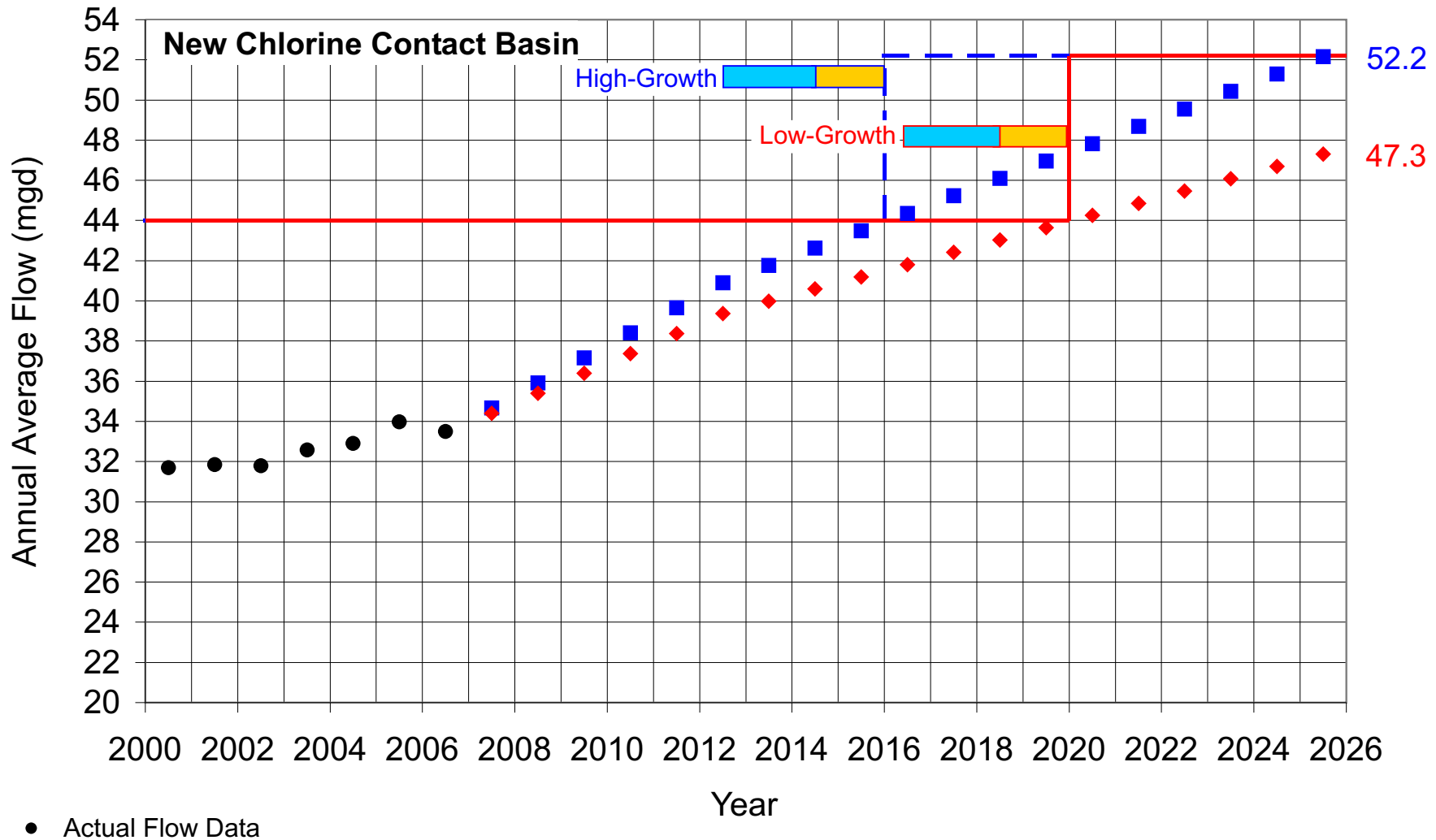
As Figure 14.7 and Figure 14.8 show, the Plant 1 Primary Expansion, Plant 1 MBR Facilities, and Acid-Phase Digester projects (discussed in Volume 8, Chapter 8 - Implementation Schedule and Cost) all need to start and finish at about the same time. An option to three separate projects is to combine the three projects into one project.



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)
- Primary Treatment Capacity (High-Growth Scenario)
- Primary Treatment Capacity (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

PLANT 1 MBR FACILITIES SCHEDULE

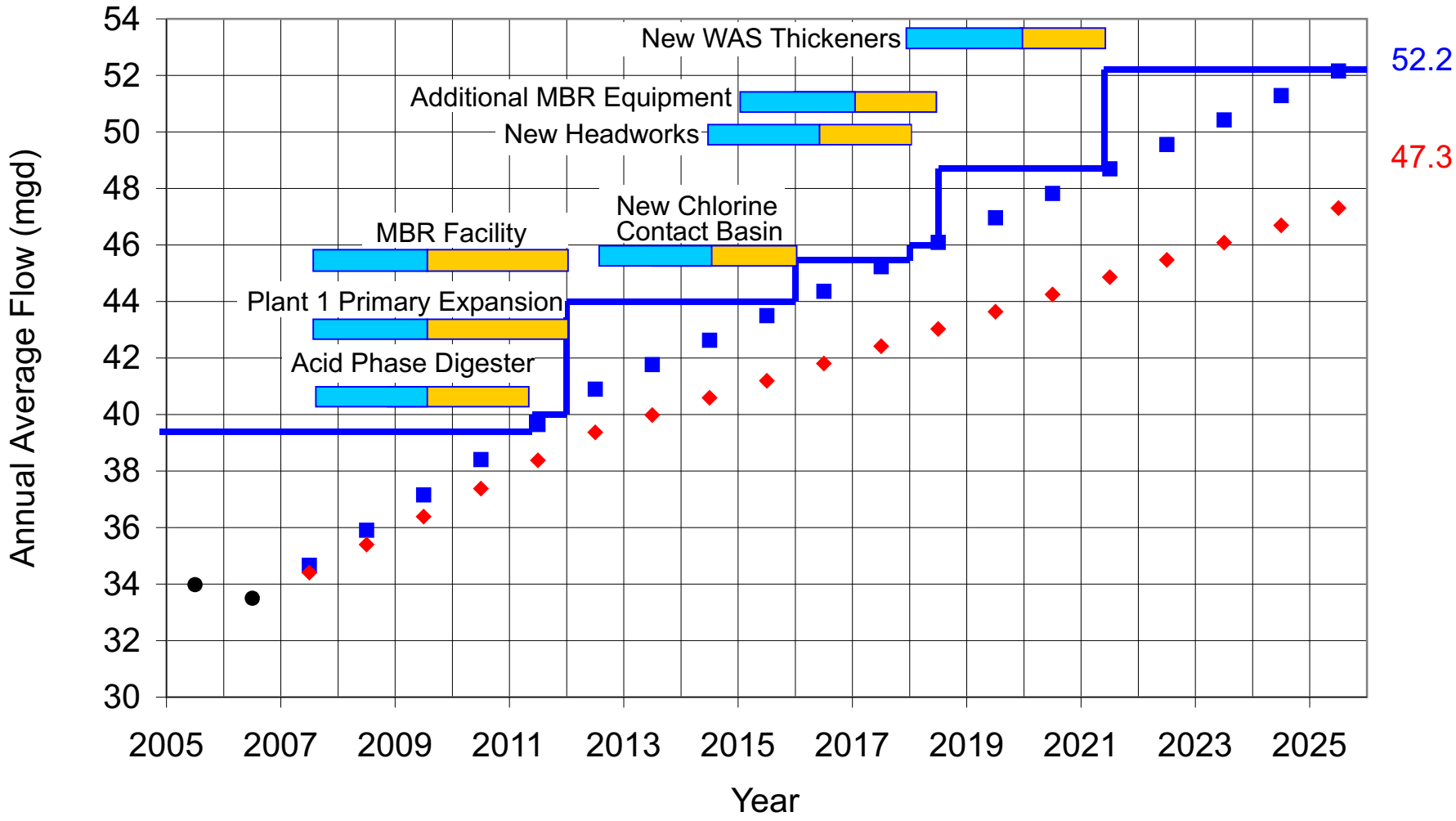
FIGURE 14.5



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)
- Primary Treatment Capacity (High-Growth Scenario)
- Primary Treatment Capacity (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

NEW CHLORINE CONTACT BASIN SCHEDULE

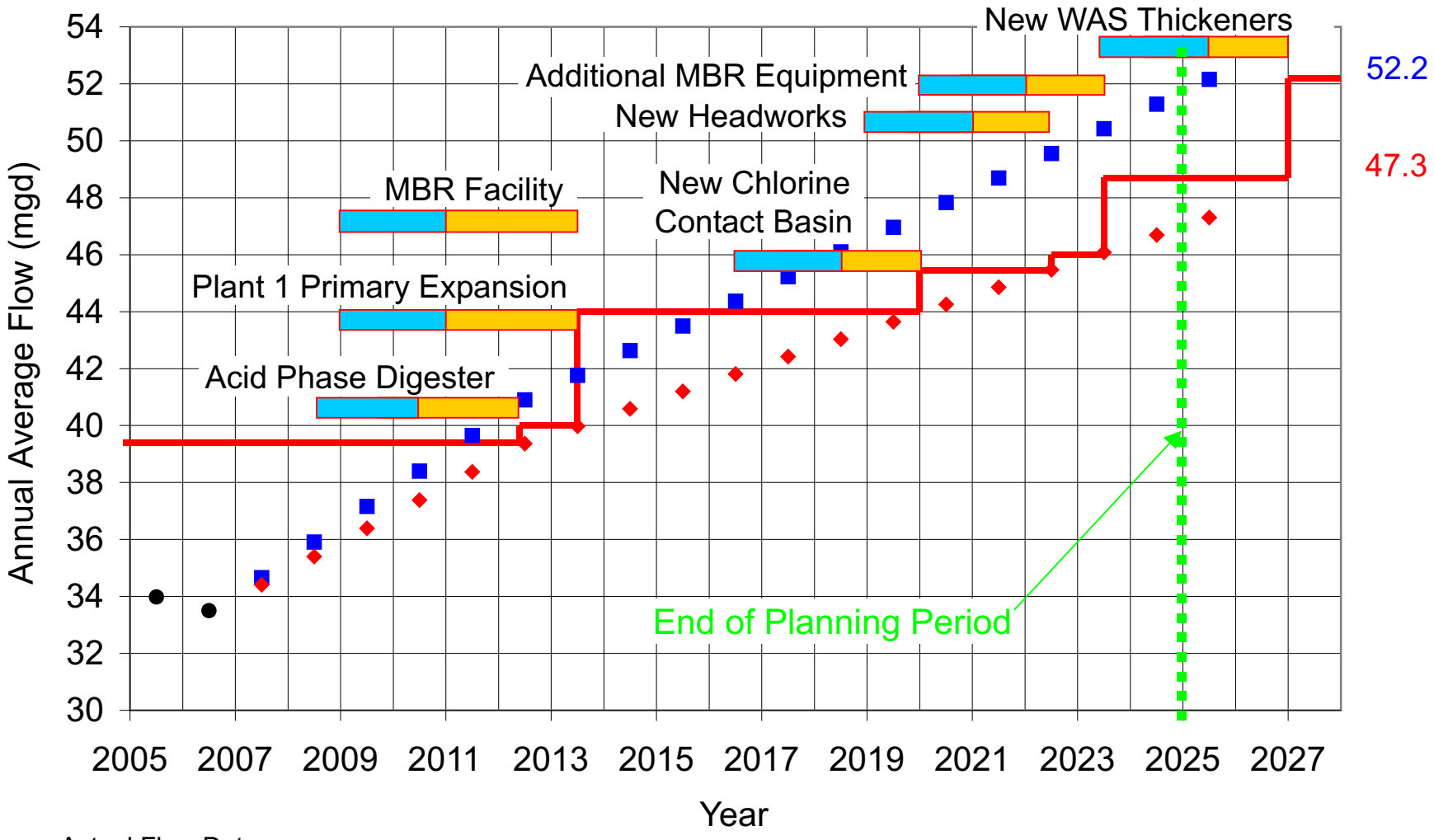
FIGURE 14.6



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)
- Treatment Capacity (High-Growth Scenario)
- Planning/Design
- Construction/Startup

PROJECT SCHEDULE OVERVIEW FOR HIGH-GROWTH SCENARIO

FIGURE 14.7



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)
- Treatment Capacity (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

PROJECT SCHEDULE OVERVIEW FOR LOW-GROWTH SCENARIO

FIGURE 14.8

There are advantages and disadvantages of doing separate projects versus a combined project. Table 14.1 shows a comparison of separate and combined projects.

Table 14.1 Comparison of Separate and Combined Projects Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

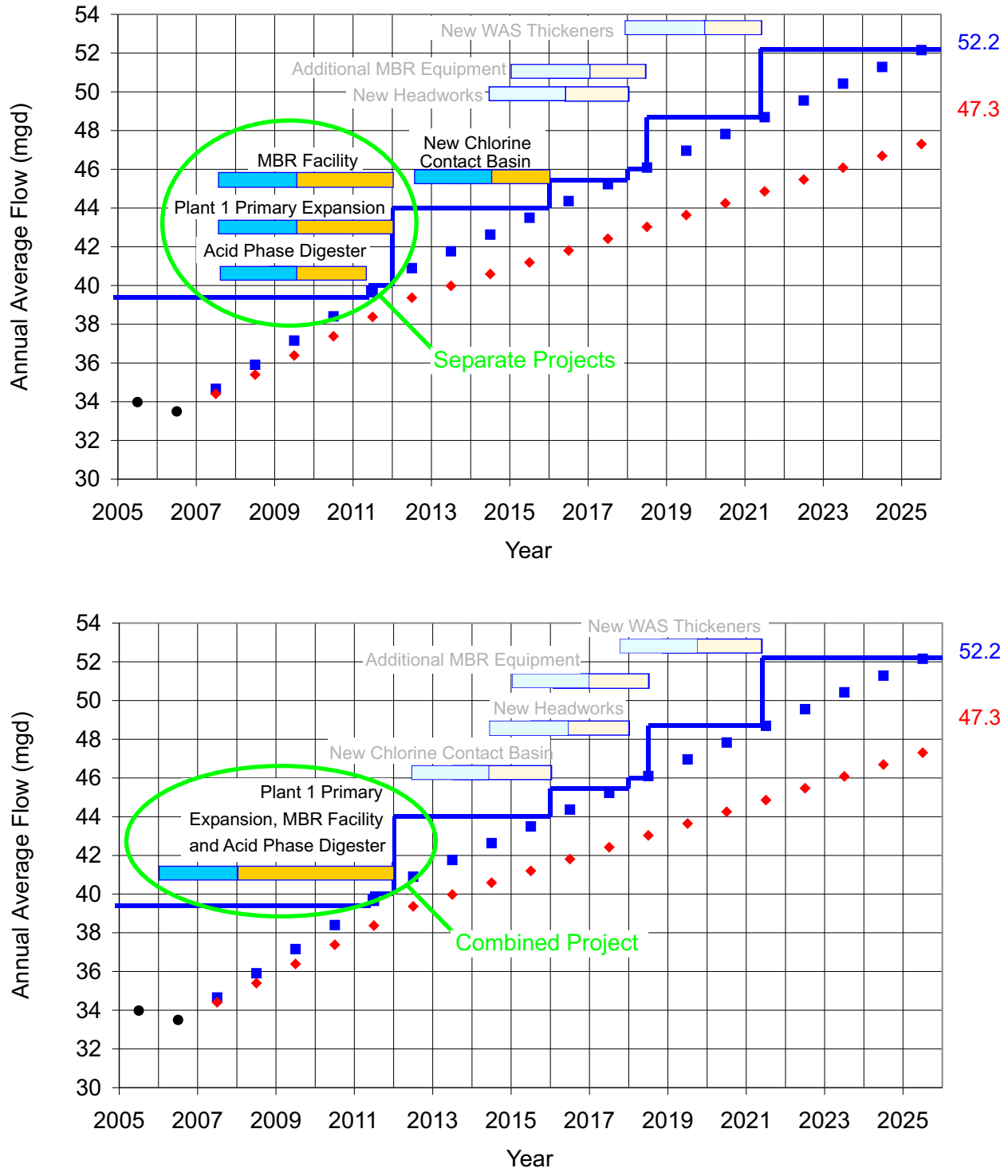
	Separate Projects	Combined Projects
Schedule	+	0
Bidding Market Competitors	+	–
Construction Cost	–	+
Management and Legal Cost	–	+
Construction Coordination	–	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

A comparison of schedules for separate projects versus a combined project is contrasted in the highlighted upper and lower portions of Figures 14.9 and 14.10. Figure 14.9 shows the comparison for the high-growth scenario, and Figure 14.10 shows the comparison for the low-growth scenario. In the upper portion of Figures 14.9 and Figure 14.10, the project schedules for the separate projects are the same as described previously in Figure 14.7 and Figure 14.8, respectively. In the lower portion of Figures 14.9 and 14.10 for the combined project, the duration of the construction and start-up period is 4 years, and the duration of the planning and design period is 2 years. On this basis, the combined project should have started in 2007, based on the low-growth scenario. However, this is a conservative schedule for the Master Plan, which may be shortened, as will be described below.

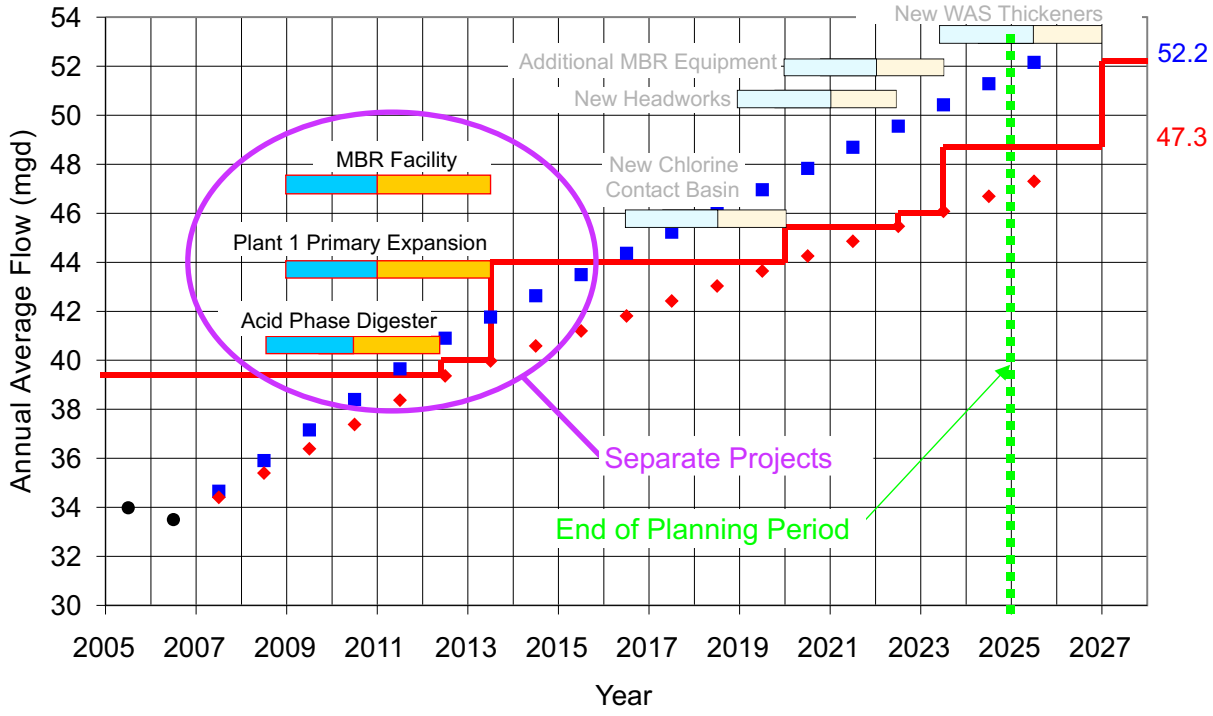
Based on Figure 14.10, a combined project would require a longer construction duration than separated projects. However, the additional time for this combined project may be minimized since there are three distinct projects, in separate areas of the RWQCP, being combined into one project. At the same time, there is a limit to the extent that the combined project schedule can be shortened. At some point, the contractor will charge a premium to further shorten the construction period. For example, the City may have to pay a premium to reduce the schedule of the combined project so that it equals the schedule of the three separate projects. If we assume that the combined project can be designed and constructed in 5 years (24 months of planning/design and 36 months of construction/start-up), then the project should start in the summer of 2008.

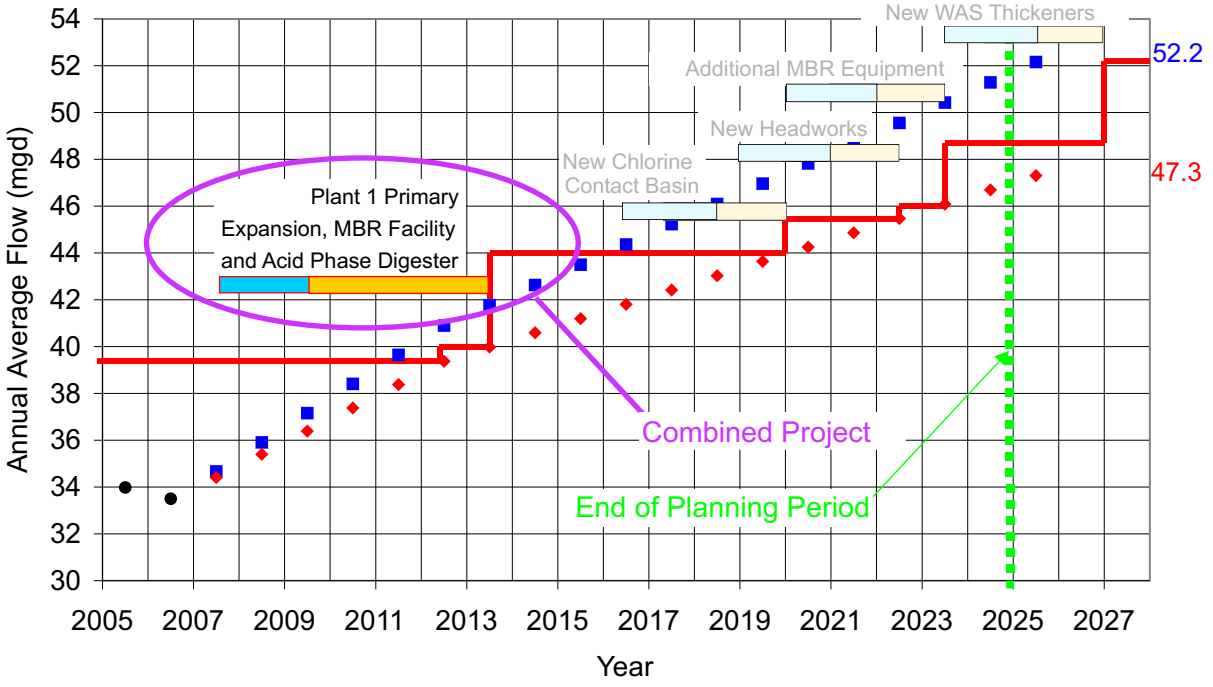
A combined project would be easier and less expensive for the City to design, coordinate, and manage. The construction cost is potentially lower, depending on the schedule, because the contractor can apply economies of scale to the work.



SEPARATE AND COMBINED PROJECTS SCHEDULE FOR HIGH-GROWTH SCENARIO

FIGURE 14.9





- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase — High-Growth Scenario)
- Master Plan Flow Projections (0.75% Annual Increase — Low-Growth Scenario)
- Treatment Capacity (Low-Growth Scenario)
- Planning/Design
- Construction/Startup

SEPARATE AND COMBINED PROJECTS SCHEDULE FOR LOW-GROWTH SCENARIO

FIGURE 14.10

One of the drawbacks to a combined project is the potential to limit the number of bidders. The combined project bid is likely to be in the $200 million range. In that price range, there are only a few contractors that have the capability to complete the work. On three recent Southern California projects in that price range, one received three bids and the others received two bids each. The concern is that the limited number of bids may increase the cost.

14.6 IMPLEMENTATION COST

Costs for the projects have been presented in the previous chapters in this volume and in Volume 8 - Solids Treatment and Handling. The total project costs of these projects are summarized in Table 14.2, based on an ENR value of 8,570 (Los Angeles, August 2006).

Table 14.2 Total Project Cost for Proposed Expansion Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Separate Projects	Project Cost[1]	Combined Projects	Project Cost[1]
Plant 1 Primary Expansion	$64 M	Primary, MBR, and Digester	$185 M
Primary Clarifiers		Primary Clarifiers	
Primary Sludge Pump Station		Primary Sludge Pump Station	
Primary Sludge Thickening Facility[2]		Primary Sludge Thickening Facility[2]	
Primary Effluent Equalization Basins		Primary Effluent Equalization Basins	
Biofilters		Biofilters	
MBR Facility	$108 M	MBR Facility	
Acid-Phase Digester[2]	$13 M	Acid-Phase Digester[2]	
New Chlorine Contact Basin	$4 M	New Chlorine Contact Basin	$4 M
New Headworks	$10 M	New Headworks	$10 M
Additional MBR Equipment	$12 M	Additional MBR Equipment	$12 M
WAS Thickening Facility[2]	$17 M	WAS Thickening Facility[2]	$17 M
Total Cost	**$228 M**	**Total Cost**	**$228 M**

Notes:
(1) As present value (ENR value of 8,570 for Los Angeles in August 2006).
(2) Details discussed in Volume 8 – Solids Treatment and Handling.

The left side of the table shows the project costs for the projects completed as separate projects. The right side shows the project costs for the Primary, MBR, and Digester projects as one combined project. The combined project cost for the Primary, MBR, and Digester projects is $185 million. This cost is the sum of the included separate projects. As described

previously, the cost of the combined project would likely be lower than the separate projects. However, at the master plan level, this reduction is difficult to determine and is subject to several factors, including schedule, which will be refined during detailed planning and design.

Costs are in August 2006 dollars. Final project costs will be determined based on schedule and phasing, which will increase the costs so that they represent the mid-point of construction values. These costs are presented in Volume 10, Chapter 1 - Capital Costs and Implementation Schedule. The total project cost for the liquid- and solid-stream projects described in this chapter is $228 million in August 2006 dollars.

Based on the discussion at the project meeting on March 21, 2007, it was decided that a combined project, consisting of the Plant 1 Primary Expansion, the MBR Facilities, and the Acid-Phase Digester, would be completed, instead of completing the projects separately.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 5: AIR QUALITY AND EMISSIONS CONTROL
CHAPTER 1: REVIEW OF THE 2005 ODOR CONTROL MASTER PLAN

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 5: AIR QUALITY AND EMISSIONS CONTROL
CHAPTER 1: REVIEW OF THE 2005 ODOR CONTROL MASTER PLAN

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REVIEW OF THE 2005 ODOR CONTROL MASTER PLAN

1.1 PURPOSE

The purpose of this chapter is to summarize the 2005 Odor Control Master Plan (2005 Report), completed for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP); present its major conclusions and recommendations; and determine whether it is sufficient for air quality planning purposes. The 2005 Report is included in Appendix A for reference.

1.2 CONCLUSIONS AND RECOMMENDATIONS

A review of the 2005 Report is summarized as follows:

- The 2005 Report provides the RWQCP staff with adequate guidance for addressing odor issues. Therefore, the report is generally sufficient for odor control planning at the RWQCP.
- Odor emission and dispersion modeling would enhance the 2005 Report but appears unnecessary at this point because odor complaints are practically nonexistent, extensive residential and commercial encroachment is not expected in the near future, and significant increases in the amounts of emitted odors are not foreseen in the near future.
- Although the 2005 Report is generally sufficient for odor control planning purposes, it is not sufficient for general air quality planning purposes. The report focuses on odor and does not discuss other regulated air pollutants emitted from the RWQCP. Furthermore, the 2005 Report does not include a regulatory section detailing current and proposed air quality regulations. Volume 5, Chapter 2 - Review of Applicable Regulatory Requirements, presents existing and proposed sources of regulated air pollutants and provides a review of applicable regulatory requirements.

1.3 INTRODUCTION TO THE 2005 REPORT

The 2005 Report was triggered by the RWQCP initiative to minimize offsite odor nuisances, given the rapid development in the land surrounding the RWQCP and the elevated profile of the RWQCP in the community.

The stated purpose of the 2005 Report was to identify possible solutions to odor problems from sources throughout the RWQCP with an emphasis on the existing and proposed future upgrades to the primary clarifiers and solids handling facilities.

1.4 2005 REPORT CONTENT SUMMARY

The 2005 Report consists of an executive summary, seven chapters, and an appendix. Brief summaries of the seven chapters and the appendix are as follows:

- **Chapter 1 - Introduction.** Chapter 1 introduces the purpose the 2005 Report. It provides descriptions and schematics of existing (as of 2005) treatment processes including: liquid stream treatment, solids treatment, and miscellaneous processes. Additionally, Chapter 1 discusses the presence or absence of odor control facilities for the various treatment processes.
- **Chapter 2 - Data Collection and Analysis.** Chapter 2 discusses collection and analysis of hydrogen sulfide and odor data for the RWQCP. Specifically, it summarizes historical liquid- and gas-phase data, presents the findings of interviews with RWQCP operators, and presents observations from site visits. Based on the collected data, Chapter 2 identifies the processes with the highest potential for odor generation.
- **Chapter 3 - Typical Odor Control Strategies.** Chapter 3 describes odor control technologies and strategies that are typically used at wastewater treatment facilities. The chapter groups the technologies and strategies in the following five categories: chemical addition, operational procedures, foul air collection and treatment, process changes, and enhanced atmospheric dispersion. The chapter includes tables that summarize the advantages and disadvantages of various liquid- and gas-phase odor control options.
- **Chapter 4 - Odor Control Strategies for the RWQCP.** Chapter 4 identifies and discusses the odor control technologies and strategies that can be effective in controlling odors from the sources identified in Chapter 2. Specifically, Chapter 4 discusses and recommends odor control alternatives for each of the following facilities: headworks, existing and new primary clarifiers, existing and future solids processing facilities, Dissolved Air Flotation Tanks (DAFTs), existing and future Dewatering Facility, and existing and future Truck Loading Facility. The discussion includes preliminary design criteria for the recommended alternatives. Finally, Chapter 4 identifies odor dispersion modeling as an important tool in selecting and optimizing odor control approaches.
- **Chapter 5 - Permitting.** Chapter 5 identifies the potential implications of odor control facility modification or construction on the air permitting process. Also, the chapter mentions the possibility of the South Coast Air Quality Management District (SCAQMD) imposing specific odor concentration goals at the RWQCP fenceline.
- **Chapter 6 - Preliminary Cost Estimates.** Chapter 6 presents preliminary cost estimates for odor control options recommended for existing facilities. The chapter does not provide cost estimates for odor control strategies and equipment related to

future facilities. Section 1.6 below presents updates to the 2005 Report cost estimates.

- **Chapter 7 - Conclusions and Recommendations.** Chapter 7 summarizes the conclusions and recommendations of the 2005 Report, which are presented below.
- **Appendix A - Liquid- and Gas-Phase Odor and Corrosion Control Technologies.** The appendix is divided into two parts. The first part discusses liquid-phase odor control technologies that involve the addition of chemicals to reduce volatilization of odorants by reducing their liquid-phase concentration. Various chemicals are discussed in detail and their advantages and disadvantages are summarized in a table. The second part of the appendix discusses gas-phase odor control technologies, including treatment methods and atmospheric dispersion methods.

1.5 CONCLUSIONS AND RECOMMENDATIONS OF THE 2005 REPORT

The 2005 Report presents conclusions and recommendation both in Chapter 7 and the Executive Summary. Conclusions and recommendations are as follows:

1.5.1 2005 Report Conclusions

1. Strong odors are emitted from several RWQCP locations, particularly the influent monitoring stations, primary clarifiers, and dewatering facility.
2. The strong odors at the influent monitoring stations are due to high dissolved sulfide concentrations in the influent wastewater.
3. Presence of strong odors near the headworks biofilter indicates that the biofilter may not be operating as designed.
4. Discontinuation of air drying at the site has significantly reduced odor complaints from neighboring areas.
5. Thickening of combined primary sludge at the Plant 2 Primary Clarifiers may be responsible for sludge septicity, high sulfide concentrations, and generation of significant odors from the primary clarifiers.
6. The lower RWQCP elevation compared to the surrounding area and its proximity to the river makes odor control difficult.

1.5.2 Recommendations of the 2005 Report

The report recommended the following odor control improvements at the RWQCP facilities:

1.5.2.1 General Improvements

1. Conduct periodic hydrogen sulfide and odor monitoring within the facility and in the surrounding area.

2. Increase atmospheric dispersion south of the solids processing facility by providing more vegetation and/or constructing an air dispersion fence.

3. Conduct air dispersion modeling to determine the odor impacts of open-air sources such as primary clarifiers and DAFTs.

1.5.2.2 Influent Monitoring Stations

1. Add iron salts 15 to 30 minutes upstream to control hydrogen sulfide emissions from the influent monitoring stations, primary clarifiers, and digesters.

2. If chemical addition is not sufficient in controlling odors, cover exposed treatment processes, vent the headspace, and treat the foul air.

1.5.2.3 Headworks Biofilter

1. Determine whether the headworks biofilter is plugged or channeling is occurring.

2. Replace the biofilter media every 5 years.

1.5.2.4 Plant 2 Primary Clarifiers

1. Re-evaluate the practice of re-settling and thickening primary sludge from Plant 1 in the Plant 2 Primary Clarifiers.

2. Evaluate the effectiveness of upstream chemical addition in reducing odors by conducting periodic hydrogen sulfide and odor surveys near the clarifiers.

3. If chemical addition is insufficient in reducing odors, cover the exposed clarifiers with flat or dome covers and vent the foul air to an odor control system.

1.5.2.5 Dewatering Facility

1. Proceed with the plan to replace the open belt filter presses with enclosed centrifuges to limit odor emissions.

2. Collect foul air from the following equipment: centrate line, centrifuge cake box, centrate tanks, and centrifuge casing.

3. Provide covers or hoods for belt conveyors and provide foul air collection at various locations along the length of the conveyors.

1.5.2.6 Truck Loadout Facility

Proceed with the planned odor control measures for the new Truck Loadout Facility, specifically:

1. Provide continuous foul air withdrawal from the truck loading facility at a rate of 12 to 30 Air Changes per Hour (ACH).

2. Provide direct air withdrawal from covered process equipment emitting odors.

3. Install magnetic interlocks and post signs to prohibit simultaneous entrance and exit of trucks to the enclosed truck loading area.

4. Ensure that truck operators are covering the truck bins before exiting the facility.

1.6 UPDATES TO THE 2005 REPORT COST ESTIMATES

This section normalizes the capital and annual cost estimates presented in the 2005 Report (based on December 2004 dollars) using the Engineering News-Record (ENR) Los Angeles Construction Costs Index (LACCI) of 8570 for August 2006. Table 1.1 presents the updated capital and annual cost estimates.

Table 1.1 Updates to the 2005 Report Cost Estimates for Odor Control Improvement Options
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Purpose	Options	Capital Cost	Annual Cost
Ambient H_2S Monitoring	One Jerome Model 631 H_2S Analyzer	$10,000 to $16,000[(1)]	-
Ambient Odor Monitoring	Two Nasal Ranger® Field Olfactometers	$3,100 to $4,200[(1)]	-
Wastewater Characterization	-	Up to $52,000[(2)]	-
Odor Emission and Dispersion Modeling	-	$55,000 to $80,000[(3)]	-
Upstream Chemical Addition	Nitrate Addition	$229,000	$161,000
	Iron Addition	104,000	$73,000
Odor Control at Plant 2 Primary Clarifiers	In-Ground Biofilters[(4)]	$16,700,000[(4)]	-
Odor Control at the Truck Loadout Facility	-	-	-

Notes:
(1) Exact cost depends on the accessories desired.
(2) Exact cost depends on number of: sampling sites, sampling frequency, and analytes.
(3) Carollo estimate; exact cost depends on the extent of required sampling and the complexity of the model.
(4) See Volume 4, Chapter 6 - Primary Treatment for details.

Appendix A

CITY OF RIVERSIDE ODOR CONTROL MASTER PLAN FOR THE REGIONAL WATER QUALITY CONTROL PLANT (BROWN AND CALDWELL, MARCH 2005)

CITY OF
RIVERSIDE

Regional Water Quality Control Plant

Odor Control Master Plan

March 2005

BROWN AND CALDWELL

CITY OF RIVERSIDE

CITY OF RIVERSIDE

ODOR CONTROL MASTER PLAN

FOR THE

REGIONAL WATER QUALITY CONTROL PLANT

MARCH 2005

Prepared By

BROWN AND CALDWELL

9665 Chesapeake Drive Suite 201
San Diego, CA 92123

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental and Industrial Hygienists
ACH	Air Changes per Hour
BFP	Belt Filter Press
BHP	Brake Horse Power
Cal-OSHA	California Occupational Safety and Health Administration
cfm	cubic feet per minute
D.O.	Dissolved Oxygen
D/T	Dilution-to-Threshold
DAFT	Dissolved Air Flotation Thickening
EPA	Environmental Protection Agency
FM	Force Main
fpm	feet per minute
gpd	gallons per day
H_2S	Hydrogen Sulfide
HRA	Health Risk Assessment
ISCST3	Industrial Source Complex Short Term
kWh	kilo Watts per Hour
lb	pounds
mg/L	milligrams per liter
MGD	million gallons per day
MICR	Maximum Individual Cancer Risk
NIOSH	National Institute for Occupational Safety and Health
O&M	Operation and Maintenance
ppbv	parts per billion by volume
ppmv	parts per million by volume
PVC	Polyvinyl Chloride
RAS	Return Activated Sludge
RSC	Reduced Sulfur Compound
RWQCP	Regional Water Quality Control Plant
SCAQMD	South Coast Air Quality Management District
TM	Technical Memorandum
VOC	Volatile Organic Compound
WAS	Waste Activated Sludge

EXECUTIVE SUMMARY

This odor control master plan was prepared for the City of Riverside to provide the Riverside Water Quality Control Plant (RWQCP) staff with guidance for identifying possible solutions to odor problems throughout the plant, with specific focus on the existing primary clarifiers and solids handling facilities and new upgrades to these facilities. En route to developing this master plan, existing facilities and historical data were reviewed, plant staff was interviewed, and some supplemental odor-related data collected.

Conclusions, recommendations and an estimate of the present worth of the recommended improvements and strategies are presented below. The cost information is limited to facilities currently in place; costs of future facilities were not determined. Where appropriate, options are provided to allow the City to select between various alternatives.

Conclusions

A review of the available data leads to the following conclusions:

1. Both historical and current data indicate strong odors at several plant locations, particularly at the influent monitoring stations, primary clarifiers, and dewatering facility.

2. High dissolved sulfide concentration in the influent wastewater is responsible for the strong odors observed at the influent monitoring stations.

3. Strong odors near the Headworks biofilter indicates that it may not be operating as designed.

4. Discontinuing air drying at the site has significantly reduced the complaints from neighboring areas.

5. The current practice of re-thickening the raw sludge from Plant 1 primary clarifiers at the Plant 2 primary clarifiers and slow withdrawal of the combined raw sludge appears to be responsible for high odor and sulfide levels at the primaries. Sludge septicity may be occurring based on bubbles found at the clarifier surface.

6. The lower elevation of the plant compared to its neighbors, and its location close to the river makes odor control difficult.

Recommendations

Recommendations for various facilities are as follows:

General Improvements

- Periodic monitoring of H_2S and odors within the facilities and at surrounding areas should be conducted and recorded to assist with prioritizing appropriate improvements.

- Improvements designed to enhance atmospheric dispersion, such as providing more vegetation and/or constructing an air dispersion fence should be used south of the RWQCP solids processing facilities to reduce impacts to businesses located south of the fenceline.

- Odor dispersion modeling should be performed to compare odor impacts of open processes versus covered processes (for example, primary clarifiers and DAFT tanks). The modeling results can be used for determining if covers are necessary for processes with low odors such as the DAFT tanks.

Influent Monitoring Stations

The following recommendations can reduce the odors emanating from the influent monitoring stations:

- Strategic chemical addition at the plant can result in significant improvement throughout. For example, iron salt addition at the influent monitoring stations or better yet, 15 to 30 minutes upstream can reduce the odors at the monitoring stations, the primary clarifiers and the digesters by tying up the sulfides present. The ferric chloride currently being added upstream of the primary clarifiers should be relocated upstream of, or to the influent monitoring stations.

- Cover open channels and withdraw and treat the foul air if chemical addition is not desirable or is insufficient to keep odors low.

Headworks Biofilter

The strong odors noted by BC staff near the east side of the Headworks biofilter indicates that it may not be performing as designed.

- The biofilter should be thoroughly evaluated to determine current performance. A smoke test will determine if the biofilter is clogged or if channeling is occurring.

- Bulk media biofilters typically require media replacement every five years. The City indicated that the media had not been replaced for more than eight years. The media should be replaced to improve performance and return the biofilter to design conditions.

Plant 1 Primary Clarifiers

The Plant 1 primary clarifiers are to be replaced with new clarifiers in the near future. In addition, gas phase sampling conducted by BC staff indicated low H_2S concentrations in the vicinity of Plant 1 clarifiers. No improvements are recommended for these clarifiers.

Plant 2 Primary Clarifiers

Strong odors were noted in the vicinity of the Plant 2 primary clarifiers. Liquid phase sampling also showed high dissolved sulfide concentrations.

- The current practice of re-settling and thickening Plant 1 primary solids in the Plant 2 primary clarifiers should be re-evaluated. The long retention time of sludge in the primaries may be contributing to the formation of septic sludge in the clarifiers. Co-thickening of raw and biological solids should be explored.

- Since design and construction of a cover, foul air collection and treatment system is likely to involve several years, upstream chemical addition is recommended initially. This option provides an economical short-term choice for reducing odors at the plant and allows the City time to evaluate the effectiveness of this method. H_2S and odor surveys can be performed periodically to determine the efficacy of upstream chemical addition. A background survey is needed for reference.

- If chemical addition is insufficient in reducing the odors, the City should proceed with the covering and ventilating the clarifiers. Upstream chemical addition can be terminated after completion of improvements. The ventilation and foul air withdrawal rates for all options are sufficient to reduce average H_2S concentration at the primaries below 5 ppmv. At these low levels, activated carbon becomes the cost-effective method for foul air treatment.

- If entry to the clarifiers is unnecessary, providing flat covers is recommended due to the reduced cost resulting from lower ventilation rates. Geodesic dome covers, which double the cost of covering the clarifiers, are necessary if personnel entry is desired for maintenance.

Dewatering Facility

Gas phase sampling conducted by BC staff indicated no H_2S near the dewatering facility; however, strong odors were noted. The current plan to replace the open belt filter presses with enclosed centrifuges should improve odor control by allowing the capture of odorants. The following recommendations should be implemented:

- Improve foul air collection at the classifying conveyor which discharges to the belt conveyor from the centrifuge.

- Provide foul air collection from the centrate line.

- Provide foul air collection from the centrifuge cake box, centrate tanks and centrifuge casing of the existing centrifuge.

- Make provisions to allow collection of foul air from future centrifuges.

- Provide covers or hoods for the belt conveyor, and foul air collection at various locations along the length of the conveyor. The foul air rate must be sufficient to provide a negative pressure of approximately 0.01 inches of water column, or a face velocity of at least 300 fpm.

Truck Loadout Facility

The truck loadout facility is currently being designed with features that will improve the capture of foul air from this process. Implement odor control measures currently planned for the new truck loadout facilities. These measures are as follows:

- Provide continuous ventilation and foul air withdrawal inside the truck loading facility to reduce odors, prevent equipment corrosion, and ensure operator comfort.

- Locate supply air registers and foul air withdrawal registers along opposing walls in the building to create a sweep of air for effectively capturing odors.

- Where feasible, provide direct foul air withdrawal from covered process equipment and maintain negative pressure at openings.

- Locate the truck loading operation in a separate enclosure or building, and provide a higher foul air withdrawal rate (between 12 and 30 ACH) in this building to capture foul air during truck loading.

- Install magnetic interlocks, or post signs prohibiting both entrance and exit doors at the truck loading enclosure from remaining open simultaneously.

- Ensure that truck operators are following proper procedures and covering the bins prior to exiting the facility.

Preliminary Cost Estimates

Preliminary cost estimates were generated for odor control strategies on facilities currently in place. The cost of odor control systems related to future facilities has not been determined. Presented are the estimated present worth for the H_2S and odor survey equipment, odor control modeling, wastewater characterization, upstream chemical addition, and odor control system improvements to the headworks, and primary clarifiers. The costs, presented in Table ES.1, are meant to guide the City in selecting the desired options.

Table ES.1.
Present Worth Costs of Odor Control Strategies for Existing RWQCP Facilities

Purpose	Option/Criteria	Annual Cost	Capital Cost	Present Worth
Ambient H_2S Measurement	One Jerome Model 631x H_2S Analyzer; Cost depends on accessories desired	-	$10,000 to $15,000	$10,000 to $15,000
Odor monitoring	Two St. Croix Sensory, Inc., Filed Olfactometers; Cost depends on accessories desired	-	$3,000 to $4,000	$3,000 to $4,000
Odor Modeling	Cost depends on sampling and monitoring required	-	Up to $50,000	Up to $50,000
Wastewater Characterization	Cost depends on number of sites and sampling frequency	-	Up to $50,000	Up to $50,000
Upstream Chemical Addition	Nitrate Addition	$154,300	$218,700	$2,315,600
	Iron Addition	$70,000	$99,300	$1,050,900
Covering, Ventilating, and Treating Foul Air from Plant 2 Clarifiers	Leakage Prevention of Covered Area	$155,300	$3,929,400	$6,040,000
	Prevent Corrosion Within Enclosure	$184,400	$3,469,100	$5,975,200
	Dilute to Improve Treatability	$95,800	$4,276,900	$5,578,900
	Personnel Entry	$815,500	$4,820,800	$15,903,700

Total present worth based on 20 years, at a discount rate of 4% per annum for annual cost items. Based on December 2004 dollars.

1.0 Introduction

The City of Riverside (City) owns and operates the Regional Water Quality Control Plant (RWQCP) that serves the City of Riverside and surrounding communities. The plant receives wastewater flow from several large gravity sewer pipelines located along Riverside Avenue, Hillside Avenue, Acorn Street and Arlanza Street, and force main sewer pipelines located along Rubidoux Boulevard and Jurupa Road. The plant currently handles an average dry weather wastewater flow of 32 million gallons per day (MGD).

1.1 Purpose of the Odor Control Master Plan

This odor control master plan serves to provide RWQCP staff with guidance for identifying possible solutions to odor problems throughout the plant, with specific focus on the existing primary clarifiers and solids handling facilities and new upgrades to these facilities. The land surrounding the RWQCP is experiencing rapid development for commercial use, bringing potential odor receptors closer and raising the plant's profile in the community. In addition, the plant is bound on the west by Van Buren Boulevard, a major city thoroughfare accessed by thousands of commuters every day. Therefore, controlling odors at the plant is critical for ensuring the least impact to the community.

This master plan document describes the existing facilities, provides a review of historical data, summarizes data from recent sampling and outlines various liquid and gas phase treatment technologies for odor reduction and control. Finally, recommendations for providing odor control at various plant facilities, and cost estimates for implementing those recommendations are outlined in this document. An appendix with detailed descriptions of various liquid and gas phase treatment technologies for odor control is also provided.

1.2 Plant Description and Odor Control at Existing Facilities

The following paragraphs describe the existing facilities and odor control practices used in various parts of the RWQCP. A schematic diagram showing the various treatment processes at the plant is shown in Figure 1.1. An aerial photo of the plant showing locations of the facilities described below is provided in Figure 1.2.

Due to plant expansions that have occurred over several years, influent wastewater is treated using two identical treatment trains. The northeast part of the RWQCP comprises the older Plant 1 facilities, some of which were constructed in the 1930s, while the newer Plant 2 facilities are located in the southern part of the facility. Certain processes, such as solids handling and tertiary water treatment, are handled in common facilities which process flows from both Plant 1 and 2.

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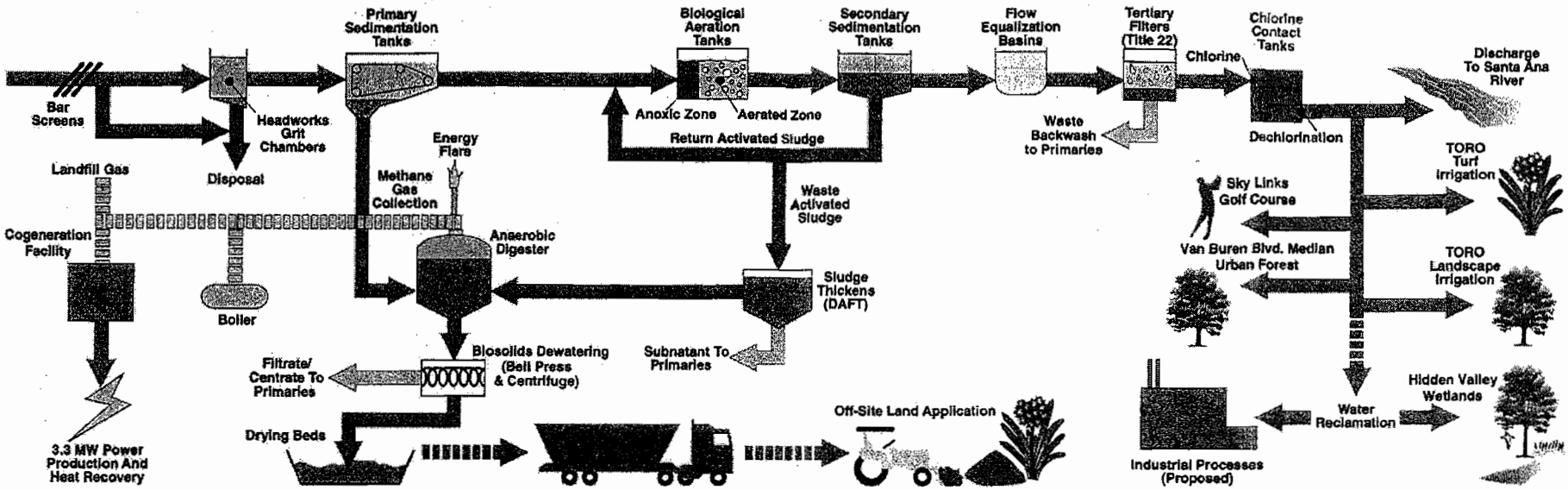
TREATMENT PROCESSES



ADAPTED FROM CITY OF RIVERSIDE INFORMATIONAL PUBLICATIONS

DATE	PROJECT NUMBER
MAR. 2005	126576

BROWN AND CALDWELL
IRVINE, CALIFORNIA

SCHEMATIC DIAGRAM OF PROCESSES AT THE REGIONAL WATER QUALITY CONTROL PLANT, RIVERSIDE

PROJECT LOCATION
CITY OF RIVERSIDE
5950 ACORN STREET
RIVERSIDE, CALIFORNIA 92504

FIGURE
1.1

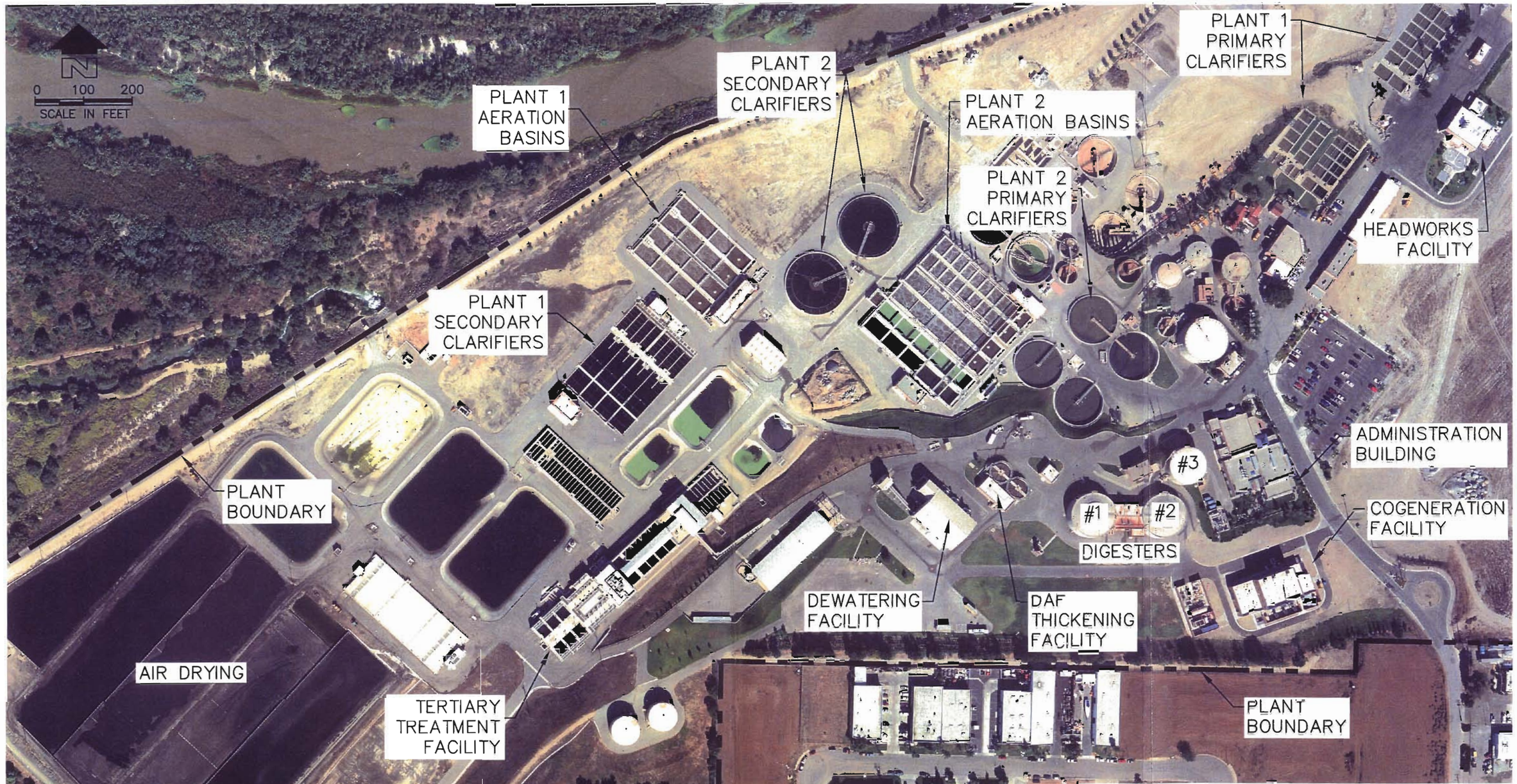


FIGURE 1.2

CITY OF RIVERSIDE-RWQCP
EXISTING FACILITIES

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN STREET RIVERSIDE, CALIFORNIA 92504	MAR. 2005	126576

BROWN AND CALDWELL
IRVINE, CALIFORNIA

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1.2.1 Description of Liquid Stream Processes

The following paragraphs describe the various liquid stream processes at Plant 1 and 2.

Influent Stations

Influent wastewater enters the plant through two influent stations at the northeast corner of the plant, upstream of the Headworks facility. These stations allow flow monitoring and sampling of influent wastewater, which enters the plant through several gravity lines and force mains. The Jurupa/Rubidoux Monitoring Station receives wastewater from force mains located along Jurupa Road and Rubidoux Boulevard.

The second monitoring station receives combined flow from gravity sewer lines located along Hillside and Riverside Avenues, and Arlanza and Acorn Streets. While this monitoring station receives wastewater in a vault, the Jurupa/Rubidoux station flow monitoring flumes are located in open channels. Currently, no odor control is provided at the influent monitoring stations.

Plant Headworks

The plant headworks station houses bar screens, screenings compactors, aerated grit chambers, grit separation and dewatering system, screenings conveyors, and a grit disposal bin. These treatment operations are significant odor sources at most wastewater treatment plants (WWTPs), and are often the most odorous areas of a treatment plant. The headworks station at the RWQCP facility is currently ventilated with fresh outside air, and foul air is withdrawn at a higher rate from equipment and process areas to maintain negative pressure inside the building. The foul air is treated in a bulk media biofilter located adjacent to the headworks building before it is discharged to the atmosphere.

A distribution structure immediately downstream of the headworks distributes flow to the rectangular primary clarifiers (Plant 1). Iron chloride is dripped into the channel for sulfide control in the digesters.

Primary Clarifiers

Plant 1 has rectangular clarifiers at the northeast end of the facility, and Plant 2 has circular clarifiers located slightly southwest of the rectangular clarifiers. The clarifiers process raw wastewater from the headworks station, producing primary effluent and primary solids. Settled sludge from the Plant 1 clarifiers is sent to the Plant 2 clarifiers where it re-settles with the other raw wastewater solids. The thickened primary solids from the Plant 2 clarifiers are sent to the anaerobic digesters for stabilization. The effluent from the Plant 1 and 2 clarifiers is sent to the respective aeration basins for treatment.

Chlorine is added upstream of the Plant 2 clarifiers for odor control. Though iron chloride added upstream of Plant 1 clarifiers is intended for sulfide control in the digesters, it provides some odor control benefits at the Plant 1 primary clarifiers. No other odor control measures are currently in place; both Plant 1 and 2 clarifiers are uncovered.

Biological Aeration Tanks

Aeration basins remove organic material from the primary effluent wastewater. Return activated sludge (RAS) from the secondary clarifiers and recycle flow from the solids dewatering process is mixed with the primary effluent just upstream of the aeration basins. The air introduced into the basins creates an aerobic environment for the development and growth of aerobic microorganisms that break down organic compounds. Despite the higher levels of ammonia contained in the recycle streams going into the aeration basins, this process does not produce odorous compounds. The aeration tanks are open to the atmosphere and no odor control is provided at this process.

Secondary Clarifiers

The RWQCP facility includes several secondary clarifiers that receive effluent from the aeration basins, and produce secondary solids and effluent. A portion of the secondary solids is recycled as RAS. To maintain a healthy biological environment, a portion of the secondary solids is removed as waste activated sludge (WAS) for thickening and stabilization. Since most organic nutrients in primary effluent streams have been removed by upstream treatment processes, secondary effluent normally contains very few odor generating substances. Currently, no odor control is provided at the secondary clarifiers; No changes are required.

Secondary Effluent Flow Equalization Basins

The flow equalization basins receive the secondary effluent prior to tertiary filtration. While the basins are open to the atmosphere, they are not a significant odor source since the effluent is free from most nutrients and solids. No odor control is currently provided at the flow equalization basins, since this area is not a major source of odors.

Tertiary Filters and Chlorine Contact Tanks

The tertiary filters receive secondary effluent and provide Title-22 level treatment. Fine solids are removed during filtration, and the filters are frequently backwashed to remove accumulated solids from the filter media. The backwash liquid is stored in two tanks and returned to the primary clarifiers. Since this process handles effluent from which nutrients and most solids have been removed, development of odors is significantly reduced, thereby obviating the need for odor control. Currently the tertiary filters do not have any odor control system.

The treated effluent from the tertiary filters is chlorinated in the chlorine contact tanks. Since the final treated effluent is used for irrigation at golf courses, roadway medians and also for recharge into the Santa Ana River, it is dechlorinated prior to leaving the RWQCP.

1.2.2 Description of Solids Treatment Processes

The following paragraphs describe the various solids treatment processes at Plant 1 and 2.

Dissolved Air Flotation Thickeners

The dissolved air flotation thickeners (DAFTs) receive WAS from the secondary clarifiers. The solids are thickened in two DAFT tanks and the resulting thickened sludge is mixed with primary solids before being stabilized in the anaerobic digesters. The DAFT subnatant is recycled to the Plant 2 primary clarifiers. The two DAFT tanks, including a building that houses the auxiliary equipment such as pumps and air handling equipment, are located southwest of the Plant 2 primary clarifiers. The tanks are open to the atmosphere, allowing off-gassing of foul air. No odor control is currently provided at this facility. Odor control options for this process are discussed later in this document.

Anaerobic Digesters

Three anaerobic digesters at the RWQCP are located just north of the southeastern plant boundary. The fourth digester vessel is used as a day tank, and is located near the primary clarifiers. Anaerobic digestion of solids produces a variety of reduced sulfur compounds (RSCs) and nitrogenous organic compounds that may cause odors at the plant.

The digesters at the RWQCP have fixed covers; the gas generated is collected and sent to the cogeneration facility for energy recovery. The digesters are equipped with valves to provide pressure relief in the event of headspace pressurization.

Biosolids Dewatering Facility

Biosolids produced in the anaerobic digesters is processed in the Biosolids Dewatering Facility. This facility consists of a centrifuge, two belt presses, dewatered sludge conveyors, and sludge storage. Filtrate from the two belt presses, which cascades into collection basins, causes odors at this facility. Foul air is not collected from the centrate box, cake discharge box at the centrifuge. Thus, the potential for odors at this facility is high due to the processing of biosolids, which typically have a high content of organic sulfur and nitrogenous compounds.

BC's experience at other facilities indicates that reduced sulfur species, H_2S, amines and other odorous volatile organic compounds (VOCs) may be present.

These compounds pose a problem both for odor control and may also be regulated by the regional air pollution authority. Currently, foul air is withdrawn from two locations: at the belt filter presses and along the east wall of the dewatering room. Foul air withdrawal rates from these two areas are 6,000 cubic feet per minute (cfm) and 69,000 cfm respectively. Outside air is supplied to the facility through open rollup doors at the north and south ends of the building, as well as the west side in front of the belt presses. The foul air collected is discharged to the atmosphere without treatment. Odor control options for this facility are discussed later in this document.

Sludge Drying Beds

The dewatered sludge and other biosolids produced at the plant were formerly dried in the sludge drying beds located at the southwest corner of the plant. These beds have been phased out. Wet cake from the dewatering facility is currently transported offsite for further processing.

1.2.3 Description of Miscellaneous Processes

A cogeneration facility handles methane gas received from the digesters and the adjacent landfill. The gas is combusted for energy recovery using reciprocating piston generators. Exhaust from the engine generators contains no odors. However, emissions are governed by the plant's air emissions permit.

2.0 Data Collection and Analysis

Historic sulfide and odor data for the RWQCP were provided to BC to assist with developing the Odor Master Plan. BC conducted two additional visits to the RWQCP to verify and supplement the available data. Plant personnel were interviewed in the process. A discussion on available data to date, including results of the recent interviews and sampling events are discussed in this section.

2.1 Historical Data

Historical data provided by the City were used to determine conditions at various facilities throughout the RWQCP. In 1993, CH2M Hill determined the dilution-to-threshold (D/T) levels of foul air from various process units. In 1995, BC collected liquid phase data en route to designing the existing headworks. Since data were obtained by various consulting firms at different times, they can only be used as indicators of odor potential at various plant locations. A complete characterization of the system requires simultaneous sampling of both liquid and gas phase streams, and a detailed assessment of other factors such as wastewater flow rate, and odor control chemical dosage.

2.1.1 CH2M Hill Odor Study

In 1993, CH2M Hill conducted an odor study at the RWQCP to assess odors at various sources within the plant. The study did not consider the odor impacts of these sources outside the plant boundary or their potential for causing odor-related complaints. It focused mainly on evaluating the odor-generating potential and in-plant impacts at various onsite facilities. Odors were quantified by an odor panel.

Air samples collected from various processes throughout the plant were analyzed for relative odor by the dilution-to-threshold (D/T) approach. In this method, an air sample is analyzed by an odor panel, usually consisting of five to eight persons. The sample is successively diluted with clean air volumes until the objectionable odor can no longer be detected by 50 percent of the panelists. For example, a D/T value of 50 means that a volume of 1-liter of odorous or foul requires mixing with 49 liters of clean odor free air to diminish the objectionable odor below the sensory detection threshold of 50 percent of the panelists.

During the study, samples were obtained on two occasions. The first sampling event occurred on February 22, 1993. Some sample locations that had a D/T value below 50 during this sampling event were excluded from the next event (which occurred in June 1993) because the potential for odors from these sources was considered very low. The odor evaluation performed by the panel is summarized in Table 2.1.

Table 2.1. Results of Odor Sampling at the RWQCP (1993) [a]

Location of Sample	Odor, D/T February	Odor D/T June
Blank	8	16
Open Channel Flow Meter	55	678
Septage Dump - Offgas	318	484
Headworks – Offgas	24	Not Sampled
Nonaerated Grit – Offgas	249	996
Aerated Grit – Offgas	18	Not Sampled
Primary Sedimentation – Offgas	287	1194
Equalization Basins	16	Not Sampled
Activated Sludge – Offgas	11	Not Sampled
Secondary Clarifier – Offgas	8	Not Sampled
Gravity Filter – Offgas	14	Not Sampled
Chlorination – Offgas	9	Not Sampled
Final Effluent Discharge Weir – Offgas	Not Operational	Not Operational
Dissolved Air Flotation (DAF) – Offgas	12	Not Sampled
Digester – Offgas	5	Not Sampled
Belt Press – Offgas	104	Not Operational
Sludge Conveyor – Offgas	15	7
Sludge Storage – Offgas	50	23
Sludge Truck Loading – Offgas	8	15
Mixed Sludge Drying Bed – Offgas	Not Operational	16
Trickling Filter	13	29

(a) Average of multiple sampling at each location

2.1.2 Brown and Caldwell Headworks Predesign Report

In 1995, Brown and Caldwell (BC) produced a design report for the ventilation and odor control of the RWQCP headworks facility. The report identified various odor generating processes at the headworks. BC staff sampled the influent wastewater for dissolved and total sulfide concentrations, dissolved oxygen and other parameters shown in Table 2.2.

Table 2.2. Data from Brown and Caldwell Predesign Report (1995)

	Sewer Type	Flow (mgd)	pH	Temp (°C)	Max. Sulfide (mg/L)	Dis. Oxygen (mg/L)
Riverside	45" Gravity	12.3	7.5	21.7	1	0.7
Hillside	24" Gravity	(Total)	7.5	20.8	1	0.5
Rubidoux	14" Force main	1.9	7.6	20.8	1	0.7
Jurupa	18" Force main	3.2	7.6	21.8	1	1.9
Acorn	36" Gravity	2.2	7.6	21.8	1	1.5
Arlanza	51" Gravity	8.2	7.7	21.6	2	0.6

2.2 Data From Recent Sampling

BC visited the RWQCP in September and November 2004 to supplement and verify historical data. In September 2004, hydrogen sulfide (H_2S) concentrations were measured at various plant locations using a Jerome meter capable of measuring H_2S concentrations as low as 1 part per billion by volume (ppbv). The sampling results are presented on Figure 2.1. Strong odors and relatively high H_2S concentrations were noted near the influent monitoring stations (111 ppbv), Headworks (33 ppbv), east side of the headworks biofilter (40 ppbv), and Plant 2 primary clarifiers (48 ppbv).

In addition to gas phase sampling, liquid phase total and dissolved sulfide concentrations were measured in November 2004 using a LaMotte 4630 field test kit, which uses the methylene blue test method. The field kit can measure concentrations as low as 0.1 mg/L. The data obtained from various plant wastewater streams are summarized in Table 2.3.

Table 2.3. Dissolved and Total Sulfide Data from Various Plant Wastewater Streams (2004)

Location	Date / Time	Total Sulfide, mg/L	Dissolved Sulfide, mg/L
Rubidoux Force main	11/10/04, 11:30 AM	1.6	1.4
Jurupa Force main	11/10/04, 11:40 AM	0.1	< 0.1
Combined Gravity Sewers	11/10/04, 11:55 AM	0.7	0.3
Primary Clarifiers Distribution Structure (Plant 1)	11/10/04, 12:55 PM	< 0.1	< 0.1

Table 2.3. (cont'd) Dissolved and Total Sulfide Data from Various Plant Wastewater Streams (2004)

Location	Date / Time	Total Sulfide, mg/L	Dissolved Sulfide, mg/L
Primary Clarifier 10 Effluent (Plant 1)	11/10/04, 12:20 PM	< 0.1	< 0.1
Primary Clarifier 2 Effluent (Plant 2)	11/10/04, 01:15 PM	0.8	0.8
Primary Clarifier 4 Effluent (Plant 2)	11/10/04, 01:30 PM	0.4	0.3

2.2.1 Prediction of H_2S Concentration Using Dissolved Sulfide Concentration

Dissolved sulfide is present in wastewater as one of the following species: sulfide ion (S^{2-}), hydrosulfide (HS^-) or H_2S. The relationship between pH and liquid phase sulfide species is shown in Figure 2.2. A low pH favors a shift in the equilibrium of the various species towards H_2S, a sparingly soluble gas at standard conditions that can be easily liberated from the wastewater at turbulent areas.

$$H_2S \rightleftharpoons HS^- + H^+ \rightleftharpoons 2H^+ + S^{2-}$$

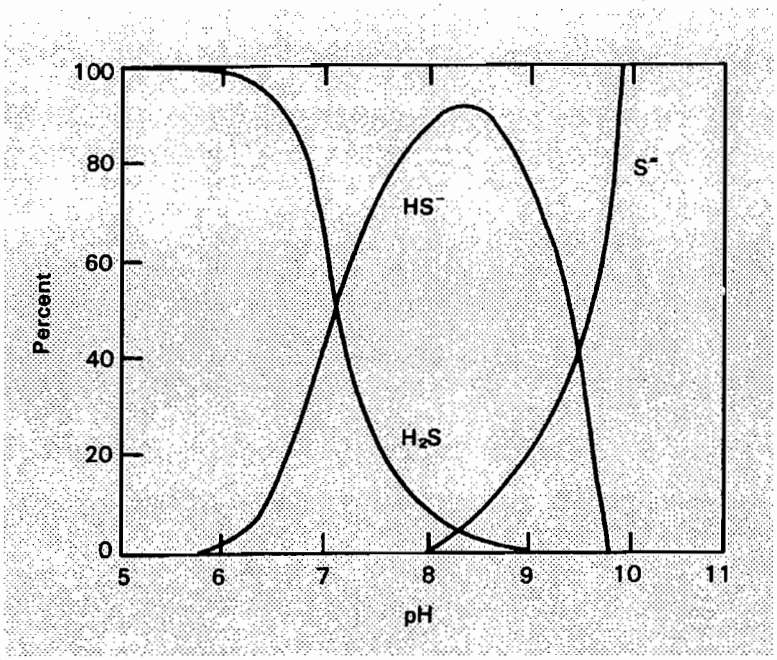

Figure 2.2. Relationship Between Liquid-Phase Sulfide and Wastewater pH
(Adapted from EPA Design Manual on Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants)

A reduction of wastewater pH to slightly lower than 6.0 favors a shift in the sulfide speciation to 100 percent H_2S. Wastewater at these conditions can easily release H_2S gas from solution if subject to turbulence. Conversely, all sulfides in wastewater are present either as S^{2-} or HS^- at pH greater than 9.0. Based on a database of sulfide data for various collection systems across the United States, the Environmental Protection Agency (EPA) reports that the amount of H_2S that exists above the wastewater typically varies between 2 to 20 percent of the equilibrium concentration (i.e. the amount of H_2S that would exist in the gas phase if sulfide laden wastewater is allowed to remain undisturbed for an indefinite amount of time).

The actual concentration will depend on wastewater turbulence and headspace ventilation provided. Ventilated spaces will exhibit lower H_2S concentrations because the liberated H_2S gas is constantly swept away by the supplied air. The liquid phase dissolved sulfide data from recent sampling events were used to predict the gas phase H_2S concentrations at RWQCP facilities that are presented in Table 2.4. Well ventilated headspaces may exhibit H_2S concentrations lower than those reported in Table 2.4.

Table 2.4. Estimated H_2S Concentrations at Various RWQCP Facilities

Location	Dissolved Sulfide, mg/L	Equilibrium * H_2S, ppmv	Possible** H_2S Concentration, ppmv
Rubidoux Force main	1.4	283	6 – 57
Combined Gravity Sewers	0.3	61	1 – 12
Primary Clarifier 2 Effluent (Plant 2)	0.8	162	3 – 32
Primary Clarifier 4 Effluent (Plant 2)	0.3	61	1 – 12

* Assumes pH 7.0 and temperature 25° C.
** Possible H_2S concentrations range between 2 percent and 20 percent of equilibrium values

2.3 Operator Interviews

During the site visit in September 2004, BC staff interviewed plant operators regarding complaints from businesses and local residents. They indicated that odor-related complaints from residents typically occurred during the evening hours, while complaints from businesses were mostly during the morning. Based on the plant layout (Figure 2.1), it is possible that the odors experienced by businesses located just south of the plant was from the sludge drying beds, while the odors experienced by residents are from the entire plant area.

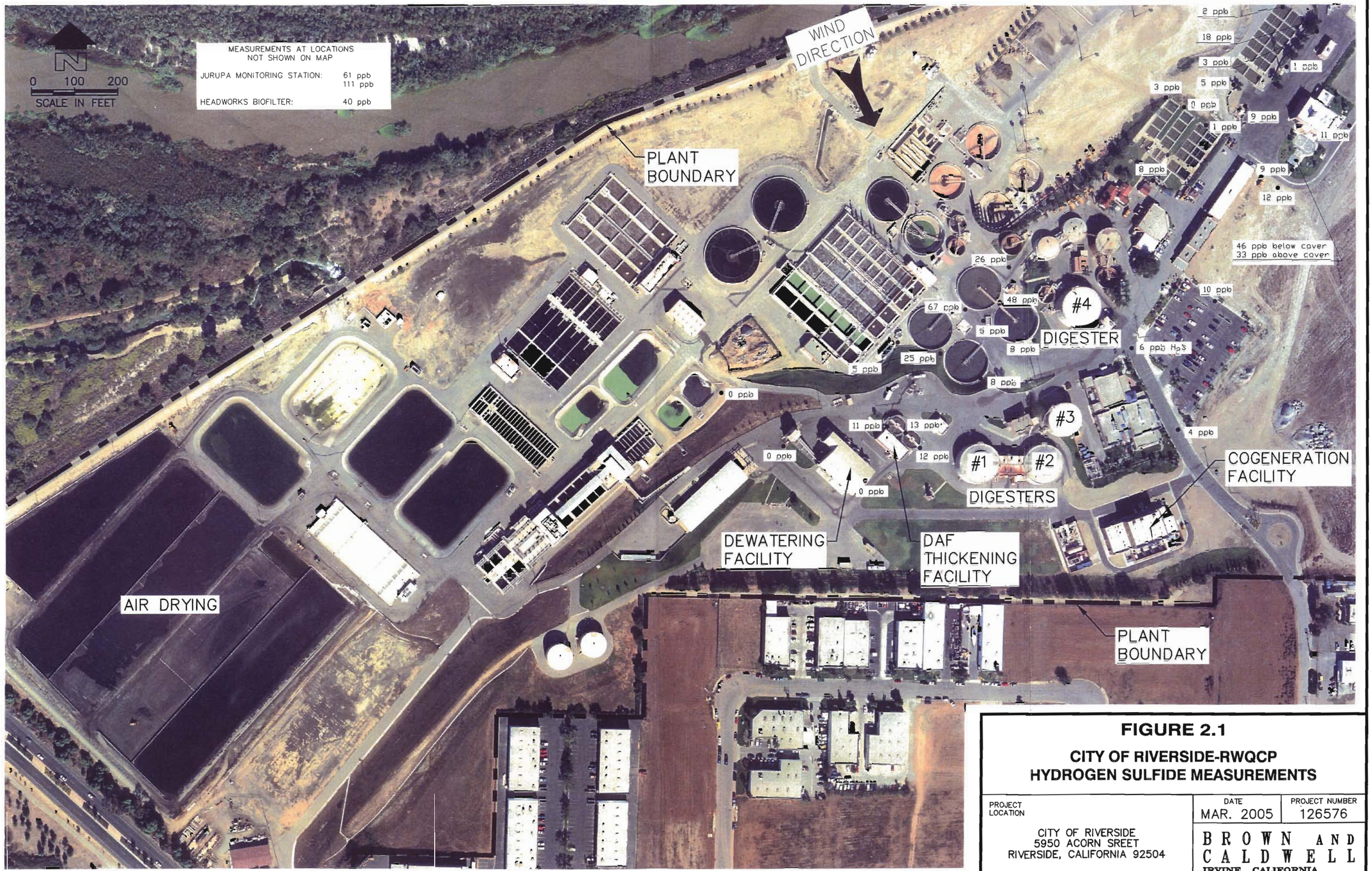

FIGURE 2.1

CITY OF RIVERSIDE-RWQCP
HYDROGEN SULFIDE MEASUREMENTS

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	MAR. 2005	126576

BROWN AND CALDWELL
IRVINE, CALIFORNIA

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The City staff also informed BC that Bioxide® is added at certain "problem spots" upstream of the RWQCP when the ambient temperature exceeds 90^0 F. This upstream addition is expected to have only minimal effects at the RWQCP.

2.4 Miscellaneous Observations

Various facilities at the RWQCP are located at elevations ranging between 25 to 50 feet below the surrounding commercial developments. Odors generated at most WWTPs typically diminish significantly at the fence line as the foul air mixes with fresh air. Often, the odor causing compounds react with other compounds in the air to form innocuous products. Due to its lower elevation compared to surrounding structures, the RWQCP is at a slight disadvantage with regard to air dispersion. However, dispersion may be enhanced by several methods, discussed later in this document.

During the recent site visits, BC staff observed the following operational practices that may contribute to odors:

- Solids from the Plant 1 primary clarifiers are re-settled in the Plant 2 clarifiers. BC staff observed bubbles on the liquid surface at the Plant 2 clarifiers, indicating the possibility of septic sludge in the clarifiers.
- Filtrate from the solids handling belt filter presses (BFPs) cascades into receiving basins.
- Solids from the BFPs are loaded onto open conveyors and loaded onto trucks for further offsite processing.

2.5 Summary of Data

Data from the 1993 CH2M Hill study show that the septage dump, non-aerated grit processing, primary sedimentation and belt presses all result in high odor loads. The 1995 BC report showed high sulfide concentration in the influent wastewater. The high incoming sulfides can produce high gas phase H_2S concentrations at facilities such as the influent monitoring stations and headworks.

Recent sampling data indicated that several influent sewer lines had high dissolved sulfide concentration, which can cause high H_2S concentrations at the influent monitoring stations. The liquid phase data indicated that some sulfide generation may be occurring in the Plant 2 primary clarifiers. Gas phase sampling conducted on a separate occasion showed that the influent monitoring stations, Plant 2 primary clarifiers, and the headworks biofilter were the process areas with the highest in-plant H_2S concentrations.

While no H_2S was detected near the dewatering facility, BC staff noted strong odors similar to other previously analyzed foul air containing nitrogenous compounds and RSCs. Some general observations and conclusions based on available historical and recent data are summarized in Table 2.5.

Table 2.5. Summary and Conclusions Based on Historical and Recent Data

CH2M Hill Odor Study (1993)	Brown and Caldwell Headworks Predesign Report (1995)	Brown and Caldwell Odor Control Master plan (2004)
• The most odorous processes at the plant are located at the upstream end. • The septage dump, non-aerated grit and primary sedimentation were the most odorous process. • Offgas from primary sedimentation was four times more odorous during June than in February. • Solids processing operations such as filter pressing and sludge storage were some potentially odorous downstream process. • The open channel flowmeter was significantly (more than ten times) more odorous during June than in February.	• All influent sewer lines contained high total sulfide concentrations. • The 51-inch diameter Arlanza sewer main had both the highest flow and the highest total sulfide concentration (2 mg/L).	• High gas phase H_2S concentrations were observed near the influent monitoring stations (111 ppb), Headworks biofilter (40 ppb), and Plant 2 primary clarifiers (48 ppb). • Rubidoux force main had high dissolved sulfide concentration (1.4 mg/L). • Wastewater from the gravity sewer lines had moderate dissolved sulfide concentration (0.3 mg/L). • Effluent at Plant 2 Clarifier No. 2, had high dissolved sulfide concentration (0.8 mg/L). • Strong odors noted near the dewatering facility.

Abbreviations

mg/L	milligrams per liter
ppb	parts per billion

3.0 Typical Odor Control Strategies

The typical odor control technologies and strategies used at wastewater processing facilities are discussed in this section. Potential odor control measures may be grouped into the following five distinct categories:

- Chemical Addition
- Operational Procedures
- Foul Air Collection and Treatment
- Process Changes
- Enhanced Atmospheric Dispersion

Each of the above methods is described in the following paragraphs. The odor control strategies specifically for the RWQCP are based on all five methods.

3.1 Chemical Addition

Addition of odor control products to the wastewater can provide significant odor reduction benefits at WWTPs. Ensuring an adequate supply of dissolved oxygen or nitrate-oxygen is an effective method for preventing formation of sulfides and odors. Alternatively, sulfides may be chemically precipitated using metal salts such as ferric chloride or ferrous chloride. Some odor control products such as sodium hypochlorite, potassium permanganate and other oxidants are fast reacting, rapidly reducing odors near the point of addition.

Iron salts require about 15 to 30 minutes to tie up inorganic sulfides in the wastewater. Other products such as nitrate (for example, calcium nitrate [Bioxide ®]) need more reaction time, and are mostly used for preventing formation of odor generating sulfides by providing a source of oxygen. Thus, nitrates must be added well upstream of the WWTP to achieve the desired odor control. Some of the possible chemical treatment alternatives are briefly summarized in Table 3.1. Details on various liquid phase treatment options are provided in Appendix A.

Anaerobic conditions in the collection system cause sulfide generation in wastewater. Microbes in wastewater require an oxygen source for respiration and other metabolic processes. When available dissolved oxygen in the wastewater is consumed, oxygen bound in nitrate (NO_3^-) is used, followed by oxygen bound in sulfate (SO_4^{-2}). Oxygen depletion occurs rapidly in long gravity sewers and force mains. After nitrate-oxygen is consumed, any sulfate present is reduced to sulfide (S^{-2}). As discussed in Section 2.2.1, when wastewater pH drops below 9.0, a fraction of the sulfides is present as H_2S.

Table 3.1. Chemical Treatment Options

Treatment Option	Treatment Method	Advantages	Disadvantages	Dosage [1]
Oxygen Addition	Increases dissolved oxygen content of wastewater, preventing conversion of sulfates to sulfides	• Fast reaction time • Immediate odor control	• Oxygen storage is hazardous • Accumulation of oxygen at pipeline high points can cause corrosion and increased power demand due to gas locking	Varies, depending on existing dissolved oxygen content in the wastewater. Target D.O. of 2 mg/L
Nitrate Addition	Makes nitrate-oxygen available to microbes, preventing conversion of sulfates to sulfides	• Proven technology • Provides good downstream odor control	• Unable to effectively treat pre-existing sulfides	2.5 – 10 lb nitrate-oxygen per lb sulfide
Chemical Oxidation	Converts existing sulfides to non-odorous compounds by direct chemical action	• Fast reaction time • Immediate odor control • Excess dosing provides downstream odor control	• Chemicals are usually hazardous • Chemical may be consumed by other non-odorous organic components of wastewater • Chemicals may have an impact on biological processes at the plant	Varies depending on chemical
Metal Salts	Precipitates sulfides present into non-volatile form	• Moderately fast reaction time • Excess dosing provides downstream odor control	• Reduces wastewater pH • Can cause corrosion of metallic equipment • Chemicals are hazardous	Per lb of sulfide: Ferric chloride: up to 14 lb Ferrous chloride: 7-11 lb
Caustic Shock Dosing	Kills slime layer in pipelines (dose to pH > 12), preventing sulfide formation for up to two week duration	• Fast reaction time • Quick odor control	• Increases wastewater pH at treatment plant temporarily • Can cause corrosion of concrete • Chemical is hazardous • Effectiveness varies	Dosage varies based on length of pipeline to be treated
PRI-SC Technology	Ferrous ion provides initial odor control. Hydrogen Peroxide added downstream regenerates ferric ions for downstream odor control	• Immediate odor control • Regenerated ferric provides odor control and coagulation advantage at treatment plant	• New technology • Hydrogen peroxide and ferrous chloride are hazardous	Ferrous: 2.4 lb per lb sulfide Hydrogen peroxide: 1.7 lb per lb sulfide

Notes and Abbreviations

1	Based on BC experience
D.O.	Dissolved Oxygen
lb	Pound

3.2 Wastewater Process Design

Process and hydraulic design can have an impact on odor generation potential at WWTPs. Process modifications can help reduce odors at certain plant facilities by preventing septic conditions. For example, eliminating re-settling of Plant 1 primary solids in the Plant 2 clarifiers is a process modification that can provide odor control benefits at Plant 2. Hydraulic design can also impact the amount of odors at WWTPs. For example, submerged weirs at primary clarifier launders minimizes turbulence consequently reducing the amount of odors liberated from the liquid.

3.3 Operational Procedures

Improving operational procedures can also have a significant impact on odors throughout the WWTP. Some of the typical modifications include improved housekeeping, monitoring sulfide concentration in the influent wastewater for determining odor control product dosage, frequent inspection and replacement of biofilter media. Carefully scheduling odor-generating maintenance activities when neighboring areas are less inhabited (for example a business park after business hours) can reduce the amount of complaints due to odors.

3.4 Foul Air Collection

Direct withdrawal of foul air from equipment or covered basins/channels, ventilating with outside air, and withdrawing and treating the foul air generated is a common method of odor control. This method usually involves higher labor and capital expenses, and its implementation often requires approval from the local air pollution control agency. A properly designed and operated foul air containment and treatment system can virtually eliminate all odors. However, minimization of odors at the source or reducing the concentration in the liquid phase can reduce foul air volume and strength, and consequently, chemical and power usage at the foul air treatment process.

The foul air withdrawal rate can be based on four primary considerations briefly discussed below. A more detailed discussion is provided in Section 4.2.4.

3.4.1 Cover Area Leakage

Foul air is withdrawn from covered process equipment at a rate sufficiently high to produce a negative pressure of about 0.01 inches of water column at openings and gaps. The negative pressure ensures that no foul air escapes to the atmosphere, even at moderately strong winds.

3.4.2 Corrosion Prevention

The primary goal of this method is corrosion prevention. Corrosion of capital facilities typically occurs when H_2S concentration in headspaces exceeds 1 part per million by volume (ppmv). In this method, foul air is withdrawn continuously at a rate that prevents H_2S concentration from exceeding 1 ppmv. The air rate chosen must also provide sufficient negative pressure at gaps and openings (Section 3.4.1).

3.4.3 Treatability

The objective of this method is to withdraw the foul air at a rate sufficient to maintain foul air H_2S concentration between 5 ppmv and 15 ppmv. Foul air is "treatable" using economical biological treatment systems such as biofilters at this H_2S concentration range. However, the withdrawal rate must be increased if it is insufficient to provide negative pressure at gaps and openings. This method may require less foul air withdrawal than other methods, thus reducing blower size and power usage.

3.4.4 Personnel Entry

In this option, process equipment covers or enclosures are designed to allow personnel entry for maintenance activities. Due to health and safety concerns, the foul air withdrawal rate required must be selected to provide worker comfort and dilute H_2S concentrations below the permissible levels mandated by regulatory agencies.

3.5 Foul Air Treatment

The headspace formed by covering process equipment must be ventilated to prevent corrosion of equipment and structures under the covers, and to prevent escape of odorous air to the atmosphere. The foul air withdrawn usually contains several odorous compounds described below:

H_2S:	Hydrogen sulfide has a very strong characteristic rotten egg odor that is frequently objectionable even at very low concentrations. H_2S has a detection threshold of 0.5 ppbv.
Mercaptans:	Mercaptans are a class of RSCs that are commonly encountered in wastewater processing operations.
Disulfides:	Disulfides are a class of RSCs that are commonly encountered in solids processing facilities.
Amines:	Amines are compounds of nitrogen. They are typically encountered in solids processing facilities.

The withdrawn air must be treated to prevent nuisance odors to the surrounding community. The foul air treatment technology chosen will depend on several factors including cost, volume and nature of foul air, available infrastructure, and amount of treatment required. Since H_2S is usually the predominant odorous compound, its concentration in the foul air may be estimated using available data for initial selection of appropriate treatment methods.

A final decision on the treatment method should be made after the foul air has been fully characterized, since foul air with low concentrations of odorous compounds may be unsuitable for certain foul air treatment options. For example, scrubber, biofilters and bioscrubbers operate best when the H_2S concentration is between 5 and 15 ppmv.

If the estimated H_2S concentration is lower than 5 ppmv, activated carbon adsorption is typically more cost-effective. A brief description of the most common options is provided in the following paragraphs.

Chemical Scrubbers

Foul air containing H_2S and other odorous compounds may be treated using chemical scrubbers. A high pH solution of caustic soda and water is contacted with foul air in a packed bed. H_2S and other odorous compounds are drawn into solution. Sodium hypochlorite can also be added to oxidize the sulfides in solution. A packed bed scrubber utilizing an acid solution must be used for removing acid-soluble ammonia and amines from foul air, when necessary.

Bioscrubbers

Biological removal of odorous compounds from foul air is another option. A bioscrubber is a packed bed containing porous medium that supports bacterial colonies. Odorous compounds are absorbed into the biological film and converted to odorless products by microbes. Secondary effluent or potable water mixed with nutrients is periodically sprinkled on the media to supply both moisture and nutrients required for biological growth.

Biofilters

The foul air treatment mechanism in biofilters is similar to bioscrubbers. The primary differences between the two are the media used, and the construction. Bulk media biofilters use wood chips, yard waste compost and granular activated carbon. The medium is contained in an excavated trench, or within built up concrete walls. Foul air introduced at the bottom of the bed using a distribution header is treated as it passes through the biofilter. Water is periodically sprinkled over the biofilter, or within the media using soaker hoses, to keep it moist. Nutrients need not be supplied since they are normally available in the biofilter medium itself. Biofilters in modular containers are also available from several commercial vendors.

Activated Carbon

Foul air treatment using activated carbon is a proven technique that has been used successfully for several years. Foul air is introduced into a bed of activated carbon where odorous compounds are adsorbed onto the highly porous carbon surface. Activated carbon may be impregnated with caustic soda or caustic potash to increase its H_2S adsorption capacity. Catalytic carbon is the third type of carbon. It provides the highest H_2S adsorption capacity. Impregnated and catalytic carbon may be regenerated several times by washing with caustic solution and water, respectively. Virgin and catalytic carbon may be thermally regenerated offsite when their adsorption capacity is diminished or lost.

3.6 Enhanced Atmospheric Dispersion

Atmospheric dispersion of odorous air can be helpful in reducing downwind impacts of odor releases. This method of odor control relies on meteorological information and odor dispersion modeling studies for determining appropriate locations for facilities (during new construction) or foul air discharge stack geometry. Some important factors to be considered in this method include odor release height, exit velocity of foul air, temperature, building wake downwash, wind direction and wind patterns. This method may be limited by permit restrictions, and may only be applicable to foul air from selected processes. For example, the allowable daily emission (total mass or pounds per day) of VOCs may be regulated by the local air pollution control district.

Dispersion of odorous air occurs when it mixes with ambient air. The odors are diluted by mixing with ambient air as they are carried downwind. Dilution ratios of up to 50 parts fresh air to 1 part foul air may be achieved at typical WWTPs, depending on local atmospheric conditions and structures surrounding the WWTP. Since the presence of dispersion fences, vegetation and other structures enhances mixing, planting trees just inside the fenceline and/or installing dispersion fences may be an effective method of reducing odor impacts to the businesses surrounding the RWQCP.

The advantages and disadvantages of the foul air treatment options discussed above are summarized in Table 3.2. Details on these treatment methods are also provided in Appendix A. Possible locations for a foul air treatment system for the Plant 2 clarifiers are shown in Figure 3.1.

Table 3.2. Foul Air Treatment Alternatives

Treatment Alternative	Treatment Method	Advantages	Disadvantages
Chemical Scrubbers	Provides driving force for absorbing H_2S into caustic soda solution, where it is converted to an odorless compound. Sodium hypochlorite oxidizes other odorous compounds such as VOCs	• Effective for a large range of concentrations • Effective on different types of odor causing components	• Requires storage and handling of hazardous chemicals • Requires more equipment compared to bioscrubbers for dosing chemicals and recirculating scrubbing solutions. • Requires soft water for operation, or period acid washing for removing scales
Bioscrubbers or Biotrickling Filters	Treatment is achieved by microbes, which convert odorous compounds to non odorous compounds	• Does not require hazardous chemicals • Effective on different types of odor causing compounds • Requires less power	• Ineffective at low H_2S concentrations (< 5 ppm) • Requires higher detention time for VOC control, resulting in larger vessels compared to chemical scrubbers • Treatment efficiency is lower than chemical scrubbers
Biofilters	Treatment is achieved by microbes, which convert odorous compounds to non odorous compounds	• Does not require hazardous chemicals • Effective on different types of odor causing compounds • Requires less power	• Ineffective at low H_2S concentrations (< 5 ppm) • Media may be acidic, requiring special handling during disposal • Treatment efficiency is lower than chemical scrubbers • Produces earthy odors from outlet gases, and may require polishing step for area with very stringent odor standards • Requires periodic media regeneration or replacement
Virgin Activated Carbon	Removes odor causing compounds by adsorption	• High treatment efficiency • Effective on a variety of odor causing compounds	• Susceptible to moisture in foul air • Uneconomical for large volumes of foul air • Uneconomical for highly concentrated foul air • Offsite regeneration required • Lower H_2S adsorption capacity than other forms of activated carbon
Catalytic Carbon	Removes odor causing compounds by adsorption. Adsorbed H_2S is catalytically converted to soluble compounds.	• High treatment efficiency • Effective on a variety of odor causing compounds • Can be regenerated several times by washing with water, extending life • Onsite regeneration is possible • Can be thermally regenerated when capacity is diminished or lost after repeated regeneration cycles	• Uneconomical for high concentration and large volumes • Media may be acidic, requiring special handling during disposal • Units may remain offline for extended time during regeneration
Impregnated Carbon	Activated carbon is impregnated with a strong base such as caustic soda or caustic potash. The carbon removes odor causing compounds by adsorption. Adsorbed H_2S is neutralized by the strong base.	• High treatment efficiency • Can be regenerated several times by washing with caustic soda or caustic potash, extending life	• Susceptible to moisture in foul air • Uneconomical for high concentration and large volumes • Units may remain offline for extended time during regeneration • Cannot be thermally reactivated when capacity is lost after repeated regeneration cycles • Has a lower ignition temperature (225^0 C) compared to other types of carbon, posing a fire danger • Absorbs oxygen during idle time. This exothermic reaction increases fire danger
Untreated Discharge / Atmospheric Dispersion	No treatment is provided. Reduces odor impacts by relying on atmospheric dispersion alone.	• Does not require any chemicals • Requires less power	• No treatment is provided • Discharge of certain compounds may be precluded by local regulations • Susceptible to local atmospheric condition changes

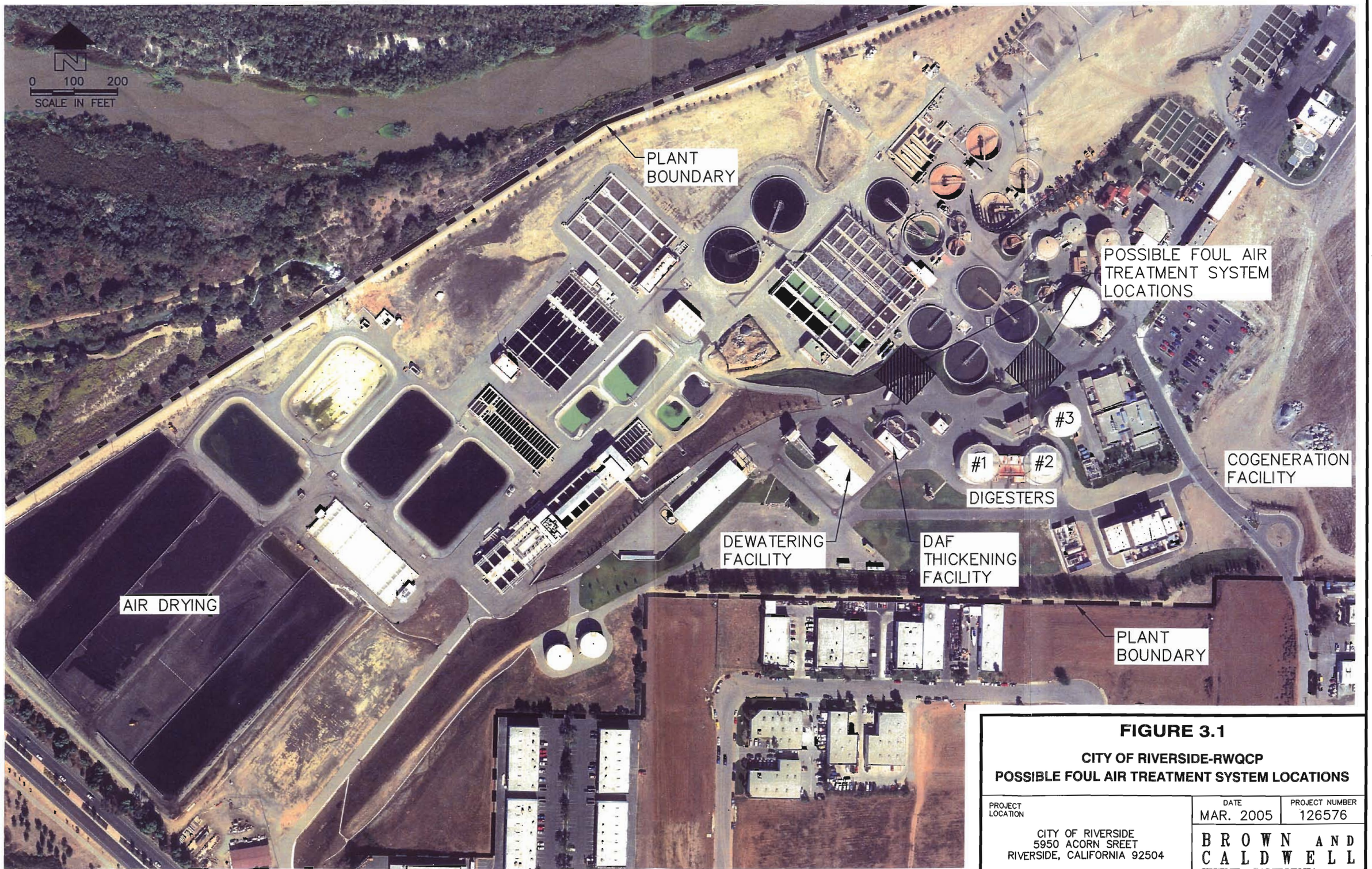


FIGURE 3.1

CITY OF RIVERSIDE-RWQCP
POSSIBLE FOUL AIR TREATMENT SYSTEM LOCATIONS

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	MAR. 2005	126576

BROWN AND CALDWELL
IRVINE, CALIFORNIA

P:\Pdl\RIVERSIDE MASTERPLAN\126576_FG-3.1.dwg

4.0 Odor Control Strategies for the RWQCP

Several approaches or strategies, which combine the five methods discussed earlier, may be used to control odors at the RWQCP. These include preventative methods such as addition of chemicals upstream to stop or reduce sulfide generation, covering process equipment areas and treating captured foul air using one of several available technologies, or a combination of both. The choice of method will depend on the cost associated with each and the benefits realized. In addition, a phased approach may also be used for implementing immediate strategies, followed by other long term solutions for providing odor control.

Effective odor control planning and implementation requires targets to be set at a critical receptor (typically the closest non-City entity outside of the plant boundaries or at the fenceline). The most common target level is to achieve 5 odor units or less at the fenceline, i.e., the air sampled at the fenceline must only be diluted 4 fresh air volumes to 1 foul air volume to meet the odor objective. The City of San Diego has the following objective included in its design guidelines (December 1996):

> *"All MWWD facilities shall be designed to achieve 5 or less odor units (OU) at established critical receptors at least 99.5 percent of the time. Experience indicates that implementation of this criterion has resulted in absence of odor complaints. Typically, odor complaints do not occur when odor is below 5 OU. The City may select more stringent criteria at highly sensitive locations."*

The City should endeavor to establish odor criteria prior to initiating the improvements noted in this Master Plan.

4.1 Odor Dispersion Modeling

Although data has been collected to characterize the odors at the several facilities within the plant, an odor dispersion modeling has not been performed. Results from an odor dispersion model can pinpoint to uncovered areas needing covers and show the effect of upstream chemical addition and covering of facilities on the plant environment and the surrounding areas. It also an important tool in determining the appropriate location, height and diameter of the treated foul air discharge stack. Odor dispersion modeling is an important element in planning improvement focused on meeting established odor targets.

4.2 Strategies for Odor Control at the Headworks and Primary Treatment Facilities

The strongest odors perceived at the plant emanated from the headworks and primary treatment facilities. Reducing odors at these facilities will greatly improve conditions at the plant and minimize the potential for complaints from neighboring areas. Strategies for reducing odors at these facilities are discussed below.

4.2.1 Headworks Odor Control

Some of the strongest odors at the RWQCP were observed in the vicinity of the Jurupa/Rubidoux influent monitoring station. Wastewater from the Rubidoux forcemain had a very high dissolved sulfide concentration (see Table 3.1). Agitation of wastewater as it flows through the flow-monitoring open channels and other structures can result in the release of significant amounts of H_2S gas at these stations. Implementation of upstream chemical addition can significantly reduce dissolved sulfide concentration in the influent wastewater and odors at this facility. A more detailed discussion on this option is provided in the section that follows.

The City currently adds ferric chloride to the wastewater upstream of the Plant 1 primary clarifiers for sulfide control in the anaerobic digesters. Addition of ferric chloride upstream of the influent monitoring stations may produce added benefits by reducing the dissolved sulfides at the stations as well as areas downstream.

Further reduction of odors may be accomplished by covering the flow-monitoring open channels and withdrawing foul air from both influent monitoring stations. A minimum airflow rate of 1.0 cfm/ft^2 should be used for providing adequate negative pressure at gaps and openings. A higher air flow rate may be necessary to adequately dilute odors. The choice of foul air treatment method will depend on the H_2S concentration. The foul air may be routed to the Headworks biofilter for treatment if sufficient capacity is available, or treated in a stand alone activated carbon unit.

4.2.2 Primary Clarifier Odor Control

Current data indicate that the strongest foul odors are detected around the primary clarifiers. Several options can be exercised for this particular facility.

Rapid Withdrawal of Primary Sludge

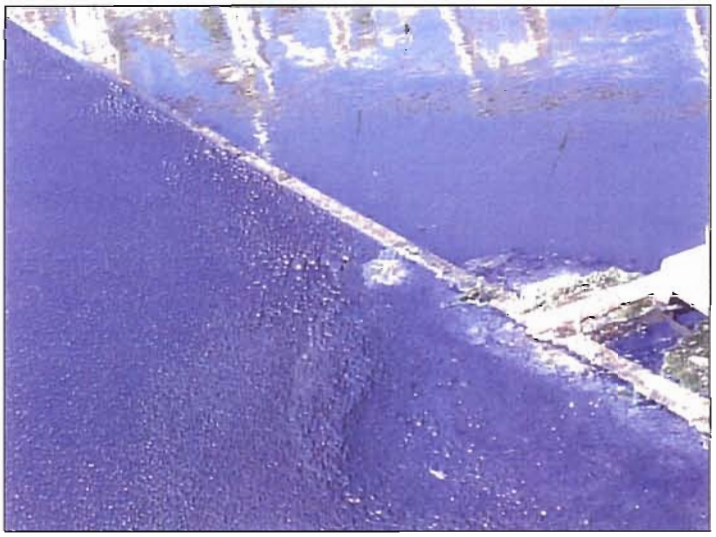
The practice of re-settling sludge from Plant 1 primary clarifiers in the Plant 2 clarifiers contributes to the formation of septic sludge in the Plant 2 clarifiers. This was witnessed during the recent plant visits when gas bubbles on the surface of some of the Plant 2 primary clarifiers were observed (see Figure 4.1), high level of sulfides measured, and strong odors detected.

The practice of re-settling and thickening of primary solids should be re-evaluated. The City should explore the possibility of thickening Plant 1 primary solids using gravity belt thickeners and conveying the thickened solids directly to the digesters. The Plant 1 primary solids may also be co-thickened using the existing DAFT process if adequate capacity is available. Co-thickening using DAFTs was discussed in detail in Technical Memorandum (TM) 2 on Digestion Options. An excerpt of the TM-2 recommendations is provided below:

"TM-1 offered two thickening options, WAS only thickening and co-thickening of primary and WAS. Implementation of WAS only thickening would require construction of two (2) 39 foot diameter DAFTs. Implementation of co-thickening would require construction of two (2) 44 foot diameter covered DAFTs, new primary sludge pumps and piping to pump thinner primary sludge, bottom sludge degritting and new odor control.

The present worth value for the two thickening options when digestion is also considered is $ 33.8 million for WAS only thickening and $43.3 million for co-thickening. As noted in TM-1 other benefits of co-thickening would include possible increased primary sedimentation surface overflow rates and grit removal prior to digestion."

Figure 4.1. Photograph of Gas Bubbles on Plant 2 Primary Clarifier Surface



Upstream Chemical Addition

The first option relies on upstream chemical addition for reducing incoming dissolved sulfide concentration. Due to the administrative and operational labor required, many municipal agencies including the City typically prefer not to operate upstream chemical addition programs. However, several product vendors can provide full service contracts, eliminating risks related to chemical handling and freeing the City's labor resources. Full service normally includes system installation and maintenance, product delivery, regular inventory checks, product replenishment, and dosage optimization. Most vendors can provide service within 24 hours of notice from clients.

Upstream chemical addition is one method for reducing influent sulfide load and odors at processes such as the influent monitoring stations and headworks. Odors are not eliminated in this method; rather, they are reduced to an acceptable level. Completely eliminating sulfides from the wastewater streams will require significant amount of product and is usually cost prohibitive.

The City currently uses chlorine gas for odor control at the Plant 2 primary clarifiers. Chlorine gas is cost-competitive with other odor control chemicals such as ferric chloride. However, most municipal agencies are transitioning to sodium hypochlorite (bleach) due to the safety and public health concerns. While hypochlorite provides the same odor control benefits as chlorine gas, it can be between 10 to 20 times more expensive than chlorine gas.

The cost of using chlorine gas versus iron chloride for odor control is essentially equal. Replacing chlorine gas with iron chloride addition at the front end of the plant or upstream can have a long range impact, helping reduce sulfide-related odors at the headworks, the primary clarifiers, and digesters. Iron, the key ingredient in iron chloride, does not react with too many other reactants and is therefore conserved to react with sulfides produced at downstream facilities such as the primary clarifiers and solids processing facilities. The cumulative effect of chemical addition (upstream and/or at the front end of the plant) and air dispersion may be sufficient to reduce odors at the fenceline.

Based on past experience, iron chloride addition is likely to be the most beneficial to the RWQCF, but other products can be considered for full scale field testing by the City. A preliminary cost comparison between iron chloride and Bioxide, the other product known to the City, is presented in a subsequent section.

The following steps outline an approach to upstream chemical addition:

1. Characterize the incoming raw wastewater. Conduct 24-hour composite and diurnal sampling to determine peak and average sulfide (inorganic and organic) and VOC concentrations at the various sampling locations, including major gravity sewers and large pump station discharges entering the RWQCP.

2. Before implementing chemical addition, conduct an initial survey of H_2S and odors around at the plant and in the surrounding neighborhood to document current odor levels. For H_2S, sensitive analyzers such as a Jerome 631x H_2S Analyzer should be used. Odors can be surveyed using field olfactometers, such as the Nasal Ranger Field Olfactometer manufactured by St. Croix Sensory, Inc., This device that can produce on-site and immediate dilution-to-threshold values (such as those given in the 1992 CH2M Hill report). The recorded values can also be used to calibrate the odor dispersion model.

3. Determine the best locations for chemical addition based on available space, electricity, water and proximity to sensitive facilities such as schools and residential properties, since it may be undesirable to locate hazardous chemicals near such properties. Locations must be chosen appropriately to allow sufficient time for product to react with odor causing compounds.

4. Select an appropriate odor control product based on the pre-existing sulfide profiles, sulfide generation capability, product hazards and other considerations.

5. Invite product vendors to provide recommendations, and/or conduct product testing. Some vendors are willing to perform tests at no cost to the City.

6. Establish performance criteria for vendors, negotiate contract, and proceed with system installation.

Another technology that may prove useful at the RWQCP is peroxide regenerated iron for sulfide control (PRI-SC)™, which uses iron salts in conjunction with hydrogen peroxide. The primary concept in this process is reintroduction of ferric ions at downstream locations using hydrogen peroxide. Wastewater in upstream reaches of the system is treated with ferrous salts for precipitating sulfides as ferrous sulfide (FeS). Hydrogen peroxide may be added at intermediate points downstream to oxidize the FeS precipitate to ferric ions and elemental sulfur. The resulting ferric ions provide additional odor control or act as a coagulant in the enhanced primary treatment process downstream of the hydrogen peroxide dosage location.

The overall cost of upstream odor control treatment and in-plant ferric chloride addition is expected to be lower with the PRI-SC system compared to operating separate upstream chemical addition and in-plant ferric chloride addition systems. However, full-scale testing and evaluation should be performed prior to full implementation and commitment to this concept.

Covering Equipment, Providing Ventilation and Treating Foul Air

If treatment of wastewater by dosing odor control products in the upstream reaches of the collection system is undesirable due to concerns about safety hazards and handling of odor control products, the second option is to capture foul air generated at the plant by installing equipment covers. The foul air withdrawn from below the covers must then be treated before being discharged to the atmosphere.

Covering process equipment and withdrawing and treating the foul air is a common odor control method employed. A properly operated odor control

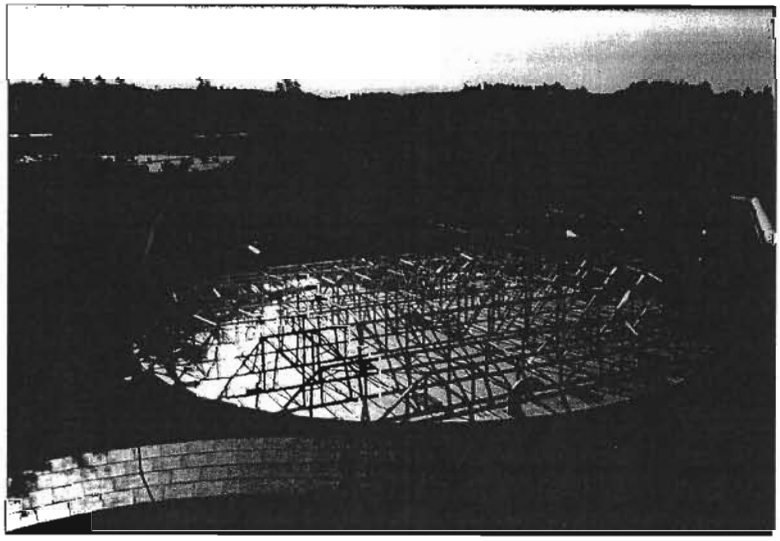
system can provide excellent odor control. However, some disadvantages of this method include:

- Significant capital cost, operation and maintenance, labor, chemical and power requirements
- Additional treatment stages may be required if the foul air contains a high concentration of odor causing compounds
- Inadequate maintenance of the system can lead to leakage of foul air from covered equipment, reducing the effectiveness of this method
- Potential handling and storage of large quantities of hazardous chemicals (for chemical scrubbers)

Covers

The two types of equipment covers used for foul air containment are flat covers and geodesic domes. Flat covers without supports may be used for clear spans of no more than 30 feet; truss supports are required when the span exceeds this length. A photograph showing truss supported flat covers for circular clarifiers is shown in Figure 4.2. Geodesic dome covers are the second option, and may be used for covering equipment with clear spans as large as 900 feet.

Figure 4.2. Photograph of Truss Supported Flat Covers For Circular Clarifiers



Materials of Construction

Aluminum is the most commonly used cover material as it provides good corrosion resistance, yet good strength and lightweight construction. Fiberglass is also frequently used, although its lifespan is shorter than aluminum since it is susceptible to ultraviolet radiation. A more recent option for flat covers is structural fabric. Fabric covers may be tailored to any shape,

but are unable to handle surface loading. The longevity of fabric covers is not yet proven.

Characteristics of Covers

Both dome and flat covers may be designed with the following characteristics:

Permanency:	Fixed, or removable to allow access
Accessibility:	Include hatches to provide access to covered spaces
Visibility:	Include clear panels to allow visibility
Aesthetics:	Designed to reflect sunlight, or resist surface oxidation
Sealing:	Gasketed, caulked or permanently sealed
Air Openings:	Openings may be incorporated, or fresh air may be allowed to enter through gaps between the covers and equipment

Foul Air Withdrawal Rates

Foul air must be withdrawn from covered process equipment to prevent corrosion of concrete structures and metallic equipment below the covers, and to prevent odorous air from escaping to the atmosphere. The foul air withdrawal rate may be selected based on one of the criteria discussed below.

Foul air withdrawal rates for Plant 2 clarifiers have been estimated. Covers are not recommended for Plant 1 clarifiers since they will be replaced in the near future. Covers for the new Plant 1 clarifiers may be designed as part of the replacement project. Cost estimates for all the options discussed below are presented in Section 5.

Criteria 1 - Prevent Leakage from Covered Area

The primary objective of this ventilation strategy is to ensure negative pressure at all leakage points along the covers; the amount of air withdrawn depends on the surface area of the covers, and presence of gaps between the covers and equipment. A close fit reduces gaps and openings, allowing less foul air to escape. Fresh air is drawn into the headspace at the gaps; alternatively, vents may be provided to allow fresh air into the headspace.

Based on BC's experience, a foul air rate of 0.5 to 1.0 cubic feet per minute (cfm) per square foot of cover provides sufficient negative pressure at openings. The lower rate may be used when a close fit between the covers and equipment reduces the number of openings and gaps.

Using this option, the total foul air rate for the four Plant 2 primary clarifiers will be approximately 34,000 cfm, and the anticipated H_2S concentration based on available dissolved sulfide data is 1.1 ppmv. Protecting the concrete structures under the covers using polyvinyl chloride (PVC) liner or spray-on epoxy coatings is recommended. Due to the moderately low H_2S concentration, foul air treatment using biological treatment technologies is unfavorable. Activated carbon is more suited for this application and is therefore the recommended option for treating the extracted air.

Criteria 2 - Prevent Corrosion Within the Enclosure

The foul air withdrawal rate is based on the headspace volume, and the nature of the space. The ventilation and foul air withdrawal rates are determined by calculating the air volume required to reduce H_2S concentration to approximately 1 ppmv. Corrosion of unprotected concrete and metallic surfaces and equipment is greatly reduced at this H_2S concentration.

Typically, 4 to 6 air changes per hour (ACH) are used for sweeping out foul air and reducing corrosion. For example, a headspace with a volume of 100 ft^3 can be supplied with 400 to 600 ft^3/hr of fresh air. The exact foul air withdrawal rate must be calculated based on the estimated H_2S generation rate to ensure that it is sufficient to reduce the H_2S concentration to 1 ppmv. The foul air rate must also be sufficient for producing negative pressure at gaps and openings.

The required rate of withdrawal for reducing H_2S concentration to 1 ppmv at the Plant 2 primary clarifiers is 38,000 cfm. Due to the low concentration of H_2S, activated carbon is an economical and efficient option for foul air treatment.

Criteria 3 - Dilute Foul Air to Improve Treatability

This method estimates ventilation rates by determining the H_2S concentration and supplying enough fresh air to dilute it to a predetermined concentration. The objective is to reduce the H_2S concentration to allow treatment using more cost-effective biofilters or bioscrubbers, which typically operate best 5 ppmv and 15 ppmv H_2S. However, if the calculated foul air rate is lower than 0.5 cfm/ft^2, it must be increased to this amount to ensure negative pressure at gaps and openings. The concrete must be protected against corrosion using polyvinyl chloride liners or spray-on epoxy coatings.

A foul air withdrawal rate sufficient to lower the H_2S concentration to 10 ppmv is chosen to enable treatment using the more cost-effective biological technologies. An activated carbon unit is typically provided for "polishing" treated air before discharge. The total estimated foul air rate for the four Plant 2 clarifiers is approximately 3,800 cfm. However, an air flow rate of at least 17,000 cfm is required to provide negative pressure at gaps and openings, and consequently reduces the H_2S concentration to approximately 2 ppmv. Due to the low concentration of H_2S, an activated carbon system is the recommended foul air treatment method for this option.

Criteria 4 - Personnel Entry

Flat panel covers are usually designed with hatch openings along the perimeter of circular clarifiers to allow personnel to wash down the weirs and for other maintenance activities. Hatch openings or removable panels are also provided at the center of clarifiers to allow maintenance of the scum skimmer and rake drive mechanisms.

However, if desired, clarifiers may be provided with geodesic dome covers to allow personnel to enter the headspace. A walkway can be provided for accessing the scum skimmer and rake drives. The ventilation rates in such headspaces must be increased for personnel health and safety. The typical ventilation rate chosen for such applications is 20 ACH, which ensures sufficient fresh air in the headspace and reduces H_2S concentrations to safe levels.

The exact foul air withdrawal rate must be calculated based on the estimated H_2S generation rate and other factors including the applicable local and federal regulations governing personnel entry into hazardous atmospheres. The National Institute for Occupational Safety and Health (NIOSH) lists a maximum exposure limit of 10 ppmv, with a 10-minute ceiling. The American Conference of Governmental Industrial Hygienists (ACGIH) and California Occupational Safety and Health Administration (Cal-OSHA) also list an exposure limit of 10 ppmv. The air flow rate must also be sufficient to provide fresh air for ensuring worker comfort during entry. Based on BC experience, 20 ACH was chosen for this option.

The total estimated foul air rate for the four clarifiers is 178,000 cfm; the estimated H_2S concentration is 0.2 ppmv. Due to the low H_2S concentration, activated carbon adsorption is the recommended foul air treatment technology.

Phased Approach - Combining Upstream Chemical Addition and Cover, Ventilate and Treat

The third option uses a phased approach. Since design and construction of covers for the Plant 2 primary clarifiers are likely to involve several years, the first phase focuses on providing immediate short-term odor control. This will be accomplished by adding odor control chemicals upstream of the RWQCP to reduce incoming sulfides. This approach allows the City time to delay the more expensive cover, ventilate and treat method and evaluate the effectiveness of upstream chemical addition alone. During Phase I, the City can survey the effectiveness of chemical addition and offsite odor impacts using the equipment mentioned earlier (i.e., the Jerome Meter and the field olfactometer).

If Phase I improvements fail to provide the desired control, equipment covers should be provided for capturing foul air. The withdrawal rates will be based on one of the four ventilation criteria discussed previously. Since the headspace H_2S concentration for all options is below 5 ppmv, the foul air can be effectively treated as described previously. Upstream chemical addition may be discontinued once the Phase II improvements are implemented.

4.2.3 Odor Control for New Primary Clarifiers

The odor control strategy for the existing primary clarifiers can also be used for the new primary clarifiers that will replace the existing Plant 1 clarifiers. Preventing formation of septic sludge by faster sludge withdrawal rates can reduce odors from this potential source.

4.2.4 Headworks Biofilter

During the September 2004 site visit, BC staff noted strong odors and a H_2S concentration of 40 ppbv along the eastern boundary of the Headworks biofilter. The RWQCP staff mentioned that the biofilter media had not been replaced since its installation eight years ago. Bulk media biofilters need periodic media replacement, typically once every three to five years. Uneven compaction can occur over time and can result in channeling, preventing foul air from receiving the contact time needed for treatment. These factors, including the relatively high H_2S concentration in the vicinity of the biofilter suggest that the unit may not be performing as designed.

It is recommended that the biofilter be inspected. A smoke test may be helpful in determining if channeling is occurring. Replacement of the biofilter media must be undertaken.

4.3 Strategies for Existing and Future Solids Processing Facilities

Several changes to the existing solids processing facilities are expected to occur in the near future, including construction of new dewatering and truck loading facilities and possibly expansion of the existing thickening system. Odor-related historical data

indicate that the existing facilities do not contribute significantly to the odors emanating from the entire plant. Improvements to the existing and future solids processing facilities proposed to mitigate any odor-related concerns are discussed below.

4.4 Odor Control at Existing DAFT Tanks

The 1993 study by CH2M Hill showed moderate odor at the DAFT process. The air sampling conducted by BC staff in September 2004 indicated low to moderate H_2S concentration (12 ppbv) near the open DAFT tanks. Dilution of odors by air dispersion may provide sufficient odor control at this facility. Increasing vegetation inside the southern fence near the DAFT tanks may provide sufficient dispersion to reduce odor impacts south of the fenceline.

Covering the tanks with flat covers, withdrawing foul air from the headspace, and discharging untreated air using a tall stack is another option. The stack must be located at a sufficient distance from buildings and other structures to prevent "building downwash." This phenomenon occurs when aerodynamic turbulence caused by structures such as buildings pull the discharged plume downward towards receptors at ground level. The effect reduces the opportunity for mixing and dispersion of the discharged air. An air dispersion modeling study will be useful in determining appropriate stack locations to prevent building downwash. Dispersion modeling comparison of downwind odor impacts of open tanks versus covered tanks will be useful in determining if tank covers are necessary.

4.5 Odor Control at the Existing and Future Dewatering Facility

The existing dewatering facility processes digested biosolids for producing wet cake that is hauled off-site. Biosolids are currently dewatered using filter presses and one centrifuge. BC staff noted strong odors in the vicinity of this facility. Filtrate from the BFPs that cascades into open collection basins (see Figure 4.3) is one of the main sources of odors at this facility. Since the filtrate sumps are not enclosed, foul air withdrawn above the sumps has little effect in reducing odors in the building.

Planned upgrades to the solids handling facility include the design of a new truck loadout facility, which will improve solids loading operations. Recent improvements to the dewatering facility included addition of a dewatering centrifuge, which has allowed less frequent operation of the BFPs and consequently reduced odors in the facility. However, during periods of higher dewatering demand, the BFPs are placed into service, resulting in noticeably higher odors.

Figure 4.3. Photograph of Existing Belt Filter Press

Since Operations staff reported that the BFPs will be phased out in the near future, modifications to the existing foul air collection system designed to improve ventilation and foul air collection at the BFPs will not provide any value. The City should focus on the following improvements, process and operational changes for reducing odors at the dewatering facility:

1. Improve foul air collection at the classifying conveyor which discharges to the belt conveyor.
2. Provide foul air collection from the centrate line.
3. Provide foul air collection from the centrifuge cake box, centrate tanks and centrifuge casing of the existing centrifuge.
4. Make provisions to allow connection of foul air from future centrifuges.
5. Provide covers or hoods for the belt conveyor, and foul air collection at various locations along the length of the conveyor. The foul air rate must be sufficient to provide a negative pressure of approximately 0.01 inches of water column, or a face velocity of 300 feet per minute (fpm).

Withdrawing foul air directly from process equipment such as the centrifuges can reduce odors both within the building and the vicinity by preventing foul air from escaping. The foul air may be treated using an activated carbon unit or modular biofilter. The appropriate treatment technology must be chosen after characterizing the foul air generated by these processes.

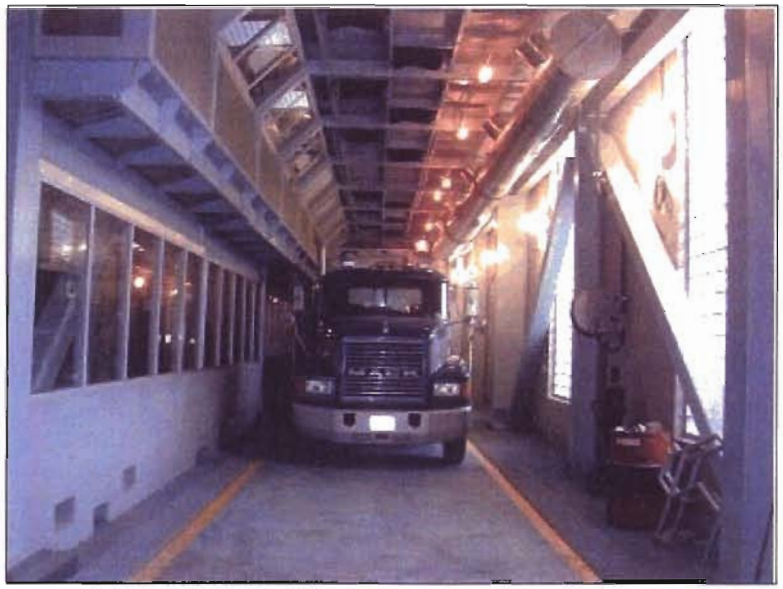
4.6 Odor Control at the Existing and Future Truck Loading Facility

Biosolids produced at the RWQCP were previously dried in air drying beds. Since the air drying process has recently been phased out, wet cake is hauled offsite with future planned heat drying. The City is currently designing a new truck loading facility for streamlining the dewatering and cake transport process. Since biosolids processing and

conveying can produce foul air containing compounds such as RSCs, amines, and H_2S, odors can be a significant concern at the truck loading facility. The new facility is being designed to control odors and treat foul air by implementing the following measures:

1. Providing continuous ventilation and foul air withdrawal inside the truck loading facility to reduce odors, prevent equipment corrosion, and ensure operator comfort.
2. Locating supply air registers and foul air withdrawal registers along opposing walls in the building to create a sweep of air for effectively capturing odors.
3. Where feasible, providing direct foul air withdrawal from covered process equipment and maintain negative pressure at openings. This will reduce the rate of foul air escaping into the facility, thus preventing odors.
4. Locating the truck loading operation in a separate enclosure or building, and providing a higher foul air withdrawal rate (between 12 and 30 ACH) in this building to capture foul air during truck loading. This approach has been used in Toronto, Ontario (Figure 4.4).
5. Installing magnetic interlocks or post signs prohibiting both entrance and exit doors at the truck loading enclosure from remaining open simultaneously. This will prevent odors being swept away outside the building by prevailing winds. Alternatively, air curtains may be used at the entrance and exit to isolate the foul air within this enclosure.
6. Ensuring that truck operators are following proper procedure and covering the bins prior to exiting the facility.

Figure 4.4. Photograph of Truck Loading Enclosure at Toronto, Ontario



The concentration of malodorous compounds in the foul air is expected to be very low due to the high foul air withdrawal rate. Therefore, foul air from the enclosed truck loading space may be treated using activated carbon. The dimensions of the truck loading facility based on the predesign and foul air withdrawal calculations are as follows:

Length:	70 ft	Volume:	21,000 ft^3
Width:	15 ft	Air Withdrawal Rate:	30 ACH
Height:	20 ft	Air Flow Rate:	10,500 cfm

The 10,500 cfm foul air rate may be treated in an activated carbon system. If necessary, combined foul air from the truck loading facility and other process equipment such as silos may be treated using one activated carbon system. Up to 15,000 cfm of air may be treated using a single carbon unit with a diameter of 8 feet and height of 12 feet.

5.0 Permitting

Air emissions from the RWQCP are subject to the stipulations of permit-to-operate issued by the South Coast Air Quality Management District (SCAQMD), which maintains jurisdiction over Riverside County. Installation of new foul air treatment systems, or modifications to existing systems are likely to be subject to the SCAQMD's new source review process. A health risk assessment (HRA) may also be required to prove that emissions from facilities pose a Maximum Individual Cancer Risk (MICR) no greater than 1 in a million. Air dispersion modeling using the Industrial Source Complex Short Term (ISCST3) method, the same model used for odor dispersion modeling, may be required to determine downwind concentration of toxic substances.

In addition to permit requirements, SCAQMD may also require the RWQCP to meet certain fenceline odor concentration goals. These concentration goals are usually based on the frequency of complaints received from the local community, as well as the potential for complaints when odor concentration exceeds a pre-determined value. For example, based on the history of complaints, the SCAQMD has established a fenceline H_2S concentration goal of 10-ppbv for the Orange County Sanitation District's wastewater treatment plants.

6.0 Preliminary Cost Estimates

Preliminary cost estimates were generated for odor control strategies on currently known facilities. The cost of odor control systems related to future facilities has not been determined. Presented are the estimated present worth for the H_2S and odor survey equipment, odor control modeling, wastewater characterization, upstream chemical addition, and odor control system improvements to the headworks, primary clarifiers, and truckload out facility. While foul air withdrawal rates for the new truck loadout facility have been presented in earlier sections, construction cost estimates are more appropriately handled as part of other documents, and are not presented here.

The annual and capital costs for the various cover, ventilate and treat options presented in Table 6.1 are intimately linked to the liquid phase dissolved sulfide concentration of the process streams, and the headspace gas phase H_2S concentrations of the processes requiring odor control. Changes in these parameters can render certain options cost prohibitive, while improving cost effectiveness of other options. Preventing leakage of foul air from covered equipment is the governing factor in determining the foul air withdrawal rates from the Plant 2 primary clarifiers. Since the foul air withdrawal rates calculated for the various options result in dilution of H_2S to below 5 ppmv, the "Treatability" criterion does not apply to odor control at the RWQCP and provides no significant cost benefit over other options.

Table 6.1. Present Worth Costs of Odor Control Improvements for Known RWQCP Facilities

Purpose	Option/Criteria	Annual Cost	Capital Cost	Present Worth
Ambient H_2S Measurement	One Jerome Model 631x H_2S Analyzer; Cost depends on accessories desired	-	$10,000 to $15,000	$10,000 to $15,000
Odor monitoring	Two St. Croix Sensory, Inc., Field Olfactometers; Cost depends on accessories desired	-	$3,000 to $4,000	$3,000 to $4,000
Odor Modeling	Cost depends on sampling and monitoring required	-	Up to $50,000	Up to $50,000
Wastewater Characterization	Cost depends on number of sites and sampling frequency	-	Up to $50,000	Up to $50,000
Upstream Chemical Addition	Nitrate Addition	$154,300	$218,700	$2,315,600
	Iron Addition	$70,000	$99,300	$1,050,700

Total present worth based on 20 years, at a discount rate of 4% per annum for annual cost items. Based on December 2004 dollars.

Table 6.1. (cont'd) Present Worth Costs of Odor Control Improvements for Known RWQCP Facilities

Purpose	Option/Criteria	Annual Cost	Capital Cost	Present Worth
Covering, Ventilating, and Treating Foul Air from Plant 2 Clarifiers	Leakage Prevention of Covered Area	$155,300	$3,929,400	$6,040,000
	Prevent Corrosion Within Enclosure	$184,400	$3,469,100	$5,975,200
	Dilute to Improve Treatability	$95,800	$4,276,900	$5,578,900
	Personnel Entry	$815,500	$4,820,800	$15,903,700
Truck Loadout Odor Control	Includes Ducting and Foul Air Treatment	---	---	---

Total present worth based on 20 years, at a discount rate of 4% per annum for annual cost items. Based on December 2004 dollars.

7.0 Conclusions and Recommendations

A review of the available data leads to the following conclusions:

1. Both historical and current data indicate strong odors at several plant locations, particularly at the influent monitoring stations, primary clarifiers, and dewatering facility.
2. High dissolved sulfide concentration in the influent wastewater is responsible for the strong odors observed at the influent monitoring stations.
3. Strong odors near the Headworks biofilter indicates that it may not be operating as designed.
4. Discontinuing air drying at the site has significantly reduced the complaints from neighboring areas.
5. The current practice of re-thickening the raw sludge from Plant 1 primary clarifiers at the Plant 2 primary clarifiers and slow withdrawal of the combined raw sludge appears to be responsible for high odor and sulfide levels at the primaries. Sludge septicity may be occurring based on bubbles found at the clarifier surface.
6. The lower elevation of the plant compared to its neighbors, and its location close to the river makes odor control difficult.

Recommendations for various facilities are as follows:

General Improvements

Improvements designed to enhance atmospheric dispersion may be used south of the RWQCP solids processing facilities to reduce impacts to businesses located south of the fenceline.

- Periodic monitoring of H_2S and odors within the facilities and at surrounding areas should be conducted and recorded to assist with prioritizing appropriate improvements.
- Improvements designed to enhance atmospheric dispersion, such as providing more vegetation and/or constructing an air dispersion fence should be used south of the RWQCP solids processing facilities to reduce impacts to businesses located south of the fenceline.
- Odor dispersion modeling should be performed to compare odor impacts of open processes versus covered processes (for example, primary clarifiers and DAFT tanks). The modeling results can be used for determining if covers are necessary for processes with low odors such as the DAFT tanks.

Influent Monitoring Stations

The following recommendations can reduce the odors emanating from the influent monitoring stations:

- Strategic chemical addition at the plant can result in significant improvement throughout. For example, iron salt addition at the influent monitoring stations or better yet, 15 to 30 minutes upstream can reduce the odors at the station, the primary clarifiers and the digesters by tying up the sulfides present. The ferric chloride currently being added upstream of the primary clarifiers should be relocated upstream of, or to the influent monitoring stations.
- Cover open channels and withdraw and treat the foul air if chemical addition is not desirable or is insufficient to keep odors low.

Headworks Biofilter

The strong odors noted by BC staff near the east side of the Headworks biofilter indicates that it may not be performing as designed.

- The biofilter should be thoroughly evaluated to determine current performance. A smoke test will determine if the biofilter is clogged or if channeling is occurring.
- Bulk media biofilters typically require media replacement every five years. The City indicated that the medium had not been replaced for more than eight years. The media should be replaced to improve performance and return the biofilter to design conditions.

Plant 1 Primary Clarifiers

The Plant 1 primary clarifiers are to be replaced with new clarifiers in the near future. In addition, gas phase sampling conducted by BC staff indicated low H_2S concentrations in the vicinity of Plant 1 clarifiers. It is recommended that these clarifiers not be provided with covers at this time.

Plant 2 Primary Clarifiers

Strong odors were noted in the vicinity of the Plant 2 primary clarifiers. Liquid phase sampling also showed high dissolved sulfide concentrations.

- The current practice of re-settling and thickening Plant 1 primary solids in the Plant 2 primary clarifiers should be re-evaluated. The long retention time of sludge in the primaries may be contributing to the formation of septic sludge in the clarifiers. Co-thickening of raw and biological solids should be explored.
- Since design and construction of cover, foul air collection and treatment system is likely to involve several years, upstream chemical addition is recommended initially. This option provides an economical short-term choice for reducing odors at the plant and allows the City time to evaluate the effectiveness of this method. H_2S and odor surveys can be performed periodically to determine the efficacy of upstream chemical addition. A background survey is needed for reference.
- If chemical addition is insufficient in reducing the odors, the City should proceed with the covering and ventilating the clarifiers. Upstream chemical addition can be terminated after completion of improvements. The ventilation and foul air withdrawal rates for all options are sufficient to reduce average H_2S concentration at

the primaries below 5 ppmv. At these low levels, activated carbon becomes the cost-effective method for foul air treatment.

- If entry to the clarifiers is unnecessary, providing flat covers is recommended due to the reduced cost resulting from lower ventilation rates. Geodesic dome covers, which double the cost of covering the clarifiers, are necessary if personnel entry is desired for maintenance.

Dewatering Facility

Gas phase sampling conducted by BC staff indicated no H_2S near the dewatering facility. However, strong odors were noted. The current plan to replace the open belt filter presses with enclosed centrifuges should improve odor control by allowing the capture of odorants. The following recommendations should be implemented:

- Improve foul air collection at the classifying conveyor which discharges to the belt conveyor.
- Provide foul air collection from the centrate line.
- Provide foul air collection from the centrifuge cake box, centrate tanks and centrifuge casing of the existing centrifuge.
- Make provisions to allow connection of foul air from future centrifuges.
- Provide covers or hoods for the belt conveyor, and foul air collection at various locations along the length of the conveyor. The foul air rate must be sufficient to provide a negative pressure of approximately 0.01 inches of water column, or a face velocity of at least 300 fpm.

Truck Loadout Facility

Implement odor control measures currently planned for the new truck loadout facilities. These measures are as follows:

- Provide continuous ventilation and foul air withdrawal inside the truck loading facility to reduce odors, prevent equipment corrosion, and ensure operator comfort.
- Locate supply air registers and foul air withdrawal registers along opposing walls in the building to create a sweep of air for effectively capturing odors.
- Where feasible, provide direct foul air withdrawal from covered process equipment and maintain negative pressure at openings.
- Locate the truck loading operation in a separate enclosure or building, and providing a higher foul air withdrawal rate (between 12 and 30 ACH) in this building to capture foul air during truck loading.
- Install magnetic interlocks or post signs prohibiting both entrance and exit doors at the truck loading enclosure from remaining open simultaneously.
- Ensure that truck operators are following proper procedures and covering the bins prior to exiting the facility.

BROWN AND
CALDWELL

APPENDIX A

LIQUID AND GAS PHASE ODOR AND CORROSION CONTROL TECHNOLOGIES

LIQUID PHASE ODOR CONTROL TECHNOLOGIES

Liquid phase control allows agencies the opportunity to capture or remove odor compounds while in a matrix that is controllable. Once odorants volatilize, it becomes more difficult to effectively capture all the foul air and treat them effectively. Openings and gaps in access holes, tank covers, etc., allow the foul air to escape, often times causing a nuisance in nearby areas. Chemicals can be added upstream of the RWQCP to reduce the liquid phase concentration of the odor compounds thus reducing the amount that volatilize and escape to the atmosphere.

Because of the high expense, chemicals are typically added to reduce the odor compound concentration, but not to completely eliminate it. The post-treatment gas phase concentrations are typically low enough to rely on dispersion and dilution from the fugitive emission points to the nearest receptors. Most agencies target an average of 5-10 ppmv of H_2S gas and 10-20 ppmv H_2S peak, depending on the location of the receptors.

Chemicals added to the wastewater stream to control sulfide-related odor and corrosion are subdivided into four groups: inhibitors, oxidizers, precipitators, and H_2S suppressors. The first group inhibits the formation of sulfides, whereas the second and third groups reduce the concentration of already-formed sulfides by oxidation or precipitation, respectively. The final category shifts the chemical equilibrium to favor dissolved sulfides (non-odorous ionic) instead of H_2S gas. This shift is accomplished by raising the pH of the liquid stream. Chemical addition to the wastewater can normally be expected to reduce pipeline corrosion because H_2S is reduced. However, even highly effective sulfide control will not completely alleviate corrosion or odor concerns.

Chemicals can be added to the wastewater in a number of ways. The simplest approach is to add directly to the wet well. It is also possible to pump through nozzles directly into the force main. Under turbulent conditions, such as the NBI crossing of Interstate 5, and pH below 7.0, the selected odor control chemical must reduce dissolved sulfide levels to less than 0.1 milligrams per liter (mg/L) to reach the gas phase target values mentioned previously. Thus, it is essential to select a chemical that can lower dissolved sulfides to this desired value. The following paragraphs describe some of the typical chemicals used for odor control.

Sulfide Inhibitors

Some chemicals inhibit or prevent the formation of sulfides by chemical or biological modification. Included in this category are: nitrates, anthroquinone, and caustic soda (NaOH) (when slugged, as opposed to dosed).

Nitrates. Sodium nitrate has been used for odor control in sewers, treatment plants, and lagoons. Sulfate-reducing bacteria will preferentially use nitrates, rather than sulfates, as an oxygen source, reducing nitrate to nitrogen gas. Continued use encourages increased development of nitrate reducers and minimizes sulfate reducers. In addition to its preventive mechanism, nitrate can also provide some chemical oxidation of existing sulfides. However, this mechanism requires up to two hours of detention time. One of the chief advantages of nitrates is that they are non-hazardous formulations.

Some chemical suppliers of nitrate formulations may add other compounds to the mix to achieve oxidation of sulfide. Altivia Chemicals, who produce a sodium nitrate ($NaNO_3$) product called Nitrazyme, proposes that 8 to 10 pounds of $NaNO_3$ is required to oxidize 1 pound of sulfide. US Filter provides a product using calcium nitrate ($CaNO_3$) marketed under the name Bioxide®. Some utilities currently inject Bioxide® at a dose rate of approximately 10 gallons per million gallons of wastewater. Note that there are about 3.5 pounds of NO_3-O per gallon of Bioxide.

The nitrate solutions have been proven effective for force mains in particular. However, in some cases, dosage and cost have been high. In order to establish dosages and effectiveness, testing is normally recommended. Whether nitrate could effectively oxidize sulfides entering the pump station is an important question that a trial test may answer. A high dose rate at the pump station could result in carryover to the downstream gravity section to provide additional sulfide control.

Anthroquinone. This chemical is an organic inhibitor. It has the ability to modify a particular strain of sulfate reducing bacteria, thus interrupting the transformation of sulfate to sulfide. For this technique to work, the chemical must diffuse through the slime layer to reach the critical bacteria. This is best accomplished under alkaline conditions. One chemical company (Environmental Biocontrol, Inc.) has developed a method to diffuse the chemical into the wastewater on an intermittent feed basis. There has been some success with this approach. However, the chemical does not treat the sulfide that has already formed and is within the wastewater at the point of chemical addition.

The effectiveness of anthroquinone is reduced in large diameter pipelines due to the lower fraction contacting the slime layer. Because it is normally applied at intermittent intervals of every few weeks, it is not necessary to construct permanent dosing equipment. Conversely, the O&M staff must dedicate time to perform the dosing. US Filter supplies a formulation that combines Bioxide® and anthroquinone, marketed under the name Bioxide AQ®.

Other Biological Inhibitors. There are other biological inhibitors on the market that impede the ability of sulfate reducing bacteria (SRB) in the pipe slime layer to convert sulfates into H_2S gas. They perform this task either by killing the SRB or blocking the chemical pathway $SO_4 \rightarrow S^{-2}$. Two such products are Enzybate®, produced by Ashland, Inc., and Biogon®.

These products typically require a period of days to produce their ultimate inhibitory effect on the bacteria and achieve maximum effectiveness. Their beneficial effects generally diminish slowly as the bacteria regain their initial sulfate reducing capability. Although Enzybate® and Biogon® can substantially reduce the generation of H_2S gas, they usually do not control to very low values. They have had mixed results in other wastewater systems.

Caustic Slugging. A special application of pH control is caustic or high-pH "slugging." By maintaining wastewater pH at 12 to 12.5 for about 20 minutes, inactivation of the slime layer can be achieved through microbial sterilization. Sodium hydroxide (caustic soda) is normally chosen for slug dosing, but lime can also be used. Sodium hydroxide produces a higher pH than lime and is more easily handled.

Periodic shock treatment with 25 or 50 percent sodium hydroxide solution is used by the Sanitation Districts of Los Angeles County and other agencies to control sulfide in problem areas with relatively small flows. It is dumped directly into a manhole or wet well, with an objective of maintaining a pH of at least 12.5 for a 20-minute slug of wastewater. The major advantage of caustic slugging is that it is an intermittent treatment. This can result in very economical sulfide control. The major disadvantage of caustic slugging is that its effectiveness diminishes with time. The length of time for sulfide regeneration varies with temperatures and the intensity of treatment.

Typically, however, this period is less than 2 weeks, and can be as little as 3 to 4 days. On the basis of dollars per pound of sulfide eliminated, however, this technique is often very attractive. Downstream handling of the high pH slug is needed in some cases to avoid affecting biological treatment processes at WWTPs (in this case, the RWQCP). If possible, the slug is diverted to a spare tank (primary clarifier), stored, and recycled over the 2 to 3 days following. Alternatively, the influent can be neutralized. This option is not viable if storage facilities are unavailable.

Sulfide Oxidizers

Several chemicals are used to oxidize soluble sulfide and H_2S to sulfate or elemental sulfur. Oxidizers can control odors and corrosion by several different methods:

- Direct chemical oxidation of hydrogen sulfide within the wastewater.
- Support of an aerobic bacterial community, particularly at the surface of the pipe wall slime layer, to oxidize sulfides and other odorous compounds.
- Maintenance of aerobic conditions in the wastewater, thereby preventing sulfide build-up.

Oxidizing agents can provide oxygen to the wastewater. This can create very high chemical demand in the upstream portion of the force main, leaving a potentially long section of force main in which sulfides could be generated after the oxidizer is expended. This could be remedied by constructing an intermediate dosing station, but this would increase neighborhood impact, maintenance, and capital cost. The most common chemicals used for this purpose are discussed below.

Hydrogen Peroxide. H_2O_2 is an effective oxidant. It is a strong oxidant capable of oxidizing the hydrosulfide ion (HS^-) (which oxygen cannot). An advantage of hydrogen peroxide is that it decomposes into oxygen and water. There are no chemical residuals added to the wastewater. Any oxygen remaining after oxidation of existing sulfide will prevent the formation of additional sulfide. The disadvantages are that H_2O_2 is considered hazardous at normal concentrations due to it being a strong oxidizer. It can also be somewhat costly. Reactions for oxidation of sulfide by H_2O_2 are:

$$H_2S + H_2O_2 \rightarrow 2H_2O + S^0 \quad \text{(at pH<8.5)}$$

$$HS^- + H_2O_2 + H^+ \rightarrow 2H_2O + S$$

$$H_2S + 4H_2O_2 \rightarrow 4H_2O + SO_4^{2-} + 2H^+ \quad \text{(at pH>8.5)}$$

These reactions reflect the typical sulfide reactions in which elemental sulfur or ionic sulfate is produced. The literature suggests that the final reaction product is pH dependent; however, the final product is also dependent on the relative concentration levels of sulfide and oxidant. Since H_2O_2 will react with organic material, the dosage required is often greater than the dosage indicated by the above reactions. In general, H_2O_2 to sulfide weight ratios of 4:1 to 8:1 are often required.

For chemical oxidation, H_2O_2 requires up to 60 minutes detention time, although 90 percent of the reaction typically occurs within 15 minutes. The efficiency of treatment also depends on the level of iron (reaction catalyst) in the wastewater, wastewater pH, and temperature. For biological oxidation, H_2O_2 requires 30 to 180

minutes detention time. The efficiency of treatment also depends on the temperature, BOD, and the biomass available to effect the transformation.

H_2O_2 can be applied to the wastewater to alleviate the formation of odors downstream. The efficiency of treatment depends on the retention time, wastewater temperature, and wastewater BOD. This treatment method is generally most cost-effective for gravity sewers with detention times less than 3 to 4 hours and for force mains with detention times less than 2 to 3 hours. Although hydrogen peroxide is typically one of the more expensive control methods, it can provide good control.

Chlorine. Chlorine (Cl_2) is widely used for disinfection of municipal wastewater. Although Cl_2 is toxic to sulfide-forming bacteria, the dosage required to suppress sulfide formation is high, and it is sometimes more feasible to oxidize sulfide after it has formed. Cl_2 oxidizes sulfide chemically, according to the following reactions:

$$Cl_2 + H_2S \rightarrow 2H^+ + 2Cl^- + S^0$$
$$4Cl_2 + H_2S + 4H_2O \rightarrow 10H^+ + 8Cl^- + SO_4^{2-}$$

In theory, 2.22 pounds of chlorine per pound of sulfide (as S^{2-}) are required for the first reaction, and 8.87 pounds of chlorine are needed for each pound of sulfide oxidized in the second reaction. Since both reactions often occur, the composite is usually somewhere between these ratios. Also, chlorine reacts with organic material, thus increasing the dosage needed. In practice, weight ratios (Cl_2 to sulfide) of 7 to 10 are often required for light-to medium-strength wastewater. Higher ratios are needed for high organic content wastewaters.

The use of chlorine requires eductor mixing to produce a chlorine solution. The benefit of using locations of natural or induced turbulence as application points must be weighed against the probability of liberating H_2S gas. For this reason, it may be desirable to feed chlorine solution upstream from points of turbulence. Because of its hazardous nature and stringent code requirements, chlorine is seldom used for new odor control systems, especially in the collection system.

Chlorine dioxide (ClO_2) is a gas similar in appearance and odor to chlorine. ClO_2, however, cannot be compressed and bottled and must be generated on-site (impractical in most situations). Stabilized ClO_2 is generated by adding acid and sodium hypochlorite (NaOCl) to a solution of chlorine.

Sodium hypochlorite is another chlorine option frequently used in collection systems and treatment plants. The primary advantage of liquid NaOCl (bleach) is its much safer handling compared to chlorine gas. However, commercial strength NaOCl (12 to 15 percent strength) is still considered a strong oxidizer and must be handled carefully and stored in appropriate equipment. Although sodium hypochlorite is

typically one of the more expensive control methods, it can provide good control and it is highly convenient to use. It is quite appropriate to treat small system flows. It is a candidate for further evaluation to determine its economic effectiveness.

Potassium Permanganate. Potassium permanganate ($KMnO_4$) is commonly used for iron and manganese removal in water treatment plants. It has also been used to treat sulfide-containing groundwaters. $KMnO_4$ oxidizes sulfide according to the following chemical reaction at neutral pH:

$$4MnO_4 + 3H_2S \rightarrow 2SO_4^{2-} + S^o + MnO_{2(s)} + 3MnO_{(s)} + 3\,H_2O$$

At alkaline or acidic pHs, other reactions occur. Potassium permanganate is commercially available in granular form and is usually dissolved in water prior to addition to wastewater.

Oxygen. Oxygen can be added through air injection or via high-purity oxygen (HPO) addition to force mains to achieve aerobic conditions in the wastewater to limit sulfide production. Oxygen addition also allows chemical and biological oxidation of the dissolved sulfide that already exists in the wastewater. Stoichiometric quantities indicate two parts of oxygen will oxidize one part of sulfide. In practice, dosage rates are typically three to six pounds of oxygen per pound of sulfide oxidized, plus the amount needed to maintain "fresh" sewage throughout the force main.

The major drawback to adding air or oxygen to a force main is crown bubble formation. Crown corrosion is a major potential problem to be evaluated. It is especially acute in force mains with an irregular profile or operating at low pressure. Given the right conditions, however, oxygen addition can be very cost-effective. A typical injection rate is 20 mg/L.

Air. Although air is more easily handled than oxygen, its oxidizing effect is several times less effective due to the lower dissolved oxygen level that can be achieved. The potential disadvantages of bubble formation and crown corrosion also apply. Air as well as pure oxygen can produce unintended corrosion in the crown of the force main. Dissolved air can be released at a low pressure or high point of the force main. This creates a gas pocket that allows H_2S and sulfuric acid to form and thereby accelerates corrosion.

Ozonation. Sulfide control by ozonation is a relatively new application. It is currently being tested in foul air applications. It is directly sprayed via mist into the foul air. We are not aware of any experience with direct addition of ozone to a force main. Ozone is produced by a corona discharge and is a hazardous vapor.

Sulfide Precipitation

When certain metal salts are added to wastewater, they react with dissolved sulfide to form an insoluble sulfide precipitate. This removes the dissolved sulfide that is responsible for H_2S odors. Copper, iron, and zinc can accomplish this precipitation, but due to cost and potential toxicity, iron is the only practical alternative. By the nature of their action, dissolved sulfides are converted to total sulfides which increases solids in the wastewater. Generally, iron addition in the interceptors provides excellent sulfide control well downstream--including at plant processes such as anaerobic digestion.

Iron Salts. Iron salts are used by hundreds of wastewater agencies nationwide with excellent results. Soluble ferrous (Fe^{2+}) and ferric (Fe^{3+}) combine with sulfide to form compounds such as iron sulfide (FeS), iron disulfide (FeS_2), and smythite (Fe_3S_4). Fe^{2+} and Fe^{3+} cations react with sulfide (S^{2-}) and hydrosulfide (HS^-), as shown in the following reactions:

$$Fe^{2+} + S^{2-} \rightarrow FeS$$
$$2Fe^{3+} + S^{2-} \rightarrow 2Fe^{2+} + S^{\circ}$$
$$2Fe^{2+} + 2Fe^{3+} + 4HS^- \rightarrow Fe_3S_4 + 4H^+$$

Iron and dissolved oxygen may work in combination to reduce dissolved sulfide levels. Iron can lower dissolved sulfide efficiently to below concentrations of 0.5 mg/L at Fe to S weight ratios of 2:1 to 4:1. Lowering the dissolved sulfide concentration below 0.5 mg/L may require Fe to S ratios of up to 10:1, although some systems are able to achieve dissolved sulfides of 0.1 to 0.2 mg/L with low Fe to S weight ratios (<4:1).

Iron can be added as ferrous or ferric chloride or as ferrous sulfate. All of these compounds are provided as liquid solutions. They are highly acidic solutions and must be handled safely and stored in the proper equipment. Ferrous sulfate adds sulfate to the wastewater. This is undesirable when trying to control sulfide. One benefit of ferric addition over ferrous addition is that it raises the oxidation-reduction potential of the wastewater, assisting in the biological processes, as well as promoting sulfide oxidation. However, either chemical is considered a highly effective sulfide control.

Hydrogen Sulfide Suppressors

All of the listed H_2S suppressors reduce the formation of H_2S by elevating the wastewater pH. This reduces the proportion of odorous H_2S in solution and raises the proportion of non-odorous ionic species HS^- and $S^=$. At near neutral conditions, relatively small changes in the wastewater pH results in relatively large changes in the H_2S fraction dissociated in solution, according to the equilibrium reaction expressed by the following relationship:

$$H_2S \leftrightarrow H^+ + HS^- \leftrightarrow H^+ + S^{2-}$$

At a pH of 7.0, approximately 50 percent of the constituents exist as H_2S. When the pH is raised to 8.0, only 8.3 percent is present as H_2S. At a pH of 9.0, the H_2S component drops to less than 1.0 percent. A major drawback of this approach is that the sulfide is never removed. If the wastewater pH shifts back, H_2S is again formed and released.

Caustic Soda. Caustic soda (NaOH) is often dosed into wastewater to moderately elevate the pH and prevent off-gassing of H_2S. This can strategically delay the release of H_2S. Caustic soda is a strong chemical that requires care in handling and usage. A 50 percent solution of caustic soda contains 42.5 percent hydroxide. Overdosing can result in elevated wastewater pH levels that can adversely affect treatment plant operations. Chemical dosage is unique to each system and contingent upon the specific water chemistry of the wastewater. It is not dependent on sulfide level. Caustic soda is also a potentially dangerous substance to handle, capable of causing severe damage to skin and other tissue, as well as being very corrosive to certain metals such as aluminum.

Increasing the wastewater pH up to 8.5 to 9.0 effectively minimizes off-gassing of H_2S by shifting the H_2S to bisulfide and sulfide ions. Off-gassing at this pH range will typically maintain gas-phase H_2S concentrations to less than 5 ppm. Work at Los Angeles County Sanitation District on this method in the early 1990s shows that very effective H_2S corrosion and odor control can be obtained in this manner. At continuous operation in this pH range (8.5 to 9.0), Los Angeles County staff has also discovered lower sulfide production in the slime layer since sulfate reducing bacteria growth is significantly stunted at this higher pH. Dosage rates of sodium hydroxide (NaOH) to reach this pH range are typically about 75 to 100 mg/L. The dosing rate for Six-Mile Creek was estimated from titration tests and will be refined during the current pilot test. This dosage rate is relatively insensitive to the dissolved sulfide concentration of the wastewater, being more a factor of the wastewater flow rate and water chemistry.

Hydrated Lime. pH adjustment can also be achieved with hydrated lime ($Ca(OH)_2$). This chemical falls in between the caustic soda (above) and Thioguard® (below) options in terms of both effectiveness and hazard. Handling is somewhat involved since it is a high-solids slurry and mixing of the stored chemical is required. The low wastewater flow speeds could produce lime settlement inside the pipes. Additionally, lime can produce calcium carbonate scaling under high pH conditions.

Thioguard®. Thioguard® is a proprietary alkaline slurry of magnesium hydroxide ($Mg(OH)_2$). Unlike caustic soda, it is considered non-hazardous. A 58 percent solution of Thioguard® contains 58.3 percent hydroxide. This corresponds to fewer pounds of magnesium hydroxide for a given situation: 37 percent more caustic soda and 27 percent more hydrated lime are necessary to neutralize the same amount of acid. However, Thioguard® can only raise the pH to between 8.5 and 9.0, even when

overdosed. At this pH range, H_2S is not totally shifted to HS^- and $S^=$, and therefore odors are still possible. In contrast, caustic soda and hydrated lime can attain maximum pH values of roughly 14 and 12.5, respectively. While such elevated pH values can be trouble at the treatment plant, the capability to reach them means that even when the wastewater chemistry resists an increase in pH, the other H_2S suppressor chemicals can always raise the pH sufficiently. This is not always the case with Thioguard®, so H_2S control is compromised in such instances.

The handling characteristics of Thioguard® also sometimes present problems. Thioguard® is shipped as a high-solids slurry. Therefore, tank mixers are required and pumping is sometimes difficult. A minimum flow speed of about 2 ft/sec is required to keep the chemical in suspension. The conditions under which Thioguard® provides the most economical treatment are those in which the target pH of 9.0 is easily attainable, the wastewater dissolved sulfide values are very high (perhaps in the neighborhood of 5 to 10 ppm), and the wastewater moves through the lines at more than 2 ft/sec.

Table B-1 shows a qualitative comparison of the technologies described above. The non-economic ranking is comprised of chemical effectiveness, ease of use, and proven history of successful application.

Table B-1. Summary of Sulfide and Corrosion Control Chemicals

Method and chemical	Non-economic ranking	Advantages	Disadvantages
Inhibitors			
Caustic slugging	Low	• Can be mobile feed system • Often very cost-effective	• Variable performance due to intermittent application • Operator attention at pump station and downstream slug handling required • Often variable performance • Does not reduce pre-existing dissolved sulfide component • Very corrosive to body tissue and certain metals
Nitrate formulations (Bioxide®)	Medium to High	• Relatively simple feed system • Can be used to prevent sulfide generation or oxidize existing sulfides • Chemical is safe to handle	• Uncertain dosage requirement • Provides some sulfide removal; however, mainly a preventive measure • Bioxide® is a proprietary formulation

Table B-1. Summary of Sulfide and Corrosion Control Chemicals

Method and chemical	Non-economic ranking	Advantages	Disadvantages
Anthroquinone (normally added as nitrate supplement)	Low	• Simple intermittent feed system	• Uncertain performance due to limited history • Bioxide/AQ® requires mixing in storage to maintain chemical in suspension • Bioxide/AQ® is a proprietary formulation
Oxidizers			
Hydrogen peroxide	Medium to High	• Relatively simple feed system • Provides certain control if dosage is sufficiently high • No byproducts • Effective in wide range of applications • Oxidizes many odorous compounds	• High dosages and costs, at times • Strong oxidizer, requires handling precautions
Chlorine (Cl_2) or sodium hypochlorite (NaOCl)	Medium to High	• Effective in wide range of applications • Provides certain control if dosage is sufficiently high • Rapid oxidation of sulfide • Oxidizes many odorous compounds	• Safety concerns, especially of gaseous chlorine • High costs for NaOCl • Reacts with compounds other than sulfide
Potassium permanganate	Low	• Relatively powerful oxidant	• Difficult to handle (solid material) • High cost
Air injection	Low	• Low cost • Relatively simple system	• Limited to force mains • Potential for air binding and crown corrosion • Limited rate of oxygen transfer
High purity oxygen	Low	• Relatively low cost • Five times the solubility of air	• Uncertain oxygen transfer rates • Potential for air binding and crown corrosion • Pressurized storage of oxygen • Safety concerns
Ozonation	Low	• Very strong oxidant	• Complex generation equipment • Little experience in wastewater addition

Table B-1. Summary of Sulfide and Corrosion Control Chemicals

Method and chemical	Non-economic ranking	Advantages	Disadvantages
Precipitators			
Iron chloride	Medium to High	• Effective in wide range of applications • Cost-effective in high sulfide situations • Treats pre-existing dissolved sulfides • Could achieve sufficient odor control at reasonable cost if combined with air exhaust and treatment • Carryover helps reduce plant odors	• Limited in controlling non-H_2S compounds • Sulfide control to low levels may be difficult • Adds solids to flow stream • Corrosive chemical • Widespread high dosages in collection system can have deleterious effect on receiving WWTP
Iron sulfate	Medium	• Can be effective in many situations • May be more readily available in certain parts of the country	• Limited in controlling non-H_2S compounds
Hydrogen Sulfide Suppressors			
Continuous caustic addition	Medium to High	• Excellent corrosion and H_2S odor control when wastewater is not diluted or affected by acid additions • Dosage relatively insensitive to sulfide concentrations	• Does not react liquid phase sulfide, which can "reappear" at lower pH • Can be high in chemical cost, as dosage is contingent on water chemistry • Hydrogen sulfide released at point of wastewater stream dilution due to pH depression • Handling and safety concerns • Potential treatment problems with high pH wastewater stream at WWTP
Hydrated Lime	Low	• Effective corrosion and H_2S odor control • Dosage relatively insensitive to sulfide concentrations	• Relatively involved preparation and handling requirements, including tank mixers • Potential for re-release of H_2S since it does not react with sulfide • Largely insoluble slurry requires significant wastewater line speeds to remain in suspension • Calcium carbonate scaling potential • Potential of resultant high pH wastewater stream at WWTP

Table B-1. Summary of Sulfide and Corrosion Control Chemicals

Method and chemical	Non-economic ranking	Advantages	Disadvantages
Thioguard® ($Mg(OH)_2$)	Low	• Safe to handle • Dosage relatively insensitive to sulfide concentrations • Limit to pH achievable (8.5-9.0) largely eliminates potential problems at WWTP • High proportion of hydroxide in solution • May tie up some sulfide as MgS or magnesium polysulfide	• Requires wastewater flows of 2 ft/sec to keep insoluble slurry in suspension • Preparation and handling involves use of tank mixers • Potential for re-release of H_2S since it does not react with sulfide • Achievable pH does not totally suppress H_2S

GAS PHASE ODOR CONTROL TECHNOLOGIES

Often, it is not possible to achieve total control of gas phase H_2S by controlling the liquid phase sulfide concentration. Gas phase treatment of foul air may be used to prevent emission of odorous and toxic gases to the atmosphere and for minimizing impact to critical receptors such as local residents or businesses. Foul air treatment may also be needed if foul air is withdrawn from process areas. Several factors such as regulatory requirements, concentrations of various compounds in the foul air, and impact to residents will determine if treatment is necessary.

Several of the available alternatives can be implemented at the RWQCP, however, the choice will hinge upon space constraints, cost, and other factors. Carbon adsorption is a very popular method used by several agencies for foul air treatment. This method offers great versatility and is capable of handling variations in air flow and concentration very well. Other treatment methods such as chemical and mist scrubbers, bioscrubbers, and biofilters are also available. In addition, atmospheric dispersion of foul air without treatment may also be a viable option subject to approval from the local or regional regulatory agency. Each option listed above is discussed in greater detail in the sections below.

Carbon Adsorbers

Carbon adsorbers have been used for several decades for treating foul air. Adsorption is a process during which compounds are bound to the surface of the carbon medium. This process is physical in nature, and is similar to the interaction between dust and an electrostatic duster. The choice of activated carbon media depends on the nature of the foul air to be treated. The various types of carbon media available are virgin activated carbon, caustic impregnated carbon, catalytic carbon and other vapor phase carbons.

Virgin Activated Carbon. This medium is prepared by heating carbonaceous material such as coconut shells in the absence of oxygen, resulting in a porous structure. Virgin activated carbon has no additives to improve its adsorption capacity or to render it more effective. It therefore has a slightly reduced H_2S adsorption capacity compared with other carbon media. The H_2S capacity of virgin activated carbon varies between 0.01 and 0.02 grams per cubic centimeter (g/cc). The disadvantages of virgin carbon include the low H_2S removal capacity, and possibility of low media pH at the end of the useful life.

Caustic Impregnated Carbon. As the name implies, this type of carbon medium consists of activated carbon medium impregnated with caustic soda. Addition of a strong base to the carbon medium improves the H_2S capacity of the medium significantly. The typical H_2S capacity of impregnated carbon ranges from 0.10 to 0.15 g/cc. However, the adsorption capacity of other compounds such as VOCs is reduced. The primary disadvantage of impregnated carbons is their relatively low ignition temperature (approximately 200^0 C). In addition, the H_2S adsorption process

that is exothermic creates a hazardous condition by supplying heat to a readily ignited medium. Calgon Carbon's Sulfusorb and IVP carbon and Barneby-Sutcliffe's STI-X carbon are examples of impregnated carbon media.

Catalytic Carbon. This medium contains catalytic agents to improve the H_2S adsorption capacity of virgin activated carbon. The catalytic agent converts the H_2S to sulfuric acid (H_2SO_4), which can subsequently be washed out with water to regenerate the carbon. A small portion (< 5%) of the H_2S is converted to elemental solid sulfur, and reduces the H_2S capacity of the carbon by blocking pores in the media. Adsorption of VOCs over time also reduces the number of pore sites available and thus reduces the H_2S capacity of the carbon.

The carbon can be regenerated by washing with water. The low pH rinsate may be neutralized with lime or disposed into a sanitary sewer. Regenerated carbon usually loses 20% of the original capacity during the first regeneration cycle and approximately 5% of the original capacity on subsequent cycles. An example of such a medium is Calgon Carbon Corporation's Centaur HSV. The main disadvantage of these media is the low pH at the end of useful life, which requires the media to be neutralized with lime before disposal to a landfill. In addition, the regeneration cycle can be time intensive and can require several days during which the carbon vessels are taken out of service.

Other Vapor Phase Carbons. Recently, U.S. Filter Westates has developed a new carbon product named Midas OCM. The treatment principle of this medium is different from other carbon media. The H_2S in the foul air is converted to elemental sulfur, and therefore does not lower pH of the medium. Therefore, the medium may be handled as non-hazardous material at the end of its useful life, unlike other carbon products. Midas OCM has a high H_2S capacity of approximately 0.30 g/cc.

Chemical and Mist Scrubbers

Foul air treatment using chemical scrubbers has been the traditional method of choice at large municipal facilities such as wastewater treatment plants and large pump stations. The foul air to be treated is scrubbed in a packed tower using appropriate chemical solutions. Caustic soda is commonly used for scrubbing H_2S laden foul air, and VOCs are removed by scrubbing with an oxidizing solution consisting of a mixture of caustic soda and sodium hypochlorite.

Treatment efficiency depends on the contact between foul air and the scrubbing solution, so a packing medium with a high surface area to volume ratio (up to 30 ft^2/ft^3 of packing) is chosen. Since maximum transfer of compounds from air to liquid usually occurs with countercurrent flow, this mode is normally used in packed tower scrubbers. The foul air is introduced at the bottom of the tower and the scrubbing solution is distributed from the top of the tower. Uniform distribution of both gas and liquid may be ensured by using gas and

liquid distributors as needed. The typical empty bed retention time (EBRT) of foul air in the packed tower is 2 seconds.

The treated air exits at the top of the tower after passing through a mist eliminator to remove entrained liquid particles. The scrubbing solution is collected in a reservoir at the bottom of the tower and transferred back to the top using a recirculation pump. A portion of the scrubbing solution is periodically blown down from the reservoir, and make up water and chemical are added as required. While chemical scrubber systems are usually well suited to large installations requiring custom fabrication and installation of packed towers, package systems are also available from U.S. Filter. Such package systems have air flow capacities ranging from 1,000 cfm to 25,000 cfm.

Mist scrubbers are very similar to chemical scrubbers and provide foul air treatment by contacting it with a large liquid surface area. While chemical scrubbers use large surface area packing material to achieve this goal, mist scrubbers use a fine mist of liquid to maximize liquid surface area. The typical foul air detention time in mist scrubbers is between 1 and 10 seconds. Chemical and mist scrubber systems can provide high H_2S and VOC removal efficiencies (greater than 99%), but their primary disadvantage is that they require storage and use of hazardous chemicals. This disadvantage can be eliminated by using bioscrubbers, which are discussed in the following section.

Bioscrubbers

One emerging technology for treating foul air is bioscrubbers, also known as biotrickling filters or biotowers. Bioscrubbers are similar in construction to chemical scrubbers, but do not require hazardous chemicals for operation. A bioscrubber usually consists of a tower filled with an inert packing media such as polyurethane foam that acts as a substrate for growing microbial populations. Structural supports are provided at the bottom of the tower to support the packing media and optionally at the intermediate portion of the tower to prevent bed compaction. Bioscrubbers also include mist eliminators, inlet and outlet dampers, liquid recirculation pumps, and liquid distribution systems or spray nozzles.

Foul air enters the bioscrubber at the lower end of the tower, undergoes treatment, and is either discharged to the atmosphere or to secondary treatment processes. The microbial colonies can be initiated by recirculating secondary effluent from a wastewater treatment plant through the bioscrubber without foul air input for 24-hours. During normal operation, the recirculation stream provides moisture and nutrients to the microbial cultures, carries away byproducts, and regulates the operating temperature. If pH control is desired, it may be achieved by adding lime or diluted caustic solution to the recirculation stream.

In order to achieve a high treatment efficiency, the EBRT of the foul air is typically maintained above 15 seconds. A higher EBRT allows greater time for foul air to contact the recirculating liquid and the microbial growth in the packing media, thus improving mass transfer. If the foul air characteristics do not change significantly over prolonged durations,

microbial cultures acclimated to these foul air characteristics will experience preferential growth, improving bioscrubber efficiency over time. The Orange County Sanitation District (OCSD) conducted a pilot test for retrofitting existing chemical scrubbers to bioscrubbers. The pilot test showed that good removal of H_2S (between 95 and 99%) was possible at inlet concentrations between 3 and 30 ppmv. The removal efficiencies of VOCs and other reduced sulfur compounds ranged from 0 to 80%. The main disadvantage of bioscrubbers is that the technology is relatively new and unproven, with very few currently operational installations.

Biofilters

Another biological treatment option is a biofilter, which consists of an organic medium such as granular activated carbon (GAC), yard waste compost (YWC) or proprietary media. Foul air to be treated is introduced into a vessel containing the biological medium and moisture is supplied by irrigating the biofilter from the top. While biofilters have been used for odor control and foul air treatment for a long time, their popularity has increased recently due to regulatory issues, economic benefits and availability of engineered modular and package systems from various vendors.

Atmospheric Dispersion

Covering and ventilating process equipment will generate foul air bearing reduced sulfur compounds (RSCs) and other odorous compounds. Discharge of these compounds to the atmosphere may be regulated by the local air pollution control agency. However, in the absence of regulatory requirements, when impact to critical receptors such as local residents is the only concern, atmospheric dispersion of foul air may be sufficient. Dispersion is achieved by discharging the foul air through a stack. As the discharged exhaust air travels from the stack to receptors, it mixes with ambient air and is thus diluted. The stack is designed to maximize mixing of exhaust air with the ambient air by selecting the appropriate stack location, height and exit gas velocity. Atmospheric or odor dispersion modeling can be performed for predicting the concentration of odorous compounds at downwind locations and for proving that sufficient dilution will occur.

Emerging Technologies

A new and emerging technology that shows promise is a foul air treatment that produces hydroxyl (OH^-) radicals to react with H_2S and other malodorous compounds. Vapex Inc. manufactures these units. The treatment principle relies on quick acting OH^- radicals to neutralize H_2S molecules. The OH^- radicals are generated by mixing water and air with ozone, which is produced onsite by the Vapex unit. The water is atomized into a fine mist and introduced into the headspace that requires treatment. The air and ozone are introduced just upstream of the atomizer nozzle, and OH^- radicals are produced before the mist enters the headspace.

Since both ozone and OH^- radicals have very short half lives, they are quickly consumed. The treated air may contain small quantities of ozone and OH^- radicals. The treated air is

passed through chlorine tablets prior to discharge to react with the excess ozone. The Vapex unit is especially advantageous for pump stations since it provides local odor control, utilizes a minimal amount of floor space and provides economical service. Data from certain installations have indicated good removal of H_2S at concentrations of 10 ppmv or less, but were inconclusive in proving removal effectiveness at higher H_2S concentrations.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 5: AIR QUALITY AND EMISSIONS CONTROL
CHAPTER 2: REVIEW OF APPLICABLE REGULATORY REQUIREMENTS

FINAL
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REVIEW OF APPLICABLE REGULATORY REQUIREMENTS

2.1 PURPOSE

The purpose of this chapter is to review applicable regulatory requirements and describe how they can influence air quality planning for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP). The following procedure was followed in determining applicable regulatory requirements:

- Identification of existing and future air emission sources and air emission control facilities.
- Identification of emitted pollutants and quantification of emissions.
- Identification of applicable regulatory requirements.
- Determination of the methods to achieve compliance.

2.2 EXISTING AIR EMISSION SOURCES AND AIR EMISSION CONTROL FACILITIES

A list of the existing air emission sources and air emission control facilities is as follows:

- Wastewater treatment and solids handling facilities. Complete descriptions of existing wastewater treatment facilities can be found in Volume 4, Chapter 1 - Existing Facilities. Complete descriptions of existing solids facilities can be found in Volume 8, Chapter 1 - Existing Facilities.
- The in-ground Headworks Biofilter. The biofilter media consists of bark, soil, compost, sand, scoria, and lime. The biofilter treats foul air from the Headworks channels, screw conveyors, and bin room.
- A carbon adsorber for digester gas, containing at least 400 lbs of granular activated carbon.
- A digester/natural gas compression, blending, and treatment system, consisting of: gas compressors; gas dryers; a gas mixer; a gas surge tank; and a blended gas storage tank.
- A standby 24 million BTU per hour (MMBTU/hr) digester/natural gas-fired flare, with a maximum allowable gas-burning rate of 667 cubic feet per minute.
- Three cogeneration systems (Cogeneration Systems Nos. 1 through 3), each consisting of a digester/natural gas-fueled 1,599-hp internal combustion engine and a 1.1-MW electric generator.

- Two standby 4.2 MMBTU/hr digester/natural gas-fired boilers with low Nitrogen Oxide (NO_x) burners and flue gas recirculation.
- Two non-road portable internal combustion engines diesel-fueled and rated at 71 break horsepower (bhp).
- A resident portable internal combustion engine, diesel fueled and rated at 71 bhp, equipped with 4-degree timing retard.
- A resident portable internal combustion engine, diesel fueled and rated at 102 bhp, equipped with turbocharger. Engine operation is restricted to 8,111 hours per year.
- A resident portable internal combustion engine, diesel fueled and rated at 368 bhp, equipped with turbocharger and aftercooler. Engine operation is restricted to 4,868 hours per year.
- A fuel storage and dispensing facility, consisting of a 2,000-gallon aboveground dual-compartment gasoline/diesel storage tank, a gasoline-dispensing nozzle, and a diesel-dispensing nozzle.

2.3 PROPOSED AIR EMISSION SOURCES AND AIR EMISSION CONTROL FACILITES

The following proposed facilities are potential sources of regulated air pollutants. These facilities are discussed in detail in other volumes of the Master Plan.

- New headworks facility and biofilter (Volume 4, Chapter 5 - Preliminary Treatment).
- New primary clarifiers and biofilters for all primary clarifiers (Volume 4, Chapter 6 - Primary Treatment).
- Membrane Bioreactor (MBR) facility (Volume 4, Chapter 7 - Secondary Treatment).
- New primary effluent equalization basins (Volume 4, Chapter 12 - Primary Effluent Equalization).
- New solids thickening facilities (Volume 8, Chapter 4 - Solids Production and Thickening Options).
- New fuel cells to produce electricity from digester and/or natural gas (Volume 9, Chapter 5 - Power Supply Alternatives).
- New solids dewatering centrifuges (Volume 8, Chapter 6 - Solids Dewatering).

2.4 EMITTED AIR POLLUTANTS AND ANNUAL EMISSIONS SUMMARY

Table 2.1 presents a summary of the most recent Annual Emissions Report (AER) submitted to the South Coast Air Quality Management District (SCAQMD). The table contains air pollutants other than Toxic Air Contaminants (TAC) and Ozone Depleting Compounds (ODC). Emissions of the latter are reported in Table A.1 of Appendix A.

Table 2.1 Summary of 2005-2006 Emissions for Select Air Pollutants[(1)(2)] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Air Pollutant	Annual Plant Emissions (tons)
Organic Gases	4.80
Methane	0.09
NO_x	5.65
Sulfur Oxides	0.97
Carbon Monoxide	18.9
Particulate Matter	0.45

Notes:
(1) Based on the 2005-2006 AER.
(2) A summary of the 2005-2006 emissions TAC and ODC is presented in Appendix A.

2.5 REVIEW OF APPLICABLE SCAQMD REGULATIONS

The SCAQMD has jurisdiction over air quality programs in Riverside County, where the RWQCP is located. The following paragraphs provide a review of applicable SCAQMD air quality regulations and rules.

2.5.1 SCAQMD Regulation II: Permits

2.5.1.1 Rule 201: Permit to Construct

According to Rule 201, a facility must not build, install, alter, or replace any equipment emitting air pollutants or controlling emissions of air pollutants without first obtaining a Permit to Construct from the SCAQMD. A Permit to Construct remains in effect until a Permit to Operate is granted or denied, or the application for the Permit to Construct is cancelled. The supporting information required with an application for a Permit to Construct is described in detail in Regulation II of the SCAQMD.

2.5.1.2 Rule 203: Permit to Operate

In connection to Rule 201, Rule 203 states that a facility must not operate or use any equipment emitting air pollutants or controlling emissions of air pollutants without first obtaining a Permit to Operate from the SCAQMD. The equipment must be operated according to the conditions specified in the Permit to Operate.

2.5.1.3 Rule 219: Equipment Not Requiring a Written Permit Pursuant to Regulation II

Pieces of equipment included in Rule 219, unless exempted, do not require written permits. Among others, they include:

- Mobile equipment (e.g., motor vehicles).
- Piston-type internal combustion engines with a rating of 50 bhp or less.
- Gas turbine engines with a maximum heat input rate of 2.975 MMBTU/hr or less.
- Boilers, process heaters, and combustion equipment with a maximum heat input rate of less than 2.000 MMBTU/hr.
- Fuel cells using phosphoric acid, molten carbonate, proton exchange membrane, or solid oxide technologies.
- Modifications to structures and equipment, including maintenance, repairs, and identical replacement, that cannot change the quality, nature, or quantity of air contaminant emissions.
- Listed utility equipment, including: equipment used exclusively to generate ozone and associated ozone destruction equipment for water treatment processes; passive carbon adsorbers with a volume of 55 gallons or less, used exclusively for foul air odor control from sanitary sewer systems.

2.5.1.4 Implications of Regulation II for the RWQCP

Regulation II of the SCAQMD requires application for a Permit to Construct and a Permit to Operate with any RWQCP expansion or modification, unless Regulation II specifically exempts the activity.

2.5.2 SCAQMD Regulation IV: Prohibitions

2.5.2.1 Rule 402: Nuisance

Rule 402 prohibits the discharge of air pollutants or other material that can cause injury, detriment, nuisance, or annoyance to any considerable number of persons or to the public or have the potential to cause injury or damage to business or property.

2.5.2.2 Implications of Regulation IV for the RWQCP

Rule 402 applies to odor emissions from the RWQCP. To ensure compliance with this rule, the SCAQMD may require in the future that the RWQCP meet specific fenceline odorant

concentration goals. As discussed in the 2005 Odor Control Master Plan, these concentration goals are based on the frequency of complaints received by the surrounding community. For example, the SCAQMD has established a fenceline hydrogen sulfide concentration of 10 parts per billion by volume (ppbv) for the wastewater treatment plants of the Orange County Sanitation District. Compliance with such a requirement would require emission and dispersion modeling.

2.5.3 SCAQMD Regulation XI: Source Specific Standards

2.5.3.1 Rule 1110.2 and Proposed Amendments: Emissions from Gaseous- and Liquid-Fueled Engines

Rule 1110.2 applies to all stationary and portable engines over 50 bhp. It sets concentration limits for NO_x, Volatile Organic Compounds (VOCs), and Carbon Monoxide (CO) emissions.

SCAQMD proposed amendments to Rule 1110.2 in January 2007. The proposed concentration limits for stationary engines fired by 90 percent or more of landfill or digester gas, based on the annual heat input of the fuels are presented in Table 2.2. The proposed stringent concentration limits in Table 2.2 do not apply to stationary engines used exclusively in standby mode.

Table 2.2 Proposed Concentration Limits for Digester Gas-Fired Engines Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Air Pollutant	Corrected Average Concentration (ppm)
Proposed Concentration Limits Effective before July 1, 2012	
NO_x	bhp ≥ 500: 36 x ECF(1) bhp < 500: 45 x ECF(1)
VOC	250 x ECF(1)
CO	2,000
Proposed Concentration Limits Effective July 1, 2012	
NO_x	11
VOC	30
CO	70

Notes:
(1) ECF is the efficiency correction factor. Its value is typically 1.0.

The proposed concentration limits possibly apply to the three internal combustion engines of the cogeneration facility. To comply with the proposed limits, the RWQCP can either shut down the engines or convert them to standby; or retrofit the engines with fuel conditioning systems, Selective Catalytic Reduction (SCR) systems and CO catalysts. Installation of fuel cells that use digester/natural gas can allow conversion of the cogeneration engines to standby.

The amended Rule1110.2 also proposes that the operator of any portable diesel engine complies with the applicable requirements of the Airborne Toxic Control Measure for Diesel Particulate Matter from Portable Engines Rated at 50 Horsepower and Greater, Sections 93116 through 93116.5 of Title 17 of the California Code of Regulations. These specific sections and their implications are discussed below.

2.5.3.2 SCAQMD Rule 1179: Publicly Owned Treatment Works Operations

Rule 1179 applies to all existing Publicly Owned Treatment Works (POTWs). For large-capacity POTWs, i.e., those with a design capacity of 10 mgd or greater, the rule requires submission of an Emissions Inventory Plan for quantification and reporting of VOC and odor emissions through 2010. Although such plans and inventories have been completed in the past for the RWQCP, an amendment to Rule 1179 would possibly require updates to the Emissions Inventory Plan and the emissions projections beyond 2010.

2.5.4 SCAQMD Regulation XIII: New Source Review

This regulation defines pre-construction review requirements for new, modified, or relocated facilities, to ensure that operation of such facilities will not interfere with progress in attainment of the National Ambient Air Quality Standards (NAAQS), including state ambient air quality standards. The goal of this regulation is to achieve no net emission increases from new or modified permitted sources of nonattainment air contaminants or their precursors. In addition, this regulation limits emission increases of ammonia and ODCs from new, modified or relocated facilities by requiring the use of Best Available Control Technologies (BACT).

2.5.4.1 Rule 1302: Definitions

The following definitions are useful in understanding the New Source Review rules that affect air quality planning at the RWQCP.

- BACT is the most stringent emission limitation or control technique which: has been achieved in practice for such category or class of source; or is contained in any State Implementation Plan (SIP) approved by the U.S. EPA for such category or class of source; or is found by the SCAQMD to be technologically feasible for such category or class of source, and cost-effective.
- MAJOR POLLUTING FACILITY means any facility located in the South Coast Air Basin (SOCAB) that emits or has the potential to emit the following amounts or more:
  - VOC: 10 tons per year.
  - NO_x: 10 tons per year.
  - Sulfur oxides (SO_x): 100 tons per year.
  - Particulate matter (PM_{10}): 50 tons per year.
  - CO: 70 tons per year.

- MODIFICATION involves any physical change in equipment, change in method of operation, or an addition to an existing facility, which may cause emission of air pollutants. Routine maintenance and/or repair are not considered a physical change.
- ODCs are Class I substances identified in 40 CFR, Part 82, Appendix A, Subpart A, including, but not limited to the following compounds:
  - 1,1,1-Trichloroethane (methyl chloroform).
  - Trichlorofluoromethane (CFC-11).
  - Dichlorodifluoromethane (CFC-12).
  - 1,1,2-Trichloro-1,2,2,-trifluoroethane (CFC-113).
  - 1,2-Dichloro-1,1,2,2-tetrafluoroethane (CFC-114).
  - Chloropentafluoroethane (CFC-115).
- POTENTIAL TO EMIT means the estimate for the amount of air pollutants emitted from a source based on the source maximum rated capacity and the maximum daily hours of operation. The Potential to Emit includes fugitive emissions.
- PRECURSORS to secondary air pollutants include VOCs, NO_x, and SO_x.

2.5.4.2 Rule 1303: Requirements

According to Rule 1303, SCAQMD will deny a Permit to Construct for construction or modification of a source that results in an emission increase of any nonattainment air contaminant unless use of BACT is demonstrated. A modified source is exempted from this requirement when the sole purpose of the modification is to reduce emissions of air pollutants. Also, a new or modified source is exempted if its potential to emit is less than the following amounts:

- VOC: 4 tons per year.
- NO_x: 4 tons per year.
- SO_x: 4 tons per year.
- PM_{10}: 4 tons per year.
- CO: 29 tons per year.

2.5.4.3 Implications of Regulation XIII for the RWQCP

The RWQCP is considered a major polluting facility for the purposes of Regulation XIII. There are no specific BACT requirements for major polluting facilities and the requirements are determined on a case-by-case basis at the time of the application for a Permit to Construct.

2.5.5 SCAQMD Regulation XIV: Toxics and Other Non-Criteria Pollutants

2.5.5.1 Rule 1401: New Source Review of Toxic Air Contaminants

Rule 1401 specifies limits for Maximum Individual Cancer Risk (MICR), cancer burden, and non-cancer acute and chronic Hazard Index (HI) from new permit units, relocations, or modifications to existing permit units emitting toxic air contaminants. The rule also applies to new, relocated, and modified equipment not requiring a written permit, if the risk from the equipment will be greater than identified below. Within a POTW facility, each process within multi-process permit units is considered a separate permit unit for purposes of this rule.

The requirements of this rule include:

- Risk assessment based on published procedures by the SCAQMD.
- An increase in sum MICR (for all carcinogens) no greater than one in a million (1.0×10^{-6}) at any receptor location, if the permit unit is constructed without TBACT (BACT for toxics); an increase in sum MICR (for all carcinogens) no greater than ten in one million (1.0×10^{-5}) at any receptor location, if the permit unit is constructed with TBACT; and a cancer burden no greater than 0.5.
- A cumulative increase in total chronic HI for any target organ system of no greater than 1.0 at any receptor location.
- The Potential to Emit is used for the purpose of estimating MICR and cancer burden.

The above requirements do not apply in the following cases:

- Permit renewal.
- Unit modification with no increase in risk.
- Functionally identical replacement.
- Emergency internal combustion engines.
- Gasoline transfer and dispensing facilities.

2.5.5.2 Implications of Regulation XIII for the RWQCP

A risk assessment study will likely be required with an application for a Permit to Construct for expansion facilities at the RWQCP. Coordination with the SCAQMD will be required at the time of application to define the scope and extent of the risk assessment study.

2.5.6 SCAQMD Regulation XXX: Title V Permits

The Title V Permit is the air pollution control permit system required to implement the federal Operating Permit Program as mandated by Title V of the federal Clean Air Act (CAA).

2.5.6.1 Rule 3001: Applicability

According to Rule 3001, facilities with the potential to emit equal to or exceeding the threshold amounts shown below must submit an application to SCAQMD for an initial Title V Permit.

- VOC: 10 tons per year.
- NO_x: 10 tons per year.
- SO_x: 100 tons per year.
- CO: 50 tons per year.
- PM_{10}: 70 tons per year.
- A single Hazardous Air Pollutant (HAP): 10 tons per year.
- Combination of HAPs: 25 tons per year.

Facilities demonstrating to SCAQMD that their potential to emit has been reduced, either through a facility modification or by accepting an enforceable condition in the District facility permit, to less than the thresholds presented above, are exempted from Title V permit requirements. Unless renewed, a Title V Permit expires five years from the date of issuance.

2.5.6.2 Rule 3004: Permit Types and Content

Rule 3004 describes the contents of a Title V Permit. Among others, a permit includes:

- Emissions limitations and operational requirements that assure compliance with all regulatory requirements at the time of permit issuance.
- The origin and authority of each permit term or condition.
- Monitoring, recordkeeping, and reporting requirements.
- Provisions for alternative operating scenarios consistent with regulatory requirements.
- If requested by the applicant, terms and conditions for trading of emissions increases and decreases, provided that regulatory requirements allow such trading.
- Compliance requirements, including: compliance certification, testing, monitoring, reporting, and recordkeeping requirements; inspection requirements; progress reports.

The rule also describes the Permit Shield provision. If requested by the applicant, SCAQMD may expressly include in a Title V permit, a provision stating that compliance with the conditions of the permit is considered compliance with any regulatory requirements as of the date of issuance.

2.5.6.3 Implications of Regulation XXX for the RWQCP

The RWQCP submitted a Title V Permit application to the SCAQMD in November 2001. The application was triggered by the Potential to Emit exceeding 10 tons per year for NO_x and VOCs, and 50 tons per year for CO, due to the engines of the cogeneration facility. As of June 2007, SCAQMD has not issued a Title V Permit for the RWQCP. A Permit Shield was requested for the three internal combustion engines of the cogeneration facility. If the RWQCP demonstrates to SCAQMD that its potential to emit has been reduced to less than the thresholds presented above (e.g., through the installation of fuel cells and conversion of the cogeneration engines to standby) there will be no obligation for a Title V renewal.

2.5.7 SCAQMD Best Available Control Technology Guidelines

As discussed above, the SCAQMD Regulation XIII: New Source Review requires applicants to use BACT for new, relocated, and modified sources that may result in an emission increase of any nonattainment air contaminant, ODC, or ammonia.

BACT standards apply to both major and non-major polluting facilities. Major polluting facilities, such as the RWQCP, are required by the Clean Air Act to exhibit the Lowest Achievable Emission Rate (LAER). LAER is determined at the time a permit is issued. SCAQMD staff determines LAER requirements on a permit-by-permit basis. In essence, LAER is the most stringent emission limit or control technology that is:

- Found in a SIP.
- Achieved in Practice (AIP).
- Technologically feasible and cost effective.

For practical purposes, nearly all SCAQMD LAER determinations are based on the AIP criterion because it is generally more stringent than the SIP criterion, and because state law constrains use of the third criterion.

An emission limit or control technology may be considered as AIP for a source category or class if it exists in any BACT or LAER guideline document or clearinghouse issued by the U.S. EPA or any of the states or air quality districts. A control technology or emission limit may also be considered as AIP if it meets all of the following criteria:

- Commercial availability: At least one vendor offers the equipment in the United States.
- Reliability: All control technologies have been installed and operated reliably for at least 6 months.
- Effectiveness: The equipment is verified to perform effectively over the range of operation expected for that type of equipment.

2.6 REVIEW OF APPLICABLE CARB REGULATIONS

2.6.1 California Code of Regulations, Title 17, Section 93116: Airborne Toxic Control Measure for Diesel Particulate Matter from Portable Engines Rated at 50 Horsepower and Greater

The purpose of this Airborne Toxic Control Measure (ATCM) is to reduce diesel Particulate Matter (PM) emissions from portable diesel-fueled engines.

2.6.1.1 Section 93116.1: Applicability

The regulation applies to portable diesel-fueled engines with rated brake horsepower of 50 and greater (> 50 bhp). The regulation does not apply to portable engines using alternative fuels.

2.6.1.2 Section 93116.2: Definitions

The following definitions are useful in understanding the implications of Section 93116 for air quality planning at the RWQCP.

ALTERNATIVE FUEL means gasoline, natural gas, propane, Liquid Petroleum Gas (LPG), hydrogen, ethanol, or methanol.

EMERGENCY means any of the following situations or conditions:

- Failure of all or part of normal electrical power service or natural gas supply to the facility.
- Failure of an internal power distribution system.
- Pumping of water or sewage to prevent or mitigate a flood or sewage overflow.
- Pumping of water for fire suppression or protection.
- Pumping of water to maintain pressure in the water distribution system.
- Breakdown of electric-powered pumping equipment at sewage treatment facilities or water delivery facilities.
- Training of personnel in the use of portable equipment for emergency purposes.

FLEET refers to a portable engine or group of portable engines that are owned and managed by an individual operational entity.

LEVEL-3 VERIFIED TECHNOLOGY means a technology that has demonstrated a reduction in diesel particulate matter of 85 percent or greater.

LOW-USE ENGINES refers to portable diesel-fueled engines that operate 80 hours or less in a calendar year.

SCR SYSTEM refers to an air pollution emissions control system that reduces NO_x emissions through the catalytic reduction of NO_x by injecting nitrogen-containing compounds into the exhaust stream, such as ammonia or urea.

TIER 4 EMISSION STANDARDS refers to the final emission standards adopted by the U.S. EPA for newly manufactured non-road engines.

2.6.1.3 Section 93116.2: Requirements

Owners of portable diesel-fueled engines used exclusively in emergency applications or as low-use engines must satisfy one of the following requirements by January 1, 2020:

- Replace portable diesel-fueled engines with engines certified to meet Tier 4 emission standards.
- Equip existing portable diesel-fueled engines with properly functioning level-3 verified technologies.
- Equip existing portable diesel-fueled engines with a combination of verified emission control strategies that have been verified together to achieve at least 85 percent reduction in diesel PM emissions.

Apart from equipment requirements, specific PM emission rate requirements apply to portable diesel-fueled engines. For engines less than 175 bhp, the following weighted fleet average PM emissions must be met: 0.30 g/bhp-hr by January 1, 2013; 0.18 g/bhp-hr by January 1, 2017; 0.04 g/bhp-hr by January 1, 2020. For engines equal to or greater than 175 bhp but less than 750 bhp, the following weighted fleet average PM emissions must be met: 0.15 g/bhp-hr by January 1, 2013; 0.08 g/bhp-hr by January 1, 2017; 0.02 g/bhp-hr by January 1, 2020. Incentives to meet fleet average emissions include use of alternative fuels and addition of Tier 4 non-road engines prior to January 1, 2015.

The above emission requirements do not apply to portable diesel-fueled engines used in emergency applications or as low-use engines that do not exceed the allowed hours of operation in a calendar year. In addition, the emission requirements do not apply to engines equipped with properly operating SCR systems. Finally, changes in the fleet, including engine additions or deletions, cannot result in noncompliance with the above emission limits.

2.6.1.4 Implications of California Regulation Title 17, Section 93116

Title 17, Section 93116 applies to all five portable diesel-fueled engines in the RWQCP. The specific requirements for the five engines are explicitly described in the Statewide Portable Equipment document issue for each engine by the California Air Resources Board (CARB).

2.7 REVIEW OF CALIFORNIA ASSEMBLY BILL 32 (AB 32 – GLOBAL WARMING SOLUTIONS ACT OF 2006) AND RELATED REGULATIONS

California initiated the first regulatory program in the U.S. with the objective of reducing Greenhouse Gas (GHG) emissions. The following paragraphs discuss the bill and related regulations, as well as their potential impacts on air quality planning on POTWs.

On a national level, the U.S. Supreme Court ruled on April 2, 2007 that GHGs qualify as air pollutants under the Clean Air Act. While the rule was specific to the authority of U.S. EPA to regulate emissions from new motor vehicles, it opens the door for federal lawsuits and statewide regulations regarding GHG emissions from other sources, including POTWs.

2.7.1 AB 32 - Global Warming Solutions Act of 2006

California Assembly Bill 32 (AB 32), also known as the Global Warming Solutions Act of 2006, creates a comprehensive, multi-year program to reduce GHG emissions in California, with the overall goal of restoring emissions to 1990 levels by the year 2020. AB 32 targets the following six GHGs:

- Non-biogenic carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous oxide (N_2O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulfur hexafluoride (SF_6).

Under AB 32, the CARB has the primary responsibility for reducing GHG emissions. Table 2.3 provides a summary of actions CARB will take to meet the objectives of AB 32.

Table 2.3 AB 32 Implementation Schedule
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Date	Action
June 30, 2007	CARB publishes a list of early-action reduction measures for GHG emissions.
January 1, 2008	CARB adopts GHG monitoring and reporting regulations.
January 1, 2009	CARB approves plan to achieve the maximum technologically feasible and cost-effective reductions in GHG emissions by 2020.
January 1, 2010	CARB adopts regulations to implement early-action reduction measures for GHG emissions.

Table 2.3 AB 32 Implementation Schedule Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Date	**Action**
January 1, 2011	CARB adopts GHG emission limits and reduction measures to become operative on January 1, 2012. CARB may also establish a system of market-based declining annual aggregate emission limits for GHGs applicable from January 1, 2012 to December 31, 2020.
January 1, 2012	Adopted GHG emission limits and reduction measures become operative. Adopted market-based system becomes operative.
December 31, 2020	Statewide GHG emission levels become equivalent to 1990 levels.

2.7.1.1 California Climate Action Registry

The California Climate Action Registry (Registry) is a non-profit entity in charge of tracking voluntary reporting of GHG emissions. The Registry publishes the General Reporting Protocol that provides guidance for the estimation and reporting of GHG emissions. The Registry also offers the Climate Action Registry Reporting Online Tool (CARROT), an electronic protocol that facilitates estimation and reporting of GHG emissions. There are early indications that CARB will either adopt CARROT for mandatory reporting or will incorporate it into a statewide system.

At a minimum, participants in the Registry must report at least 95 percent of their entity-wide emissions for each of the following categories:

- Direct emissions from mobile source combustion (transportation).
- Direct emissions from stationary combustion.
- Indirect emissions from electricity use and imported steam, heating, and cooling.
- Direct process emissions.
- Direct fugitive emissions (e.g., N_2O and CH_4 emissions from wastewater).

For the first three years after joining the Registry, participants must report at a minimum their CO_2 emissions. Starting with the fourth year, participants must report emissions for all six GHGs. A Registry-approved third party must certify the reported emission estimates. Participants must pay all expenses for the third party evaluation and certification, as well as a size-scaled annual Registry Fee ranging from $400 to $4,000. Use of the CARROT is free.

The Registry notes four key benefits to early voluntary GHG emissions reporting:

- Detection of process inefficiencies through emissions monitoring.
- Preparedness for new regulations on GHG emissions.
- Being in a position to help shape policy.
- Gaining credit for GHG emission reductions.

In 2005, 48 entities voluntarily reported GHG emissions including four POTWs: East Bay Municipal Utilities Department, the City of Palo Alto, the Los Angeles Department of Water and Power, and the San Francisco Public Utilities Commission.

2.7.1.2 California Statewide POTW Steering Committee

California Statewide POTW Steering Committee (Committee) is a statewide group of POTWs established in response to AB 32. The Bay Area Clean Water Agencies (BACWA) currently acts as the Committee coordinator. The Committee met for the first time in March 2007. The objectives of the Committee are to:

- Be a forum and go-to group for the wastewater industry.
- Work with agencies to develop wastewater specific emissions protocols and an industry strategy.
- Avoid duplication of efforts.

Membership to the Committee is open to any agency. There are currently two tiers of membership, loosely defined by the agency size and contribution amount. The annual membership fee is $10,000 for large agencies and $500 for small agencies. Small agencies have no voting rights.

2.7.1.3 Potential Implications of AB 32 and Related Regulations to the RWQCP

Potential implications of AB 32 for the RWQCP include:

- Reporting of GHG emissions, initially voluntary and later mandatory.
- Reduction of GHG emissions.
- A cap-and-trade program setting an overall emission cap and allowing flexibility in complying with the cap through trading and allocation schemes, such as auctioning credits, and/or offsets.
- Participation in Municipal Utility Energy Efficiency Programs to increase energy use efficiency and energy production from renewable sources (e.g., biogas, solar energy, and wind energy). These programs would be administered by the California Public Utilities Commission (CPUC) and could feature risk/reward incentive mechanisms.
- Increase in recycling requirements.

Appendix A
PLANT EMISSIONS OF TAC AND ODC

Table A.1 Summary of 2005-2006 Emissions for Toxic Air Contaminants (TAC) and Ozone Depleting Compounds (ODC)[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Air Pollutant[2]	**Annual Plant Emissions (lb)**
Benzene	15.2
1,3-Butadiene	3.97
Cadmium	0.02
Carbon Tetrachloride	0.15
Ethylene Dibromide	0.59
Ethylene Dichloride	0.10
Formaldehyde	827
Inorganic Arsenic	0.09
Lead	0.14
Methylene Chloride	1.40
Nickel	0.08
Perchloroethylene	1.94
Polycyclic Aromatic Hydrocarbons (PAHs)	3.09
Trichloroethylene	0.72
Vinyl Chloride	0.08
1,1,2,2-Tetrachloroethane	0.54
1,1,2-Trichloroethane (Vinyl Trichloride)	0.43
1,2,4-Trimethylbenzene	0.19
1,2-Dichloropropane	0.36
1,3-Dichloropropene	0.35
Acetaldehyde	118
Acrolein	70.0
Ammonia	581
Chloroform	279
Ethylbenzene	131
Hexane	17.7
Methanol	33.6
p-Dichlorobenzene	0.80

Table A.1 Summary of 2005-2006 Emissions for Toxic Air Contaminants (TAC) and Ozone Depleting Compounds (ODC)[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Air Pollutant[2]	**Annual Plant Emissions (lb)**
Selenium Compounds	0.44
Styrene	0.32
Toluene	68.4
Xylenes	6.84

Notes:
(1) Based on the 2005-2006 Annual Emissions Report provided by the RWQCP.
(2) The AER does not report emissions of hydrogen sulfide, a TAC.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 7: RECLAMATION AND REUSE
CHAPTER 1: RECLAMATION AND REUSE

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RECLAMATION AND REUSE

1.1 PURPOSE

The purpose of the reclamation and reuse volume is to review the information in the existing City of Riverside (City) Recycled Water Phase I Feasibility Study and Citywide Master Plan (Parsons, September 2003), present an update to the existing Master Plan regarding the planned recycled water pump station, and develop costs for the planned pump station that can be used in the overall Capital Improvement Plan (CIP) for the Integrated Master Plan. An order of magnitude dollar-per-acre-foot cost is also presented, but is only applicable to the costs (capital and Operations and Maintenance (O&M)) for the pump station, and not the full cost to deliver recycled water.

1.2 CONCLUSIONS AND RECOMMENDATIONS

- None of the information from the 2003 Master Plan is used in this volume of the Integrated Master Plan. This is due to the fact that the focus of the 2003 Master Plan was the customers and the distribution system in the City, and not the wastewater treatment plant facilities, which is the focus of this integrated plan.
- A dollar-per-acre-foot cost for installation and O&M of a new recycled water pump station was developed for this volume of the Integrated Master Plan. This cost ranges from approximately $106/acre-foot in 2007 to approximately $177/acre-foot in 2025.

1.3 BACKGROUND

In the fall of 2003, the City of Riverside Recycled Water Phase I Feasibility Study and Citywide Master Plan (Parsons, September 2003) was developed. This master plan includes eight chapters which cover a variety of topics including regulations, recycled water quality and quantity, a market analysis, layouts for various Citywide reuse systems, costs, potential funding sources, and recommendations. City staff agreed that the 2003 report was fairly recent and therefore a new reuse market assessment was not undertaken. The 2003 Master Plan is included in Appendix A for reference.

There are currently three recycled water pump stations at the Regional Water Quality Control Plant (RWQCP). The main pump station is located adjacent to Chlorine Contact Basin (CCB) 1. This pump station supplies recycled water to the Van Buren Golf Course. It is also the source for on-site uses (i.e. utility water) for the RWQCP. The on-site uses are described in Volume 4, Chapter 11 - Plant Utilities and Support Facilities. A second pump station is located adjacent to CCB 3. This pump station supplies recycled water to the Urban Forest. The third pump station is located adjacent to the RWQCP outfall. It supplies water to the Toro Manufacturing Facility.

A new recycled water pump station is planned to be added at the end of CCB 2. This pump station will replace the first and second recycled water pump stations that are described above. The sizing of this pump station was developed using customer demand information provided by the City. The 2003 report was not used for demand information as the City staff has newer information on the expected customers.

1.4 EXISTING MASTER PLAN REPORT CONTENT SUMMARY

The 2003 Master Plan report covers a variety of planned projects and conditions as they were existing when the report was developed. However, as times change, so do conditions, and plans get revised. The following paragraphs describe some changed conditions to the 2003 report along with our understanding of the information to be used in this integrated plan.

Chapter 2, Recycled Water Regulations, lists some regulations and documents which have since been updated and revised. For example, the chapter refers to the 1992 U.S. EPA Guidelines for water recycling. The 2004 U.S. EPA Guidelines for Water Reuse updates the 1992 Guidelines by incorporating information on water reuse that has been developed since the 1992 document was issued. The draft water recycling and groundwater recharge regulations referenced are also outdated and the latest versions can be found electronically at http://www.dhs.ca.gov/ps/ddwem/publications/waterrecycling/index.htm. The Basin Plan referenced is also outdated and can be found electronically at http://www.swrcb.ca.gov/rwqcb8/html/basin_plan.html.

Chapter 3 of the reuse master plan summarizes the RWQCP water quality and quantity. These topics are being updated under other sections of this integrated plan. A process flow schematic is shown in the 2003 plan as Figure 3.1. This is slightly outdated as CCB 2 is shown on the diagram but is not in service at this time. CCB 2 is planned to be used to produce and store tertiary recycled water with the new planned pumps to be installed at the effluent end of the basin.

Chapter 4 of the reuse master plan discusses the current uses of recycled water including the Van Buren Golf Course, the Urban Forest, and the Toro Manufacturing Facility. This chapter also discusses the allowable uses under Title 22 and the customer market survey. Since the 2003 Master Plan was completed, these uses have been revised considerably. The uses considered at this time, and planned through 2025, include the Van Buren Golf Course, landscaping along Van Buren Boulevard, the Toro Manufacturing Facility, a proposed new golf course, and on-site uses such as for process demands and the power plant that is adjacent to the RWQCP. The assumed demands that will be used for this Integrated Master Plan, for both on-site and off-site uses, are shown in Section 1.4, Planned Recycled Water Pump Station Demands, of this chapter of the Integrated Master Plan.

Chapter 5 discusses the Citywide recycled water system, distribution system, hydraulic modeling, and distribution system costs. As mentioned above, only those demands identified in Section 1.4 of this volume of the Integrated Master Plan are currently being considered.

Chapter 6 details some options to a Phase I water recycling program and the various corresponding costs associated with each option.

Chapter 7 identifies potential funding sources. The funding sources include state and State Revolving Fund (SRF) grants/loans, the Bureau of Reclamation, General Obligation (GO) bonds, revenue bonds, and Certificates of Participation (COPs). Most of the funding sources listed are still available for planning or construction grants and/or loans, but may have slight changes to their programs. These should be considered closer to the time a loan or grant is needed. Also, Proposition 84 was recently passed in November 2006 and could be considered but its intricacies are not defined as of this time.

Chapter 8 briefly outlines the Citywide Phase I project and its implementation guidelines and recommendations.

1.5 PLANNED RECYCLED WATER PUMP STATION DEMANDS

A new recycled water pump station is planned to be constructed at the discharge end of CCB 2. The pump station will be used to supply the on-site and off-site demands for recycled water. The recycled water pump station demands and customers are summarized in Table 1.1. The average day demands were used to calculate the average cost per acre-foot while the peak hour demands were used to determine the pump size required. RWQCP staff supplied the customers and their corresponding demands. It is assumed that this is the demand to be supplied through the year 2025.

Table 1.1 Recycled Water Pump Station Demands
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Demand Quantity			
	Avg Day gpm	Avg Day ac-ft/yr	Peak Hr gpm	Peak Hr ac-ft/yr
Off-Site Demand				
Van Buren Golf Course				
Landscaping Along Van Buren Blvd				
Toro Manufacturing Company				
Proposed Golf Course				
Subtotal	64	103	1,733	2,796

Table 1.1 Recycled Water Pump Station Demands Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
		Demand Quantity			
Description		Avg Day gpm	Avg Day ac-ft/yr	Peak Hr gpm	Peak Hr ac-ft/yr
On-Site Demand(1)					
On-Site Processes(2)					
	Subtotal	2,610	4,211	2,750	4,437
	Total	**2,674**	**4,314**	**4,483**	**7,232**

Notes:
(1) Average day demand was assumed as the continuous demands provided by staff. Peak hour demand includes the intermittent demands.
(2) On-site processes include belt filter press wash water, pump seal water, alum dilution, chlorine injectors, scum sprays, wash down hydrants (1-inch and 3-inch), power plant, miscellaneous, and future gravity belt thickeners wash water.

1.5.1 Recycled Water Pump Station Design Considerations

The recycled water pump station design assumptions are summarized in Table 1.2. It was requested by RWQCP staff that the design include a cover over CCB 2 to help reduce chlorine demand and prevent wind-born trash from entering the basin. This cover can be made of concrete, aluminum, or fiberglass, but concrete is assumed for this evaluation. The pumps are assumed to be vertical turbine pumps, with a total of three provided, two duty and one standby. A Variable Frequency Drive (VFD) is assumed with each pump for operating efficiency. It is also assumed that some minor basin modifications will be required to assure even flow distribution to the pumps to achieve an optimum operating environment. A total head was assumed which considered the elevation of the RWQCP in relation to the elevation of the customers at the intersection of Van Buren Street and Arlington Street, while also maintaining adequate pressure to 'pop' the customer's sprinkler heads.

Table 1.2 Recycled Water Pump Station Design Assumptions Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Recycled Water Peak Hour Demand	4,483 gpm
Wastewater Treatment Plant Elevation	700 feet
Elevation at Intersection of Van Buren and Arlington	730 feet
Total Head	120 feet
Horsepower	200 hp total

Table 1.2 Recycled Water Pump Station Design Assumptions Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Pump Type	Vertical turbine
Pump Location	End of CCB 2
No. of Pumps	3 total (2 duty and 1 standby)

1.5.2 Recycled Water Pump Station Costs

Costs were developed for the recycled water pump station. These costs will be used in Volume 10, Capital Improvement Plan and Overall Implementation Schedule. Recycled water pump station cost assumptions are contained in Table 1.3. Many of the cost assumptions are from this Integrated Master Plan, Volume 2, Chapter 4 - Basis of Cost Estimates. However, some costs are also from RWQCP staff.

Table 1.3 Recycled Water Pump Station Cost Assumptions Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Power Cost	$0.09/kW-hr
Inflation Rate (Years 1-5)	6 percent
Inflation Rate (after Year 5)	4 percent
Life-Cycle Period	19 years
Annual Labor Rate Increase	3 percent
Annual Labor Effort	365 hrs/yr
Labor Cost	$50/hr
Discount Rate to Annualize Cash Flows	6 percent
Estimated Pump Station Capital Cost(1)	$900,000

Notes:
(1) Pump Station capital cost includes three pumps (two duty and one stand by), three VFDs, electrical, Instrumentation/Controls (I&C), minor basin modifications, installation, 500 feet of 12-inch diameter pipe, and a concrete basin cover.

Table 1.4 summarizes the total project cost for the recycled water pump station. This cost uses the direct cost mark-up percentages provided in Volume 2, Chapter 4 - Basis of Cost Estimates. The pump station capital cost is assumed to include three pumps (two duty and one standby) each with a VFD, electrical and I&C, minor basin modifications, installation of the pumps and equipment, a concrete basin cover, and 500 feet of 12-inch diameter piping. The added piping is assumed since the pump station is being relocated from CCB 3 to CCB 2.

Table 1.4 Recycled Water Pump Station Estimated Project Cost Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Description		**Value**
Total Estimated Direct Costs[(1)]		$900,000
Contingency @ 30%		270,000
	Subtotal	1,170,000
General Conditions @ 10%		117,000
	Subtotal	1,287,000
General Control Overhead/Profit @ 15%		193,050
	Subtotal	1,480,050
Bid Market Allowance @ 15%		222,008
	Subtotal	1,702,058
Engineering, Legal, Administrative @ 30%		510,617
Sales Tax @ 50% of Capital Cost X 7.75%		34,875
Total Project Cost		**$2,247,550**

Notes:
(1) Assumes and ENRCCI of 8570, August 2006, LA area. Cost includes three pumps, VFDs, electrical, I&C, 500 feet of 12-inch diameter pipe, and basin cover and modifications. No building or structure is assumed.

Table 1.5 summarizes the power costs, calculated horsepower, kilowatt-hours, and cost per kilowatt-hour.

Table 1.5 Recycled Water Pump Station Power Cost Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Average Annual Flow	2,674 gpm (2 duty + 1 standby)
Cost of Power	$0.09/kW-Hr[(1)]
TDH	120 feet
Pump Efficiency	75 percent
HP	108[(2)]
kW	81[(3)]

Table 1.5 Recycled Water Pump Station Power Cost Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
kW Hrs	706,040[4]
Annual Power Cost	**$63,544**

Notes:
(1) Data provided by City.
(2) Based on formula: HP = (gpm x TDH)/(3,960 x pump efficiency).
(3) Based on formula: kW = (HP x 0.746).
(4) Based on formula: kW-hrs = (kW x 24 x 365). Year-round operation is assumed.

Table 1.6 summarizes the O&M costs and the dollar-per-acre-foot cost for years 2007 through 2025. The dollar-per-acre-foot cost developed for this Integrated Master Plan only includes the costs associated with the new pump station capital and O&M costs.

Table 1.6 Recycled Water Pump Station Estimated Operation and Maintenance Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Year	Year	Escalation Rate	Exist O&M Cost	New PS O&M Cost	Add'l Labor Cost 365 hrs/yr@ $50/hr	Annualized Project Cost	Total Annual Cost	Discount Annual Cost	$/ac-ft
2007	1	-	$175,000	$63,544	$18,250	$201,427	$458,221	$458,221	106.22
	2	6%	$185,500	$67,356	$18,798	$201,427	$473,081	$446,303	109.66
	3	6%	$196,630	$71,398	$19,925	$201,427	$489,380	$435,547	113.44
2010	4	6%	$208,428	$75,681	$21,121	$201,427	$506,657	$425,399	117.45
	5	6%	$220,933	$80,222	$22,388	$201,427	$524,971	$415,826	121.69
	6	4%	$229,771	$83,431	$23,284	$201,427	$537,913	$401,960	124.69
	7	4%	$238,962	$86,768	$24,215	$201,427	$551,372	$388,696	127.81
	8	4%	$248,520	$90,239	$25,184	$201,427	$565,370	$376,003	131.06
2015	9	4%	$258,461	$93,849	$26,191	$201,427	$579,928	$363,854	134.43
	10	4%	$268,799	$97,603	$27,239	$201,427	$595,068	$352,220	137.94
	11	4%	$279,551	$101,507	$28,328	$201,427	$610,814	$341,075	141.59
	12	4%	$290,733	$105,567	$29,461	$201,427	$627,189	$330,395	145.39
	13	4%	$302,363	$109,790	$30,640	$201,427	$644,219	$320,157	149.33
2020	14	4%	$314,457	$114,181	$31,865	$201,427	$661,931	$310,339	153.44
	15	4%	$327,036	$118,749	$33,140	$201,427	$680,351	$300,920	157.71
	16	4%	$340,117	$123,499	$34,465	$201,427	$699,508	$291,880	162.15
	17	4%	$353,722	$128,438	$35,844	$201,427	$719,432	$283,202	166.77
	18	4%	$367,870	$133,576	$37,278	$201,427	$740,152	$274,866	171.57

Table 1.6 Recycled Water Pump Station Estimated Operation and Maintenance Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Year	Year	Escalation Rate	Exist O&M Cost	New PS O&M Cost	Add'l Labor Cost 365 hrs/yr@ $50/hr	Annualized Project Cost	Total Annual Cost	Discount Annual Cost	$/ac-ft
2025	19	4%	$382,585	$138,919	$38,769	$201,427	$761,701	$266,857	176.57
							Present Value	**$6,783,721**	

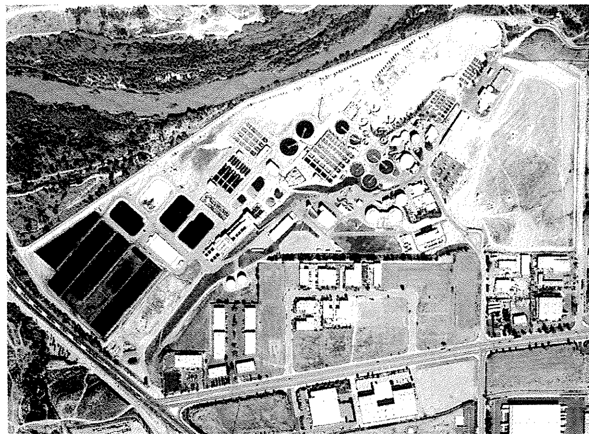
Assumptions:
Pump Station - Project Cost: $2,247,550.
Annual Interest Rate (assumes loan): 6 percent.
Period: 19 years.
Discount Rate: 6 percent.
Flow - Average Day: 2,674 gpm.
Flow: 4,314 afy.
Labor Rate Increase: 3 percent per year.

Appendix A

CITY OF RIVERSIDE RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN (PARSONS, SEPTEMBER 2003)

CITY OF RIVERSIDE

RIVERSIDE
PUBLIC UTILITIES



Recycled Water Phase I Feasibility Study and Citywide Master Plan

PARSONS

SEPTEMBER 2003

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September 5, 2003

Mr. Kevin Milligan, P.E.
Principal Water Engineer
Riverside Public Utilities
City of Riverside
3900 Main Street
Riverside, CA 92522

Subject: Recycled Water Phase 1 – Feasibility Study and Citywide Master Plan

Dear Mr. Milligan:

Parsons is pleased to submit ten (10) copies of the Recycled Water Phase I – Feasibility Study and Citywide Master Plan to the City of Riverside. Ten (10) copies of CD ROMs for the report are also submitted for your use.

We greatly appreciate the contribution from the City of Riverside's staff in completing this report, which provides details of the planning effort for the implementation of the Phase I Water Recycling Project and future water recycling projects.

Please feel free to call me at (626) 440-6263 if you have any questions.

Respectfully,

Surendra K. Thakral, P.E., DEE
Vice President – Water and Infrastructure, Inc.

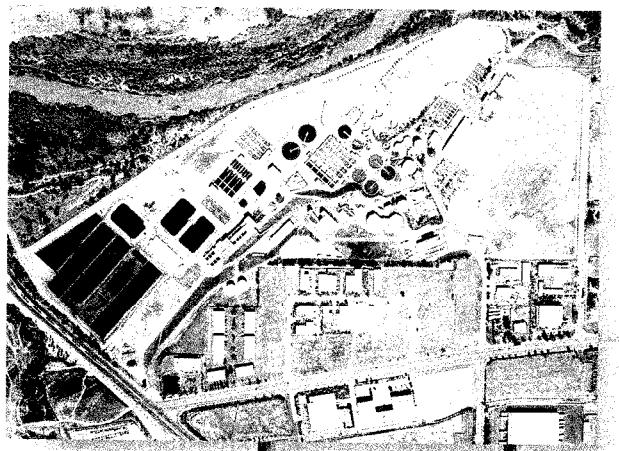
Enclosure

REGISTERED PROFESSIONAL ENGINEER
SURENDRA K. THAKRAL
No. C044599
Exp. 3/31/05
CIVIL
STATE OF CALIFORNIA

CITY OF RIVERSIDE

RIVERSIDE

PUBLIC UTILITIES



Recycled Water Phase I Feasibility Study and Citywide Master Plan

PARSONS

SEPTEMBER 2003

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CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Executive Summary

PARSONS

This executive summary presents a brief summary of the **Recycled Water Phase I Feasibility Study and Citywide Master Plan** for the City of Riverside (City).

PROJECT BACKGROUND

The City objectives include optimizing the use of recycled water from the Regional Water Quality Control Plant (RWQCP) for various non-potable applications.

The 1992 Recycling Master Plan focused on recycled water quantity and quality evaluation, recycled water use options, market assessment, development of a core distribution system, and excess recycle management. Although the City has not formally adopted and implemented this master plan, it has gradually increased the use of recycled water around the RWQCP on a case-by-case basis.

PURPOSE OF STUDY

This study has been conducted to assist the City in evaluating the cost effectiveness and benefits of using recycled water for landscape irrigation, agricultural irrigation, groundwater recharge, and commercial and industrial purposes. It updates the 1992 Recycling Master Plan with an economic analysis of the development and phased implementation of recycled water systems for non-potable water users throughout the City as well as the Jurupa Community Water District.

The specific purposes of this study included developing a more detailed plan for the Phase I Water Recycling Project and updating the City-wide Water Recycling Master Plan to validate the future demands and capital outlay.

RECYCLED WATER QUALITY CRITERIA AND REGULATIONS

California recognizes the importance of recycling water to meet overall water demand, as backed by Resolution No. 77-1, State Board's Policy with Respect to Water Reclamation in California, and specifically addressed in the California Water Code, Sections 13575 and 13577. As California's demand for water continues to increase, so will the necessity to recycle wastewater effluent from water reclamation facilities throughout the state. The Department of Health Services (DHS) establishes water quality standards and treatment reliability criteria for water recycling under Title 22, Chapter 4, of the California Code of Regulations (Title 22), and in Title 17, Division 1, Chapter 5, Group 4, Article 1, and Section 7604 (Title 17). Requirements for recycled water use in California, not described in Title 22, are considered and approved by DHS on a case-by-case basis.

Title 22 sets bacteriological water quality standards based on the expected degree of public contact with recycled water.

- For water reuse applications with a high potential for the public to come in contact with the recycled water, Title 22 requires disinfected tertiary treatment.

- For applications with lower potential for public contact, Title 22 requires three levels of secondary treatment, differing by the amount of disinfection required.

In addition to establishing recycled water quality standards, Title 22 specifies the reliability and redundancy of each recycled water treatment and use operation.

Title 17 provides protection against cross-connections between potable water systems and recycled water systems.

RECYCLED WATER QUALITY AND QUANTITY

The RWQCP, a municipal wastewater treatment plant operated by the City, is located on a 121-acre site at 5950 Acorn Street, south of the Santa Ana River, near the intersection of Van Buren Boulevard and Jurupa Avenue. The City completed construction of the first phase of the Hidden Valley Wetlands Enhancement Project (HVWEP) in March 1995. The HVWEP has been expanded to include an educational pond and other ponds. Approximately 100 acres of constructed wetlands are being used for additional wastewater treatment (nitrogen removal) from the RWQCP final effluent.

The RWQCP is currently producing about 32 mgd of recycled water on an annual average basis, while it is designed and permitted to produce up to 40 mgd of recycled water. The RWQCP is master planned for an ultimate capacity of 60 mgd. Thus, with the growth in population, the availability of recycled water is likely to go up to 40 mgd in the near future and 60 mgd ultimately.

Considering the City's obligations associated with the Prado Settlement (maximum 13.38 mgd) and potential evaporation losses at the HVWEP (about 0.5 mgd), about 18 mgd on annual average basis is available for the non-potable water uses discussed in Section 4 of this master plan.

Considering the projected population growth in the RWQCP service area, including population growth in the City, Jurupa, Rubidoux, and Edgemont, recycled water availability is likely to grow with time. However, to be conservative, this master plan has considered only 19 mgd to be available for non-potable water uses.

RECYCLED WATER MARKET ANALYSIS

Table EX-1 below summarizes the City's total non-potable reuse potential. Approximately 20,400 AFY (18 mgd annual average) of recycled water demand can be reasonably anticipated within the City limits and in the vicinity. Preliminary supply and demand analysis indicates that the 32 mgd of recycled water produced from the RWQCP will meet annual average demands. Storage facilities will be required to meet the peak monthly/daily/hourly demands.

Due to the speculative nature of current arrangements between the City and neighboring cities, this report assumes all required water will be available from the RWQCP. No arrangement for potable water supply supplement is investigated, although minimally a potable water supply hookup will be required for emergencies.

This estimated market does not include demands within the City's 15,000-acre southerly sphere of influence.

Table EX-1
Recycled Water Average Annual Demand
Assessment of Direct Non-potable Reuse Market

	User Code	Category	Reuse Potential (AFY) Existing Establishment		Future Establishment
A.	**Within the City Limts/School Districts**				
	Landscape Irrigagation				
	100	Cemeteries	253		
	200	Colleges/Universities/Schools	2,256		176
	300	Golf Courses	1,335		400
	400	Parks	1,744		895
	500	Miscellaneous	268		270
	600	Freeway Irrigation and City Greenbelts	793		100
	800	Industrial - Landscape Irrigation	422		
			7,070		
		Minor Potential Users	1,000		
		Subtotal - Landscape Irrigation	**8,070**		**1,841**
	Industrial Process/Commercial				
	700	Commercial	500		300
	900	Industrial - Processes	86		850
		Subtotal - Industrial Process/Commercial	**586**		**1,150**
Total Within City Limits			**8,656**		**2,991**
Total Existing and Future			**11,700**	**AFY**	
B.	**Additional Users Along City's Notherly Boundary**		**1,310**	**AFY**	
C.	**Potential User's Along City's Southerly Boundary**		**1,360**	**AFY**	
D.	**Potential Gage Canal Agricultural Irrigation Usage**		**6,000**	**AFY**	
E.	**Grand Total (A + B + C + D)**		**20,370**	**AFY**	
		Say	**20,400**	**AFY**	

CITYWIDE RECYCLED WATER MASTER PLAN

The City recycled water core distribution systems, for users identified in Section 4, will provide recycled water to users throughout the City, JCSD and users located in southerly boundaries in the Western Municipal Water District (WMWD). The core system provides an estimate of the pipe sizes and footage, pipeline alignments, reservoirs and pump stations to supply recycled water and to provide the basis for the conceptual cost estimates.

The total estimated capital cost for the citywide distribution system is approximately $64,670,000. As detailed in Section 5, the capital cost can be financed according to different scenarios. The monthly capital and O&M costs to the City for the various financing scenarios are listed in **Table 5-7** through **Table 5-10** of Section 5. With a potential reuse of 20,400 AFY, as described in Section 4, the cost for reclaimed water production ranges from $264/AFY to $409/AFY, depending on the financing option as summarized in **Table EX-2** below.

Table EX-2
Summary of Alternative Pricing Options for
Citywide Recycled Water Production Cost

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AF/Y)
1.	City Funds - No Grants and/or Loans	309
2.	City Funds (75%) and Grant (25%)	244
3.	City Funds (25%) and SRF Loan (75%)	263
4.	Grant (25%) and SRF Loan (75%)	197

PHASE 1 – WATER RECYCLING PROJECT

Section 6 describes the Phase I – Water Recycling Project. The Phase I Project is restricted to about a 3-mile radius around the City's RWQCP. This 3-mile radius includes major potential users within the City, Jurupa Community Service District (JCSD) and Rubidoux Community Service District (RCSD). Two alternatives, with two sub-alternatives each, were identified, surveyed and evaluated for the development of Phase I – Water Recycling Project. These alternatives include:

- **Alternative 1a** – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- **Alternative 1b** – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- **Alternative 2a** – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.
- **Alternative 2b** – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.

A detailed presentation of the above alternatives, along with their associated costs under different financing scenarios, is given in Section 6 (**Table 6-3 through Table 6-36**). To summarize, the total Phase I project cost will include miscellaneous water resources costs, the incremental costs associated with upgrading the City RWQCP system, and distribution costs within the City. **Table 6-37** (reproduced below as **Table EX-3**) presents the combined capital and operation and maintenance costs for the different alternatives assessed for the project. It is observed that the water production cost for a system designed to meet only Phase I demand is lower than that for a system designed to meet citywide demand. Considering that the typical water production cost in Southern California ranges between $300/AFY to $700/AFY, the feasible Phase I recycled water system alternatives are:

- Alternative 1a – with or without grant and loan.
- Alternative 1b – only with grant and loan.
- Alternative 2a – with or without grant and loan.
- Alternative 2b – with or without grant and loan.

POTENTIAL FUNDING SOURCES

A variety of funding alternatives could be used to funding the projects developed under this master plan. The standard practice for water recycling projects such as this one relies on California SRF loans, Proposition 13 grants, water system cash reserves, and, as required, long-term debt. The availability of water system cash reserves, or relatively short-term loans from the City, with repayment at interest from the water sales, is an important financing resource. The City would like to explore grants under the federal funds, Propositions 50 and 13 grants, and SRF loan. It is obvious that some kind of innovative project funding approach is needed for the economical viability of the City's water recycling project.

The Project Recommendations and Implementation Plan (Section 8) of this master plan evaluates the potential project alternatives under the following economical scenarios:

- No grant and SRF (City' own financing)
- Only 25% Proposition 13 grants

- Combination of propositions 13 and low interest rate SRF loan for 75 percent of project cost

PROJECT RECOMMENDATIONS AND IMPLEMENTATION PLAN

The Citywide Project and the two alternatives for the Phase I Project evaluated in this report vary considerably in cost. However, they have similar features, including serving all the major potential users and providing flexibility of phased implementation. The Phase 1 Project has a potential recycled water reuse of approximately 1,870 AFY. The Citywide project has a significant number of potential recycled water users with an estimated demand of 12,400 AFY.

As the initial phase of a water recycling system, Parsons recommends the implementation of Alternative 1a or 2a. Alternatives 1a and 2a have the lowest overall cost per acre-foot compared to other alternatives with SRF loan and 25% grant. The estimated production cost of Alternative 1a is $360/AFY and Alternative 2a is $362/AFY.

Implementation of a recycled water program must consider many issues before design and construction programs are initiated. These issues must be resolved or addressed before final project feasibility and scope can be accurately determined. The following proposed implementation sequence provides a directive for effective implementation of the water recycling program in conjunction with the City's overall objectives. All of these tasks should be completed prior to project design.

- **Water Quality Issues**
- **Water Recycling Ordinance**
- **Recycled Water Supply**
- **Agreement with JCSD and neighboring Cities**
- **Users Agreement**
- **Environnemental Documentation**
- **Loan Application**
- **Engineering Report (Title 22 Report)**
- **Public Information Program**
- **Conversion Costs**
- **Reliability and Public Health Protection**
- **Groundwater Recharge Issues**

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Table EX-3
Summary of Alternative Pricing Options

Alternatives	Riverside Potential Reuse (AFY)	Pipe Length (LF)	Approximate Capital Cost	Water Production Cost Option 1 ($/AFY)	Option 2 ($/AFY)	Option 3 ($/AFY)	Option 4 ($/AFY)	Option 5 ($/AFY)
1 - JCSD, City of Riverside Users up to Arlington Ave.								
A. System to meet phase I demand only	1,100	31,104	$6,297,000	550	439	470	360	276
B. System to meet Citywide demand also	1,100	31,104	$7,904,000	651	513	552	413	308
Difference (A - B)			$1,607,000	$101	$74	$82	$53	$32
2 - JCSD, City of Riverside Users up to Arlington Ave., Adams St. & Magnolia Ave.								
A. System to meet phase I demand only	1,500	47,026	$9,368,000	569	448	482	362	270
B. System to meet Citywide demand also	1,500	47,026	$9,961,000	594	466	502	374	277
Difference (A - B)			$593,000	$26	$18	$20	$13	$7

Option 1: City Funds - No Grants and/or Loans
Option 2: City Funds (75%) and Grant (25%)
Option 3: City Funds (25%) and SRF Loan (75%)
Option 4: Grant (25%) and SRF Loan (75%)
Option 5: Grant (50%) and SRF Loan (50%)

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 1
Introduction

PARSONS

SECTION 1
INTRODUCTION

Water is always in short supply in southern California and the need for water is expected to grow, driven by increasing population, need for protection of the Delta, and continued industrialization. Increased conservation efforts will slow but not stop this growth in demand. In fact, the California Department of Water Resources has predicted chronic water shortages by the year 2020.

As water demands and environmental needs grow, water recycling provides an additional viable source that will play a greater role in California's overall water supply. Using drought-proof recycled water reduces dependence on freshwater for uses such as landscape irrigation, dust control and industrial cooling; thus reserving the best and purest source of water for public drinking water. Water recycling can help conserve and sustainably manage California's vital water resources.

The City of Riverside's objectives include optimizing use of recycled water from the Regional Water Quality Control Plant (RWQCP) for various non potable uses.

1.1 PROJECT BACKGROUND

The City of Riverside (City) 1992 Reclamation Report (1992 Recycling Master Plan) focused on recycled water quantity and quality evaluation, recycled water use options, market assessment, development of a core distribution system, and excess recycle management.

Although, the City has not formally adopted and implemented the water recycling master plan, it has gradually increased the use of recycled water around the RWQCP on a case-by-case basis.

Users that have made the switch to recycled water include Van Buren Golf Course (Sky Links Executive Golf Course), Toro Manufacturing and Urban Forest. However, several types of non-potable water users that do not require potable water, such as landscape irrigation, commercial and industrial consumers are still using high quality potable water. No formal effort has been made to convince these users to use non-potable water.

While water recycling is a sustainable approach and has been cost-effective in other communities, the treatment of wastewater (no extra cost in this case) for reuse and the installation of distribution systems can be initially expensive compared to water supply alternatives such as ground water or imported water. Considering this situation, the Metropolitan Water District, the California State and Federal governments, have several financial support incentive programs to promote and make water recycling projects more cost effective and viable for a variety of purposes.

1.2 PURPOSE

This study has been conducted to assist the City in evaluating the cost effectiveness and benefits of using recycled water for landscape irrigation, agricultural irrigation, groundwater recharge, commercial and industrial purposes. It updates the 1992 Recycling Master Plan with an economic analysis of the development and phased implementation of recycled water systems for non-potable water users throughout the City as well as Jurupa Community Service District.

The specific purposes of this study included developing a more detailed plan for the Phase I Water Recycling Project and updating the City-wide Water Recycling Master Plan to validate the future demands as well as capital outlay.

1.3 PROJECT ORGANIZATION

This master plan report is organized into the following 8 sections and relevant appendices.

SECTIONS

Section 1 – Introduction

Section 2 – Recycled Water Quality Criteria and Regulations

Section 3 – Recycled Water Quality and Quantity

Section 4 – Recycled Water Market Analysis

Section 5 – Citywide Recycled Water System

Section 6 – Phase I – Water Recycling Project

Section 7 – Potential Funding Sources

Section 8 – Project Recommendation and Implementation Plan

APPENDICES:

Appendix A: 001 NPDES Permit

Appendix B: Prado Agreement

Appendix C: Hydraulic Modeling Results

Appendix D: Water Recycling Funding Guidelines

Appendix E: Prop 50 Funding Forms

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 2

Recycled Water Quality Criteria

PARSONS

SECTION 2

RECYCLED WATER QUALITY CRITERIA AND REGULATIONS

2.1 RECYCLED WATER QUALITY CRITERIA

Water reclamation and reuse criteria are principally directed at health and environmental protection and typically address wastewater treatment, recycled water quality, treatment reliability, distribution systems, and use area controls.

There are no federal regulations governing water reclamation and reuse in the U.S.; the regulatory burden rests with the individual states. The criteria vary among the states that have developed regulations. California's regulations (Title 22 and Title 17) are briefly discussed in this section. The U.S. Environmental Protection Agency (EPA) published guidelines in 1992 that are intended to provide guidance to states that have not developed their own criteria or guidelines.

Water quality criteria are based on a variety of considerations, including the following:

- ***Public health protection***: Recycled water should be safe for the intended use. Most existing water reuse regulations are directed at public health protection.
- ***Use requirements***: Many agricultural, industrial and other applications have specific physical and chemical water quality requirements that are not related to health considerations. Water quality requirements not associated with public health or environmental protection are seldom included in water reuse criteria by regulatory agencies.
- ***Irrigation effects***: The effect of individual constituents or parameters on crops or other vegetation, soil, and groundwater or other receiving water affects the water quality requirements. User water quality concerns often fall outside the scope of regulatory responsibility.
- ***Environmental considerations:*** The natural flora and fauna in and around recycled water use areas and the recycled water should not adversely impact receiving waters.
- ***Aesthetics***: For high level uses, e.g. urban irrigation and toilet flushing, the recycled water should be no different in appearance than potable water, i.e., clear, colorless, and odorless. For recreational impoundments, recycled water should not promote algal growth.
- ***Economics and Political realities:*** Regulatory decisions regarding water reclamation and reuse are influenced by public policy, technical feasibility, and economics.

2.2 RECYCLED WATER ACCEPTABILITY ISSUES

The acceptability of recycled water for any particular use is dependent on the physical, chemical, and microbiological quality of the water. Factors that affect the quality of

recycled water include source water quality, wastewater treatment processes and treatment effectiveness, treatment reliability, and distribution system design and operation. Local considerations include:

- Industrial wastes discharged to municipal sewerage systems can introduce chemical constituents that may adversely affect biological wastewater treatment processes and subsequent recycled water quality. California requires implementation of **industrial source control programs** to limit the input of chemical constituents that may adversely affect biological treatment processes and subsequent acceptability of the water for specific uses.
- Assurance of **treatment reliability** is an obvious, yet sometimes overlooked, quality control measure.
- **Distribution system design and operation** is important to ensure that the recycled water is not degraded before use and not subject to misuse.
- Open storage may result in water quality degradation by microorganisms, algae, or particulate matter, and may cause objectionable odor or color in the recycled water.

Making recycled water suitable and safe for reuse applications is achieved by eliminating or reducing the concentrations of microbial and chemical constituents of concern through wastewater treatment and/or by limiting public or worker exposure to the water via design and operational controls.

Toxic, and Microbial Constituents

The presence of toxic chemicals and microbial pathogens in wastewater creates the potential for adverse health effects where there is contact, inhalation, or ingestion of chemical or microbiological constituents of health concern.

The potential transmission of infectious disease by pathogenic agents is the most common concern associated with non-potable reuse of treated municipal wastewater. The principal infectious agents that may be found in raw municipal wastewater can be classified into three broad groups: bacteria; parasites (protozoa and helminths); and viruses. Excluding the use of raw sewage or primary effluent on sewage farms in the late 19th century, there have not been any confirmed cases of infectious disease resulting from recycled water use in the U.S.

Organic Constituents

Health effects related to the presence of organic constituents are of primary concern with regard to potable reuse. Both organic and inorganic constituents must be considered where recycled water is utilized for food crop irrigation, where recycled water from irrigation or other beneficial uses reaches potable groundwater supplies, or where organics may bio-accumulate in the food chain, e.g., in fish-rearing ponds.

The effect of organic constituents in recycled water used for crop irrigation may warrant attention if industrial wastes contribute a significant fraction to the wastewater.

Chemical Constituents and Physical Parameters

The chemical constituents potentially present in municipal wastewater generally are not a major health concern for urban uses of recycled water but may affect the acceptability of the water for uses such as food crop irrigation, industrial applications, and indirect potable reuse. Chemical constituents may be of concern when recycled water percolates into potable groundwater aquifers because of irrigation, groundwater recharge, or other uses.

Effects of physical parameters, e.g. pH, color, temperature, and particulate matter, and chemical constituents, e.g. chlorides, sodium, and heavy metals, are well known, and recommended limits have been established for many constituents.

2.3 WATER QUALITY CONSIDERATIONS FOR REUSE APPLICATIONS

2.3.1 Irrigation – Landscape and Agricultural

Both agricultural and landscape irrigation with recycled water are well accepted and widely practiced in the U.S. The water quality requirements and operational controls placed on the system depend on the area being irrigated, its location relative to populated areas, and the extent of public access or use of the grounds. The chemical composition of recycled water that has received secondary or higher levels of treatment, although highly variable, normally meets existing guidelines for landscape and agricultural irrigation use.

The recycled water available at the RWQCP goes through advanced treatment (tertiary filtration, chlorination and dechlorination) and meets existing guidelines for irrigation use.

Landscape Irrigation

Landscape irrigation involves the irrigation of golf courses, parks, cemeteries, school grounds, freeway medians, residential lawns, and similar areas. The concern for pathogenic microorganisms is somewhat different than for agricultural irrigation in that landscape irrigation frequently takes place in urban areas where the likelihood of human contact is higher and control over the use of the recycled water is more critical.

Agricultural Irrigation

The mechanism of potential food contamination from irrigation with recycled water includes:

- Physical contamination, where evaporation and repeated application may result in a buildup of contaminants on crops;
- Uptake through the roots from the applied water or the soil; and
- Foliar uptake.

Spray irrigation of food crops that grow above the ground surface requires more stringent requirements than surface irrigation because of the direct contact between the recycled water and the crops. Surface irrigation of root crops, such as carrots, beets, and onions also results in direct contact between the crop and recycled water; hence, irrigation of those and similar root crops should be subject to the same requirements.

Organisms contaminating food crops remain viable on the food surface unless they succumb to desiccation, exposure to sunlight, starvation, or action of other organisms or chemical agents. The reliability and completeness of pathogen inactivation by these mechanisms are questionable. Therefore, recycled water that is essentially free of measurable levels of pathogens is typically required for the spray irrigation of all crops that are eaten or sold raw.

Trace elements in recycled water normally occur in low concentrations that are not hazardous, but some are toxic at elevated concentrations. Some constituents are known to accumulate in particular crops, thus presenting potential health hazards to both grazing animals and/or humans.

2.3.2 Dual Systems

Although use of recycled water inside buildings for toilet and urinal flushing or for fire protection does not result in frequent human contact with the water, regulatory agencies usually require that the recycled water be essentially pathogen-free to reduce health hazards upon inadvertent cross-connection to potable water systems.

Areas that use both potable and recycled water are usually required to have backflow prevention devices on the potable water supply line to each site to reduce the potential of contaminating the potable drinking water system in the event of an inadvertent cross-connection.
Currently recycled water for toilet or urinal flushing or for fire protection is not allowed in single family residential dwellings.

2.3.3 Industrial Reuse

The suitability of recycled water for industrial processes depends on the particular use. Recycled water is used in the manufacture cooling and a wide variety of paper products, ranging from kraft pulp newsprint to high quality paper for stationery and wrappings. Additional site specific treatment beyond the Title 22 Requirements might be required on a particular use.

Use of recycled water in industrial or commercial facilities where the waste flow is returned to the municipal sewer system could increase the TDS load at the municipal treatment plant. The effect of this additional load should be analyzed on a case-by-case basis.

2.3.4 Recreational and Environmental Uses

Impoundments may serve a variety of functions from aesthetic non-contact uses to boating, fishing, and swimming. The level of treatment required will vary with the intended use of the water. Water quality requirements and thus required treatment levels increase as the potential for human contact increases. Typical quality requirements include:

- The appearance of the recycled water is important when it is used for impoundments, and treatment for nutrient removal may be required. Without nutrient control, there is a potential for algae blooms, resulting in odors, an unsightly appearance, and eutrophic conditions.

- Recycled water used for recreational impoundments where fishing and boating are allowed should not contain high levels of pathogenic microorganisms or heavy metals that accumulate in fish to levels that present health hazards to the consumers of the fish.
- For use in nonrestricted recreational impoundments where full-body contact with the water is allowed, the water should be microbiologically safe, colorless, and non-irritating to eyes and skin.

2.3.5 Groundwater Recharge – Spreading and Injection

The purposes of groundwater recharge using recycled water include establishing saltwater intrusion barriers in coastal aquifers, providing soil-aquifer treatment (SAT) for future reuse, providing storage of recycled water, controlling or preventing ground subsidence, and augmenting potable or non-potable aquifers. The two principal means of recharging groundwater basins with recycled water are surface spreading and injection.

Surface Spreading

Where surface spreading of recycled water is used to augment potable groundwater supplies, tertiary treatment, i.e., secondary treatment followed by filtration and disinfection, or advanced wastewater treatment processes may be needed and in some cases required by regulatory agencies to assure that the recharged water does not contain pathogens or health-significant levels of chemical constituents.

Injection

Injection involves pumping recycled water directly into the groundwater zone, which is usually a confined aquifer. Injection requires water of higher quality than surface spreading:

- To prevent clogging of injection equipment
- Because of the absence of soil matrix treatment afforded by surface spreading, and,
- More importantly, to have the injection water meet drinking water standards or match or exceed the quality of the groundwater into which it is injected.

Treatment processes beyond secondary treatment that may be used before injection include chemical coagulation/clarification, filtration, air stripping, ion exchange, granular activated carbon, reverse osmosis or other membrane processes, and disinfection.

2.4 U.S. EPA WATER REUSE GUIDELINES

The U.S. Environmental Protection Agency, in conjunction with the U.S. Agency for International Development, published *Guidelines for Water Reuse* in 1992 (Ref. EPA/625/R-92/004). The primary purpose of the document is to provide guidelines, with supporting information, for utilities and regulatory agencies in the U.S., particularly in states where standards do not exist or are being revised or expanded. California's comprehensive standards are discussed later in this section.

The guidelines address all of the important aspects of water reuse including recommended treatment processes, recycled water quality limits, monitoring frequencies, setback distances, and other controls for various water reuse applications. The guidelines address water reclamation and reuse for nonpotable applications as well as indirect potable reuse by groundwater recharge and augmentation of surface water sources of supply.

The treatment processes and recycled water quality limits recommended in the guidelines for various recycled water applications are presented in **Table 2-1**. Both recycled water quality limits and wastewater treatment unit processes are recommended for the following reasons:

(1) Water quality criteria involving surrogate parameters alone do not adequately characterize recycled water quality;

(2) A combination of treatment and quality requirements known to produce recycled water of acceptable quality obviates the need to monitor the finished water for certain constituents;

(3) Expensive, time-consuming, and in some cases, questionable monitoring for pathogenic microorganisms is eliminated without compromising health protection; and

(4) Treatment reliability is enhanced.

The guidelines suggest that, regardless of the type of recycled water use, some level of disinfection should be provided to avoid adverse health consequences from inadvertent contact or accidental or intentional misuse of a water reuse system.

Table 2-1
U.S. EPA Guidelines for Water Reuse
(Applicable to the States not having their own standards)

Type of Use	Treatment	Recycled Water Quality
Urban uses, Food crops eaten raw, Recreational impoundments	• Secondary • Filtration • Disinfection	• pH = 6-9 • 10 mg/L NO3-N • 2NTU[a] • No detectable fecal coli/l00 mL[b] • 1 mg/L Cl_2 residual[c]
Restricted access area irrigation, Processed food crops, Nonfood crops, Aesthetic impoundments, Construction uses, Industrial cooling[d], Environmental reuse	• Secondary • Disinfection	• pH = 6-9 • 30 mg/L BOD • 30mg/L SS • 200 fecal coli/l00 mL[e] • 1 mg/L Cl_2 residual[c]
Groundwater recharge of nonpotable aquifers by spreading	• Site specific & use dependent • Primary (minimum)	• Site specific & use dependent
Groundwater recharge of nonpotable aquifers by injection	• Site specific & use dependent • Secondary (minimum)	• Site specific & use dependent
Groundwater recharge of potable aquifers by spreading	• Site specific • Secondary & Disinfection (minimum)	• Site specific • Meet drinking water standards after percolation through vadose zone
Groundwater recharge of potable aquifers by injection, Augmentation of surface supplies	• Includes the following: • Secondary • Filtration • Disinfection • Advanced wastewater treatment	• Includes the following: • pH = 6-8.5 • 2NTU [a] • No detectable fecal coli/100mL[b] • 1 mg/L Cl_2 residual[c] • Meet drinking water standards

[a] Should be met prior to disinfection. Average based on a 24-hour time period. Turbidity should not exceed *5* NTU at any time.
[b] Based on 7-day median value. Should not exceed 14 fecal coli/l00 mL in any sample.
[c] After a minimum contact time of 30 minutes.
[d] Re-circulating cooling towers.
[e] Based on 7-day median value. Should not exceed 800 fecal coli/l00 mL in any sample.
Source: Adapted from [31].

2.5 REGIONAL BOARD/LOCAL REQUIREMENTS

In California, nine Regional Boards oversee the federal clean water regulations and implement the federal National Pollutant Discharge Elimination System (NPDES) program. NPDES permit requirements related to wastewater treatment and discharges to the Santa Ana River are discussed briefly in Section 3.

The Regional Board authority to protect Waters of the State is stated in the Porter-Cologne Water Quality Act of 1969. In protecting Waters of the State, each of the 9 Regional Boards (which are territorially divided by drainage basins) develop and adopt water quality control plans (basin plans) whereby beneficial uses of waters in the respective drainage basins are established, and water quality objectives are also established to protect such beneficial uses. The Regional Boards issue NPDES permits and waste discharge requirements consistent with protection of the beneficial uses in the respective basin plan, as well as compliant with federal clean water standards.

The Regional Board adopted the Water Quality Control Plan Report, Santa Ana Region (Basin Plan) on March 11, 1994 and became effective on January 24, 1995. The Basin Plan sets forth requirements for adequate water quality planning, implementation, management, and enforcement practices. It provides a definitive program to preserve and enhance both surface water and groundwater quality in the basin.

2.5.1 Groundwater Recharge Objectives

Groundwater recharge of treated wastewater is handled in a similar manner to water reuse, although the limits and the amount of flow that is affected are different.

The Basin Plan establishes water quality objectives necessary to protect the beneficial uses of receiving waters, including groundwater, inland surface water and coastal water. Currently, the Basin Plan objectives dictate that the wastewater reaching the groundwater table must not exceed a TIN (Total Inorganic Nitrogen) concentration of 10 mg/L.

The draft Groundwater Recharge Reuse Guidelines (GRRG) currently promulgated by the DHS (Department of Health Services) stipulate a total nitrogen concentration range between 1 and 10 mg/L for the recharge water. The DHS is currently considering adoption of an exact limit for total nitrogen but is unsure what total nitrogen limit in recharge water is necessary to assure that the nitrate standard will not be exceeded due to any groundwater recharge projects. Nevertheless, the DHS recognizes and may allow TIN treatment and removal through the soil column. The result is that recycled water used for groundwater recharge could contain higher concentrations of TIN.

The Basin Plan, 1995 lists the groundwater and inland surface water beneficial uses by hydrographic subunit (HSU) as shown in **Table 2-2** with regulated parameters for total dissolved solids, hardness, sodium, chloride and sulfate.

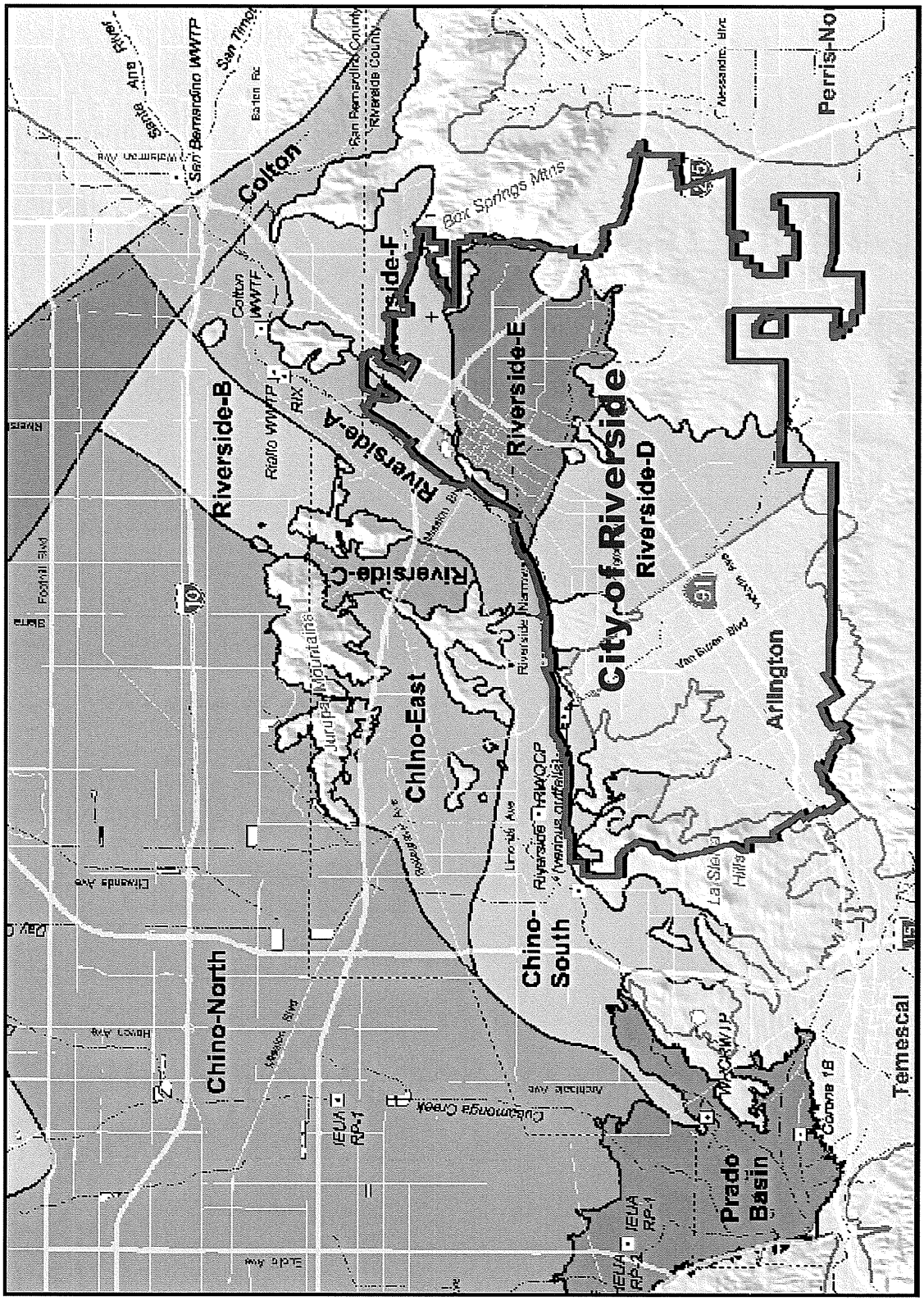
Table 2-2
RWQCP Sub Basins Ground Water Quality Objectives

Groundwater Supply Sub-basins	TDS	Hardness	Sodium Na	Chloride Cl	NO_3-N	Sulfate SO_4	Hydrologic Unit	
							Primary	Secondary
Arlington	1050	500	125	180	20	160	801.26	801.25
Bunker Hill I	260	190	15	10	1	45	801.51	-
Bunker Hill II	290	190	30	20	5	62	801.52	-
Bunker Hill Pressure	300	160	30	20	1	62	801.52	-
Riverside I	490	270	50	50	4	85	801.27	-
Riverside I	650	360	70	85	10	100	801.27	-
Riverside I	990	500	125	170	20	135	801.27	-

(Ref: Santa Ana Region Basin Plan, 1995)

Basin Plan Revision and New Groundwater Recharge Requirements

The Regional Water Quality Control Board (RWQCB) is scheduled to finalize a revision to the basin plan in the first quarter of 2004. The revision will include new groundwater basin boundaries and associated objectives for nitrate nitrogen and TDS. The proposed changes may limit the uses of reclaimed water in some areas due to water quality limitations. Under the proposed amendment, the City will overlay six different groundwater management zones (eight zones if the Jurupa and Rubidoux Community Services Districts are included). **Figure 2-1** overlays the City boundaries over the latest proposed groundwater management zones. Each of these zones will have specific groundwater objectives for TDS and nitrate nitrogen. Specific reclamation proposals will need to be assessed based on the type and location of the proposed activity after the revisions are finalized. **Table 2-3** summarizes the Water Quality Objectives associated with TDS and N03-N.



Source: Modified from Wildermuth Environmental, Inc.

Figure 2-1 – Groundwater Management Zone Boundaries and City of Riverside Boundary

Table 2-3
Revised Water Quality Objectives
(Likely to be adopted by RWQCB in few months)

Groundwater Subbasins Management Zones	Water Quality objective (mg/L)		HYDROLOGIC UNIT	
	TDS	NO_3-N	Primary	Secondary
SAN JACINTO RIVER BASIN				
Garner Valley*	300	2.0	802.22	
Idyllwild Area**	--	--	802.22	802.21
Canyon	230	2.5	802.21	
Hemet - South	730	4.1	802.15	802.21
Lakeview - Hemet North	520	1.8	802.14	802.15
Menifee	1020	2.8	802.13	
Perris North	570	5.2	802.11	
Perris South	1260	2.5	802.11	802.12, 802.13
San Jacinto - Lower	520	1.0	802.21	
San Jacinto - Upper	320	1.4	802.21	802.23
LOWER SANTA ANA RIVER BASIN				
La Habra**	--	--	845.62	
Santiago**	--	--	801.12	
Orange	580	3.4	801.11	801.13, 845.61, 801.14
Irvine**	910	5.9	801.11	
UPPER SANTA ANA RIVER BASIN				
Big Bear Valley	220	5.0	801.71	801.73
Beaumont "maximum benefit"++	340	5.0	801.62	801.63, 801.69
Beaumont "antidegradation"++	230	1.5	801.62	801.63, 801.69
Bunker Hill - A	310	2.7	801.51	801.52
Bunker Hill - B	330	7.3	801.52	801.53, 801.54, 801.57, 801.58
Colton	410	2.7	801.44	801.45
Chino - North "maximum benefit"++	420	5.0	801.21	481.21, 481.23, 481.22, 801.21, 801.23, 801.24, 801.27
Chino 1 - "antidegradation"++	290	4.9	802.21	481.21
Chino 2 - "antidegradation"++	260	2.9	802.21	
Chino 3 - "antidegradation"++	260	3.5	802.21	
Chino - East	730	10.0	802.21	801.27
Chino - South	680	4.2	802.21	801.26
Cucamonga "maximum benefit"++	420	5.0	801.24	801.21
Cucamonga "antidegradation"++	210	2.4	801.24	801.21
Lytle	260	1.5	801.41	801.42
Rialto	230	2.0	801.41	801.42
San Timoteo "maximum benefit"++	370	5.0	801.62	
San Timoteo "antidegradation"++	300	2.7	801.62	
Yucaipa "maxium benefit"++	370	5.0	801.61	
Yucaipa "antidegradation"++	320	4.2	801.61	
MIDDLE SANTA ANA RIVER BASIN				
Arlington	980	10.0	801.26	
Bedford**	--	--	801.32	
Coldwater	380	1.5	801.31	
Elsinore	480	1.0	802.31	
Lee Lake**	--	--	801.34	
Riverside - A	560	6.2	801.27	
Riverside - B	290	7.6	801.27	
Riverside - C	680	8.3	801.27	
Riverside - D	810	10.0	801.27	
Riverside - E	720	10.0	801.27	
Riverside - F	660	9.5	801.27	
Temescal	770	10.0	801.25	

* Additional objectives for Garner Valley: Hardness 100 mg/L; Sodium 65 mg/L; Chloride 30 mg/L; Sulfate 40

** Numeric objectives not established; narrative objectives apply

++ "maximum benefit" objectives apply unless Regional Board determines that lowering of water quality is no of maximum benefit to the people of the state; "antidegradation" objectives then would apply.

Groundwater recharge is a potential year-round use of recycled water in the area. This alternative must consider Title 22 guidelines such as required times (12 months) prior to withdrawal, blending ratios (20% recycled water, 80% natural groundwater), and setback requirements (injection/recharge points one mile away from potable wells). Total organic carbon concentrations must also be met, and the recharge of groundwater would likely require demineralization prior to injection/recharge to meet these.

The use of recycled water (RWQCP effluent), ranging TDS ranges between 515 to 540 mg/L, may not allowed to be used in certain groundwater management zones (sub basins which out demonstration to the RWQCB that it will not degrade the ground water quality. Under similar conditions, the RWQCB has required Salt Balance Study by qualified professional to demonstrate no impact on the ground water. This master planning efforts considers that the City will be eventually able to use the RWQCP effluent for the potential users located in these sub basins, thus such users are not precluded from this study.

Groundwater modeling would be required to determine impacts to and protection of beneficial guidelines. Long-term groundwater monitoring would likely be required as part of the alternative. Groundwater recharge would be the ideal alternative to compensate for the wide variation in recycled water availability at the RWQCP. When agricultural and turf irrigation demands are lowest (winter time), recharge of the groundwater can be implemented to its fullest extent, and it can be minimized during summer months when demands are high.

2.6 CALIFORNIA WATER RECYCLING AND REUSE CRITERIA

2.6.1 Treatment Requirements

The California Department of Health Services (DHS) has determined that recycled water should be essentially free of pathogenic organisms. DHS specifies treatment processes (secondary treatment, filtration, and disinfection), operational requirements (filtration rates, chlorine contact time, etc.), and water quality parameters (turbidity and coliform organisms) that have been demonstrated to result in the production of water of the desired quality.

2.6.2 Water Quality Monitoring

Water quality monitoring is a very prominent issue during development of reuse standards or guidelines. Monitoring decisions include selection of water quality parameters, numerical limits, sampling frequency, and the monitoring compliance point. Important issues include the need to monitor for viruses and the appropriate parameter for measurement of particulates. It would be impractical to monitor recycled water for all of the toxic chemicals and pathogenic organisms of concern, and surrogate parameters are universally accepted.

The state of California has comprehensive regulations (Title 22 and Title 17 Requirements) and prescribes requirements according to the end use of the water. The California reuse criteria include requirements for treatment reliability that address standby power supplies, alarm systems, multiple or standby treatment process units, emergency storage or disposal of inadequately treated wastewater, elimination of

treatment process bypassing, monitoring devices and automatic controllers, and flexibility of design.

California is in the process of revising its comprehensive regulations and reuse criteria. The most recent draft criteria are presented in **Table 2-4** (non-potable reuse) and **Table 2-5** (potable reuse via groundwater recharge).

Table 2-4
California Treatment and Quality Criteria[a] for Nonpotable Uses of Recycled Water (1)

Type of Use	Total Coliform Limits [b]	Treatment Required
Irrigation of fodder, fiber, & seed crops, orchards and vineyards[c], and processed food crops; Flushing sanitary sewers	None required	Secondary
Irrigation of pasture for milking animals, landscape areas[d], omamental nursery stock, and sod farms; Landscape impoundments; Industrial or commercial cooling water where no mist is created; Nonstructural fire fighting; Industrial boiler feed; Soil compaction; Dust control; Cleaning roads, sidewalks, and outdoor areas	23/100 mL	Secondary & disinfection
Surface irrigation of food crops; restricted landscape impoundments	2.2/100 mL	Secondary & disinfection
Irrigation of food crops[e] and open access landscape areas[f] Nonrestricted recreational impoundments; Toilet and urinal flushing; Industrial process water; Decorative fountains; Commercial laundries; Snow making; Structural fire fighting; Industrial or commercial cooling where mist is created	2.2/100 mL	Secondary Coagulation[g], filtration[h], & disinfection

[a] Includes proposed revisions.
[b] Based on running 7-day median.
[c] No contact between recycled water and edible portion of crop.
[d] Cemeteries, freeway landscaping, restricted access golf courses, and other controlled access irrigation areas.
[e] Contact between recycled water and edible portion of crop; includes edible root crops.
[f] Parks, playgrounds, schoolyards, residential landscaping, unrestricted access golf courses, and other uncontrolled access irrigation areas.
[g] Not required if the turbidity of the influent to the filters does not exceed 5 NTU more than 5 percent of the time.
[h] The turbidity of filtered effluent cannot exceed a daily average of 2 nephelometric turbidity units (NTU).
(1) Source Reference: (State of California. 1998. Draft Water Recycling Criteria. California Department of Health Services, Drinking Water Program, Sacramento, California)

Table 2-5
Proposed California Groundwater Recharge Criteria (1)

Treatment and Recharge Site Requirements	Project Category[a] I	II	III
Required treatment			
Secondary	X[b]	X	X
Filtration	X	X	X
Disinfection	X	X	X
Organics removal	X		X
Water Quality Limits	Drinking water standards except nitrogen, 10 mg/L total nitrogen, & 1 mg/L TOC of wastewater origin in extracted water		
Maximum allowable recycled water in extracted well water (%)	50	20	50
Depth to groundwater at initial percolation rate of:			
<0.5 cmlmin (<0.2 in/min)	3 m (10 ft)	3 m (10 ft)	n.a.[c]
<0.8 cm/min (<0.3 in/min)	6 m (20 ft)	6 m (20 ft)	n.a.[c]
Minimum retention time underground (months)	6	6	12
Horizontal separation	150m (500 ft)	150m (500 ft)	600m (2000 ft)

[a] Categories I and II, are for surface spreading projects. Category III is for injection projects.
[b] X means that the treatment process is required.
[c] Not applicable.
[d] From edge of recharge operation to the nearest potable water supply well.

(1) Source: Reference (State of California. 1999. Draft Proposed Groundwater Recharge Regulation. California Department of Health Services, Division of Drinking Water, Sacramento, California)

2.7 TITLE 22 CRITERIA - DEPARTMENT OF HEALTH AND SAFETY

California recognizes the importance of recycling water to meet the overall water demand, as backed by Resolution No. 77-1, State Board's Policy with Respect to Water Reclamation in California, and specifically addressed in the California Water Code, Sections 13575 and 13577. As California's demand for water continues to increase, so will the demand for and the necessity to recycle wastewater effluent from water reclamation facilities throughout the state.

The DHS establishes water quality standards and treatment reliability criteria for water recycling under Title 22, Chapter 4, of the California Code of Regulations (Title 22), and in Title 17, Division 1, Chapter 5, Group 4, Article 1, and Section 7604 (Title 17). Requirements for recycled water use in California, not described in Title 22, are considered and approved by DHS on a case-by-case basis.

Title 22 sets bacteriological water quality standards based on the expected degree of public contact with recycled water.

For water reuse applications with a high potential for the public to come in contact with the recycled water, Title 22 requires disinfected tertiary treatment.

For applications with lower potential for public contact, Title 22 requires three levels of secondary treatment, differing by the amount of disinfection required.
In addition to establishing recycled water quality standards, Title 22 specifies the reliability and redundancy for each recycled water treatment and use operation.

Title 17 provides protection against cross-connections between potable water systems and recycled water systems.

2.7.1 Proposed Title 22 Regulations Changes

California DHS issued the latest versions of both Title 17 and 22 on August 30, 1999 for public comment prior to formal adoption. The significant pending changes to Title 22 tertiary water treatment standards are with respect to the disinfection and filtration processes. These proposed changes are described as follows:

Section 60301.230, Disinfected Tertiary Recycled Water.

The chlorine disinfection process to achieve a 2.2 MPN (Maximum Probable Number) would require a "CT" (chlorine dosage times time, milligrams-minutes/liter) of not less than 450 at all times with a modal contact time of at least 90 minutes, based on peak dry weather flow. The current criterion requires a 2 hour detention time at plant maximum flow rate.

The combined disinfection/filtration process must also achieve 99.999 percent removal of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the recycled water. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of the demonstration. This proposed requirement allows alternative disinfection processes, in combination with conventional filtration (chemical coagulation, clarification prior to filtration) and direct filtration alternatives that reliably meet the virus removal criteria.

Section 60301.320, Filtered Wastewater.

The filtration requirement recognizes direct filtration as an acceptable alternative, and now lists microfiltration, ultrafiltration, nanofiltration and reverse osmosis as alternative means of filtration.

2.7.2 Key Title 22 Requirements

2.7.2.1 Water Recycling Potential Uses Requirements (Title 22 – Article 3)

A. Use of Recycled Water for Irrigation (*Ref. Title 22 Code Section - §60304*)

(a) Recycled water used for the surface irrigation of the following shall be a disinfected tertiary recycled water, except that for filtration pursuant to Section 60301.320(a) coagulation need not be used as part of the treatment process provided that the filter effluent turbidity does not exceed 2 NTU, the turbidity of the influent to the filters is

continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes:

(1) Food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop,

(2) Parks and playgrounds,

(3) School yards,

(4) Residential landscaping,

(5) Unrestricted access golf courses, and

(6) Any other irrigation use not specified in this section and not prohibited by other sections of the California Code of Regulations.

(b) Recycled water used for the surface irrigation of food crops where the edible portion is produced above ground and not contacted by the recycled water shall be at least disinfected secondary-2.2 recycled water.

(c) Recycled water used for the surface irrigation of the following shall be at least disinfected secondary-23 recycled water:

(1) Cemeteries,

(2) Freeway landscaping,

(3) Restricted access golf courses,

(4) Ornamental nursery stock and sod farms where access by the general public is not restricted,

(5) Pasture for animals producing milk for human consumption, and

(6) Any nonedible vegetation where access is controlled so that the irrigated area cannot be used as if it were part of a park, playground or school yard

(d) Recycled wastewater used for the surface irrigation of the following shall be at least undisinfected secondary recycled water:

(1) Orchards where the recycled water does not come into contact with the edible portion of the crop,

(2) Vineyards where the recycled water does not come into contact with the edible portion of the crop,

(3) Non food-bearing trees (Christmas tree farms are included in this category provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting or allowing access by the general public),

(4) Fodder and fiber crops and pasture for animals not producing milk for human consumption,

(5) Seed crops not eaten by humans,

(6) Food crops that must undergo commercial pathogen-destroying processing before being consumed by humans, and

(7) Ornamental nursery stock and sod farms provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting, retail sale, or allowing access by the general public.

(e) No recycled water used for irrigation, or soil that has been irrigated with recycled water, shall come into contact with the edible portion of food crops eaten raw by humans unless the recycled water complies with subsection (a).

B. Use of Recycled Water for Impoundments (*Ref. Title 22 Code Section - §60305*)

(a) Except as provided in subsection (b), recycled water used as a source of water supply for nonrestricted recreational impoundments shall be disinfected tertiary recycled water that has been subjected to conventional treatment.

(b) Disinfected tertiary recycled water that has not received conventional treatment may be used for nonrestricted recreational impoundments provided the recycled water is monitored for the presence of pathogenic organisms in accordance with the following:

(1) During the first 12 months of operation and use the recycled water shall be sampled and analyzed monthly for Giardia, enteric viruses, and Cryptosporidium. Following the first 12 months of use, the recycled water shall be sampled and analyzed quarterly for Giardia, enteric viruses, and Cryptosporidium. The ongoing monitoring may be discontinued after the first two years of operation with the approval of the department. This monitoring shall be in addition to the monitoring set forth in section 60321.

(2) The samples shall be taken at a point following disinfection and prior to the point where the recycled water enters the use impoundment. The samples shall be analyzed by an approved laboratory and the results submitted quarterly to the regulatory agency.

(c) The total coliform bacteria concentrations in recycled water used for nonrestricted recreational impoundments, measured at a point between the disinfection process and the point of entry to the use impoundment, shall comply with the criteria specified in section 60301.230 (b) for disinfected tertiary recycled water.

(d) Recycled water used as a source of supply for restricted recreational impoundments and for any publicly accessible impoundments at fish hatcheries shall be at least disinfected secondary-2.2 recycled water.

(e) Recycled water used as a source of supply for landscape impoundments that do not utilize decorative fountains shall be at least disinfected secondary-23 recycled water.

C. Use of Recycled Water for Cooling (*Ref. Title 22 Code Section - §60306*)

(a) Recycled water used for industrial or commercial cooling or air conditioning that involves the use of a cooling tower, evaporative condenser, spraying or any mechanism that creates a mist shall be a disinfected tertiary recycled water.

(b) Use of recycled water for industrial or commercial cooling or air conditioning that does not involve the use of a cooling tower, evaporative condenser, spraying, or any mechanism that creates a mist shall be at least disinfected secondary-23 recycled water.

(c) Whenever a cooling system, using recycled water in conjunction with an air conditioning facility, utilizes a cooling tower or otherwise creates a mist that could come into contact with employees or members of the public, the cooling system shall comply with the following:

(1) A drift eliminator shall be used whenever the cooling system is in operation.

(2) A chlorine, or other, biocide shall be used to treat the cooling system recirculating water to minimize the growth of Legionella and other micro-organisms.

D. Use of Recycled Water for Other Purposes. (*Ref. Title 22 Code Section - §60307*)

(a) Recycled water used for the following shall be disinfected tertiary recycled water, except that for filtration being provided pursuant to Section 60301.320(a) coagulation need not be used as part of the treatment process provided that the filter effluent turbidity does not exceed 2 NTU, the turbidity of the influent to the filters is continuously measured, the influent turbidity does not exceed 5 NTU for more than 15 minutes and never exceeds 10 NTU, and that there is the capability to automatically activate chemical addition or divert the wastewater should the filter influent turbidity exceed 5 NTU for more than 15 minutes:

(1) Flushing toilets and urinals,

(2) Priming drain traps,

(3) Industrial process water that may come into contact with workers,

(4) Structural fire fighting,

(5) Decorative fountains,

(6) Commercial laundries,

(7) Consolidation of backfill around potable water pipelines,

(8) Artificial snow making for commercial outdoor use, and

(9) Commercial car washes, including hand washes if the recycled water is not heated, where the general public is excluded from the washing process.

(b) Recycled water used for the following uses shall be at least disinfected secondary-23 recycled water:

(1) Industrial boiler feed,

(2) Nonstructural fire fighting,

(3) Backfill consolidation around nonpotable piping,

(4) Soil compaction,

(5) Mixing concrete,

(6) Dust control on roads and streets,

(7) Cleaning roads, sidewalks and outdoor work areas and

(8) Industrial process water that will not come into contact with workers.

(c) Recycled water used for flushing sanitary sewers shall be at least undisinfected secondary recycled water.

2.7.2.2 Recycled Water Use Area Requirements (Title 22 -Article 4)

(a) No irrigation with disinfected tertiary recycled water shall take place within 50 feet of any domestic water supply well unless all of the following conditions have been met:

(1) A geological investigation demonstrates that an aquitard exists at the well between the uppermost aquifer being drawn from and the ground surface.

(2) The well contains an annular seal that extends from the surface into the aquitard.

(3) The well is housed to prevent any recycled water spray from coming into contact with the wellhead facilities.

(4) The ground surface immediately around the wellhead is contoured to allow surface water to drain away from the well.

(5) The owner of the well approves of the elimination of the buffer zone requirement.

(b) No impoundment of disinfected tertiary recycled water shall occur within 100 feet of any domestic water supply well.

(c) No irrigation with, or impoundment of, disinfected secondary-2.2 or disinfected secondary-23 recycled water shall take place within 100 feet of any domestic water supply well.

(d) No irrigation with, or impoundment of, undisinfected secondary recycled water shall take place within 150 feet of any domestic water supply well.

(e) Any use of recycled water shall comply with the following:

(1) Any irrigation runoff shall be confined to the recycled water use area, unless the runoff does not pose a public health threat and is authorized by the regulatory agency.

(2) Spray, mist, or runoff shall not enter dwellings, designated outdoor eating areas, or food handling facilities.

(3) Drinking water fountains shall be protected against contact with recycled water spray, mist, or runoff.

(f) No spray irrigation of any recycled water, other than disinfected tertiary recycled water, shall take place within 100 feet of a residence or a place where public exposure could be similar to that of a park, playground, or school yard.

(g) All use areas where recycled water is used that are accessible to the public shall be posted with signs that are visible to the public, in a size no less than 4 inches high by 8 inches wide, that include the following wording: "RECYCLED WATER - DO NOT DRINK". Each sign shall display an international symbol similar to that shown in figure 60310-A. The Department may accept alternative signage and wording, or an

educational program, provided the applicant demonstrates to the Department that the alternative approach will assure an equivalent degree of public notification.

(h) Except as allowed under section 7604 of title 17, California Code of Regulations, no physical connection shall be made or allowed to exist between any recycled water system and any separate system conveying potable water.

(i) The portions of the recycled water piping system that are in areas subject to access by the general public shall not include any hose bibs. Only quick couplers that differ from those used on the potable water system shall be used on the portions of the recycled water piping system in areas subject to public access.

2.7.2.3 Dual Plumbed Recycled Water Systems Requirements (Title 22 - Article 5)

(a) No person other than a recycled water agency shall deliver recycled water to a dual-plumbed facility.

(b) No recycled water agency shall deliver recycled water for any internal use to any individually-owned residential units including free-standing structures, multiplexes, or condominiums.

(c) No recycled water agency shall deliver recycled water for internal use except for fire suppression systems, to any facility that produces or processes food products or beverages. For purposes of this Subsection, cafeterias or snack bars in a facility whose primary function does not involve the production or processing of foods or beverages are not considered facilities that produce or process foods or beverages.

(d) No recycled water agency shall deliver recycled water to a facility using a dual plumbed system unless the report required pursuant to section 13522.5 of the Water Code, and which meets the requirements set forth in section 60314, has been submitted to, and approved by, the regulatory agency.

2.7.2.4 Groundwater Recharge. (Title 22- Article 5)

Reclaimed water used for groundwater recharge of domestic water supply aquifers by surface spreading shall be at all times of a quality that fully protects public health. The State Department of Health Services' recommendations to the Regional Water Quality Control Boards for proposed groundwater recharge projects and for expansion of existing projects will be made on an individual case basis where the use of reclaimed water involves a potential risk to public health.

(a) The State Department of Health Services' recommendations will be based on all relevant aspects of each project, including the following factors: treatment provided; effluent quality and quantity; spreading area operations; soil characteristics; hydrogeology; residence time; and distance to withdrawal.

(b) The State Department of Health Services will hold a public hearing prior to making the final determination regarding the public health aspects of each groundwater recharge project. Final recommendations will be submitted to the Regional Water Quality Control Board in an expeditious manner.

2.8 TITLE 17 REQUIREMENTS

Title 17 of the California Administrative Code establishes regulations relating to cross-connections of potable and non-potable water systems to ensure safety of public health. The regulations require a cross-connection control program whereby the public water supply is protected from contamination.

In effect, the requirements state that connections to a domestic water system must be isolated from the recycled water main by an air gap, a reduced pressure principle device or a double check valve assembly. Title 17 regulations disallow direct connection between any system or facility delivering recycled water and the domestic water system.

2.8.1 Protection of Water System (Title 17- Article 2)

2.8.1.1 Approval of Backflow Preventers (*Ref. Title 17 Code Section* 7601)

(a) Air-gap Separation. An Air-gap separation (AG) shall be at least double the diameter of the supply pipe, measured vertically from the flood rim of the receiving vessel to the supply pipe; however, in no case shall this separation be less than one inch.

(b) Double Check Valve Assembly. A required double check valve assembly (DC) shall, as a minimum, conform to the AWWA Standard C506-78 (R83) adopted on January 28, 1978 for Double Check Valve Type Backflow Preventive Devices which is herein incorporated by reference.

(c) Reduced Pressure Principle Backflow Prevention Device. A required reduced pressure principle backflow prevention device (RP) shall, as a minimum, conform to the AWWA Standard C506-78 (R83) adopted on January 28, 1978 for Reduced Pressure Principle Type Backflow Prevention Devices which is herein incorporated by reference.

2.8.1.2 Location of Backflow Preventers (*Ref. Title 17 Code Section* 7603)

(a) Air-gap Separation. An air-gap separation shall be located as close as practical to the user's connection and all piping between the user's connection and the receiving tank shall be entirely visible unless otherwise approved in writing by the water supplier and the health agency.

(b) Double Check Valve Assembly. A double check valve assembly shall be located as close as practical to the user's connection and shall be installed above grade, if possible, and in a manner where it is readily accessible for testing and maintenance.

(c) Reduced Pressure Principle Backflow Prevention Device. A reduced pressure principle backflow prevention device shall be located as close as practical to the user's connection and shall be installed a minimum of twelve inches (12") above grade and not more than thirty-six inches (36") above grade measured from the bottom of the device and with a minimum of twelve inches (12") side clearance.

2.8.1.3 Type of Protection Required (*Ref. Title 17 Code Section* 7604)

The type of protection that shall be provided to prevent backflow into the public water supply shall be commensurate with the degree of hazard that exists on the consumer's

premises. The type of protective device that may be required (listed in an increasing level of protection) includes: Double Check Valve Assembly-(DC), Reduced Pressure Principle Backflow Prevention Device-(RP), and an Air-gap Separation-(AG). The water user may choose a higher level of protection than required by the water supplier. The minimum types of backflow protection required to protect the public water supply, at the water user's connection to premises with various degrees of hazard are given in Table 1. Situations which are not covered in Table 1 shall be evaluated on a case-by-case basis and the appropriate backflow protection shall be determined by the water supplier or health agency.

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 3

Recycled Water Quality and Quantity

PARSONS

SECTION 3
RECYCLED WATER QUALITY AND QUANTITY

This section describes the City's Regional Water Quality Control Plant (RWQCP) ownership, effluent quantity and quality, basin quality objectives, comparison between RWQCP final effluent and recycled water regulatory requirements.

3.1 REGIONAL WATER QUALITY CONTROL PLANT

RWQCP is a municipal wastewater treatment plant operated by the City. The plant is located on a 121 acre site at 5950 Acorn Street in the City, south of the Santa Ana River, near the intersection of Van Buren Boulevard and Jurupa Avenue. It started operation in 1946 as a small primary treatment plant and has gone through several major upgrades. The RWQCP is currently designed and permitted to treat 40 million gallons per day (mgd) of wastewater.

The City completed construction of the first phase of the Hidden Valley Wetlands Enhancement Project (HVWEP) in March 1995. The HVWEP has been expanded to include an educational pond and other ponds. Approximately 100 acres of constructed wetlands are being used for additional wastewater treatment (nitrogen removal) from the RWQCP final effluent.

Process Description

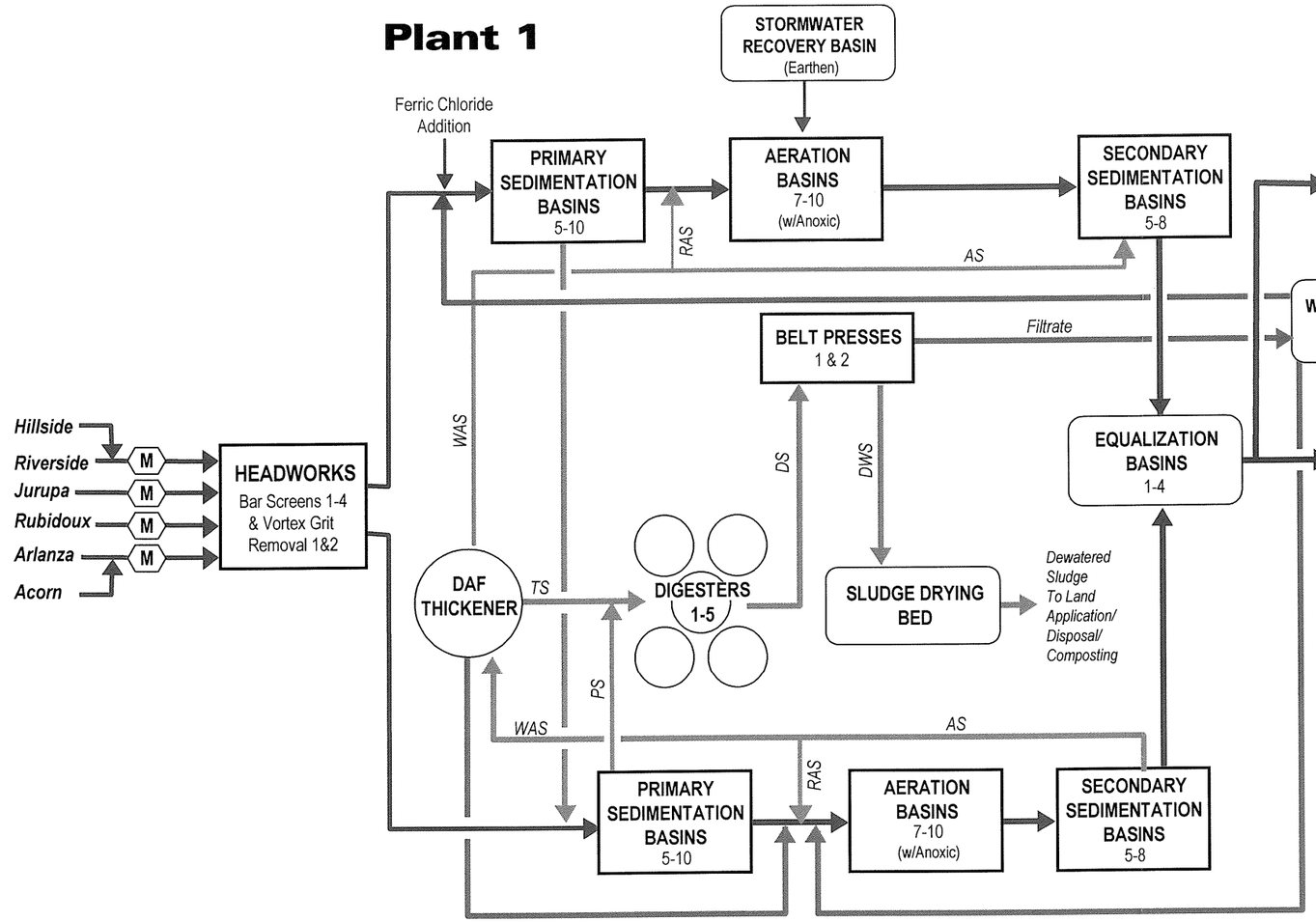
The RWQCP treats wastewater from the following agencies that have contractual agreements with the City: Jurupa Community Services District (JCSD), Rubidoux Community Services District (RCSD), Western Municipal Water District (WMWD) and Edgemont Community Services District (ECSD).

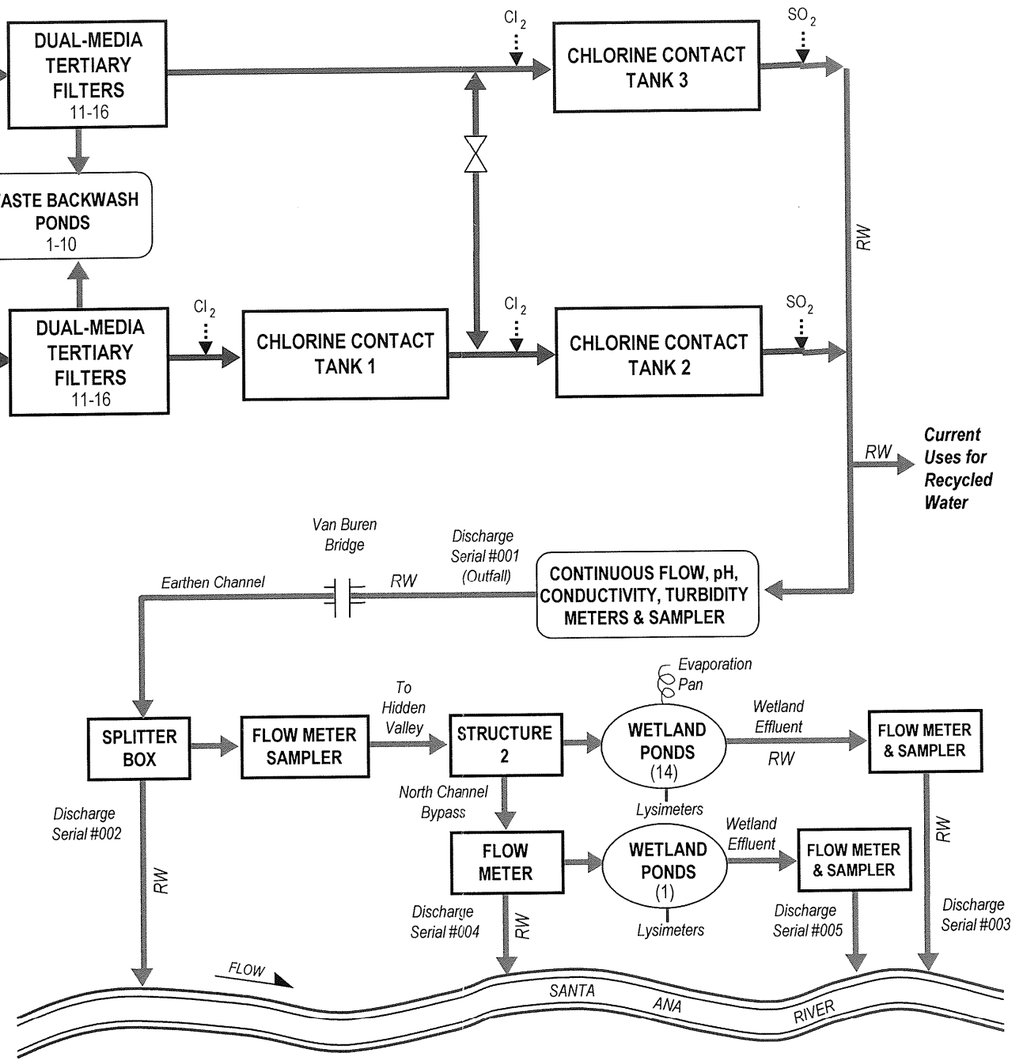
Influents to the RWQCP are metered at a common headworks structure consisting of bar screens and vortex grit removal (Pista Grit System). Effluent from the headworks is proportionately channeled to Plant 1 and Plant 2 consisting of primary clarifiers, aeration tanks, and secondary clarifiers.

Plant 1 and 2 flows are combined in equalization basins prior to tertiary treatment. Tertiary treatment consists of a chemical feed system, dual media filtration (16 filters), chlorination (3 chlorine contact tanks), and dechlorination by sulfur dioxide (SO_2).

The RWQCP discharges tertiary treated wastewater to Reach 3 of the Santa Ana River. Final effluent is conveyed through an earthen channel in the Santa Ana River basin to the HVWEP. Partial flow of approximately 19 mgd is discharged to the Santa Ana River just before the HVWEP; about 13 mgd of flow is directed through the HVWEP for further nitrogen removal.

A schematic diagram of the treatment process of the City's RWQCP is shown in **Figure 3-1**.





LEGEND	
	LIQUID FLOW
	SOLIDS FLOW
	PLANT RECYCLE
	RECYCLED WATER
M	FLOW MEASURED: - E.C. Monitored - pH Monitored - Sampler

ABBREVIATIONS	
PS	PRIMARY SLUDGE
RAS	RETURN ACTIVATED SLUDGE
WAS	WASTE ACTIVATED SLUDGE
AS	ACTIVATED SLUDGE
TS	THICKENED SLUDGE
DS	DIGESTED SLUDGE
DWS	DEWATERED SLUDGE
RW	RECYCLED WATER

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN

Figure 3-1 Riverside Water Quality Control Plant Process Flow Schematic

3.2 SANTA ANA RIVER DISCHARGE/NPDES PERMIT REQUIREMENTS

The Santa Ana River is an effluent dominated natural stream that provides water for recreation and for aquatic and wildlife habitat. River flows are also a significant source of groundwater recharge (approximately 70% of total recharge) in the lower basin, which provides domestic supplies for more than two million people.

The National Pollution Discharge Elimination System (NPDES) permit for discharge into Santa Ana River requires secondary treatment, virus control, in-line coagulation and filtration and improved disinfection (or their equivalents) for all wastewater discharges in order to protect the health of the people who used the Santa Ana River for contact recreation. Control of inorganic nitrogen levels in discharged water is also required to protect the aquatic habitat from un-ionized ammonia toxicity and to manage nitrate levels in groundwater for subsequent municipal uses. Control on residual chlorine levels in discharges is also a requirement of the NPDES permit.

3.2.1 Current NPDES Permit Requirements

The tertiary effluent from RWQCP is discharged into Santa Ana River at two discharge points – before and after the HVWEP. Both discharges are regulated by the recently adopted (January 2001) Santa Ana Regional Water Quality Control Board (RWQCB) Order No. 01-3 replacing Order No. 95-18, NPDES No. CA0105350. This Order is based on the plant's current design rating of 40 mgd ADWF. Copy of the referred NPDES permit is enclosed, as **Appendix A.** Effluent quality standards require tertiary treatment with filters and disinfection equivalent to Title 22 requirements for recycled water, due to the use of receiving waters for water contact recreation.

A summary of the main effluent quality limits is provided in **Table 3-1.**

3.2.2 Future NPDES Permit Requirements

The TIN limits at RWQCP are expected to be reduced to perhaps as low as 8 to 10 mg/L at the conclusion of the Santa Ana River TIN/TDS Study in the near future. Section 2.5 "Regional Board/Local Requirements" of this report discussed more in detail current status of the TIN/TDS study and anticipated TDS and NO3-N limits for groundwater subbasins.

Irrigation with recycled water must be performed in a manner that will ensure the groundwater quality objectives for TIN are met. The City of Riverside as the applicant must demonstrate that the application rates for recycled water do not exceed the plant nitrogen uptake. This will prevent nitrogen from migrating to the groundwater.

Table 3-1
Summary of Key NPDES Effluent Requirements

Parameter	Weekly Average	Monthly Average	Annual Average	Daily Max.	Notes
BOD	30 mg/L	20 mg/L	-	-	
TSS	30 mg/L	20 mg/L	-	-	
NH_4-N	-	5.0 mg/L	-	-	
Chlorine Residual	-	-	-	0.1 mg/L	Instantaneous max, ceiling 2 mg/L
TIN	-	-	10 mg/L 13 mg/L	-	For flow > 38 MGD For flow < 38 MGD
TDS	-	-	650 mg/L	-	250 mg/L incremental limit
Turbidity	-	-	-	-	Daily avg. 2 NTU 5 NTU for 5% of the time during any 24 hours
Coliform	< 2.2 MPN	-	-	-	Max. 23 MPN, once per mo.
pH	-	-	-	6.5-8.5	99% compliance
- not specified					

3.3 RECYCLED WATER - QUANTITY AND AVAILABILITY

3.3.1 Current And Future Availability Of Recycled Water

The RWQCP is currently producing about 32 mgd of recycled water on an annual average basis, while it is designed and permitted to produce up to 40 mgd of recycled water. The RWQCP is master planed for ultimate capacity of 60 mgd. Thus, with the growth in population, the availability of recycled water is likely to go up to 40 mgd in the near future and 60 mgd ultimately.

3.3.2 Santa Ana River Flow Contribution Requirements – Prado Dam Settlement

In support of the Prado Settlement, an agreement between the Western Municipal Water District (WMWD) and the City on November 30 1968, obligated an annual discharge of 15,5250 acre feet (13.38 mgd) from the RWQCP for maintenance of base flows at the Prado Dam. The volume may be slightly reduced by quality and credit adjustments.

The City delivers more effluent than is required under this agreement. It may, in any given year, reduce its adjusted contribution by the amount of such excess deliveries, but in no event shall the City's adjusted contribution be less than 13,420 AFY (11.78 mgd on annual average basis).

However, if the minimum obligations under the Prado Settlement are lowered to 34,000 AFY, then the 13,420 AFY shall be reduced to 12,420 AFY (10.88 mgd on annual average basis). Please note that the City has the option to discharge more during rainy days than during peak demand days.

A copy of the referenced agreement is provided in **Appendix B.**

3.3.3 Hidden Valley Wetlands Enhancement Project

The HVWEP consisting of several unlined wetlands ponds, Treats about 13 mgd of the RWQCP final effluent for further nitrogen removal. Nitrogen is removed by plant uptake. About 3 mgd of water is lost to evaporation and seepage. Therefore, about 10 mgd of the wetlands final effluent joins the Santa Ana River through surface flow. The City could pump this water for non-potable uses, but may prefer to leave it in the Santa Ana River to meet obligations related to Prado Settlement.

3.3.4 Recycled Water Availability for Non-Potable Uses

In summary, currently about 32 mgd of recycled water is available for both non-potable uses and ground water recharge.

Considering the City's obligations associated with the Prado Settlement (maximum 13.38 mgd) and potential losses at the HVWEP (about 3 mgd), about 16 mgd on annual average basis is available for the non-potable water uses discussed in the following section of this master plan.

Considering the projected population growth in the RWQCP service area, including population growth in the City, Jurupa, Rubidox, and Edgemont communities, the recycled water availability is likely to grow with time. However, to be conservative this master plan has considered only 16 mgd available for non-potable water uses.

3.4 RWQCP EFFLUENT (RECYCLED WATER) QUALITY

The RWQCP produces high quality effluent, which consistently exceeds the Title 22 requirements. The final effluent is being used for water recycling and is suitable for additional recycled water uses.

Tables 3-2 through 3-5 summarize the major effluent quality parameters.

Table 3-2
2001 Annual Summary of Suspended Solids, BOD & COD Effluent Monitoring Data (1)

Parameter:	SusSolids	SusSolids	SusSolids	SusSolids	SusSolids	BOD	BOD	BOD	BOD	BOD	COD
Units:	mg/l	mg/l	lbs/day	lbs/day	% red	mg/l	mg/l	lbs/day	lbs/day	% red	mg/l
Limits	20	30	6,672	10,008	85	20	30	6,672	10,008	85	
	avg mnth	avg wkly	avg mnth	avg wkly		avg mnth	avg wkly	avg mnth	avg wkly		
Month	**MONTHLY AVERAGES**										
January	<2	<2	282	283	99.5	<2	<2	454	719	99.2	16
February	<2	<2	<533	<533	99.5	<2	<2	<533	<533	99.3	17
March	<2	<2	<533	<533	99.1	<2	<2	<533	<533	99.1	17
April	<2	<2	<533	<533	99.3	<2	<2	<533	<533	99.1	17
May	<2	<2	661	674	98.8	<2	<2	432	426	98.9	21
June	2	<2	609	553	98.9	2	<2	511	448	99.1	*
July	5	5	1225	1275	98.0	3	3	715	746	98.7	*
August	<2	<2	<518	<518	99.2	<2	<2	<518	<518	99.0	*
September	<2	<2	<568	<568	99.5	<2	<2	<568	<568	99.3	*
October	<2	<2	<576	<576	99.6	<2	<2	<576	<576	99.4	*
November	<2	<2	<572	<572	99.6	<2	<2	<572	<572	99.4	*
December	<2	<2	<564	<564	99.7	<2	<2	<564	<564	99.1	*
	ANNUAL SUMMARY										
Min	2	<2	0	37	95	<2	<2	241	264	98.2	10
Max	10	3	2,590	885	100	4	3	1,058	787	100.0	40
Avg	2.5	1	346	346	99.4	1.9	1.2	451	446	99.2	17
Violations	0	0	0	0	0	0	0	0	0	0	0

(1) Ref: RWQCP 2001 Annual Report

Table 3-2 (Continued)
2001 Annual Summary of Suspended Solids, BOD & COD Effluent Monitoring Data [1]

Parameter:	Flow	ECond	pH	pH	Cl2 Res	Turbidity	Turbidity	Coliform	Coliform	NH_3-N
Units:	MGD	μmhos/cm	SU	SU	mg/l	NTU	NTU	MPN	MPN	mg/l
Limits					0.1 max		≯5	2.2		5
		mnthly avg	6.5 min	8.5 max	[99%]	2	[5%]	7D med max	23 max	avg mnthly
Month	**MONTHLY AVERAGES & MINIMUMS/MAXIMUMS OF pH & COLIFORM**									
January	**32.11**	**928**	**6.57**	**7.23**	**<01**	**0.88**	**0**	**<2**	**4**	**0.20**
February	**32.84**	**920**	**6.71**	**7.17**	**<01**	**0.63**	**0**	**<2**	**2**	**0.20**
March	**32.60**	**929**	**6.71**	**7.10**	**<01**	**0.68**	**0**	**<2**	**23**	**0.20**
April	**31.78**	**923**	**6.68**	**8.32**	**<01**	**0.77**	**0**	**<2**	**4**	**0.20**
May	**31.24**	**937**	**6.71**	**7.13**	**<01**	**0.57**	**0**	**<2**	**2**	**0.30**
June	**31.21**	**921**	**6.76**	**7.27**	**<01**	**0.50**	**0**	**<2**	**13**	**0.30**
July	**31.17**	**924**	**6.50**	**7.21**	**<01**	**0.63**	**0**	**<2**	**2**	**0.13**
August	**31.05**	**919**	**6.84**	**7.24**	**<01**	**0.45**	**0**	**<2**	**2**	**0.38**
September	**31.83**	**922**	**6.51**	**7.48**	**<01**	**0.46**	**0**	**<2**	**2**	**0.60**
October	**32.46**	**917**	**6.62**	**7.16**	**<01**	**0.46**	**0**	**<2**	**2**	**0.30**
November	**32.45**	**926**	**6.50**	**7.50**	**<01**	**0.54**	**0**	**<2**	**23**	**0.38**
December	**31.60**	**960**	**6.50**	**7.00**	**<01**	**0.76**	**0**	**<2**	**2**	**1.10**
	ANNUAL SUMMARY									
Min	**23.52**	**659**	**6.41**	**6.61**	**<01**	**0.29**	**0**	**<2**	**2**	**<0.1**
Max	**38.96**	**990**	**7.36**	**8.32**	**1.88**	**1.52**	**0**	**2**	**23**	**3.9**
Avg	**31.85**	**928**	**6.82**	**7.03**	**0.02**	**0.61**	**0**	**<2**	**<2**	**0.08**
Tot	**11,626.23**									
Violations	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

(1) Ref: RWQCP 2001 Annual Report

Table 3-3
Potable Water - Weighted Average Constituent Concentrations[1]

12 MONTH AVE. DATA				1 MONTH AVERAGE DATA						
DATE	POTABLE WATER TDS	EFFLUENT TDS	INCREMENT	TDS	Cl	SO_4	HARD	Na	NO_3	B
01/01	331	531	200	322	30	54.1	176	37	20.5	0.084
02/01	332	524	192	340	33	56.4	187	40	22.6	0.083
03/01	332	518	186	327	31	55.4	179	39	20.4	0.083
04/01	329	515	186	317	29	56.6	179	38	20.4	0.078
05/01	330	515	185	328	30	54.1	189	40	23.0	0.080
06/01	329	516	186	326	31	53.2	188	38	23.3	0.085
07/01	329	513	184	326	31	52.9	187	39	23.5	0.079
08/01	329	518	189	328	31	53.4	190	39	23.8	0.078
09/01	329	521	192	332	31	54.6	189	39	23.1	0.078
10/01	330	524	194	334	31	54.2	189	39	23.2	0.077
11/01	330	527	197	328	30	57.3	183	39	21.5	0.081
12/01	328	532	204	332	32	57.8	185	41	20.3	0.082

(1) Ref: RWQCP 2001 Annual Report

Table 3-4
RWQCP Effluent Monitoring Part I

Constituent	12-month Avg-Limit (mg/l)	12-month Average (mg/l)	# Exceeded	12-month Avg Emission Rate Limit (lbs/day)	12-month Avg Emission Rate Value (lbs/day)
Total Filtrable Residue	650	531	0	216,840	140,629
Total Hardness	275	207	0	91,740	54,797
Chloride	140	88	0	46,704	23,342
Sodium	110	91	0	36,696	24,370
Sulfate	125	85	0	41,700	21,718
Boron	0.75	0.4	0	250	103
Fluoride	1	0.4	0	334	121
Barium	1	0.02	0	334	6
Iron	0.3	<0.10	0	100	<27
Manganese	0.05	<0.02	0	17	<5
Total Inorganic Nitrogen *(Note 1)*	13	10.1	0	5,004	2,690

Table 3-5
RWQCP Effluent Monitoring on Part II

	Max Daily Limit (µg/l)	Max Daily Value (µg/l)	# Exceeded	Avg Monthly Limit (µg/l)	Avg Monthly Value (µg/l)	# Exceeded
Chromium (VI) *	16	<15	0	11	<15	0
Mercury	2.4	<0.5	0			
Selenium	20	<14	0	5	<14	0
Silver	13.1	<16	0			
Total Recoverable Cadmium	19	<15	0	4.4	<15	0
Total Recoverable Copper	84	22	0	53	19	0
Total Recoverable Lead	1040	<26	0	77	<26	0

	Daily Mass Rate Limit (lbs/day)	Max Daily Mass Rate (lbs/day)	# Exceeded	Avg Monthly Mass Rate Limit (lbs/day)	Avg Monthly Mass Rate (lbs/day)	# Exceeded
Chromium (VI) *	5	<3.8	0	4	<3.8	0
Mercury	0.8	<0.2	0			
Selenium	7	<3.6	0	2	<3.6	0
Silver	4	<4	0			
Total Recoverable Cadmium	6	<3.8	0	1	<3.8	0
Total Recoverable Copper	28	6	0	18	5	0
Total Recoverable Lead	347	<6.6	0	26	<6.6	0

Table 3-6
Effluent Monitoring on January 16, 2001

	Sample Date	Monthly Average (mg/l)	Daily Max (mg/l)	Sample Type
Total Organic Carbon	01/16/2001	7.7		Comp
Carbonate	01/16/2001	0		Comp
Bicarbonate	01/16/2001	150		Comp
Calcium	*		64	Comp
Magnesium	*		11.7	Comp
Specific Cond. in umhos/cm	CONTINUOUS	928	952	Cont
Ammonia nitrogen	*	0.2	Limit = 5.0 mg/l monthly avg	Grab

Table 3-7
Influent Monitoring on January 16, 2001

	Monthly Average		Daily Max		Daily Min	
Ammonia Nitrogen		mg/l	28.1	mg/l		
Total Inorganic N		mg/l	27.3	mg/l		
TDS	579	mg/l		mg/l		
Specific Conductivity	1163	umhos/cm	1242	umhos/cm		
pH			8.92	S.U.s	6.13	S.U.s

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 4
Recycled Water Market Analysis

PARSONS

SECTION 4
RECYCLED WATER MARKET ANALYSIS

City of Riverside (City) prepared a Technical Memorandum on Water Reclamation (TM-2 of the 1992 Master Plan Update) in 1992 to establish the framework for a water recycling system. This section updates the recycled water market survey and assessment (Chapter 4 of TM-2) and includes any changes in demand, and addition/ deletion of potential users. The market analysis focuses on major potential users and their potential contribution to the Phase I project distribution system. The market assessment results will become the basis for the development of this report.

4.1 EXISTING RECYCLED WATER USES

The City currently serves recycled water from the Regional Water Quality Control Plant (RWQCP) to the following three existing users for landscape irrigation:

- Van Buren Golf Center (Sky Link Executive Golf Course)
- Toro Manufacturing Company
- Urban Forest

Table 4-1 summarizes the existing recycled water consumption (November 2001 data) and presents the estimated demands of these users. The estimated demands are approximately 290 acre-feet per year (AFY). The recycled water utilization by these users is anticipated to be stable and should not vary too much in the future. These existing users installed their own pipeline distribution system. The Van Buren Golf Center currently pays about $80/AF for golf course irrigation with recycled water. The Urban Forest irrigates landscape median twice a week on Van Buren/Jurupa (just before the Van Buren Bridge) therefore is not charged for recycled water usage. Toro Manufacturing Company uses recycled water for industrial processing and pays a lower rate of $6/AF.

Table 4-1
City of Riverside Existing Recycled Water Reuse
Recycled Water Usage in November 2001[1]

Facility	Maximum (gpd)	Minimum (gpd)	Average (gpd)	Estimated Demand (AFY)
Van Buren Golf Center (Sky Link Executive Golf Course)	335,000	14,000	173,373	195
Urban Forest	4,550	0	921	25[3]
Toro Manufacturing Company	---	---	62,488 [2]	70

(1) Information is from the RWQCP
(2) Estimated value based on telecom with Toro Manufacturing staff
(3) Including Van Buren Median & Frontage usage

4.2 POTENTIAL RECYCLED WATER USES

The Title 22 effluent produced from the RWQCP is suitable for a variety of reuses, including the following:

Landscape Irrigation

- Parks and recreation centers
- School yards and athletic fields
- Freeway medians and street median strips
- Golf courses
- Churches and cemeteries
- Areas around residential/commercial/industrial developments

Recreational Uses –

- Recreational impoundments
- Ornamental landscape uses and decorative water features (e.g. fountains, reflecting pools, waterfalls, etc.)

Agricultural Uses –

- Food crops
- Harvested feed, fiber and seed
- Orchards and vineyards
- Pasture, nursery and sod, etc.

Industrial/Commercial Uses –

- Industrial process water
- Cooling water
- Vehicle/window washing
- Mixing water for pesticides, herbicides, liquid fertilizers, etc.
- Dust control
- Concrete production
- Fire protection
- Other miscellaneous uses

There are many other potential uses for recycled water, as outlined in the Title 22 guidelines (**Table 4-2**). Many of the identified alternative uses are more occasional or intermittent in nature, such as dust control, fire fighting, flushing sewers, for example. Some uses can provide constant demands throughout the year, such as toilet flushing and groundwater recharge, if feasible for implementation.

Table 4-2

Recycled Water Uses Allowed* In California

This summary is prepared for WateReuse Association, from the December 2, 2000, Title-22 adopted Water Recycling Criteria, and supersedes all earlier versions.

Use of Recycled Water	Treatment Level: Disinfected Tertiary Recycled Water	Disinfected Secondary-2.2 Recycled Water	Disinfected Secondary-23 Recycled Water	Undisinfected Secondary Recycled Water
Irrigation of:				
Food crops where recycled water contacts the edible portion of the crop, including all root crops	Allowed	Not allowed	Not allowed	Not allowed
Parks and playgrounds	Allowed	Not allowed	Not allowed	Not allowed
School yards	Allowed	Not allowed	Not allowed	Not allowed
Residential landscaping	Allowed	Not allowed	Not allowed	Not allowed
Unrestricted-access golf courses	Allowed	Not allowed	Not allowed	Not allowed
Any other irrigation uses not prohibited by other provisions of the California Code of Regulations	Allowed	Not allowed	Not allowed	Not allowed
Food crops, surface-irrigated, above-ground edible portion, and not contacted by recycled water	Allowed	Allowed	Not allowed	Not allowed
Cemeteries	Allowed	Allowed	Allowed	Not allowed
Freeway landscaping	Allowed	Allowed	Allowed	Not allowed
Restricted-access golf courses	Allowed	Allowed	Allowed	Not allowed
Ornamental nursery stock and sod farms with unrestricted public access	Allowed	Allowed	Allowed	Not allowed
Pasture for milk animals for human consumption	Allowed	Allowed	Allowed	Not allowed
Nonedible vegetation with access control to prevent use as a park, playground or school yard	Allowed	Allowed	Allowed	Not allowed
Orchards with no contact between edible portion and recycled water	Allowed	Allowed	Allowed	Allowed
Vineyards with no contact between edible portion and recycled water	Allowed	Allowed	Allowed	Allowed
Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest	Allowed	Allowed	Allowed	Allowed
Fodder and fiber crops and pasture for animals not producing milk for human consumption	Allowed	Allowed	Allowed	Allowed
Seed crops not eaten by humans	Allowed	Allowed	Allowed	Allowed
Food crops undergoing commercial pathogen-destroying processing before consumption by humans	Allowed	Allowed	Allowed	Allowed
Ornamental nursery stock, sod farms not irrigated less than 14 day before harvest	Allowed	Allowed	Allowed	Allowed
Supply for impoundment:				
Nonrestricted recreational impoundments, with supplemental monitoring for pathogenic organisms	Allowed**	Not allowed	Not allowed	Not allowed
Restricted recreational impoundments and publicly accessible fish hatcheries	Allowed	Allowed	Not allowed	Not allowed
Landscape impoundments without decorative fountains	Allowed	Allowed	Allowed	Not allowed
Supply for cooling or air conditioning:				
Industrial or commercial cooling or air conditioning involving cooling tower, evaporative condenser, or spraying that creates a mist	Allowed***	Not allowed	Not allowed	Not allowed
Industrial or commercial cooling or air conditioning not involving cooling tower, evaporative condenser, or spraying that creates a mist	Allowed	Allowed	Allowed	Not allowed

WateReuse Association 1 (916) 442-2746 www.watereuse.org/h2o

Table 4-2 (Continued)

Recycled Water Uses Allowed* In California

This summary is prepared for **WateReuse Association**, from the December 2, 2000, Title-22 adopted **Water Recycling Criteria**, and supersedes all earlier versions.

Use of Recycled Water	Treatment Level			
	Disinfected Tertiary Recycled Water	Disinfected Secondary-2.2 Recycled Water	Disinfected Secondary-23 Recycled Water	Undisinfected Secondary Recycled Water
Other uses:				
Groundwater Recharge	**Allowed under special case-by-case permits by RWQCBs******			
Flushing toilets and urinals	**Allowed**	Not allowed	Not allowed	Not allowed
Priming drain traps	**Allowed**	Not allowed	Not allowed	Not allowed
Industrial process water that may contact workers	**Allowed**	Not allowed	Not allowed	Not allowed
Structural fire fighting	**Allowed**	Not allowed	Not allowed	Not allowed
Decorative fountains	**Allowed**	Not allowed	Not allowed	Not allowed
Commercial laundries	**Allowed**	Not allowed	Not allowed	Not allowed
Consolidation of backfill material around potable water pipelines	**Allowed**	Not allowed	Not allowed	Not allowed
Artificial snow making for commercial outdoor uses	**Allowed**	Not allowed	Not allowed	Not allowed
Commercial car washes, not heating the water, excluding the general public from washing process	**Allowed**	Not allowed	Not allowed	Not allowed
Industrial process water that will not come into contact with workers	**Allowed**	**Allowed**	**Allowed**	Not allowed
Industrial boiler feed	**Allowed**	**Allowed**	**Allowed**	Not allowed
Nonstructural fire fighting	**Allowed**	**Allowed**	**Allowed**	Not allowed
Backfill consolidation around nonpotable piping	**Allowed**	**Allowed**	**Allowed**	Not allowed
Soil compaction	**Allowed**	**Allowed**	**Allowed**	Not allowed
Mixing concrete	**Allowed**	**Allowed**	**Allowed**	Not allowed
Dust control on roads and streets	**Allowed**	**Allowed**	**Allowed**	Not allowed
Cleaning roads, sidewalks and outdoor work areas	**Allowed**	**Allowed**	**Allowed**	Not allowed
Flushing sanitary sewers	**Allowed**	**Allowed**	**Allowed**	**Allowed**

* Refer to the full text of the December 2, 2000 version of Title-22: California Water Recycling Criteria. This chart is only an informal summary of the uses allowed in this version.

The complete and final 12/02/2000 version of the adopted criteria can be downloaded from : <http://www.dhs.ca.gov/ps/ddwem/publications/Regulations/recycleregs_index.htm>

** With "conventional tertiary treatment". Additional monitoring for two years or more is necessary with direct filtration.

*** Drift eliminators and/or biocides are required if public or employees can be exposed to mist.

**** Refer to Groundwater Recharge Guidelines, available from the California Department of Health Services.

Prepared by Bahman Sheikh and edited by EBMUD Office of Water Recycling, who acknowledge this is a summary and not the formal version of the regulations referenced above.

Toilet flushing with recycled water is becoming more prevalent in Southern California (e.g. Irvine Ranch Water District). However, dual plumbing with cross-connection prevention and backflow protection devices would be required to protect potable water. Therefore, this is generally implemented for new buildings. Retrofitting existing facilities for dual plumbing is costly and cumbersome. Similarly, it would require extensive geotechnical investigation to determine the feasibility of groundwater recharge projects. For the purpose of this study, only landscape irrigation, agricultural irrigation, recreational, commercial and industrial uses will be addressed in the market survey and assessment.

4.3 MARKET SURVEY

The market survey compiled for this project consist of major potential users within Phase I project boundary, which includes a 70 percent probability capture of the City users, as well as users in Jurupa Community Service District (JCSD) and Rubidoux Community Service District (RCSD) that are located around the City boundaries, as shown on **Figure 4-1**.

The City dictates that the market survey be limited within a two-mile radius of the RWQCP for the Phase I Feasibility Study. The major potential recycled water users were identified and compiled using information contained in the City's 1992 Master Plan Update TM-2, Thomas Bros. Maps, JCSD Indian Hills Water Recycling Project Report and field survey by Parsons.

Letters and questionnaire forms were sent to existing and potential recycled water users within the City to gather information to update projected demands and assess degree of future customer interest. It was anticipated that these identified users would have the most interest in the distribution systems developed in this study.

4.3.1 Classification of Potential Users

The market survey and assessment focuses on the users, which will significantly impact the recycled water distribution system alignment and project economic feasibility. In order to quantify and organize total potential demands, the users have been categorized as follows:

- **Major Potential Users.** Major users have a potential recycled water demand of 10 AFY or more. These users are the focus of the market survey since they represent the majority of potential reuse and dictate the alignment of the distribution system. Major potential users are further distinguished as existing or future consumers.
    - **Existing Facilities.** These users include facilities that are either currently in place or will be in business in the near-term. Near-term denotes facilities scheduled for development and water connection in the next five years. These facilities are typically in a construction or final planning stage.
    - **Future/Planned Facilities.** Accordingly, these users denote facilities in the preliminary or conceptual planning stage. Facility development will not occur in the next five years.

LEGEND

User Symbol		Potential Reuse (Acre Feet / Year)
Existing Facility	Future Facility	
▲	△	10 - 49
■	□	50 - 99
●	○	100 - 199
◆	◇	200 - 399
⬣	⬡	400 Plus
		City of Riverside Boundary

GRAPHIC SCALE

0 6000' 12000'

SCALE: 1" = 6000'

FIGURE 4-1 POTENTIAL RECYCLED WATER USERS

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN

SEPTEMBER 2003

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- **Minor Potential Users.** Minor users include users with a potential recycled water demand less than 10 AFY. Minor users include small parks and schoolyards and small residential, commercial, and industrial landscape irrigation areas. Since minor users are prevalent throughout the City, they do not influence the alignment of the recycled water distribution system and are not specifically identified in this market survey. Furthermore, it may not be economically feasible to serve many minor users due to remoteness from major reuse areas or prohibitive on-site repiping costs for small industrial users. While minor industrial users are not included in the market assessment, some minor irrigation users near main recycled water transmission lines can be served. Therefore, the Market Assessment section of this chapter incorporates some potential minor irrigation consumption when assessing market demands.

4.3.2 Survey of Major Potential Users

A comprehensive market survey was conducted throughout the City to identify the potential major recycled water users. Many potential users were contacted to verify water consumption, estimate potential reuse, and assess the general sentiment on water recycling. As mentioned earlier, market survey was focused on the major users who could have a significant effect on distribution system alignment and project economics. The market survey involved data collection from the following categories:

Landscape Irrigation. This irrigation market includes cemeteries, universities, colleges, schools, golf courses, parks, hospitals, airports, sports complex, nursery, greenbelts, commercial, commercial and industrial users. An initial database of potential users was developed from the City's 1992 Master Plan Update (TM-2). The following sources provided information to update and expand user base and estimate potential demands:

- City of Riverside – Park & Recreation, Public Works, Public Utilities, and Planning Departments
- Riverside and Alvord Unified School Districts
- Contacts with major potential users
- Various reports
- City maps and Thomas Brothers Map Guide

Selected agencies representing cemeteries, universities, colleges, schools, parks, golf courses, hospitals, and industries were contacted to obtain information about their current water use and future potential recycled water uses.

Agricultural Irrigation. No market survey was conducted for the agricultural users. The City has substantial agricultural acreage, primarily orange groves, which are presently served by the Gage Canal, Riverside Canal and some potable wells. These users are ideal candidates for recycled water. The water pumped from various wells to the canal is currently distributed to agricultural users by Gage Canal Company at a relatively low rate. It may be the City's best interest to replace the potable quality water in the Gage Canal with recycled water to serve these sites in the future.

Agricultural irrigation is included in this market assessment for potential recycled water demand but is not considered for the development of the core distribution system and cost analysis.

Industrial. Several industries were contacted to obtain their potential interest in using recycled water for irrigation and/or processing water. Additional input from the RWQCP's Compliance and Monitoring Group was also obtained to update the reuse potential of those industries previously identified on the 1992 list.

Commercial. No specific information was available on potential commercial reuse. An estimate was generated for the market assessment based on the City's 1992 Master Plan Update, field survey, and previous experience.

4.3.3 User Codes and Classifications

Each major potential user was allocated a unique code number with the first digit corresponding to the type of facility (golf course, park, industry, etc.). Major potential users are categorized as shown in **Table 4-3** below.

Table 4-3
Potential Recycled Water User Code and Classification

Code	Description of Users
100 Series	Cemeteries
200 Series	Colleges, Universities, Schools
300 Series	Golf Courses
400 Series	Parks
500 Series	Miscellaneous (airport, nurseries, etc.)
600 Series	Freeway Irrigation and City Greenbelts
700 Series	Commercial
800 Series	Industrial - Landscape Irrigation
900 Series	Industrial - Process

Larger users are located and represented symbolically on the map figures of this report based on their potential reuse, as shown in **Table 4-4**.

Table 4-4
Symbolical Representation

Symbol	Potential Recylced Water Users (Acre Feet/Year)
▲	10 - 49
■	50 - 99
●	100 - 199
◆	200 - 399
⬢	400 or more

The potential users who currently exist or will be in business within the next 5 years are identified with solid colored symbols while future facilities are represented with hollow symbols. This procedure identifies general growth areas and facilitates distribution system layout, phasing and extensions.

4.4 MARKET ASSESSMENT

Data gathered in the market survey included existing and major potential recycled water users, type of recycled water use, specific water quality requirements, estimated demands and schedule of water usage for irrigated areas.

The following were steps undertaken to assess potential recycled water users market for the Phase I Project:

1. Evaluated several alternatives and identified Phase I project boundary based on major potential recycled water users around the vicinity of RWQCP.
2. Sent letters and recycled water user survey forms to potential users to verify and update demands.
3. Conducted field investigations within Phase I project boundary to ensure accuracy in demands of identified major potential users.
4. Developed understanding for on-site conversion needs from potable to recycled water.
5. Performed economical analysis on various alternatives to identify the most cost effective recommendation for the project.

4.4.1 Average Annual Demand

Tables 4-5, 4-6 and 4-7 summarize the average annual demand for the potential major recycled water users within the City, and along the northerly and southerly boundaries, respectively. Their ID code number, acreage (if available) and potential reuse volume are also included in these tables. Note that some of the schools within the Riverside and Alvord Unified School Districts are located outside of City limit (see Figure 4-1) but are grouped together with the other schools in Table 4-5.

The potential landscape irrigation demands are based on actual water consumption data if available. Otherwise, demand is calculated as 2.5 AFY per irrigated acre based on the findings of previous area studies. This multiplier was previously verified by an investigation of water consumption by the City Parks and Recreation Department.

The potential commercial reuse demand is an estimated value. The potential industrial demands are based on actual consumption data provided by the water utilities department. Location of these potential users can be found on Figure 4-1.

4.4.2 Potential User Demands by Category Within the City

Cemeteries. Three cemeteries within the City were identified and assessed with an estimated total potential demand of 253 AFY. Crestlawn Memorial Park currently uses non-potable ground water for irrigation.

Table 4-5
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
	CEMETERIES			
101	Crestlawn Memorial Park	190	35	88
102	Evergreen Memorial Park	25	22	55
103	Olivewood Memorial Park	78	35	110
	SUBTOTAL			**253**
	SCHOOLS			
	Colleges/Universities			
201	California Baptist University	65	23	60
202	California School for the Deaf	90	32	80
203	La Sierra University	--	90	225
204	Riverside Community College	115	40	100
205	University of California Riverside	1,140	320	480
				945
	Riverside Unified School District			
206	Adams Elementary School	8	4	10
207	Alcott Elementary School	10	5	13
208	Arlington High School	47	24	59
209	Bethel Christian High School	20	10	25
210	Bryant Elementary School	3	1	3
211	Castle View Elementary School	12	6	15
212	Central Middle School	21	11	26
213	Chemawa Middle School	21	11	26
214	Earhart Middle School	20	15	38
215	Emerson Elementary School	10	5	13
216	Franklin Elementary School	10	5	13
217	Fremont Elementary School	10	5	13
218	Gage Middle School	18	9	23
219	Grant Elementary School	10	2	5
220	Harrison Elementary School	15	8	19
221	Hawthorne Elementary School	6	3	6
222	Highgrove Elementary School	10	5	13
223	Highland Elementary School	10	5	13
224	Hyatt Elementary School	8	4	10
225	Jackson Elementary School	11	6	14
226	Jefferson Elementary School	10	5	13
227	King High School	50	35	88
228	Liberty Elementary School	6	2	5
229	Lincoln High (Alternative School)	4	2	4
230	Longfellow Elementary School	5	0.3	1
231	Madison Elementary School	10	5	13
232	Magnolia Elementary School	9	5	11
233	Monroe Elementary School	10	5	13
234	Mt View Elementary School	13	7	16
235	North High School	43	22	54
236	Notre Dame High School	20	10	25
237	Pachappa Elementary School	7	3	6

Table 4-5 (Continued)
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
238	Poly High School	40	20	50
239	Raincross High/Ed Options Center (Alt. Sch.)	7	1	2
240	Ramona High School	54	27	68
241	Riverside Adult School (Alt. School)	6	1	1
242	Riverside Christian High School	20	10	25
243	Rivera Elementary School	10	1	2
244	Sierra Middle School	20	10	25
245	Sunshine Elementary School	10	0.1	0.3
246	Taft Elementary School	10	5	13
247	University Heights Middle School	18	9	23
248	Victoria Elementary School	6	3	6
249	Washington Elementary School	10	5	13
				833
	Alvord Unified School District			
251	Alvord High School	4	2	5
252	Arizona Intermediate School	20	10	25
253	Arlanza Elementary School	12	6	15
254	Colette Elementary School	10	5	13
255	Foothill Elementary	11	6	14
256	La Granada Elementary	7	4	10
257	La Sierra Academy High School	20	10	25
258	La Sierra High School	46	23	58
259	Loma Vista Intermediate School	22	11	28
260	McAuliffe Elementary School	10	5	13
261	Myra Linn Elementary School	8	4	10
262	Norte Vista High School	47	24	59
263	Orrenmaa Elementary School	10	5	13
264	Promenade Elementary School	10	5	13
265	Rosemary Kennedy Elementary School	10	5	13
266	Sherman Indian High School	85	40	100
267	Terrace Elementary School	10	5	13
268	Twinhill Elementary School	11	6	14
269	Valley View Elementary School	10	5	13
270	Wells Intermediate School	20	10	25
				478
	SUBTOTAL			**2,256**
	Future Schools			
271	Ysmael Village Elementary School	--	6	15
272	Alessandro Heights Elem School	10	5	13
273	Lake Hills Elementary School	10	5	13
274	Mockingbird Canyon Elementary	10	5	13

Table 4-5 (Continued)
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
275	Orangecrest 2 Elementary School	12	6	15
276	Orangecrest High School	54	27	68
277	Orangecrest Middle School	21	11	26
278	South Woodcrest Elem School	10	5	13
	SUBTOTAL			**176**
	GOLF COURSES			
301	Canyon Crest Country Club	152	120	300
302	Fairmount Park Golf Course	100	80	200
303	Ingalls	35	30	75
304	Riverside Golf Club	108	86	215
305	Van Buren Golf Center (Sky Links Golf Course)	--	--	195
306	Victoria Club	120	100	350
	SUBTOTAL			**1,335**
	Future Golf Courses			
307	Tequesquite Landfill Golf Course	100	80	200
308	Rancho La Sierra	100	80	200
	SUBTOTAL			**400**
400	**PARKS**			
401	Arlington	4	4	10
402	Bergamont	5	2	6
403	Bobby Bonds Park/Cesar Chavez Ctr.	15	15	38
404	Bordwell Park/Stratton Center	23	23	58
405	Bryant, John/Aelanza Center	22	22	55
406	Carlson	1.8	1.4	4
407	Castleview	26.6	1.25	3
408	Castleview Park Site	27	27	68
409	Collett	6	4	9
410	Dario Vasquez	1.8	1.03	3
411	Don Derr Park	24	24	61
412	Don Jones	6	6	15
413	Don Lorenzi Sport Camp	9	9	22
414	Evans, Samuel C.	12	12	30
415	Fairmount	165	70	175
416	Frost Reservoir	10	10	25
417	Harrison	6	6	15
418	Highland	7	7	17
419	Hunt Park/ Renck Center	14	14	35
420	Hunter	36	26	65
421	Islander	28	24	60
422	La Sierra Park / La Sierra Center	28	28	70
423	Lincoln	4	3	7

Table 4-5 (Continued)
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
424	Low	1	1	3
425	Martha Mclean Anza Narrows	--	200	500
426	Mount Vernon	8	8	20
427	Mtn. View	6	6	15
428	Myra Linn	9	9	23
429	Newman	0.4	0.4	1
430	Nichols Park / Joyce Jackson Center	17	17	43
431	North	1.4	1.4	4
432	Orange Terrace Community	--	15	38
433	Patterson	5	5	11
434	Rancho Loma	7	6	14
435	Reid Park / Ruth Lewis Center	41	29	73
436	Rutland	9	9	23
437	Shamel	10	10	25
438	Swanson	1	1	2
439	Taft	7	2	4
440	Thundersky	12	10	26
441	Villegas Park / Ysmael Villegas Ctr.	18	18	45
442	Washington	4	4	10
443	White Park / Dales Center	6	6	15
	SUBTOTAL			**1,744**
	Future Parks			
444	Alessandro Heights	10	10	25
445	Andulka	37	37	93
446	Campbell & Golden	10	10	25
447	Challen Hill	34	34	85
448	Hillside Ave	10	10	25
449	Hunter Business	10	10	25
450	Landfill Area Park	40	40	100
451	Lusk Highlander	10	10	25
452	Mitchell Ave	6	6	15
453	Orange Terrace Comm.	21	21	53
454	Orangecrest #2	4	4	10
455	Prenda Reservoir	25	15	38
456	Quail Run	27	27	68
457	Rancho La Sierra	60	60	150
458	River Ranch	10	10	25
459	Tequesquite Arroyo	43	43	108
460	Victoria - Cross	10	10	25
	SUBTOTAL			**895**
	MISCELLANEOUS USES			
501	Kaiser Permanente Hospital	40	12	30
502	Parkview Comm. Hosp. Med. Ctr.	--	5	13

Table 4-5 (Continued)
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
503	Riverside Municipal Airport	304	50	125
504	Riv. Community Hospital	--	--	10
505	Teen Challenge International	--	10	25
506	AB Brown Sports Complex	47	24	59
507	Wholesale Nursery	10	3	6
	SUBTOTAL			**268**
	Future Miscellaneous Uses			
503	Riverside Municipal Airport	304	100	250
508	Riverside Pkwy @ La Sierra University	--	--	20
	SUBTOTAL			**270**
	GREENBELTS			
601	Caltrans Hwy 60 (2 Mi)	--	--	71
602	Caltrans Hwy 215 (2 Mi)	--	--	71
603	Caltrans Hwy 91 (12 Mi)	--	--	213
604	City Medians	165	165	413
605	Van Buren Median & Frontage (Urban Forest)	-	10	25
	SUBTOTAL			**793**
	Future Greenbelts			
604	City of Medians	40	40	**100**
	COMMERCIAL			
	Existing Commercial Establishments	--	--	**500**
	Future Commercial Establishments	--	--	**300**
	INDUSTRIES - LANDSCAPE IRRIGATION			
801	Bourns, Inc.	--	5	13
802	Caddock Electronics, Inc.	--	--	6
803	Corona College Heights	--	--	6
804	Layton Softwater	--	--	6
805	Progressive Wheel	--	--	6
806	Toro Irrigation (Manufacturing Company)	--	--	70
807	Dow Jones & Company, Inc.	--	--	50
808	Airport Industrial Area	--	--	100
809	La Sierra Industrial Area	--	5	13
810	Hunter Park Industrial Area	--	50	125
811	Residential Industrial Area	--	5	13
812	Presidential Industrial Area		6	15
	SUBTOTAL			**422**
	INDUSTRIES - PROCESS			
901	Alumax Mill	--	--	74
902	Bourns	--	--	12
	SUBTOTAL			**86**

Table 4-5 (Continued)
Recycled Water Average Annual Demand
Major Potential Users within the City/School Districts

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
	Future Industries - Process			
903	400 MW Power Plant (planned by PUD)	--	--	150
	Other future industries	--	--	700
	SUBTOTAL			**850**
	MINOR POTENTIAL REUSE			
	City Total	--	--	**1,000**

SUMMARY OF POTENTIAL USES

Existing		
Landscape Irrigation		6,648
Industrial Process/Commercial		1,008
Minor		1,000
SUBTOTAL		**8,656**
Future Establishments		
Landscape Irrigation		1,841
Industrial Process/Commercial		1,150
SUBTOTAL		**2,991**
GRAND TOTAL		**11,647**
	Say	**11,700**

Table 4-6
Recycled Water Average Annual Demand
Major Potential Users Along City's Northerly Boundary

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)	Status*
	AREA GOLF COURSES				
309	El Rivino Country Club	90	72	180	Existing
310	India Hills Golf Course**	--	--	600	Existing
311	Jurupa Hills Country Club	110	88	220	Existing
312	Paradise Knolls Golf Course	70	56	140	Existing
	SUBTOTAL			**1,140**	
	AREA PARKS				
461	Havenview Park No. 1**	35	30	12	Existing
462	Havenview Park No. 2**	35	30	15	Existing
	SUBTOTAL			**27**	
	MISCELLANEOUS				
509	EDA Streetscape East of Camino Real & Limonite	--	--	36	Existing
510	JUSD (Linares)**	--	--	27	Existing
511	NE Corner Limonite and Clay**	--	--	9	Existing
512	W. Side Camino Real**	--	--	8	Existing
513	Camino Real South of Lamonite**	--	--	0.1	Existing
	SUBTOTAL			**80**	
	INDUSTRIES				
903	Northwest Pipe Company	--	6	25	Existing
904	Robertson Ready Mix	--	--	35	Existing
	SUBTOTAL			**60**	
	TOTAL			**1,307**	
			Say	**1,310**	

* Only existing potential users were assessed outside the City limits
** JCSD Indian Hills Water Recycling Project

Table 4-7
Average Annual Demand
Major Potential Users Along City's Southerly Boundary

ID Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)	Status*
1. USERS CURRENTLY SERVED BY GAGE CANAL AND/OR RIVERSIDE CANAL					
	AREA CEMETERIES				
104	Riverside National Cemetery	740	280	700	Existing
	SUBTOTAL			**700**	
200	**AREA SCHOOLS**				
279	Woodcrest Christian High School	20	10	25	Existing
280	Woodcrest Elementary School	10	2	4	Existing
	SUBTOTAL			**29**	
300	**AREA GOLF COURSES**				
313	March AFB Golf Course	90	72	180	Existing
	SUBTOTAL			**180**	
500	**MISCELLANEOUS**				
514	March Air Force Base	--	6	15	Existing
	SUBTOTAL			**15**	
600	**GREENBELTS**				
606	March Air Force Base	--	6	**15**	Existing
	TOTAL			**939**	
2. USERS CURRENTLY SERVED BY POTABLE WATER					
	AREA CEMETERIES				
105	Green Acres Memorial Gardens	85	55	138	Existing
	SUBTOTAL			**138**	
300	**AREA GOLF COURSES**				
314	Cresta Verde Golf Course	140	112	280	Existing
	SUBTOTAL			**280**	
	TOTAL			**418**	
	GRAND TOTAL			**1,360**	

* Only existing potential reuse was assessed outside the City limits

Schools. Five colleges/universities and two school districts were surveyed. La Sierra University has its own well. Irrigated areas for all schools were identified and assessed at 2.5 AFY per acre. The reuse potential for the colleges/universities totals 945 AFY for landscape irrigation. Existing major elementary, intermediate, and high schools have been assessed at 1,311 AFY. Future schools add another 176 AFY.

Four schools under this category has a recycled water demand equal to or greater than 100 AFY, including La Sierra University (225 AFY), Riverside Community College (100 AFY), University of California Riverside (480 AFY), and Sherman Indian High School (100 AFY).

Golf Courses. Six existing area golf courses were assessed at a total potential recycled water demand of 1,335 AFY. These existing golf courses include Canyon Crest, Fairmount Park, Ingalls, Riverside, Van Buren (Sky Links) and Victoria courses. An additional potential demand of 400 AFY is identified for two future golf courses, the Tequesquite Landfill Golf Course and Rancho La Sierra Golf Course. The Van Buren golf course is one of the three existing recycled water users in the City. All except one golf course have a demand close to or greater than 200 AFY.

Minimal amount of water is currently purchased from the City because the majority of these golf courses have their own wells. However, these potential users are still considered and are included in this market assessment.

Parks/Recreational Areas. Forty-three existing major parks/recreational areas have a total reuse potential of 1,744 AFY with an additional 895 AFY for future parks. Seventeen future major parks were identified within the City with a total area of 357 acres. Fifteen of the seventeen future parks are planned with an area larger than 10 acres. It should be noted that parks can have acreage less than 5 AFY and could be served recycled water economically.

Five of the parks/recreational areas were identified with a recycled water demand exceeding 100 AFY, including Fairmount, Martha Mclean Anza Narrows, Landfill Area Par, Rancho La Sierra, and Tequesquite Arroyo.

Miscellaneous Irrigation. This category includes irrigation at hospitals, airport, sports complex and nursery grounds. The major reuse potential in this group is Riverside Municipal Airport, which has an existing reuse demand of 125 AFY and a future demand of 250 AFY. The total potential reuse demand for this category is 268 AFY for existing facilities and 270 AFY for future facilities.

Greenbelts and Freeway Irrigation. Approximately 355 AFY is assessed for irrigating the three freeways that traverse through the City (i.e. Hwy 60, Hwy 215, and Hwy 91). The recycled water demands for irrigating the city medians are estimated to be 438 AFY for the existing facilities and 100 AFY for future facilities.

Commercial. The potential commercial users were not surveyed for recycled water use. A total estimate of 800 AFY for total commercial reuse was generated based on the City's 1992 Master Plan Update, field survey, and previous experience.

Industries Landscape Irrigation. The primary users in this group are various industries and the future 400 MW power plant planned by the City of Riverside Public

Utility Department. The user base identified a total potential users demand of 422 AFY for existing facilities and 850 AFY for future facilities.

Industries Process. Two industries in this category were identified with a total recycled water demand of 86 AFY.

Minor Potential Reuse. The minor potential reuse assessment represents a fragment of the minor nonpotable market in the City. Minor users include small greenbelts, parks, schoolyards, residential, commercial and industrial landscape irrigation areas. The minor reuse potential has been assessed at 1,000 AFY.

Agricultural Irrigation. The City owns the Gage Transmission System, which is operated by the Gage Canal Company. The present capacity of the system, as reported by the City, is approximately 30,000 gpm (43 mgd). The City owns 19000 gpm of this capacity.

Gage Canal gets 24,000 gpm from Gage well system and 6,000 gpm from the City potable wells. Out of 24,000 gpm from Gage wells, the City is stockholder for 13,000 gpm and Gage Canal Company for 11,000 gpm. Out of 11,000 gpm, the City trades with the Gage Canal for 5,400 gpm for potable uses and provides 25 percent more from the Riverside Canal system in the down stream.

The total length of the Gage Canal transmission system is approximately 54,300 linear feet. In the upper reach of the Gage Transmission Pipeline (approximately 6,500 linear feet) the pipeline increases in diameter from 24 to 30, 36, 42 and 48 inches. The remainder of the transmission pipeline varies in diameter from 48 to 60 inches. At the terminal point of the pipeline (Linden Street), a 36-inch diameter pipeline delivers potable water to the Linden and Evans Reservoirs.. Given the City's share of the Gage Canal Company and water exchange agreements, the City's continuous delivery of domestic water to the Linden and Evans reservoirs is approximately 24,400 gpm (35.6 mgd). Typically, for a period of two months in the winter, the lower Gage Canal system is taken out of service for maintenance and the entire Gage transmission capacity is available for use by the City of Riverside. All deliveries up to 27,000 gpm (39 mgd) flow by gravity through a 36-inch-diameter pipeline, which connects the turnout on Linden Street to the Linden and Evans reservoirs.

The lower reaches of the Gage Transmission system, which is used exclusively for agricultural irrigation, could be of use for excess recycled water. This utilization would reduce the amount of groundwater pumping required for irrigation.

The City operates a second canal, the Riverside Water Company Canal, that is used for irrigation water conveyance and storm water control. Non-potable wells in the Colton and Riverside groundwater basins are pumped to provide the exchange water with the Gage Canal Company, and to meet irrigation conveyance and delivery obligations with other agencies.

"Approximately 8,000 AFY of non-potable water is delivered to the Gage Canal Company through a pumping system on the Riverside Canal. An additional 6,000 AFY may be delivered to Western Municipal Water District under the terms of a 2003

agreement. In addition the Riverside Canal conveys water produced on behalf of San Bernardino Valley Municipal Water District for delivery to Orange County Water District, and water produced for delivery to Elsinore Valley Municipal Water District (the so-called Temescal Water rights)."

The agricultural demand currently met through the use of non-potable water represents a large potential market for recycled water, perhaps as much as 30,000 AFY. However, the non-potable water supply is cheap and easily accessible. Furthermore, there are a number of institutional issues related to the delivery of recycled water to these other agencies. However, the feasibility and cost effectiveness of this recycling opportunity should be explored in detail.

For the purpose of this study, the agricultural users are included in the market assessment as potential users but not considered for development of the core distribution system and cost analysis. The impact of future development in the agricultural areas must be considered as it affects water reuse.

4.4.3 Potential Recycled Water Demands Along City's Northerly Boundary

A study was done by the JCSD entitled Indian Hills Water Recycling Project which provided the potential user demand for both JCSD and RCSD. This report consists of areas currently using potable water and proposed new areas of reuse. Approximately 1,310 AFY is predicted by JCSD for potential reuse of recycled water for golf course irrigation (4 courses), park irrigation, industrial use, and other miscellaneous uses. **Table 4-6** provides detailed information of these potential users along the City's northerly boundary.

4.4.4 Additional Recycled Water Demands Along City's Southerly Boundary

The City may consider selling recycled water to downstream users (e.g. Norco, Rancho La Sierra, etc.) in the future. Among the potential water recycling opportunities along the City's southerly boundary, there are some existing users currently receiving water from either Gage Canal or Riverside Canal. Approximately 940 AFY of recycled water demand is expected from these potential users.

In addition to the above potential users currently served by the Gage Canal/Riverside Canal, other users along the City's southerly boundary currently served by potable water were also identified with a total potential recycled water demand of 440 AFY. Nearly all of the identified demands are for irrigation. **Table 4-7** provides detailed information of these potential users along the City's southerly boundary.

4.5 PEAKING FACTORS

Recycling water user demands typically vary on a monthly, daily, and hourly basis. A typical irrigation demand curve is depicted in **Figure 4-2**. Peaking factors used for the hydraulic modeling are described under Section 5.3 of this report.

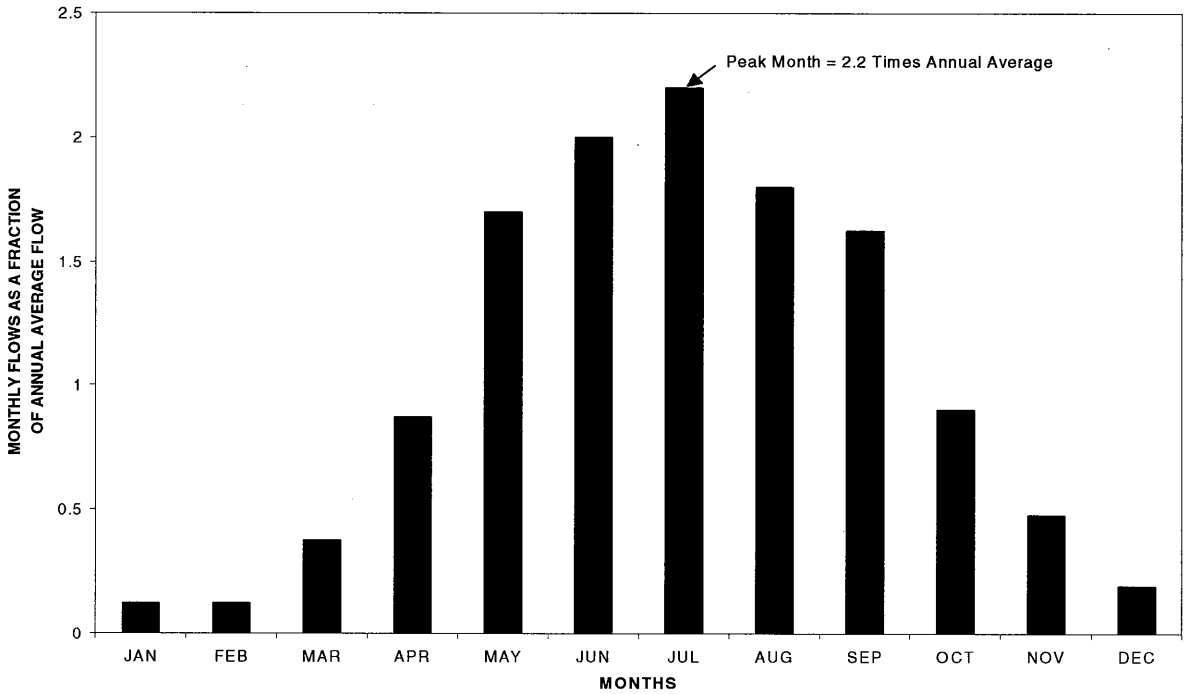


Figure 4-2
Typical Monthly Irrigation Demand

The peaking factors terminology normally used is discussed below.

- **Maximum Month Demand (MMD).** Demand is greatest during the months with low precipitation. MMD varies greatly in most arid regions due to climate changes and evapo-transpiration rates from winter to summer. MMD is important to consider for availability of plant effluent for various customers, and seasonal storage requirements. .
- **Maximum Day Demand (MDD).** MDD is important in determining on-site or off-site storage requirements to meet the demands, and available recycled water for delivery to customers. The peaking factor for MDD is generally depicted as a ratio of the MDD to the MMD.
- **Peak Hour Demand (PHD).** PHD is important in determining proper distribution system sizing (pipelines and pumping requirements). With recycled water irrigation for landscape irrigation, demands and irrigation schedules are generally restricted to nighttime irrigation, an 8- to 10-hour irrigation "window". Due to this restriction, PHD for recycled water systems is typically high compared to that for potable water systems. PHD for recycled water systems range from 1.5 to 3.0 times the MDD.

4.6 SUMMARY

Table 4-8 summarizes the City's total non potable reuse potential. Approximately 20,400 AFY of recycled water demand can be reasonably anticipated within the City limits and in the vicinity. By category, the potential reuse of recycled water for irrigation totals 12,600 AFY; the industrial process/commercial reuse is assessed at 1,800 AFY. The reuse potential for agricultural irrigation is conservatively estimated at 6,000 AFY through the replacement of pumped non-potable groundwater with recycled water in the Gage and Riverside canals.

Preliminary supply and demand analysis indicates that the 32 mgd of recycled water produced from the RWQCP would meet annual average demands. Storage facilities would be required to meet the peak monthly/daily/hourly demands.

Due to the speculative nature of current arrangements between the City of Riverside and neighboring cities, this report assumes all required water would be available from the RWQCP. No arrangement for potable water supply supplement is investigated, although minimally a potable water supply hookup will be required for emergencies.

This estimated market does not include demands within the City's 15,000 acre southerly sphere of influence.

Table 4-8
Recycled Water Average Annual Demand
Assessment of Direct Nonpotable Reuse Market

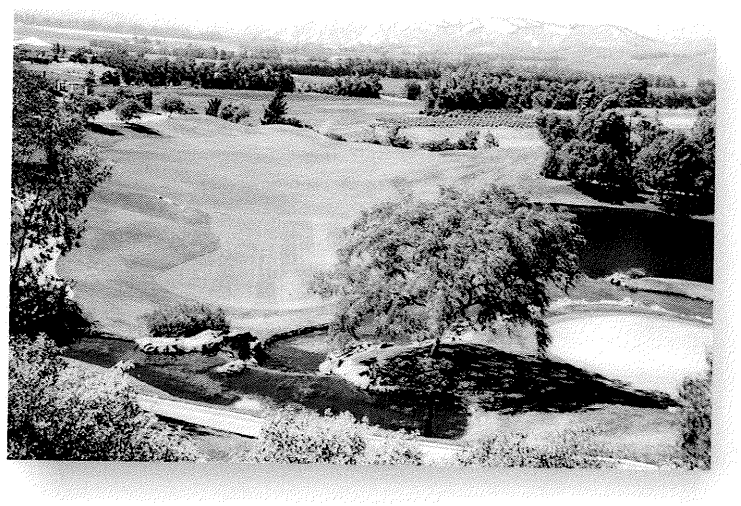
User Code	Category	Reuse Potential (AFY) Existing Establishment		Future Establishment
A.	**Within the City Limts/School Districts**			
	Landscape Irrigagation			
100	Cemeteries	253		
200	Colleges/Universities/Schools	2,256		176
300	Golf Courses	1,335		400
400	Parks	1,744		895
500	Miscellaneous	268		270
600	Freeway Irrigation and City Greenbelts	793		100
800	Industrial - Landscape Irrigation	422		
	Subtotal	7,070		
	Minor Potential Users	1,000		
	Subtotal - Landscape Irrigation	**8,070**		**1,841**
	Industrial Process/Commercial			
700	Commercial	500		300
900	Industrial - Processes	86		850
	Subtotal - Industrial Process/Commercial	**586**		**1,150**
Total Within City Limits		**8,656**		**2,991**
Total Existing and Future		**11,700**	**AFY**	
B.	**Additional Users Along City's Notherly Boundary**	**1,310**	**AFY**	
C.	**Potential User's Along City's Southerly Boundary**	**1,360**	**AFY**	
D.	**Potential Agricultural Irrigation Usage**	**6,000**	**AFY**	
E.	**Grand Total (A + B + C + D)**	**20,370**	**AFY**	
	Say	**20,400**	**AFY**	
	Jurupa Community Water District	**770**	**AFY**	**(Ref. Table 6.1)**

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 5

Citywide Recycled Water System



PARSONS

SECTION 5
CITYWIDE RECYCLED WATER SYSTEM

5.1 GENERAL PROJECT DESCRIPTION

The purpose of the Citywide Recycled Water Master Plan is to update the 1992 Water Reclamation Master Plan Technical Memorandum No. 2: Water Reclamation for the Regional Water Quality Control Plant Master Plan report prepared by Montgomery Watson.

This chapter discusses the City of Riverside (City) recycled water core distribution systems for users identified in Section 4. This system will provide recycled water to users throughout the City, JCSD and uses located in southerly boundaries in the Western Municipal Water District (WMWD). The core system provides an estimate of pipe sizes and footage, pipeline alignments, reservoirs and pump stations, to supply recycled water and to provide the basis for the conceptual cost estimates.

5.2 PIPELINE ALIGNMENT

The purpose of the core system alignment is not to set the specific route for the distribution system, but to identify a possible alignment, which will serve the largest users and user clusters. Site constraints such as existing water and sewer lines, traffic, and utilities may revise the proposed alignments and must be investigated during pre-design phase. The primary alignment in **Figure 5-1** is effective in the planning stage to present the reuse concept, model the system, and develop project economics.

The alignment is sensitive to the location of the largest users and clusters of users. The pipeline lengths used in the proposed system are approximate and will need to be verified during pre-design phase. Service distribution lines from the core system to each user are not included in the estimates.

The service area of the core distribution system incorporates the total potential reuse of about 20,400 AFY as detailed in Table 4-8 Section 4.

5.3 HYDRAULIC MODEL

The hydraulic model geometry and physical characteristics for the City's Recycled Water System was developed using H_2ONET v3.1 software, which includes a 24-hour simulation and performance analysis. Water demand data from potential users developed from market survey analysis in Section 4 was used to develop the proposed demands for the recycled water distribution system model.

The hydraulic model geometry and physical characteristics of the distribution system includes pipes (length, diameter, Hazen-Williams friction C-factor), pumps (hydraulic head, pump characteristic curve), and storage facilities. GIS files provided by the City were used as the basis to develop the model geometry. **Figure 5-1** presents a schematic of the transmission pipelines throughout the City.

Preliminary pipes were sized based on hydraulic criteria of having friction loss less than 12-ft per 1000-ft of pipe and a velocity at peak flow of less than 10ft/sec. Estimated pressures at the nodes were calculated based on Hazen Williams equation for head loss in the pipe including the elevation difference between nodes of pipe segments. Booster pumps are incorporated when the downstream demand node pressures were less than 50 psi.

Design Criteria

Peaking factors have been established to account for monthly, daily and hourly variations in demand due to fluctuations in irrigation demands. Generally the average maximum day to yearly average day demand factor is approximately 2.5 for water recycling systems.

The peak hour to the yearly average day varies considerably depending on the type of water use. Industrial process demands are generally constant.

As a basis for design for the hydraulic model, the following peaking factors for irrigation demands were used:

- Golf Courses → 5.0
- Schools, Parks and Cemeteries → 3.0
- Industrial → 2.5

Peak hourly demands for golf courses is based on the assumption that irrigation operation will be four hours per day between midnight and 4:00 am, while for schools, parks, cemeteries and other irrigation users, an eight hour per day irrigation operation between the hours of 10:00 p.m. and 6:00 a.m. It should be noted that if golf courses incorporate water hazards (lakes) the peaking factor would be 1.0. The assumption is that recycled water can be delivered to a water hazard at a constant rate 24 hours of the day. At such time when irrigation demands are required, the water source will be the water hazards. The distribution system is designed to deliver the peak hourly demand while maintaining a minimum system pressure of 50 psi and a maximum pressure of 120 psi. Maximum pipeline velocities were maintained at 10 ft/sec or less.

Modeling Results

The following is a summary of the modeling results for each supply alternative as required to meet system demands anticipated in the citywide master plan.

- ***Pipelines.*** **Table 5-1** summarizes the pertinent pipeline characteristics for the core distribution system including length and diameter of each pipe section. **Figure 5-1** shows schematic of the hydraulic model.
- ***Junction Nodes.*** **Table 5-2** summarizes the pertinent junction node characteristics for the core distribution system.

Table 5-1
Pipe Sizes for Citywide System

Pipe#	Length (ft)	Pipe Size (in)
1	2020	30
3	6114	18
5	5629	30
7	7691	24
9	8145	12
11	10242	12
13	3521	12
17	10885	12
19	6160	24
21	5449	24
23	6868	24
25	3516	18
27	6089	24
29	4696	12
31	10155	12
33	10876	24
35	2617	24
41	11898	24
45	12737	12
47	2609	24
49	2644	24
51	7649	12
59	5850	24
61	5649	24
71	8169	12
73	7182	24
75	1000	24
77	3385	12
81	8198	12
83	3775	24
85	6866	24
87	9180	24
89	8661	24
91	2686	24
93	3806	24
97	14708	12
99	3096	12
101	5292	12
105	8509	24
107	6039	24
109	3088	24
111	8604	12

City of Riverside

Citywide Water Recycling Master Plan

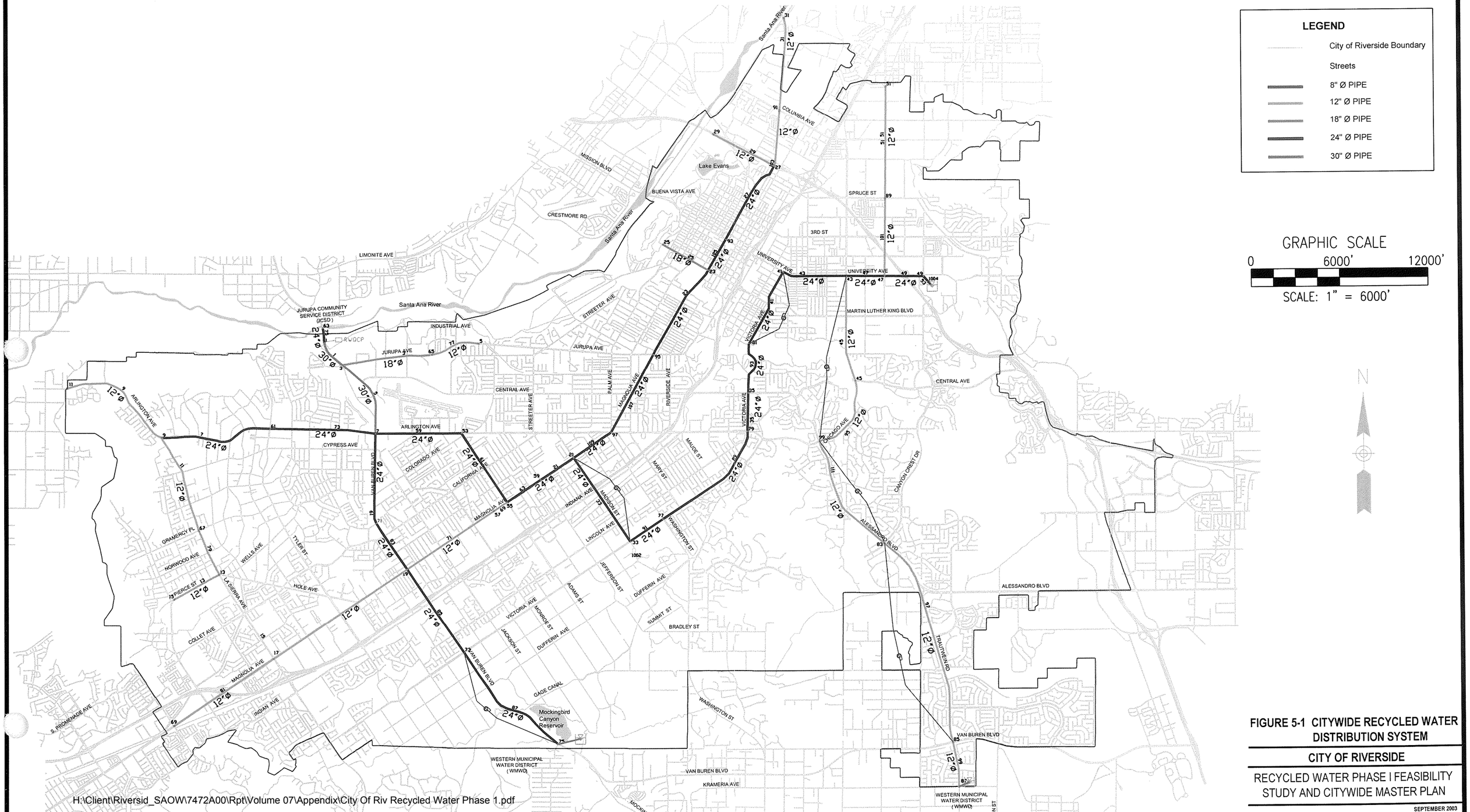


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FIGURE 5-1 CITYWIDE RECYCLED WATER DISTRIBUTION SYSTEM

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN

SEPTEMBER 2003

Table 5-2
Junction Node Characteristics for Citywide System

Node#	Average Day Demand (gpm)	Peak Hour Demand (gpm)
3	30	89
5	911	2950
7	416	1458
9	146	661
11	398	1666
13	66	199
15	248	744
17	250	777
19	35	105
21	42	126
23	107	320
25	294	1129
29	244	981
31	292	1105
33	44	129
35	107	322
43	39	117
49	733	2198
51	125	348
53	14	43
57	181	561
61	166	720
63	896	4478
65	310	1148
69	194	928
71	123	369
72	111	333
75	19	56
77	38	113
79	77	231
81	217	1085
83	48	145
85	232	697
87	580	1962
89	79	236
93	13	40
95	11	32
97	49	147
99	320	1332

- ***Storage Facilities.*** Assuming an eight-hour irrigation period, sixteen hours of peak day storage is required. With a peak hourly demand of 25,600 gpm, about 7 million gallons of operational storage are required.

  The recommended location for these storage facilities is at the University of California, Riverside and at the service boundary between the City of Riverside and Western Municipal Water District.

- **Pumping Station.** Seven booster-pumping stations are required for the core distribution system to operate on a 24 hours continuous basis, see **Table 5-3**.

Table 5-3
Estimate Size for Booster Pump Station

Pump Location	Average Flow (gpm)	Required Head (ft)	HP
RWQCP to system	7300	277	730
Van Buren Blvd. between Victoria Ave. and Mockingbird reservoir	3000	198	215
Madison St. between Magnolia Ave. and Victoria Ave.	4000	107	155
Victoria Ave. between Central Ave. and University Ave.	4000	70	100
Chicago Ave. between Central Ave. and Arlington Ave.	1000	180	65
Alessandro Blvd. between Arlington Ave. and E Alessandro Blvd.	1000	370	135
Alessandro Blvd. between E Alessandro Blvd. and Van Buren Blvd.	1000	160	60
Total			**1460**

5.4 DISTRIBUTION SYSTEM COST ANALYSIS

In order to assess overall project cost and economics, it is necessary to discuss the project components and estimated construction costs. The estimates consider normal engineering design, construction, and construction management costs with moderate utilities interference. Costs for right-of-way and property acquisition are not included. Additionally, other related costs for legal counsel, administrative overhead, public awareness programs, coordinate with the Regional Board or Department of Health Services are not included. Costs are presented in current dollars with an *Engineering News-Record* (ENR) index of 7228 for November 2002 for the Los Angeles area. See **Table 5-5** for a complete list of cost assumptions.

Table 5-4 summarizes the preliminary capital costs associated with pipe sizes and lengths. The capital cost for citywide pipe system is approximately $64,670,000. Lateral distribution piping to individual users is not included in this conceptual plan, and therefore, no cost estimates were included for the distribution pipes. Each user will generally require on-site conversion. Consideration should be given to requiring new development to install irrigation systems to meet AWWA and DHS standards for recycled water use.

A total of six booster pump stations are anticipated for the citywide master plan. The capacity of the booster stations will range from 1,000 gpm to 4,000 gpm. The estimated capital cost for the six booster pump stations is $2,520,000. An additional booster pump station at the RWQCP will be required and is estimated to have a firm capacity

of approximately 7,300 gpm. The estimated capital cost for the RWQCP booster pump station is $1,314,000.

Storage tanks are needed to provide supply to the distribution system during peak demand periods and storage during off peak times such that the booster pump stations can operate at an efficient rate. It is anticipated that three storage reservoirs will be required with a total storage capacity of approximately 7 million gallons. The estimated construction cost for the three storage reservoirs is approximately $5,600,000, not including land acquisitions.

Table 5-4
Citywide System Preliminary Capital Cost Analysis

System Description	Quantity	Total Cost
1 RWQCP Facilities		
a. Booster Pump Station (including disinfection & Misc. Structures)	7,300 gpm	$1,314,000
2 Transmission Pumps		
a. 1000 gpm Booster Pump Station (3 ea.)	3,000 gpm	$540,000
b. 3000 gpm Booster Pump Station (1 ea.)	3,000 gpm	$540,000
c. 4000 gpm Booster Pump Station (2 ea.)	8,000 gpm	$1,440,000
Tansmission Pumps Subtotal	14,000 gpm	$2,520,000
3 Transmission Pipelines		
a. 12" Transmission Pipelines	119,483 LF	$10,036,572
b. 18" Transmission Pipelines	9,630 LF	$1,213,380
c. 24" Transmission Pipelines	135,191 LF	$22,712,088
d. 30" Transmission Pipelines	7,649 LF	$1,606,290
Tansmission Pipeline Subtotal	272,000 LF	$35,570,000
4 Reservoir Storage		
a. 3 MG Reservoir (2 ea.)	6 MG	$4,800,000
b. 1 MG Reservoir (2 ea.)	1 MG	$800,000
Reservoir Storage Subtotal	7 MG	$5,600,000
5 Provision for On-Site Conversion @ Average $10,000/Each Site	186 Ea	$1,860,000
Total Estimated Cost		**$46,864,000**
Contigency @ 20%		**$9,372,800**
Engineering, Legal and Administration @ 15%		**$8,435,520**
Total Estimated Project Cost		**$64,672,320**
say		**$64,670,000**

Note:
- The estimate is based on year 2002 costs at an ENR Construction cost index of 7228 for the Los Angeles area for November 2002.
- It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets.
- It is assumed that equalization basin at RWQCP is already in existence.
- Above estimates do not include financing cost.

5.5 COST CRITERIA

Table 5-5
Citywide System Cost Criteria for Capital Cost Estimate

Item	Cost Factor
Pipeline Construction	$7/ft-in dia
Onsite conversion	$10,000/each
Storage Tanks	$0.80/gal
Booster Pump Station (including disinfection & miscellaneous structures)	$180/gpm
Engineering, Legal & Construction Administration	15% of total estimated cost
Construction Contingency	20% of total estimated cost

5.6 OPERATION COST ESTIMATE AND FINANCING ALTERNATIVES

Operation and maintenance costs include the annual maintenance costs for pipelines, power, labor and pump station repairs. These costs were estimated as a percentage of construction cost. It was assumed that JCSD would share proportion of the costs for power, O & M and miscellaneous costs with the City. **Table 5-6** summarizes the cost criteria used to estimate the operation and maintenance cost as well as total annual costs.

Table 5-6
Cost Criteria for Annual Cost Estimates

Item	Cost Factor
Maintenance	
Pipelines	(Capital Expenditure) - (25% Grant x Capital Cost) (Capital Expenditure) - (75% SRF Loan x Capital Cost)
Reservoirs	None
Operation	
Power	$0.10/KWH
Treatment	None
Capitalization	5.5% Interest (City's loan) 2.4% Interest (SRF Loan) 20 Years Recovery Period

Total annual costs are based on the amortized construction cost plus the annual operation and maintenance cost. Capital costs are amortized based on 5.5 percent interest and a 20-year recovery period. in **Tables 5-7** through **Table 5-10** show the O&M cost assessed for the different alternatives.

Table 5-7
Citywide System Preliminary Cost Estimate

City Funds - No Grants and/or Loans

Item Description	Total Cost	City of Riverside Share
1. Annuity on Loan	$445,000 /month	$445,000 /month
2. Operations and Maintenance		
a. Power Cost	$27,000 /month	$26,000 /month
b. Operation and Maintenance Cost [(a)]	$50,000 /month	$45,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$10,000 /month	$9,500 /month
Total		**$525,500 /month***
Recycled Water Production Cost for City of Riverside (20,400 AFY)		**$309 /AFY**

Note:

(a) 5 additional persons full time, City of Riverside share 4.5 persons time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 5-8
City Funds (75%) and Grant (25%)

Item Description	Total Cost	City of Riverside Share
1. Annuity on Loan	$334,000 /month	$334,000 /month
2. Operation and Maintenance Cost		
a. Power Cost	$27,000 /month	$26,000 /month
b. Operation and Maintenance Cost [(a)]	$50,000 /month	$45,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$10,000 /month	$9,500 /month
Total		**$414,500 /month***
Recycled Water Production Cost for City of Riverside (20,400 AFY)		**$244 /AFY**

Note:

(a) 5 additional persons full time, City of Riverside share 4.5 persons time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 5-9
City Funds (25%) SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Capital Cost		
a. City Fund	$112,000 /month	$112,000 /month
b. SRF Loan	$255,000 /month	$255,000 /month
2. Operation and Maintenance Cost		
a. Power Cost	$27,000 /month	$26,000 /month
b. Operation and Maintenance Cost [(a)]	$50,000 /month	$45,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$10,000 /month	$9,500 /month
Total		**$447,500 /month***
Recycled Water Production Cost for City of Riverside (20,400 AFY)		**$263 /AFY**

Note:
(a) 5 additional persons full time, City of Riverside share 4.5 persons time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 5-10
Grant (25%) and SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity on Loan	$255,000 /month	$255,000 /month
2. Operation and Maintenance Cost		
a. Power Cost	$27,000 /month	$26,000 /month
b. Operation and Maintenance Cost [(a)]	$50,000 /month	$45,000 /month
3. Miscellaneous Costs	$10,000 /month	$9,500 /month
Total		**$335,500 /month***
Recycled Water Production Cost for City of Riverside (20,400 AFY)		**$197 /AFY**

Note:
(a) 5 additional persons full time, City of Riverside share 4.5 persons time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

5.7 SUMMARY

Total estimated capital cost for the citywide distribution system is approximately $64,670,000. This capital cost can be financed monthly by different alternatives, together with O&M cost the monthly costs to the city are listed in **Table 5-7** through **Table 5-10**. With a potential reuse of 20,400 AFY as detailed in Section 4, the cost for reclaimed water production ranks from $197/AFY to $309/AFY depending on the financing option as summarized in **Table 5-11** below. Cost of water production for citywide system is lower than system that is limited to Phase I users only. Compare to a typical production cost range of $300/AFY to $700/AFY in Southern California, the recycled water system therefore is feasible.

Table 5-11
Summary of Alternative Pricing Options for Citywide Water Production Cost

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AF/Y)
1.	City Funds - No Grants and/or Loans	309
2.	City Funds (75%) and Grant (25%)	244
3.	City Funds (25%) and SRF Loan (75%)	263
4.	Grant (25%) and SRF Loan (75%)	197

Section 6

Phase I - Water Recycling Project

PARSONS

SECTION 6

PHASE 1 – WATER RECYCLING PROJECT

This section presents Phase I – Water Recycling Project including project boundary, current and potential users of recycled water from within the City of Riverside (City), outside the City, the criteria and basis for the hydraulic modeling, preliminary costs and economic analysis.

6.1 DEFINITION AND CRITERIA

Recycled Water Phase I Feasibility Study is an economical analysis to be used in the development and implementation of recycled water within the City of Riverside focusing on its funding, regulatory compliance, constructability, operability and expandability. Phase I Project is restricted to about 2-mile radius around the city's RWQCP. This 2-mile radius includes major potential users within the City, Jurupa Community Service District (JCSD) and Rubidoux Community Service District (RCSD).

6.2 ALTERNATIVES

Two alternatives were identified, surveyed and evaluated for the development of Phase I – Water Recycling Project. These alternatives include:

- Alternative 1 – JCSD, City of Riverside Users up to Arlington Avenue; and
- Alternative 2 – JCSD, City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.

6.2.1 Alternative 1

Alternative 1, would supply recycled water to major potential users located along:

- Van Buren Boulevard between Jurupa Avenue and Arlington Avenue;
- Jurupa Avenue between Van Buren Boulevard and Florence Street;
- Arlington Avenue between Van Buren Boulevard and Tyler Street; and
- Arlington Avenue between Van Buren Boulevard and Adams Street

The service area for Alternative 1 incorporates the total potential reuse of about 1,870 AFY as shown in **Table 6-1.**

6.2.2 Alternative 2

Alternative 2, would supply recycled water to major potential users located along:

- Van Buren Boulevard between Jurupa Avenue and Arlington Avenue;
- Jurupa Avenue between Van Buren Boulevard and Florence Street;
- Arlington Avenue between Van Buren Boulevard and Adams Street;
- Adams Street between Arlington Avenue and Magnolia Avenue;
- Magnolia Avenue between Adams Street and Verde Street; and
- Magnolia Avenue between Adams Street and Wayne Center

The service area for Alternative 2 incorporates the total potential reuse of about 2,270 AFY as shown in **Table 6-2.**

Table 6-1
Alternative 1 – JCSD, City of Riverside Users up to Arlington Avenue

Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)	
A	**JURUPA COMMUNITY SERVICE DISTRICT USERS**				
-	**AREAS CURRENTLY USING POTABLE WATER**				
-	Havenview Park No. 1	--	--	12	
-	Havenview Park No. 2	--	--	15	
-	JUSD (Linares)	--	--	27	
-	NE Corner Limonite and Clay	--	--	9	
-	W. Side Camino Real	--	--	8	
-	Camino Real South of Lamonite	--	--	<1	
	PROPOSED NEW AREAS OF REUSE				
-	Plant 2 (Indian Hills Golf Course)	--	--	600	
-	EDA Streetscape East of Camino Real & Limonite (Rubidioux Community Services District Area)	--	--	36	
	SUBTOTAL			**707**	*
	INDUSTRIES				
-	Robertson Ready Mix	--	--	25	
-	Northwest Pipe Company	--	--	35	
	SUBTOTAL			**60**	
	JCSD USERS SUBTOTAL			**767**	
			Say	**770**	**AFY**
B	**CITY OF RIVERSIDE USERS**				
200	**SCHOOLS**				
206	Adams Elementary School	8	4	10	
226	Jefferson Elementary School	10	5	13	
262	Norte Vista High School	47	24	59	
267	Terrace Elementary School	10	5	13	
	SUBTOTAL			**95**	
300	**GOLF COURSES**				
305	Van Buren Golf Center (Sky Links Executive Golf Course)	--	--	195	
	SUBTOTAL			**195**	
400	**PARKS**				
425	Martha McLean Anza Narrows	--	200	500	**
436	Rutland	9	9	23	
448	Hillside Ave (Future)	10	10	25	
	SUBTOTAL			**548**	

Table 6-1 (cont.)
Alternative 1 – JCSD, City of Riverside Users up to Arlington Avenue

500	**MISCELLANEOUS**				
503	Riverside Municipal Airport	304	50	125	
503	Riverside Municipal Airport (Future)	304	100	250	
605	Van Buren Median and Frontage (Urban Forest)	--	10	25	
	SUBTOTAL			**400**	
800	**INDUSTRIES - LANDSCAPE IRRIGATION AND POWER PLANT**				
806	Toro Irrigation (Manufacturing Company)	--	--	70	
807	Dow Jones & Company, Inc.	--	--	50	
903	400 MW Power Plant (planned by PUD in the near future)	--	--	150	**
	SUBTOTAL			**270**	
	CITY OF RIVERSIDE SUBTOTAL			**1,508**	**AFY**
	PROBABILITY OF CAPTURE - CITY OF RIVERSIDE (Approx. 70%)			**1,056**	**AFY**
			Say	**1,100**	**AFY**
	TOTAL USERS (CITY OF RIVERSIDE & JCSD)			**1,870**	**AFY**

Note:

* From JCSD Indian Hill Water Recycling Project Report

** Estimated per information provided by the City of Riverside Public Utility Department

Table 6-2
Alt. 2 – JCSD, City of Riverside Users up to North of Freeway 91 on Magnolia Ave. between Madison and Van Buren

Code	Potential Users	Total Acres	Irrigation Acres	Reuse Potential (AFY)
A	**JURUPA COMMUNITY SERVICE DISTRICT USERS**			
-	**AREAS CURRENTLY USING POTABLE WATER**			
-	Havenview Park No. 1	--	--	12
-	Havenview Park No. 2	--	--	15
-	JUSD (Linares)	--	--	27
-	NE Corner Limonite and Clay	--	--	9
-	W. Side Camino Real	--	--	8
-	Camino Real South of Lamonite	--	--	<1
	PROPOSED NEW AREAS OF REUSE			
-	Plant 2 (Indian Hills Golf Course)	--	--	600
-	EDA Streetscape East of Camino Real & Limonite (Rubidoux Community Services District Area)	--	--	36
	SUBTOTAL			**707 ***
	INDUSTRIES			
-	Robertson Ready Mix	--	--	25
-	Northwest Pipe Company	--	--	35
	SUBTOTAL			**60**
	JCSD USERS SUBTOTAL			**767**
			Say	**770 AFY**
B	**CITY OF RIVERSIDE USERS**			
200	**SCHOOLS**			
201	Cal Baptist University	65	40	60
206	Adams Elementary School	8	4	10
213	Chemawa Middle School	21	11	26
225	Jackson Elementary School			14
226	Jefferson Elementary School	10	5	13
228	Liberty Elementary School			5
231	Madison Elementary School			13
236	Notre Dame Elementary School			25
240	Ramona High School	54	27	68
242	Riverside Christain High School	20	10	25
266	Sherman Indian High School	85	40	100
	SUBTOTAL			**359**

Table 6-2 (cont.)
Alt. 2 – JCSD, City of Riverside Users up to Arlington Ave., Adams St. & Magnolia Ave.

300	**GOLF COURSES**				
305	Van Buren Golf Center (Sky Links Executive Golf Course)	--	--	195	
	SUBTOTAL			**195**	
400	**PARKS**				
401	Arlington			10	
412	Don Jones			15	
413	Don Lorenzi Sport Camp			22	
424	Low			3	
425	Martha McLean Anza Narrows	--	200	500	**
436	Rutland	9	9	23	
437	Shamel			25	
448	Hillside Ave (Future)	10	10	25	
	SUBTOTAL			**623**	
500	**MISCELLANEOUS**				
502	Parkview Comm. Hosp. Med.Ctr.			13	
503	Riverside Municipal Airport	304	50	125	
503	Riverside Municipal Airport (Future)	304	100	250	
605	Van Buren Median and Frontage (Urban Forest)	--	10	25	
	SUBTOTAL			**413**	
800	**INDUSTRIES - LANDSCAPE IRRIGATION AND POWER PLANT**				
806	Toro Irrigation (Manufacturing Company)	--	--	70	
807	Dow Jones & Company, Inc.	--	--	50	
903	400 MW Power Plant (planned by PUD in the near future)	--	--	150	**
	SUBTOTAL			**270**	
C	**CALTRANS**				
C-2	3440 ADAMS			**23.2**	
C-7	3440 JACKSON			**24.0**	
C-8	3440 JEFFERSON			**14.7**	
C-10	3440 MADISON			**23.0**	
C-11	3440 MONROE			**9.9**	
C-14	3440 VAN BUREN			**34.7**	
	SUBTOTAL			**129.6**	**AFY**
	CITY OF RIVERSIDE SUBTOTAL			**1,990**	**AFY**
	PROBABILITY OF CAPTURE - CITY OF RIVERSIDE			**1,432**	**AFY**
	(Capture Probability is assumed 70% except for above CALTRANS data for which it is 100%)		**Say**	**1,500**	**AFY**
	TOTAL USERS (CITY OF RIVERSIDE & JCSD)			**2,270**	**AFY**

Note:

* From JCSD Indian Hill Water Recycling Project Report

** Estimated per information provided by the City of Riverside Public Utility Department

6.3 ALIGNMENTS

Several alignments for the Phase I Project distribution system were considered. These alternatives were reviewed to consider relative advantages based on field investigations, traffic conditions, existing utilities and input from City staff. A summary of the approximate footage for each alternative is shown in **Tables 6-3 and 6-4.**

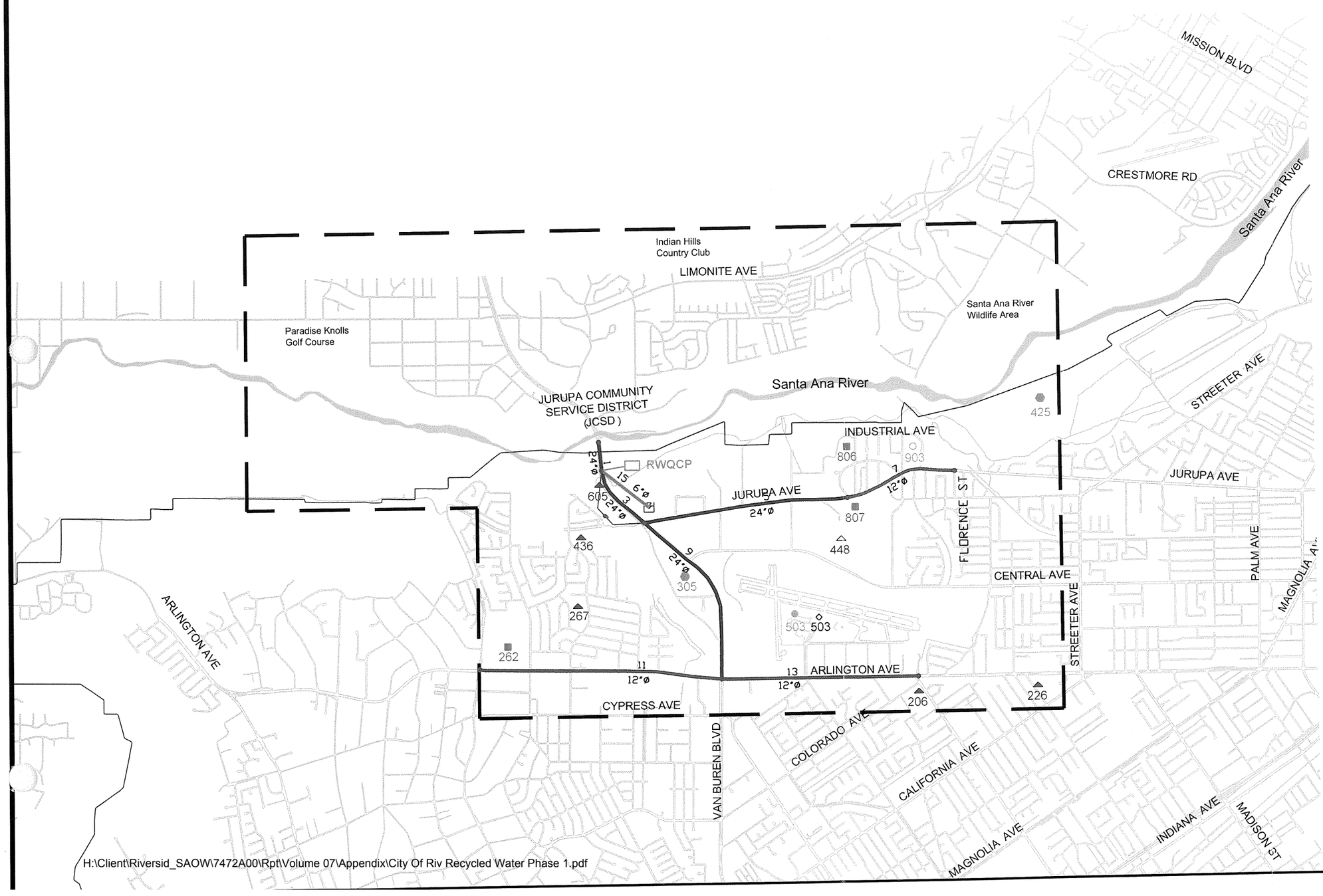
It is necessary to consider both economic and non-economic factors in the evaluation of each alternative alignment. Economic considerations include capital costs and constructability. Non-economic factors include community impact, traffic disruption, utility conflicts, easement/ROW requirements and permits, if required.

6.4 HYDRAULIC MODEL

The hydraulic model for the Phase I project was developed using H_2ONET v3.1 software, which included a 24-hour simulation and performance analysis. Water demand data of potential users was developed from a market survey analysis discussed in Section 4.

The hydraulic model geometry and physical characteristics of the distribution system include pipes (length, diameter, Hazen-Williams friction C-factor), pumps, and storage facilities. GIS files, provided by the City, were used as the basis to develop the model base maps. **Figures 6-1 and 6-2** present the proposed size of transmission pipelines for Alternatives 1 and 2 respectively.

City of Riverside
Recycled Water Phase I Feasibility Study



LEGEND

User Symbol Existing	User Symbol Future	Potential Reuse (Acre Feet / Year)
▲	△	10 - 49
■	□	50 - 99
●	○	100 - 199
◆	◇	200 - 399
●	⬡	400 Plus

- City of Riverside Boundary
- Alternative 1 Boundary
- Streets
- 6"Ø PIPE
- 12"Ø PIPE
- 24"Ø PIPE

N

GRAPHIC SCALE

0 3000' 6000'

SCALE: 1" = 3000'

FIGURE 6-1 PHASE 1 - ALTERNATIVE 1

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN

SEPTEMBER 2003

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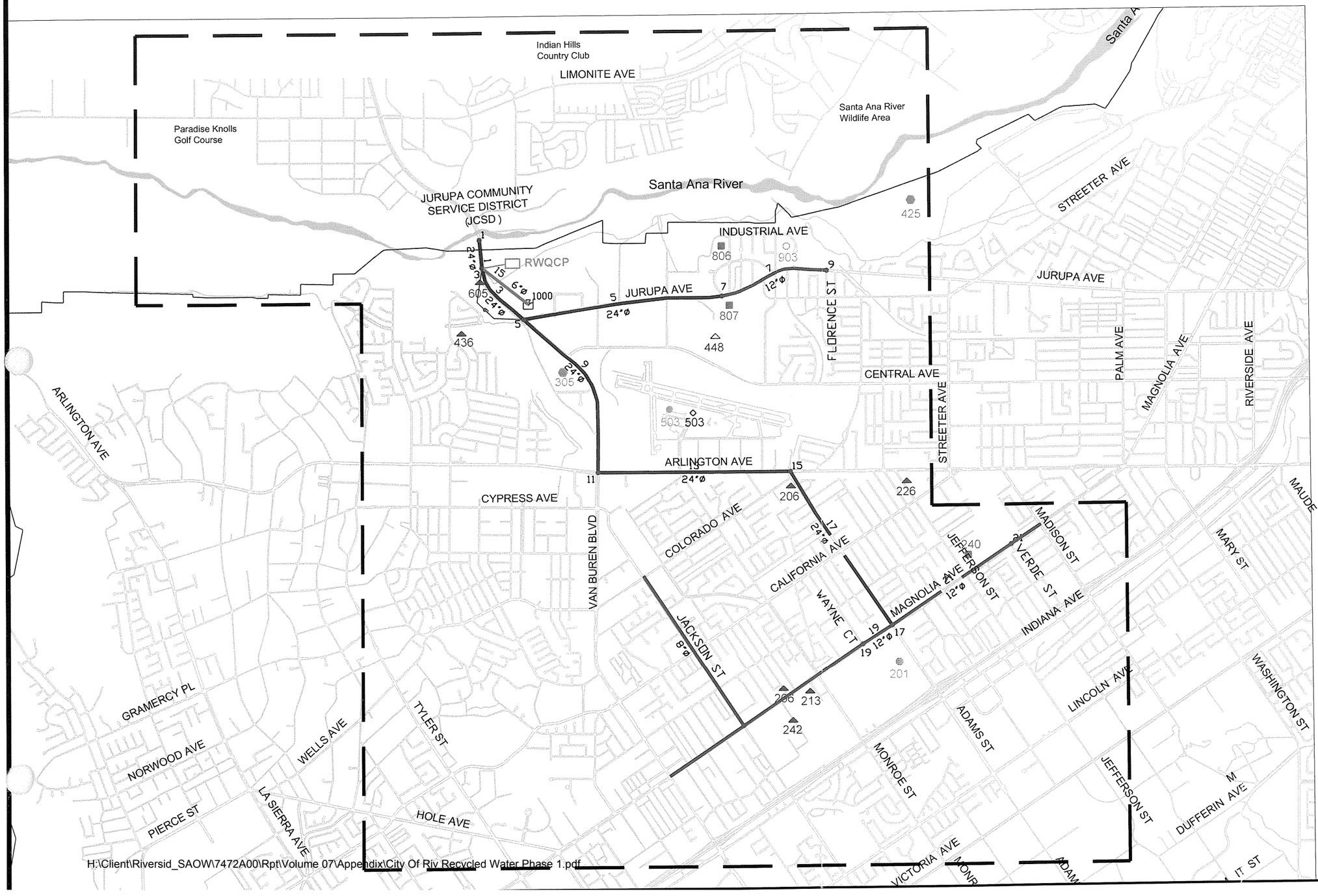
City of Riverside
Recycled Water Phase I Feasibility Study



LEGEND

User Symbol Existing	User Symbol Future	Potential Reuse (Acre Feet / Year)
▲	△	10 - 49
■	□	50 - 99
●	○	100 - 199
◆	◇	200 - 399
⬢	⬡	400 Plus

- City of Riverside Boundary
- Alternative 1 Boundary
- Streets
- 6"Ø PIPE
- 8"Ø PIPE
- 12"Ø PIPE
- 24"Ø PIPE

FIGURE 6-2 PHASE 1 - ALTERNATIVE 2

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY AND CITYWIDE MASTER PLAN

SEPTEMBER 2003

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Design Criteria

Peaking factors have been established to account for monthly, daily and hourly variations in demand due to fluctuations in irrigation demands. Generally the average maximum day to yearly average day demand factor is approximately 2.5 for water recycling systems.

The peak hour to the yearly average day varies considerably depending on the type of water use. Industrial process demands are generally constant, but depend upon the hours of operation and on-site storage.

As a basis for design for the hydraulic model, the following peaking factors for irrigation demands were used:

- Golf Courses → 5.0
- Schools, Parks and Cemeteries → 3.0
- Industrial → 2.5

Peak hourly demands for golf courses is based on the assumption that irrigation operation will be four hours per day between midnight and 4:00 am, while for schools, parks, cemeteries and other irrigation users, an eight hour per day irrigation operation between the hours of 10:00 p.m. and 6:00 a.m. It should be noted that if golf courses incorporate water hazards (lakes) the peaking factor would be 1.0. The assumption is that recycled water can be delivered to a water hazard at a constant rate 24 hours of the day. At such time when irrigation demands for golf courses are required, the water source will be from the water hazards. The distribution system is designed to deliver the peak hourly demand while maintaining a minimum system pressure of 50 psi and a maximum pressure of 120 psi. Maximum pipeline velocities were maintained at 10 ft/sec or less.

Modeling Results

The following is a summary of the modeling results for each supply alternative as required to meet system demands anticipated in the Phase I project.

- ***Pipelines.*** **Tables 6-3 and 6-4** summarize the pertinent pipeline characteristics for Alternatives 1 and 2, respectively. The location, length, and proposed pipe diameter of each section are listed.
- ***Storage Facilities.*** The recycled water storage will be from the RWQCP chlorine contact tanks, which will be used as the operational storage for the Phase I Project.
- ***Pumping Station.*** It is anticipated that a booster pumping station will be installed at the chlorine contact tanks. The pumping facility at RWQCP requires a total firm capacity of approximately 6100 gpm. The station would include multiple pumps with one standby pump equal to the largest pump used in operation.

Table 6-3
Pipe Characteristics for Alternative 1a

Pipeline Location	Diameter (in)	Length (ft)
Van Buren Blvd. between City Limits (JCSD) and RWQCP	24	851
Van Buren Blvd. between RWQCP and Arlington Ave.	24	7700
Jurupa Ave. between Van Buren Blvd. and UP Railroad	24	6104
Jurupa Ave. between UP Railroad and Florence St.	12	3382
Arlington Ave. between Van Buren Blvd. and Tyler St.	12	7205
Arlington Ave. between Van Buren Blvd. and Adams St.	12	5862

Table 6-4
Pipe Characteristics for Alternative 2a

Pipeline Location	Diameter (in)	Length (ft)
Van Buren Blvd. between City Limits (JCSD) and RWQCP	24	851
Van Buren Blvd. between RWQCP and Arlington Ave.	24	7700
Jurupa Ave. between Van Buren Blvd. and UP Railroad	24	6104
Jurupa Ave. between UP Railroad and Florence St.	12	3382
Arlington Ave. between Van Buren Blvd. and Adams St.	24	5862
Adams St. between Arlington Ave. and Magnolia Ave.	24	5642
Magnolia Ave. between Adams St. and Van Buren Blvd.	12	7345
Magnolia Ave. between Adams St. and Medison St.	12	4700
Jackson St. between Magnolia Ave. and Colorado Ave.	8	5440

6.5 PHASE I FLEXIBILITY AND EXPANDABILITY

In analyzing the proposed pipe sizing for the Phase I project, consideration is given to determining the required ultimate pipe size when the citywide recycled water system is implemented. This approach, of course, increases the initial costs for the Phase I project due to the installation of larger diameter pipes. However installing the ultimate pipe size during Phase I will avoid the cost of installing parallel pipes when the citywide recycled water system is implemented in the future.

Tables 6-5 and 6-6 summarize the sizes of pipe installed in phase I in order to serve the citywide system. The detail analysis for these pipe sizes is discussed in Section 6, Citywide Recycled Water Master Plan.

Table 6-5
Pipe Characteristics for Alternative 1b
(Enlarged Size to Serve the Citywide System)

Pipeline Location	Diameter (in)	Length (ft)
Van Buren Blvd. between City Limits (JCSD) and RWQCP	24	851
Van Buren Blvd. between RWQCP and Arlington Ave.	30	7700
Jurupa Ave. between Van Buren Blvd. and UP Railroad	18	6104
Jurupa Ave. between UP Railroad and Florence St.	12	3382
Arlington Ave. between Van Buren Blvd. and Tyler St.	24	7205
Arlington Ave. between Van Buren Blvd. and Adams St.	24	5862

Table 6-6
Pipe Characteristics for Alternative 2b
(Enlarged Size to Serve the Citywide System)

Pipeline Location	Diameter (in)	Length (ft)
Van Buren Blvd. between City Limits (JCSD) and RWQCP	24	851
Van Buren Blvd. between RWQCP and Arlington Ave.	30	7700
Jurupa Ave. between Van Buren Blvd. and UP Railroad	18	6104
Jurupa Ave. between UP Railroad and Florence St.	12	3382
Arlington Ave. between Van Buren Blvd. and Adams St.	24	5862
Adams St. between Arlington Ave. and Magnolia Ave.	24	5642
Magnolia Ave. between Adams St. and Van Buren Blvd.	12	7345
Magnolia Ave. between Adams St. and Medison St.	24	4700
Jackson St. between Magnolia Ave. and Colorado Ave.	8	5440

6.6 PRICING CONCEPTS

The commitment of users from the City and JCSD to "buy into" a recycled water system is a factor in determining whether the project is economically feasible. The following items will determine the feasibility to construct a new recycled water system:

- Provide for incremental variable expenses (booster pumps, energy, chemicals) of the water distribution system. These incremental and variable expenses include the variable expenses associated with the RWQCP water treatment facility, booster pumps, the storage option, and transmission pipelines. The transmission pipelines are sized according to the capacity needed for distribution, and therefore the allocation of annual costs associated with financing and maintaining them should be easy to determine and non-controversial.
- Provide for fixed operations and maintenance (O&M) expense associated with water treatment facility, storage option selected, and the distribution system.
- Extent of availability of grants and other subsidies
- Repay fixed debt service (SRF loans and other debt service), and
- Repay cash advances (from other funds) over a predetermined schedule, including a mutually agreed-upon interest rate.

6.7 COMPARING ALTERNATIVE PRICING OPTIONS

Water rate data was collected from the City and evaluated to form the basis for recycled water pricing in the area. The City's potable water rates are summarized as follows:

- During summer, $379/AF ($0.87/100 CF)
- During winter, $292/AF
- Gage Shareholder Customers, $90/AF
- Schools, $350/AF
- Toro Manufacturing Company, $6/AF
- Sky Links Golf Course, $80/AF

As can be seen by these rates, there is a wide variation in rates for water usage provided by the City. Pricing of recycled water can range from a small fraction of the cost of potable water, to as costly as potable water or even more.

6.8 RECYCLED WATER PRODUCTION COST SUMMARY

Tables 6-7 through 6-10 summarize the anticipated recycled water production costs under different funding scenarios for Alternatives 1a and 1b. **Tables 6-11 through 6-36** provides cost criteria, capital and O&M calculations under selected funding scenarios for Alternatives 1a and 1b.

Table 6-7
Phase I Alternative 1a – System Designed with no Citywide Expansion Considerations
Summary of Recycled Water Production Cost Design for the Needs of City of Riverside

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AFY)
1.	City Funds - No Grants and/or Loans	550
2.	City Funds (75%) and Grant (25%)	439
3.	City Funds (25%) and SRF Loan (75%)	470
4.	Grant (25%) and SRF Loan (75%)	360
5	Grant (50%) and SRF Loan (50%) & no City Funds	276

Table 6-8
Phase I Alternative 1b – System Designed with Citywide Expansion Considerations
Summary of Recycled Water Production Cost Enlarged for the City of Riverside

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AFY)
1.	City Funds - No Grants and/or Loans	651
2.	City Funds (75%) and Grant (25%)	513
3.	City Funds (25%) and SRF Loan (75%)	552
4.	Grant (25%) and SRF Loan (75%)	413
5	Grant (50%) and SRF Loan (50%) & no City Funds	308

Table 6-9
Phase I Alternative 2a – System Designed with no Citywide Expansion Considerations
Summary of Recycled Water Production Cost for the City of Riverside

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AFY)
1.	City Funds - No Grants and/or Loans	569
2.	City Funds (75%) and Grant (25%)	448
3.	City Funds (25%) and SRF Loan (75%)	482
4.	Grant (25%) and SRF Loan (75%)	362
5	Grant (50%) and SRF Loan (50%) & no City Funds	270

Table 6-10
Phase I Alternative 2b – System Designed with Citywide Expansion Considerations
Summary of Recycled Water Production Cost Enlarged for the City of Riverside

Item No.	Description of Preliminary Project Cost	Recycled Water Production Cost ($/AFY)
1.	City Funds - No Grants and/or Loans	594
2.	City Funds (75%) and Grant (25%)	466
3.	City Funds (25%) and SRF Loan (75%)	502
4.	Grant (25%) and SRF Loan (75%)	374
5	Grant (50%) and SRF Loan (50%) & no City Funds	277

6.9 CAPITAL COST COMPARISON

Construction costs are estimated on a unit cost basis for each system component including a cost per linear ft for pipeline construction. Unit costs factors are broken down by pipe diameter with different cost factors used for urban and rural construction. Costs for pump stations and reservoirs are based on equations, with estimate cost for pump stations based on pump capacity and reservoir based on capacity.

Miscellaneous costs are included for meters, backflow prevention devices, and stand-by domestic service. Engineering costs and contingency costs are included as a percentage of construction cost. **Table 6-11** summarizes cost criteria used to estimate capital costs.

Table 6-11
Cost Criteria for Capital Cost Estimate

Item	Cost Factor
Pipeline Construction	$7/ft-in dia
Onsite conversion	$10,000/each
Storage Tanks	$0.80/gal
Booster Pump Station (included disinfection & miscellaneous structures)	$180/gpm
Engineering, Legal & Construction Administration	15% of total estimated cost
Construction Contingency	20% of total estimated cost

Preliminary capital and operational costs of two alternatives were estimated in order to determine the unit cost for recycled water. The cost and other criteria will be used to select a recycled water system alternative. The estimate is based on year 2001 costs at an ENR construction cost index of 7228 for the Los Angeles area for November 2002. It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets. It is also assumed that the existing chlorine contact basins will serve as the system storage. The unit cost is based on 20-year bond. Potential savings of $209,856 on capital cost could be realized if using the existing 2,186 LF of 12" pipe from the RWQCP to Van Buren Golf Course.

A summary of the cost estimates for the two alternatives is presented in **Tables 6-12, 6-13, 6-14 and 6-15**. The estimate does not include financing cost. Estimated projected cost for the City of Riverside share includes 59% of Booster Pump Station cost. It is anticipated that the other 41% of Booster Pump Station cost will be paid by JCSD.

Table 6-12
Phase I Alternative 1a - Capital Cost for Transmission System Designed with no Citywide Expansion Considerations

System Description	Quantity	Total Cost
1. RWQCP Facilities		
a. Booster Pump Station (Including disinfection & Misc. Structures)	5,700 gpm	$1,026,000
2. Transmission Pipelines		
b. 12" Transmission Pipeline	16,449 LF	$1,381,716
c. 24" Transmission Pipeline	14,655 LF	$2,462,040
Transmission Pipeline Subtotal	31,104 LF	$3,843,756
3. Provision for On-Site Conversion @ Average $10,000/Each Site	13 Ea	$130,000
Total Estimated Cost		**$4,999,756**
Contingency @20%		**$999,951**
Engineering, legal and Administration @ 15%		**$899,956**
Total Estimated Project Cost		**$6,899,663**
	Say	**$6,900,000**
City of Riverside - Capital Expenditure Share		**$6,296,471** *
	Say	**$6,297,000**

Note:
- The estimate is based on year 2002 costs at an ENR construction cost index of 7228 for the Los Angeles area for November 2002.
- It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets.
- It is assumed that equalization basin at RWQCP is already in existence.
- Above estimates does not include financing cost.
- Potential savings on Capital Cost could use an existing 12" pipe located within RWQCP to Van Buren Golf Course.
  Estimated footage from RWQCP to Van Buren Golf Course: 2,186 LF
  Estimated Cost Savings: $183,624

* City of Riverside share includes proportion of Booster Pump Station cost.
(a) Potential Project Savings Cost to be deducted from City of Riverside - Capital Expenditure Share
(b) Assumed

Table 6-13
Phase I Alternative 1b - Capital Cost for Transmission System Designed with Citywide Expansion Considerations

System Description	Quantity	Total Cost
1. RWQCP Facilities		
a. Booster Pump Station (Including disinfection & Misc. Structures)	5,700 gpm	$1,026,000
2. Transmission Pipelines		
b. 12" Transmission Pipeline	3,382 LF	$284,088
c. 18" Transmission Pipeline	6,104 LF	$769,104
d. 24" Transmission Pipeline	13,918 LF	$2,338,224
e. 30" Transmission Pipeline	7,700 LF	$1,617,000
Transmission Pipeline Subtotal	31,104 LF	$5,008,416
3. Provision for On-Site Conversion @ Average $10,000/Each Site	13 Ea	$130,000
Total Estimated Cost		**$6,164,416**
Contigency @ 20%		**$1,232,883**
Engineering, Legal and Adminstration @15%		**$1,109,595**
Total Estimated Project Cost		**$8,506,894**
	Say	**$8,507,000**
City of Riverside - Capital Expenditure Share		**$7,903,471** *
	Say	**$7,904,000**

Note:
- The estimate is based on year 2002 costs at an ENR construction cost index of 7228 for the Los Angeles area for November 2002.
- It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets.
- It is assumed that equalization basin at RWQCP is already in existence.
- Above estimates does not include financing cost.
- Potential savings on Capital Cost could use an existing 12" pipe located within RWQCP to Van Buren Golf Course.

* City of Riverside share includes proportion of Booster Pump Station cost.
(a) Potential Project Savings Cost to be deducted from City of Riverside - Capital Expenditure Share
(b) Assumed

Table 6-14
Phase I Alternative 2a - Capital Cost for Transmission System Designed with no Citywide Expansion Considerations

System Description	Quantity	Total Cost
1. RWQCP Facilities		
a. Booster Pump Station (Including disinfection & Misc. Structures)	6,100 gpm	$1,098,000
2. Transmission Pipelines		
a. 8" Transmission Pipeline	5,440 LF	$304,640
b. 12" Transmission Pipeline	15,427 LF	$1,295,878
c. 24" Transmission Pipeline	26,159 LF	$4,394,628
Transmission Pipeline Subtotal	47,026 LF	$5,995,146
3. Provision for On-Site Conversion @ Average $10,000/Each Site	22 Ea	$220,000
Total Estimated Cost		**$7,313,146**
Contingency @ 20%		**$1,462,629**
Engineering, legal and Administration @ 15%		**$1,316,366**
Total Estimated Project Cost		**$10,092,142**
	Say	**$10,093,000**
City of Riverside - Capital Expenditure Share		**$9,367,449** *
	Say	**$9,368,000**

Note:
- The estimate is based on year 2002 costs at an ENR construction cost index of 7228 for the Los Angeles area for November 2002.
- It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets.
- It is assumed that equalization basin at RWQCP is already in existence.
- Above estimates does not include financing cost.
- Potential savings on Capital Cost could use an existing 12" pipe located within RWQCP to Van Buren Golf Course.
  Estimated footage from RWQCP to Van Buren Golf Course: 2,186 LF
  Estimated Cost Savings: $183,624

* City of Riverside share includes propotion of Booster Pump Station cost.
(a) Potential Project Savings Cost to be deducted from City of Riverside - Capital Expenditure Share
(b) Assumed

Table 6-15
Phase I Alternative 2b - Capital Cost for Transmission System Designed with Citywide Expansion Considerations

System Description	Quantity	Total Cost
1. RWQCP Facilities		
a. Booster Pump Station (Including disinfection & Misc. Structures)	6,100 gpm	$1,098,000
2. Transmission Pipelines		
a. 8" Transmission Pipeline	5,440 LF	$304,640
b. 12" Transmission Pipeline	10,727 LF	$901,068
c. 18" Transmission Pipeline	6,104 LF	$769,104
d. 24" Transmission Pipeline	17,055 LF	$2,865,240
e. 30" Transmission Pipeline	7,700 LF	$1,617,000
Transmission Pipeline Subtotal	47,026 LF	$6,457,052
3. Provision for On-Site Conversion @ Average $10,000/Each Site	13 Ea	$130,000
Total Estimated Cost		**$7,685,052**
Contingency @ 20%		**$1,537,010**
Engineering, legal and Administration @ 15%		**$1,383,309**
Total Estimated Project Cost		**$10,605,372**
	Say	**$10,606,000**
City of Riverside - Capital Expenditure Share		**$9,960,118 ***
	Say	**$9,961,000**

Note:
- The estimate is based on year 2002 costs at an ENR construction cost index of 7228 for the Los Angeles area for November 2002.
- It is assumed that the pipeline will be installed in existing City easements and/or public rights-of-way such as public streets.
- It is assumed that equalization basin at RWQCP is already in existence.
- Above estimates does not include financing cost.
- Potential savings on Capital Cost could use an existing 12" pipe located within RWQCP to Van Buren Golf Course.

* City of Riverside share includes proportion of Booster Pump Station cost.
(a) Potential Project Savings Cost to be deducted from City of Riverside - Capital Expenditure Share
(b) Assumed

6.10 O&M COST COMPARISON

Operation and maintenance costs include the annual maintenance costs for pipelines, power, labor and pump station repairs. These costs were estimated as a percentage of construction cost. It was assumed that JCSD would share proportion of the costs for power, O & M and miscellaneous costs with the City. **Table 6-16** summarizes the cost criteria used to estimate the operation and maintenance cost as well as total annual costs.

Table 6-16
Cost Criteria for Annual Cost Estimates

Item	Cost Factor
Maintenance	
Pipelines	(Capital Expenditure) - (25% Grant x Capital Cost) (Capital Expenditure) - (75% SRF Loan x Capital Cost)
Reservoirs	None
Operation	
Power	$0.10/KWH
Treatment	None
Capitalization	5.5% Interest (City's loan) 2.4% Interest (SRF Loan) 20 Years Recovery Period

Total annual costs are based on the amortized construction cost plus the annual operation and maintenance cost. Capital costs are amortized based on 5.5 percent interest and a 20-year recovery period. **Tables 6-17 through 6-32** show the O & M cost assessed for the different alternatives.

Table 6-17
Alternative 1a – Preliminary Cost Estimate
City Funds – No Grants and/or Loans

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$43,300 /month	$40,600 /month
2. Operations and Maintenance		
a. Power Cost	$9,000 /month	$5,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$50,400 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$550 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-18
Alternative 1a – Preliminary Cost Estimate
City Funds (75%) and Grant (25%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$32,500 /month	$30,400 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,000 /month	$5,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$40,200 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$439 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-19
Alternative 1a – Preliminary Cost Estimate
City Funds (25%) SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan		
a. City Fund	$10,800 /month	$10,100 /month
b. SRF Loan	$24,800 /month	$23,200 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,000 /month	$5,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$43,100 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$470 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-20
Alternative 1a – Preliminary Cost Estimate
Grant (25%) and SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$24,800 /month	$23,200 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,000 /month	$5,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$33,000 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$360 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-21
Alternative 1a – Preliminary Cost Estimate
Grant (50%) and SRF Loan (50%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$16,500 /month	$15,500 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,000 /month	$5,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$25,300 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$276 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-22
Alternative 1b – Preliminary Cost Estimate
City Funds – No Grants and/or Loans

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$54,400 /month	$50,900 /month
2. Operations and Maintenance		
a. Power Cost	$7,200 /month	$4,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$59,700 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$651 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-23
Alternative 1b – Preliminary Cost Estimate
City Funds (75%) and Grant (25%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$40,800 /month	$38,200 /month
2. Operation and Maintenance Cost		
a. Power Cost	$7,200 /month	$4,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$47,000 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$513 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-24
Alternative 1b – Preliminary Cost Estimate
City Funds (25%) SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan		
a. City Fund	$13,600 /month	$12,700 /month
b. SRF Loan	$31,100 /month	$29,100 /month
2. Operation and Maintenance Cost		
a. Power Cost	$7,200 /month	$4,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$50,600 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$552 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-25
Alternative 1b – Preliminary Cost Estimate
Grant (25%) and SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$31,100 /month	$29,100 /month
2. Operation and Maintenance Cost		
a. Power Cost	$7,200 /month	$4,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$37,900 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$413 /AF**

Note:

(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-26
Alternative 1b – Preliminary Cost Estimate
Grant (50%) and SRF Loan (50%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$20,700 /month	$19,400 /month
2. Operation and Maintenance Cost		
a. Power Cost	$7,200 /month	$4,300 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$28,200 /month***
Recycled Water Production Cost for City of Riverside (1,100 AFY)		**$308 /AF**

Note:

(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-27
Alternative 2a – Preliminary Cost Estimate
City Funds – No Grants and/or Loans

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$64,500 /month	$60,400 /month
2. Operations and Maintenance		
a. Power Cost	$9,300 /month	$6,200 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$71,100 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$569 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-28
Alternative 2a – Preliminary Cost Estimate
City Funds (75%) and Grant (25%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$48,300 /month	$45,300 /month
2. Operations and Maintenance		
a. Power Cost	$9,300 /month	$6,200 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$56,000 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$448 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-29
Alternative 2a – Preliminary Cost Estimate
City Funds (25%) SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan		
a. City Fund	$16,100 /month	$15,100 /month
b. SRF Loan	$36,900 /month	$34,500 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,300 /month	$6,200 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$3,000 /month	$2,500 /month
Total		**$60,300 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$482 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-30
Alternative 2a – Preliminary Cost Estimate
Grant (25%) and SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$36,900 /month	$34,500 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,300 /month	$6,200 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$45,200 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$362 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-31
Alternative 2a – Preliminary Cost Estimate
Grant (50%) and SRF Loan (50%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$24,600 /month	$23,000 /month
2. Operation and Maintenance Cost		
a. Power Cost	$9,300 /month	$6,200 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$3,000 /month	$2,500 /month
Total		**$33,700 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$270 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-32
Alternative 2b – Preliminary Cost Estimate
City Funds – No Grants and/or Loans

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$68,500 /month	$64,200 /month
2. Operations and Maintenance		
a. Power Cost	$8,400 /month	$5,600 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$4,000 /month	$2,500 /month
Total		**$74,300 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$594 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-33
Alternative 2b – Preliminary Cost Estimate
City Funds (75%) and Grant (25%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$51,400 /month	$48,100 /month
2. Operations and Maintenance		
a. Power Cost	$8,400 /month	$5,600 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$4,000 /month	$2,500 /month
Total		**$58,200 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$466 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-34
Alternative 2b– Preliminary Cost Estimate
City Funds (25%) SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan		
a. City Fund	$17,100 /month	$16,000 /month
b. SRF Loan	$39,200 /month	$36,700 /month
2. Operation and Maintenance Cost		
a. Power Cost	$8,400 /month	$5,600 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous, PS Repair & Maintenance Costs	$4,000 /month	$2,500 /month
Total		**$62,800 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$502 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-35
Alternative 2b – Preliminary Cost Estimate
Grant (25%) and SRF Loan (75%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$39,200 /month	$36,700 /month
2. Operation and Maintenance Cost		
a. Power Cost	$8,400 /month	$5,600 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$4,000 /month	$2,500 /month
Total		**$46,800 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$374 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

Table 6-36
Alternative 2b – Preliminary Cost Estimate
Grant (50%) and SRF Loan (50%)

Item Description	Total Cost	City of Riverside Share
1. Annuity of Loan	$26,100 /month	$24,500 /month
2. Operation and Maintenance Cost		
a. Power Cost	$8,400 /month	$5,600 /month
b. Labor Cost [(a)]	$2,500 /month	$2,000 /month
3. Miscellaneous Costs	$4,000 /month	$2,500 /month
Total		**$34,600 /month***
Recycled Water Production Cost for City of Riverside (1,500 AFY)		**$277 /AF**

Note:
(a) 1 person half time

* Assumes JCSD will share proportion of the costs for power, O & M and miscellaneous costs.

6.11 SUMMARY

Section 6 describes the Phase I – Water Recycling Project. The Phase I Project is restricted to about a 3-mile radius around the City's RWQCP. This 3-mile radius includes major potential users within the City, Jurupa Community Service District (JCSD) and Rubidoux Community Service District (RCSD). Two alternatives, with two sub-alternatives each, were identified, surveyed and evaluated for the development of Phase I – Water Recycling Project. These alternatives include:

- Alternative 1a – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- Alternative 1b – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- Alternative 2a – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.
- Alternative 2b – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.

A detailed presentation of the above alternatives, along with their associated costs under different financing scenarios, is given in Section 6 (**Table 6-3** through **Table 6-36**). To summarize, the total Phase I project cost will include miscellaneous water resources costs, the incremental costs associated with upgrading the City RWQCP system, and distribution costs within the City. **Table 6-37** (shown below) presents the combined capital and operation and maintenance costs for the different alternatives assessed for the project. It is observed that the water production cost for a system designed to meet only Phase I demand is lower than that for a system designed to meet citywide demand. Considering that the typical water production cost in Southern California ranges between $300/AFY to $700/AFY, the feasible Phase I recycled water system alternatives are:

- Alternative 1a – with or without Grant and Loan.
- Alternative 1b – only with Grant and Loan.
- Alternative 2a – with or without Grant and Loan.
- Alternative 2b – with or without Grant and Loan.

Total project cost will include miscellaneous water resources costs, the incremental costs associated with upgrading the City RWQCP system, and distribution costs within the City. **Table 6-37** presents the combined capital and operation and maintenance costs for the different alternatives assessed for the project. It is observed that water production cost for system designed to meet only phase I demand is lower than that for system to meet citywide demand. With a typical water cost ranging between $300/AFY to $700/AFY in Southern California, recycled water system for the city is feasible with Grant and Loan for phase I system that will implement citywide demand and feasible even without Grant and Loan for system that serve water users in phase I only.

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Table 6-37
Summary of Alternative Pricing Options

Alternatives	Riverside Potential Reuse (AFY)	Pipe Length (LF)	Approximate Capital Cost	Water Production Cost Option 1 ($/AFY)	Option 2 ($/AFY)	Option 3 ($/AFY)	Option 4 ($/AFY)	Option 5 ($/AFY)
1 - JCSD, City of Riverside Users up to Arlington Ave.								
A. System to meet phase I demand only	1,100	31,104	$6,297,000	550	439	470	360	276
B. System to meet Citywide demand also	1,100	31,104	$7,904,000	651	513	552	413	308
Difference (A - B)			$1,607,000	$101	$74	$82	$53	$32
2 - JCSD, City of Riverside Users up to Arlington Ave., Adams St. & Magnolia Ave.								
A. System to meet phase I demand only	1,500	47,026	$9,368,000	569	448	482	362	270
B. System to meet Citywide demand also	1,500	47,026	$9,961,000	594	466	502	374	277
Difference (A - B)			$593,000	$26	$18	$20	$13	$7

Option 1: City Funds - No Grants and/or Loans
Option 2: City Funds (75%) and Grant (25%)
Option 3: City Funds (25%) and SRF Loan (75%)
Option 4: Grant (25%) and SRF Loan (75%)
Option 5: Grant (50%) and SRF Loan (50%)

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
AND CITYWIDE MASTER PLAN

Section 7
Potential Funding Sources

PARSONS

SECTION 7
POTENTIAL FUNDING SOURCES

The recycled water project will provide benefits for many years after it is completed. There are several ways to finance such a project. Capital items that have a useful life over a long period may be financed over that period or on a "pay-as-you-use" basis. The term of the borrowing should coincide with or be less than the estimated useful life of the improvements if bond market conditions permit and if the debt obligation is within the City's ability to pay.

Majority of projects are financed by a combination of resources and financing techniques. The water recycling projects typically are not cost effective without innovative funding. Some of the more common financing techniques applicable in this case are reviewed here with the objective of finding the least cost method that is reasonable and within the City's ability to pay.

7.1 FUNDING ALTERNATIVES

A variety of funding alternatives as briefly described below could possibly used in for funding the projects developed under this master plan.

Proposition 13 (2000 Bond Law)

The Costa-Machado Water Act of 2000 (AB 1584) was approved by the voters as Proposition 13 on March 7, 2000. This new bond law includes loans and grants for the design and construction of water recycling projects. These are projects that reclaim either municipal wastewater or polluted groundwater. The State Water Resources Control Board (SWRCB) develops the priority list of projects proposed for funding with these grants and loans. The SWRCB administers two funding programs under Proposition 13:

- ***Water Recycling Facilities Planning Grant Program***

  The Water Recycling Facilities Planning Grant Program provides grants up to $75,000 to local public agencies to investigate the feasibility of water recycling and to prepare a facility's plan documenting the analyses and conclusions of the investigation.

- ***Water Recycling Construction Program***

  The Water Recycling Construction Program (formally the Water Recycling Loan Program) provides low-interest loans and grants to local public agencies for the design and construction of water recycling facilities. The types of facilities include wastewater treatment, recycled water storage facilities, pump stations, and recycled water distribution pipelines. A funding application includes a facilities plan to document the need for the project, the alternatives that were analyzed, and the engineering, economic, financial, and institutional feasibility of the proposed facilities.

Funding is provided to projects within the categories of projects that have completed or are in the final stages of facilities planning and that augment the state's water supply or provide other local benefits. A maximum funding amount of combined grant and loan per eligible water recycling project is set as $20 million. A set grant funding to 25 percent of eligible costs, up to $5 million per project with the balance of the eligible project cost to be funded with a low interest loan.

Proposition 13 provides both grants and additional SRF loan funds. 25% of project cost is allocated towards Proposition 13 Grant, while 75% of project cost is allocated towards State Revolving Fund (SRF) Loan with a low interest rate (typically it ranges between 2.8% and 2.4 %). There is no application deadline. The grant is allocated on a first come first serve basis.

Proposition 50

Water Quality, Supply and Safe Drinking Water Projects. Coastal Wetlands Purchase and Protection, State of California

Proposition 50 authorizes $3,440,000,000 general obligation bonds, to be repaid from state's General Fund, to fund a variety of water projects including: specified CALFED Bay-Delta Program projects including urban and agricultural water use efficiency projects; grants and loans to reduce Colorado River water use; purchasing, protecting and restoring coastal wetlands near urban areas; competitive grants for water management and water quality improvement projects; development of river parkways; improved security for state, local and regional water systems; and grants for desalination and drinking water disinfecting projects.

Appendix E provides copy of Proposition 50 and SAWPA Project information Form for Prop 50 potential funding.

Bureau of Reclamation

A bond measure was passed in 1984 authorizing the state to issue $25 million in low-interest loans for water recycling projects, which met certain technical and cost-effective criteria. This fund would be replenished through the repayment of loans drawn from it. Loan repayment was slow and the fund was being quickly depleted and subsequent bond measures were necessary to support the fund.

This program is administered by the SWRCB, Office of Water Recycling. Loan funds are available up to 100 percent of design and construction of water recycling projects. However, no single project may receive more than $5 million. Loans may be for a period of up to 20 years with an interest rate equal to the state's most recent General Obligation Bond sale interest rate.

California State Revolving Fund (SRF) Loans

The Federal Clean Water Act provides for the creation of a State Revolving Fund (SRF) Loan Program capitalized in part by federal funds. Between $150 to $200 million are available each year in this program. This program, which was originally designed to provide funding for high priority wastewater treatment and disposal

projects, was revised in September 1990 to include water recycling projects within its list of eligible projects.

SRF low interest loans are available through the California Department of Water Resources (DWR). With a successful application, DWR will commit funds on a predetermined schedule. California requires repayment of SRF loans at ½ of the interest rate it pays on the immediately preceding sale of its General Obligation Bonds, and therefore these loans are for a very low interest rate, currently at 2.4 percent. The State sells bonds on roughly 2-month intervals. Term for repayment may be from 15 to 20 years. It is thought repayment can be structured with an escalating annual debt service payment (if required) to match a reliable schedule of hook-ups, to track with anticipated cash flow from the project.

City's water recycling project already on the SWQCB priority list. Loans are provided based upon the readiness to construct, project qualification and availability of funds. Terms for a SRF loan are that the maximum repayment period is expected to be 20 years starting with the date on the grant/loan contract.

Other Grants and Loans

Occasionally, federal, state, and/or local grants and loans are available for water recycling projects. Federal funds are mostly available for low-income localities, and it is thought the service area may not qualify. City staff usually provides tracking of the availability and application requirements for locally available grants and loans.

General Obligation Bonds

Proposition 46 passed in 1986 opened the door to financing public facilities through general obligation (G.O.) bonds. G.O. bonds are the most efficient form of long-term financing (other than SRF loans) because the bond issues require neither a reserve fund nor funded interest during construction of the project financed. Costs of issuance are lower because these bonds are easier to structure, review from a legal standpoint, and analyze for credit-worthiness. G.O. bonds are secured by the properties in the City. Costs are generally borne by property owners in proportion to the assessed valuation of their properties. There would be considerable inequity because assessed valuation in many cases would not be representative of the true costs of the property if it had not changed ownership. Property owners throughout the City would in effect subsidize recycled water users. The major difficulty in issuing G.O. bonds is that they need to be approved by a two thirds majority of the voters. Educating the voters about the issues require time and resources. Because of the inequities discussed above, approval of two thirds of the electorate required before the bonds could be sold would be difficult.

Revenue Bonds

Revenue bonds are secured solely by a pledge of revenues. Usually an enterprise's revenues are derived from the facility that the bonds are used to acquire, construct, or improve. There is no obligation on the part of the enterprise to levy assessments for the payment of revenue bond service or for the maintenance and operation of the enterprise that produces the revenues that are pledged to pay bond service.

One measure of revenue bond security is the "coverage" provided. Coverage is the ratio of net revenue to annual bond service requirements. Net revenue is defined as the difference between operating revenues (including interest but not including connections fees) and the operating expenses (not including expenses related to new connections or depreciation). For revenue bonds to be saleable, the issuer normally pledges to maintain net revenue of 1.25 times annual bond service. The marketability of the bonds will be enhanced if it can be shown that the actual coverage provided by the net revenues will exceed the pledged ratio.

In addition, revenue bond buyers demand further safeguards by the establishment of a reserve fund equal to the average or maximum annual bond service. This reserve is normally created from the proceeds of the bond sale. The reserve is maintained for the entire life of the bond issue to meet annual principal and interest requirements in case operating revenues are insufficient for bond service in any given year.

Certificates of Participation (COPs)

This form of financing provides long term financing through a lease, installment sale agreement or loan agreement that is not subject to statutory limitations such as elections, interest rate limits, etc. The parties involved in a COP issue include the public entity (lessee), another public agency such as a redevelopment agency, or parking authority (the lessor) and a trustee. Legal basis for COPs comes from basic laws that allow public entities to enter into lease agreements one year at a time, with the understanding that a public entity cannot obligate future governing bodies to honor a lease agreement. This may result in COPs commanding a higher interest rate than revenue bonds. In other respects COPs are similar to revenue bonds.

Federal Budget Line Item Appropriations

Various large recycled water projects (such as the West Basin MWD Recycled Water Project located in the South Bay area of Los Angeles County) have been funded in part through Federal line item appropriations. This funding alternative is unusual and requires a lengthy lead-time.

7.2 SUMMARY

To summarize, standard practice for water recycling projects such as this one relies on California SRF loans, Proposition 13 grants, water system cash reserves, and, as required, long-term debt. The availability of water system cash reserves, or relatively short-term loans from the City, with repayment at interest from the water sales, is an important financing resource. The City would like to explore grant under the federal funds as discussed, Proposition 13 grants, and SRF loan. It is obvious that some kind of innovative project funding approach is must for the economical viability of the City's water recycling project.

The Section 8 of this master plan evaluates the potential project alternatives under following economical scenarios:

- No grant and SRF (City' own financing)
- Only 25% Proposition 13 grants
- Combination of proposition 13 and low interest rate SRF for the 75 percent of project cost.

Economic analysis based upon 100% grant money is not fair without commitment of full grant.

CITY OF RIVERSIDE

RECYCLED WATER PHASE I FEASIBILITY STUDY
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Section 8

Project Recommendations and Implementation Plan

PARSONS

SECTION 8

PROJECT RECOMMENDATION AND IMPLEMENTATION PLAN

This section describes the recommendations and implementation plan for the Phase I Project and Citywide Water Recycling Master Plan.

The scope of this study included the following issues and topics:

- Recycled water source (City of Riverside, RWQCP), quantity and quality analysis;
- Identify potential direct recycled water users;
- Recycle water demand and supply analysis;
- Development of alternatives for recycled water system alternatives;
- Preliminary cost estimates and cost economics for most viable alternatives;
- Financial, institutional and regulatory issues;
- Recommendation of the most viable alternative; and
- Implementation plan for the recommended alternative.

8.1 CITYWIDE WATER RECYCLING MASTER PLAN

Section 5 describes the ultimate recycled water system to serve users within the City and JCSD and also Western MWD. The citywide project has a significant number of potential recycled water users with an estimated demand of 20,400 AFY. Preliminary capital and operational cost estimates and life-cycle costs for the citywide project were developed. This report will be used as road map to implement phased water recycling projects. A predesign/feasibility study, hydraulic analysis, funding plan, and economic analysis will be required for each phase.

8.2 WATER RECYCLED PHASE I PROJECT

Section 6 examined the following alternatives for developing Phase I - Project within the City and delivery of recycled water to JCSD. Each of these alternatives was also reviewed based on installing the ultimate pipe size required for the citywide water recycling system. The alternatives included:

- **Alternative 1a** – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- **Alternative 1b** – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue.
- **Alternative 2a** – System designed with no citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.

- **Alternative 2b** – System designed with citywide expansion considerations for JCSD and City of Riverside Users up to Arlington Avenue, Adams Street and Magnolia Avenue.

Section 6 also provided preliminary capital and operational cost estimates for the two alternatives and cost economics and life-cycle costs for each of the alternatives.

8.2.1 Phase I Project Implementation Recommendations

The following issues will impact the selection of the most viable alternative:

- Most practical and cost-effective;
- Consideration of groundwater recharge during low demand period;
- Refinement of distribution system during predesign; and
- Extent of environmental impacts.

As the initial phase of a water recycling system, Parsons recommends implementing Alternative 1a or 2a with grants and SRF loan. Both alternatives are very close and within the error of margin. Selection of any of these alternatives will depend upon conformation/firming of agreements with users and availability of funds.

8.2.2 Phase I Project Implementation Guidelines

Implementation of a recycled water program must consider many issues before design and construction programs are initiated. These issues must be resolved or addressed before final project feasibility and scope can be accurately determined. The following proposed implementation sequence provides a directive for effective implementation of the water recycling program in conjunction with the City's overall objectives. All of these tasks should be completed prior to project design.

- **Water Quality Issues.** Discuss water quality and groundwater recharge objectives with the RWQCP, especially regarding total dissolved solids (TDS) and nitrogen limitations. This issue is critical to the viability of the project and needs must be definitely resolved prior to implementation of the program.
- **Water Recycling Ordinance.** Consider issuing an ordinance on water recycling and a reuse compliance policy. This ordinance could mandate use of recycled water, and incorporate rules and regulations regarding the use of recycled water pursuant to DHS guidelines.
- **Recycled Water Supply.** Reevaluate the availability of the recycled water supply for the City of Riverside during different periods of the year based on additional information concerning JCSD and Western MWD systems. Consider implementing the project in phases in order to minimize the use of potable water during summer months.

- **Agreement with JCSD and Neighboring Cities.** Develop an agreement with JCSD and neighboring cities. Emphasize the following issues:
  - Recycled water purchase cost
  - JCSD and neighboring Cities system upgrade capital and O&M costs sharing
  - Recycled water sharing during different months of the year
  - Priority for surplus City of Riverside RWQCP water

  In the event of RWQCP expansion, the City should receive priority for all surplus water exceeding the City of Riverside requirements. This will provide an opportunity to serve more users within the City and within neighboring areas including JCSD, Rubidoux CDS, City of Norco, etc.
- **Users Involvement.** Contact all the identified users in order to get "buy-in" to a water recycling system as well as to confirm their demands. Obtain letters of intent from each user.
- **Environmental Documentation.** Prior to implementing the proposed project, the City will have to comply with the requirements of the California Environmental Quality Act (CEQA). An Initial Environmental Study (EIS) would investigate issues such as the potential impacts from the project construction on local traffic, air quality, biological resources, and/or archaeological resources. Operational impacts from project, including impacts to groundwater quality, would also be addressed. If no significant impacts were identified in the EIS, a Negative Declaration could be prepared. Otherwise, an Environmental Impact Report (EIR) will be required in order to fully address and mitigate any significant environmental effects.
- **Grant/Loan Application.** In order to obtain financial assistance from the State or other agencies, specific details of the proposed water recycled project must be provided in the grant/loan application. Due to the large number of grant/loan applicants and the long lag time between the application and granting of various loans, submission of all required information should be in as timely a fashion as feasible. Additionally, for state loans, certification of the required environmental documentation is required prior to an application package being deemed complete.
- **Engineering Report (Title 22 Report).** Title 22, Chapter 3, Article 7, Section 60323 of the California Code of Regulations requires an engineering report to be filed for any project producing or supplying recycled water for direct reuse. The report includes a description of recycled water production, transmission of the recycled water, existing and future users, and the proposed method of administering the recycled water system. Both the Regional Water Quality Control Board and the Department of Health Services review the Title 22 report prior to the Board issuing Water Reclamation Requirements for the project.
- **Public Information Program.** Develop a public information/awareness program in conjunction with the related conservation program.

- **Conversion Costs.** Estimate on-site conversion requirements and costs for each user.
- **Reliability and Public Health Protection.** Consider treatment reliability and public health protection guidelines (Appendix A).
- **Groundwater Recharge.** Evaluate the feasibility of groundwater recharge with recycled water from the RWQCP during low demand periods when up to 15-18 mgd of supply could be available. It may be cost effective for the City to recover recharged water as potable without any further treatment.

APPENDIX A

California Regional Water Quality Control Board
Santa Ana Region

January 19, 2001

ITEM: 10

SUBJECT:

Waste Discharge Requirements for the City of Riverside's Regional Water Quality Control Plant, Riverside County, Order No. 01-3, NPDES No. CA0105350.

DISCUSSION:

See Attached Fact Sheet

RECOMMENDATION:

Adopt Order 01-3, NPDES No. CA0105350, as presented.

Comments were solicited from the following agencies:

U.S. Environmental Protection Agency, Permits Issuance Section (WTR-5) - Terry Oda
U.S. Army District, Los Angeles, Corps of Engineers, Regulatory Branch
U.S. Fish and Wildlife Service - Carlsbad
State Water Resources Control Board, Office of the Chief Counsel - Ted Cobb
State Water Resources Control Board, Division of Water Quality - James Kassel
State Department of Health Services, Santa Ana – Frank Hamamura
State Department of Health Services, Santa Barbara - Jeff Stone
State Department of Health Services, San Diego – Toby Roy
State Department of Water Resources - Glendale
State Department of Fish and Game - Long Beach
Orange County Water District - Nira Yamachika
Riverside County Flood Control and Water Conservation District
Santa Ana River Dischargers Association
Santa Ana Watershed Project Authority – Joseph Grindstaff
Inland Empire Utilities Agency - Douglas D. Drury
Orange County Coastkeeper
Lawyers for Clean Water C/c San Francisco Baykeeper

California Regional Water Quality Control Board
Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3348

January 19, 2001

FACT SHEET

The attached pages contain information concerning an application for the renewal of waste discharge requirements and a National Pollutant Discharge Elimination System (NPDES) permit.

I. FACILITY DESCRIPTION:

The City of Riverside operates the Riverside Regional Water Quality Control Plant (RRWQCP). The RRWQCP is a municipal wastewater treatment plant located on a 121 acre site at 5950 Acorn Street in the City of Riverside, south of the Santa Ana River near the intersection of Van Buren Boulevard. The RRWQCP discharges tertiary treated wastewater to Reach 3 of the Santa Ana River.

The plant started operation in 1946 and underwent major upgrading in 1992. The City completed construction of the Hidden Valley wetlands in March, 1995. Approximately 50 acres of constructed wetlands are being used for additional wastewater treatment (nitrogen removal).

The discharge from the facility is currently regulated by Order No. 95-18, NPDES No. CA 0105350, which expired on May 1, 2000. On October 29, 1999, the discharger submitted a complete application for the renewal of the NPDES permit.

The RRWQCP treats wastewater from the City of Riverside and from the following sewering agencies that have contractual agreements with the City of Riverside: Edgemont Community Services District, Jurupa Community Services District, and Rubidoux Community Services District.

The RRWQCP is designed to treat 40 million gallons per day (mgd) of wastewater. The annual average daily flow into the plant is 32.26 mgd with the highest monthly average value of 32.81 mgd.

The RRWQCP consists of two secondary treatment plants (Plants 1 and 2), one tertiary treatment plant that treats the flow from both Plants 1 and 2, and solids handling facilities that treat the sludge produced from wastewater treatment.

Influent flows into the RRWQCP are metered at a common headworks structure consisting of barscreens and vortex grit removal. Effluent from the headworks is proportionately channeled to Plant 1 and Plant 2. The following table shows the appurtenant structures in each plant:

Plant 1 20 MGD Capacity	**Plant 2 20 MGD Capacity**
6 primary sedimentation basins 4 aeration basins w/ anoxic zones 4 secondary sedimentation basins	4 primary sedimentation basins 6 aeration basins w/ anoxic zones 4 secondary sedimentation basins

Prior to tertiary treatment, flows from Plants 1 and 2 are combined in equalization basins. Tertiary treatment consists of alum and/or polymer injection, dual media filtration (16 filters), chlorination (3 chlorine contact tanks), and dechlorination by sulfur dioxide (SO_2). Tertiary treated wastewater is then discharged to Reach 3 of the Santa Ana River. Currently, a portion of the tertiary treated wastewater is directed through constructed wetlands for further nitrogen removal.

Solids handling includes dissolved air flotation (DAF) thickeners, anaerobic digestion (5 digesters), dewatering (2 belt presses) and air drying.

The RRWQCP discharges tertiary treated wastewaster at five points designated Serial Nos. 001, 002, 003, 004, and Serial No. 005. Discharge Serial No. 001 is the main discharge point where all treated effluent from the plant is discharged. It discharges into an earthen channel that leads to a splitter box where the waste stream is split into two, one discharges directly into the river, the other goes to the Hidden Valley wetlands. Prior to entering the wetlands, at Structure No. 2, the waste stream is again split into two, one goes to a metering structure where the waste could either be discharged to the river (Discharge Serial 004) or diverted into a wetland pond after which the waste is discharged through Discharge Serial No. 005. The other waste stream at Structure No. 2 goes to the wetland ponds after which it is discharged through Discharge Serial No. 003. This could best be visualized by looking at Attachment "B" of this fact sheet. The discharge points are described as follows:

Discharge Serial No.	Latitude	Longitude	Description
001	33°57'55"	117°27'28"	Effluent metering structure at dike
002	33°57'48"	117°28'30"	Splitter box discharge
003	33°57'48"	117°29'52"	Wetland effluent structure 1
004	33°57'52"	117°29'36"	Cottonwood diversion structure
005	33°58'01"	117°30'03"	Wetland effluent structure 2

The facility location is shown in Attachment "A" of this fact sheet. Page 2 of Attachment "A" shows the RWQCP location in relation to the discharge points and Hidden Valley wetlands.

A schematic diagram of the treatment process and discharge points is shown in Attachment "B" of this fact sheet.

II. REGULATORY BASIS FOR WASTE DISCHARGE REQUIREMENTS:

This Order includes requirements that implement the Water Quality Control Plan (Basin Plan), which was adopted by the Regional Board on March 11, 1994. The Basin Plan was approved by the Office of Administrative Law and became effective on January 24, 1995. This Plan specifies water quality objectives and beneficial uses for the waters of the Santa Ana Region. The Plan also specifies wasteload allocations for total dissolved solids (TDS) and total inorganic nitrogen[1] (TIN) for the upper Santa Ana River dischargers, including the RRWQCP. These allocations were established to assure compliance with the TDS and TIN objectives for the River and to protect underlying groundwater. The TDS and TIN limits specified in this Order are based on the wasteload allocations.

Tertiary treated wastewater from the facility is discharged to Reach 3 of the Santa Ana River. The beneficial uses of Reach 3 of the Santa Ana River include agricultural supply, groundwater recharge, water contact recreation, non-contact water recreation, warm freshwater habitat, wildlife habitat, and rare, threatened or endangered species. The discharge points overlie the Chino III Groundwater Subbasin, the beneficial uses of which include municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply. Receiving waters that may be affected by the discharge include the downgradient groundwater subbasins in Orange County, which are used for municipal and domestic supply and other uses.

Under dry weather conditions, most of the flow in Santa Ana River, Reach 3, is comprised of effluent discharges from municipal wastewater treatment facilities, including the discharge from the RRWQCP. Very little natural flow exists in the River.

Article 5, Section 60315 of Title 22, Chapter 3, "Reclamation Criteria" of the California Code of Regulations specifies that recycled water used as a source of supply in a nonrestricted recreational impoundment shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater (tertiary treated). The degree of treatment specified represents an approximately 5-log reduction in the virus content of the water. The State Department of Health Services has determined that this degree of virus removal is necessary to protect the health of people using these impoundments for water contact recreation. The Department of Health Services has developed wastewater disinfection guidelines ("Wastewater Disinfection for Health Protection", Department of Health Services, Sanitary Engineering Branch, February 1987) for discharges of wastewater to surface waters where water contact recreation (REC-1) is a beneficial use. The disinfection guidelines recommend the same treatment requirements for wastewater discharges to REC-1 waters as those stipulated in Title 22 for supply of recycled water to nonrestricted recreational impoundments, since the public health risks under both scenarios are analogous. The disinfection guidelines are based on sound science and are widely used as guidance to assure public health and beneficial use protection.

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1 *Total Inorganic Nitrogen (TIN) is the sum of nitrate-N, nitrite-N and ammonia-N.*

Santa Ana River, Reach 3 is not a "nonrestricted recreational impoundment," nor is "recycled water[2]" being used as a supply source for the River pursuant to the definitions in Title 22. However, except during major storms, most of the flow in the River is composed of treated municipal wastewater discharges. The River is used for water contact recreation and, accordingly, is designated REC-1 (water contact beneficial use). People recreating in the River face an exposure similar to those coming in contact with recycled water in an impoundment. Therefore, to protect the water contact recreation beneficial use and to prevent nuisance and health risk, it is necessary and appropriate to require the same degree of treatment for wastewater discharges to the River as would be required for the use of recycled water in a nonrestricted recreational impoundment. Thus, this Order specifies requirements based on tertiary or equivalent treatment.

The City proposes to discharge secondary treated and disinfected wastewater into Reach 3 of Santa Ana River, when 20:1 dilution of the wastewater can be provided by the natural flow of the River at the point of discharge. The Department of Health Services has determined that public health and water contact recreation beneficial uses will be protected provided that at least 20:1 dilution of secondary treated and disinfected wastewater by natural receiving waters is achieved. (Wastewater Disinfection for Health Protection", Department of Health Services, Sanitary Engineering Branch, February 1987). Based on best professional judgement, the proposed Order implements these public health protection guidelines.

The proposed Order specifies numeric and narrative limits for the control of toxic substances. These limits are based on the following:

1. 1995 Basin Plan
2. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California adopted on March 2, 2000 by the State Water Resources Control Board (hereinafter, "Policy")
3. Code of Federal Regulations (40 CFR Parts 122-503)
4. U.S. EPA, Quality Criteria for Water (1986)
5. National Toxics Rule (Federal Register, vol. 57, No. 256, Dec. 22, 1992, 60848-60922)
6. U.S. EPA, Office of Water Policy and Technical Guidance on Interpretation of Aquatic Life Metals Criteria (October 1, 1993)
7. Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001, March 1991)
8. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, promulgated in May 18, 2000 by the U.S. EPA.
9. Santa Ana River Use-Attainability Analysis, Volume 10, Calculation of Total-to-Dissolved Metal Ratios to Translate Site-Specific Water Quality Objectives into NPDES Effluent Limits", Risk Sciences (May, 1994).

This Order implements federal regulations specified in 40 CFR 122, 123, 124, 125, 129 and 501, which pertain to all publicly-owned treatment works (POTW) with average design flows exceeding 1 mgd.

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[2] *As defined in the Reclamation Criteria, recycled water means water which, as a result of treatment of domestic wastewater, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.*

This Order contains requirements for the implementation of an effective pretreatment program pursuant to Section 307 of the Federal Clean Water Act Parts 35 and 403 of Title 40, Code of Federal Regulations (40 CFR 35 and 40 CFR 403) and Section 2233, Title 23, California Code of Regulations.

In accordance with Section 402 (p) of the Federal Clean Water Act, EPA published the final regulations for storm water runoff on November 16, 1990 (40 CFR Parts 122, 123 and 124). Industrial facilities, including POTW sites, are required to obtain NPDES Permits for storm water discharges. On April 17, 1997, the State Board adopted a General Industrial Storm Water Permit, Order No. 97-03-DWQ, NPDES No. CAS000001. There are no stormwater discharges to surface waters from the RRWQCP facility site. All stormwater are captured and treated at the plant. Therefore, coverage under Order No. 97-03-DWQ is not necessary for this facility

The State Water Resources Control Board adopted a water reclamation policy on January 6, 1977. This policy requires that wastewater reclamation requirements be issued to primary users of recycled water. Reclamation requirements are included in this Order to address any current and future use of recycled water.

The State Water Resources Control Board adopted the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) on March 2, 2000. This Policy establishes implementation provisions for priority pollutant criteria promulgated by the U.S. Environmental Protection Agency (U.S. EPA) through the National Toxics Rule (NTR) (promulgated on December 22, 1992 and amended on May 4, 1995) and through the California Toxics Rule (CTR) (promulgated on May 18, 2000).

III. PROPOSED EFFLUENT LIMITATIONS:

The limitations in this Order are intended to control pollutants in the waste discharge, maintain water quality, and protect the beneficial uses of the affected receiving waters. Revisions to water quality objectives or to beneficial uses designated in the Basin Plan may occur in the course of periodic review and update of the Plan. These waste discharge requirements will be re-evaluated and may be revised to accommodate any of these changes.

In determining compliance with the effluent limitations in this Order, no mixing zone allowance is provided. No mixing zone allowance is proposed since there are essentially no natural receiving waters at the points of discharge.

A. Biological/ Mineral limitations

1. Biochemical Oxygen Demand (BOD), Suspended Solids, and Total Dissolved Solids (TDS)

The proposed Biological Oxygen Demand (BOD) and suspended solids limits are based on values that are achievable with tertiary treatment. These limits are intended to ensure that only adequately oxidized wastewater is discharged.

The proposed TDS limit for the discharge to Reach 3 of the Santa Ana River is based on the Basin Plan wasteload allocation for TDS discharges to the Santa Ana River system. To implement the Basin Plan, the proposed Order specifies a TDS limit of 650 mg/l, and a TDS limit based on the quality of the water supplied to the service area plus a reasonable use increment. The more restrictive of the two TDS limits applies to the discharges.

The Basin Plan recognizes that strict compliance with the TDS limits may be difficult to achieve. The Basin Plan describes the regulatory approach the Regional Board uses to address such situations. The Board incorporates offset provisions in waste discharge requirements whereby dischargers can participate in approved programs to offset TDS discharges in excess of specified TDS limits. Provided that the discharger implements an approved offset program, and provided that the discharger makes all reasonable efforts to improve the TDS quality of the water supply (and, thereby, the wastewater), the Board has indicated in its offset provisions its intent not to enforce violations of the TDS limits, except as required by Sections 13385 (h) and (i) of the California Water Code. The Board has indicated that participation in the watershed-wide study of TDS and total inorganic nitrogen (TIN) which is being conducted under the auspices of a number of dischargers and other interested parties, with participation by the Regional Board and coordination by the Santa Ana Watershed Project Authority (SAWPA), will constitute an acceptable TDS offset for the duration of the study. The study may lead to revised findings regarding TDS assimilative capacity and recommendations for changes to the TDS wasteload allocation and other TDS management strategies

2. Total Inorganic Nitrogen (Nitrate, Nitrite, Ammonia)

High concentrations of nitrates in domestic water can be toxic to human life. To protect human health, the concentrations of nitrates in lakes, streams, and ground water which are sources of drinking water shall not exceed 45 mg/l (as NO_3) or 10 mg/l (as N) as a result of controllable water quality factors.

Un-ionized ammonia exists in equilibrium with ammonium (NH_4^+) and hydroxide (OH^-) ions. The concentrations of ammonium and hydroxide ions change with temperature, pH and salinity of the water.

On November 15, 1991, the Regional Board adopted a revised wasteload allocation for total inorganic nitrogen in Publicly Owned Treatment Works (POTW) discharges to the Santa Ana River and its tributaries and to groundwater in the Upper Santa Ana River Basin. In accordance with the wasteload allocation, the proposed Order specifies a limit of 13.0 mg/l for flows up to 38 million gallons per day (mgd); for flows in excess of 38 mgd, the TIN limit is 10 mg/l.

In accordance with the Basin Plan, this Order specifies an effluent limitation of 5.0 mg/l for total ammonia-nitrogen.

B. Inorganic Salts

Certain inorganic chemical constituents may interfere with the beneficial uses of waters. In the Santa Ana River Basin, water is sometimes used as many as three times before ultimately being discharged to the ocean, and each cycle of use or reuse adds some increment of salts to the water. In order to protect the Basin waters for their beneficial uses, the Regional Board has determined that those inorganic chemical constituents in wastewaters which may adversely affect subsequent uses of those waters should be controlled. The constituents normally controlled and the beneficial uses that may be affected are described below.

Boron

Boron is not considered a problem in drinking water supplies until concentrations of 20-30 mg/l are reached. In irrigation, boron is an essential element. However, concentrations of boron in excess of 0.75 mg/l may be deleterious to certain crops. The maximum safe concentration of even the most tolerant plants is about 4.0 mg/l of boron.

Chloride

Excess chloride concentrations lead primarily to economic damage rather than public health hazards. Because excess chlorides will affect the taste of potable water, drinking water standards are generally based on potability standards rather than on health. Chlorides are considered to be among the most troublesome anions in water used for industrial or irrigation purposes. Chlorides significantly affect the rate of corrosion of steel and aluminum and are generally more toxic to plants than sulfates. A safe value for irrigation is considered to be less than 150 mg/l of chloride.

Fluoride

Fluoride in water supply used for industrial or irrigation purposes has limited detrimental effects. Fluoride in optimum concentrations in water supply (concentration dependent upon the mean annual air temperature) is considered beneficial for the teeth of the children, but concentrations above approximately 1 mg/l, or its equivalent, at a given temperature, are considered likely to increase the risk of occurrence of objectionable dental fluorosis.

Sodium

The presence of sodium in drinking water may be harmful to persons suffering from cardiac, renal, and circulatory diseases. It can contribute to tastes and with the taste threshold depending on the sodium salt involved. Sodium in excess concentrations in irrigation water reduces soil permeability to water and air and increases its solution pH. The deterioration of soil quality because of the presence of sodium in the irrigation water is a steadily cumulative process, and one that is accelerated by poor drainage.

Sulfate

Excessive sulfates in potable waters can lead to laxative effects, but this effect is usually temporary. It is of particular concern when sulfate is present in the form of magnesium sulfate. There is some taste effect from magnesium sulfate in the range of 400-600 mg/l as $MgSO_4$. Sulfate concentrations in waters native to this region are normally low, less than 40 mg/l, but imported Colorado River water contains approximately 300 mg/l of sulfate.

Total Dissolved Solids

The Department of Health Services recommends that the concentration of total dissolved solids in drinking water be limited to 500 mg/l (secondary drinking water standards). At present, no limitation is attributable to public health problems other than taste. For irrigation uses, suitable water under most conditions should have a total dissolved solids concentration under 700 mg/l. Quality-related consumer cost analyses in the basin planning program indicated that a benefit exists at or below 500 mg/l.

Total Hardness (as CaCO3)

The major detrimental effect of hardness is economic. Any concentration over 100 mg/l results in a waste of soaps and the encrustation of utensils in domestic uses. Hardness in industrial cooling waters is generally objectionable above 50 mg/l. However, higher hardness in surface waters mitigates toxicity from several heavy metals and thus can be beneficial to aquatic life.

Based on a review of historical effluent data, staff has determined that there appears to be no reasonable potential for the waste discharge to cause or contribute to violations of water quality objectives for individual mineral constituents (boron, chloride, fluoride, sodium, sulfate, and total hardness). Consequently, there are no effluent limitations for these constituents. However, monthly monitoring is still required to be conducted for these constituents.

C. Trace Constituent Limitations

The U.S. EPA has identified 126 priority pollutants, including metals and organic chemicals. For certain of these trace constituents, numeric limitations for the protection of aquatic life and public health are specified in this Order. For discharges to Santa Ana River, Reach 3, the numeric limitations for trace constituents are based on the U.S. EPA's California Toxics Rule. In some cases, these criteria are equations in which hardness is the variable. The actual numeric value of the criterion is calculated using hardness measurements. In determining effluent limitations for these constituents, a fixed hardness value of 250 mg/l was entered in the calculations. The fixed hardness value is based on the 5th percentile of 4 day average of hardness measurements taken in the Santa Ana River, downstream[3] of the discharge point from June 1998 to January 2000. Use of a fixed hardness value results in a fixed numerical effluent limit for each metal, thereby simplifying the effluent limitation and facilitating the determination of compliance.

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3 *The upstream river water hardness was higher than downstream river water hardness and use of downstream hardness will result in more stringent effluent limits.*

Federal regulations require that the effluent limits for metals be expressed as the total recoverable form. To comply with this requirement, the dissolved criteria are translated into total recoverable effluent limits using ratios of the total recoverable metals to dissolved metals (t/d) concentrations. The State Water Resources Control Board's Policy stipulates that in the absence of site-specific information, the conversion factors cited in the CTR should be used as the t/d translators. Site-specific translators for Cd, Cu and Pb, were developed in a study and reported in the "Santa Ana River Use-Attainability Analysis, Volume 10, Calculation of Total-to-Dissolved Metal Ratios to Translate Site-Specific Water Quality Objectives into NPDES Effluent Limits", Risk Sciences (March, 1994).

No numeric limitations are specified for those priority pollutants where there was no demonstrated reasonable potential to cause a water quality objective to be exceeded. To determine reasonable potential for pollutants to exceed water quality objectives, Board staff used the procedures outlined in the State Board's Policy. The maximum effluent concentrations for individual constituents that were detected in the effluent were compared to the criteria values specified in the California Toxics Rule. If the detected concentrations were less than the criteria, it was concluded that the effluent posed no reasonable potential to exceed water quality objectives for that constituent. In situations where the criteria value and all available effluent and receiving water data were below detection limits, staff was unable to determine if there was a reasonable potential to cause a water quality objective to be exceeded, due to unavailable and/or insufficient data. Therefore, effluent limits for those constituents also were not included in this Order. Only copper showed a reasonable potential to exceed water quality objectives. Limits for those constituents are based on the criteria values specified in the California Toxics Rule. The calculations for arriving at the effluent limits for Cu is in the Regional Board's file for RRWQCP.

Although past monitoring data for bis (2-ethylhexyl) phthalate indicate its presence in the effluent, recent studies conducted by the discharger and others indicate that the submitted results may be suspect due to contamination of samples during sampling and testing. These studies indicate that the contamination may be due to the use of plastic bottles and tubing (bis (2-ethylhexyl) phthalate is widely used in such materials) during sampling and testing. Based on this new information, staff believes that there is not sufficient data to make a determination that there is reasonable potential for the discharger to cause or contribute to an exceedance of the bis (2-ethylhexyl) phthalate objective in the receiving water. Therefore in accordance with Section 2.2.2.A. of the Policy, no limit for bis (2-ethylhexyl) phthalate is included in the Order. Rather, the Order includes an interim requirement for the discharger to conduct a controlled and intensive one-year monitoring program of the effluent for bis (2-ethylhexyl) phthalate using methods and equipment that would prevent sample contamination, produce a reliable test result and use a test detection level acceptable to the Regional Board. Should monitoring data show a reasonable potential for the constituent to exceed criteria values, this Order includes a reopener provision that allows the Regional Board to reopen the Order and include a limit for bis (2-ethylhexyl) phthalate.

Although limits for most of the priority pollutants are not included in this Order, the discharger is required to routinely monitor the effluent for all priority pollutants. If warranted by the results of this monitoring, this Order will be reopened to incorporate appropriate effluent limits.

D. Toxicity Limitations

This Order requires the discharger to conduct chronic[4] toxicity testing of the effluent on a monthly basis. The Order also requires the discharger to conduct an Initial Investigation Toxicity Reduction Evaluation (IITRE[5]) program when either the two month median of toxicity test results exceeds 1 TUc or any single test exceeds 1.7 TUc for survival endpoint. Based on the results of this investigation program and at the discretion of the Executive Officer, a more rigorous Toxicity Reduction Evaluation/Toxicity Identification Evaluation (TRE/TIE) may be required. A re-opener provision is included in the Order to incorporate a chronic toxicity effluent limitation if warranted by the toxicity test results.

E. Compliance

Many of the objectives specified in the California Toxics Rule, and the effluent limits that implement them, are at extremely low concentrations. In several cases, these concentrations are below current laboratory detection values. As such, it is necessary to require laboratory analyses to be performed to the lowest possible concentrations. The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) includes a list of priority pollutants with their respective Minimum Levels (ML)[6] on which "reported Minimum Levels" (i.e., quantitation values for the sample) shall be based. The Policy recognizes that the "reported ML" may be orders of magnitude different than the listed MLs depending on the amount of dilution/concentration required for sample preparation, and the amount of dilution necessary to address matrix interferences. Unfortunately, the policy lacks guidance for the development of appropriate "reported MLs".

For the last several permit cycles, the Regional Board has required discharges to meet practical quantitation levels (PQLs[7]). The PQLs for wastewater were developed based on the following:

1. A survey of laboratories in the Southern California area and a review of method detection levels (MDLs) in accordance with 40 CFR 136 for a wastewater matrix reported by local laboratories;

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4 *The chronic test method for the water flea "Ceriodaphnia dubia" also measures acute toxicity.*

5 *An IITRE is the initial stage of investigation conducted prior to implementing a complete toxicity reduction evaluation (TRE) study. A TRE is a stepwise process for identifying the agent(s) and/or source(s) of toxicity in a given effluent.*

6 *Minimum Level is the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.*

7 *PQL is the lowest concentration of a substance that can be determined within ± 20 percent of the true concentration by 75 percent of the analytical laboratories tested in a performance evaluation study. Alternatively, if performance data are not available, the PQL is the method detection limit (MDL) x 5 for carcinogens and MDL x 10 for noncarcinogens.*

2. The consensus PQLs determined during the meeting of major Southern California laboratories with the Regional Board staff on January 28, 1992. The consensus PQLs are believed to represent the lowest quantitation levels that can be achieved by most laboratories in Southern California based on proven laboratory performance and the reasonable application of best available analytical technology for most toxic substances;

3. The report "A Study To Determine The Practical Quantitation Levels (PQL) For Selected Water Chemistry Parameters Analyzed by Commercial Laboratories Operating In The Santa Ana River Watershed" (Risk Sciences, 1993). This report recommended PQLs for cadmium, copper, lead, selenium, and silver that better represented the actual PQLs attained by analytical laboratories performing analyses for these substances in a recycled water matrix.

Order No. 01-3 sets the PQLs listed in Attachment "A" of the monitoring and reporting program as the "reported MLs" for those constituents listed, until July 1, 2001. Order No. 01-3 requires that by July 1, 2001, the discharger shall meet the quantitation levels specified in Attachment "B" of the Monitoring and Reporting Program No. 01-3, unless an alternative minimum level is approved by the Regional Board's Executive Officer. The Executive Officer is authorized to extend this schedule provided that the discharger demonstrates good cause and that the extension is as short as possible.

In cases where the discharger believes that the sample matrix justifies a different "reported ML", the discharger is required to demonstrate to the satisfaction of the Regional Board's Executive Officer the appropriateness of the alternative "reported ML" for that sample matrix prior to July 1, 2001.

All analytical data are required to be submitted with the corresponding MDLs and MLs. Sample results shall be reported as "DNQ" (Detected, but Not Quantified) if the results are less than the reported ML, but greater than the MDL. Sample results shall be reported as "ND" (Not Detected) if the results are less than the MDL.

Dischargers shall be deemed out of compliance with an effluent concentration limit if the concentration of the effluent sample is greater than the effluent limit and greater than or equal to the "reported ML". Dischargers shall not be deemed out of compliance for any sample result reported as DNQ or ND. However, the discharger is required to conduct a Pollutant Minimization Program, as described in the Policy, if there is an indication that a constituent is present in the effluent above an effluent limitation and either:

a. A sample result is reported as DNQ and the effluent limitation is less than the "reported ML", or

b. A sample result is reported as ND and the effluent limitation is less than the MDL.

IV. ANTIDEGRADATION ANALYSIS:

The Regional Board has considered antidegradation pursuant to 40 CFR 131.12 and State Board Resolution No. 68-16. The water quality of the receiving waters is not expected to degrade as a result of this discharge. Neither the volume of the discharge nor the mass loading of pollutants associated with the discharge will adversely impact the receiving waters. Therefore, this discharge is consistent with federal and state antidegradation policies.

V. WRITTEN COMMENTS:

Interested persons are invited to submit written comments on the proposed discharge limits and the Fact Sheet. Comments should be submitted by December 29, 2000, either in person or by mail to:

Jun Martirez
California Regional Water Quality Control Board
Santa Ana Region
3737 Main street, Suite 500
Riverside, CA 92501-3348

VI. INFORMATION AND COPYING:

Persons wishing further information may write to the above address or call Jun Martirez of the Regional Board at (909) 782-3258. Copies of the application, proposed waste discharge requirements, Fact Sheet, and other documents (other than those which the Executive Officer maintains as confidential) are available at the Regional Board office for inspection and copying between the hours of 8:00 a.m. and 4:00 p.m., Monday through Thursday (excluding holidays).

VII. REGISTER OF INTERESTED PERSONS:

Any person interested in a particular application or group of applications may leave his name, address, and phone number as part of the file for an application.

VIII. PUBLIC HEARING:

The Regional Board will hold a public hearing regarding the proposed waste discharge requirements as follows:

DATE:	**January 19, 2001**
TIME:	**9:00 a.m.**
PLACE:	**City Council Chambers of Loma Linda** **25541 Barton Road** **Loma Linda, California**

Location Map

Discharge Points Location Map

Schematic of Wastewater Flow

California Regional Water Quality Control Board
Santa Ana Region

Tentative

ORDER NO. 01-3
NPDES NO. CA0105350

Waste Discharge and Producer/User Reclamation Requirements

for the

City of Riverside
Regional Water Quality Control Plant
Riverside County

California Regional Water Quality Control Board
Santa Ana Region

ORDER N0. 01-3
NPDES NO. CA0105350

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Tentative

California Regional Water Quality Control Board
Santa Ana Region

ORDER NO. 01-3
NPDES NO. CA0105350

Waste Discharge and Producer/User Reclamation Requirements
for
The City of Riverside
Riverside Regional Water Quality Control Plant
Riverside County

Tentative

The California Regional Water Quality Control Board, Santa Ana Region (hereinafter Regional Board), finds that:

1. The City of Riverside (hereinafter discharger) operates the Riverside Regional Water Quality Control Plant (RRWQCP), a municipal wastewater treatment plant. Order No. 95-18 NPDES NO. CA. 0105350 currently regulates the discharge from the RRWQCP. Order No. 95-18 expired on May 1, 2000.

2. The RRWQCP is located at 5950 Acorn Street in the City of Riverside in the SE¼ of Section 25, T2S, R6W, SBB&M.

3. The RRWQCP is designed to treat 40 million gallons per day (mgd) of wastewater. Wastewater treatment at the plant includes the following:

   a. Preliminary treatment consisting of bar screens and vortex grit removal.

   b. Two parallel secondary treatment plants (Plant 1 and Plant 2) that use the activated sludge process. Plants 1 and 2 operate simultaneously and independently. The treatment facilities include primary sedimentation basins, aeration basins and secondary sedimentation basins.

   c. A tertiary treatment facility that handles the effluents from Plants 1 and 2. Flows from both plants are combined in four equalization basins prior to tertiary treatment. The tertiary treatment consists of alum and/or polymer injection, dual media filtration, chlorination, dechlorination by SO_2, and nitrogen removal by constructed wetlands.

   d. Solids handling facilities that handle all solids produced in the plant. Solids handling includes 6 dissolved air flotation thickeners, 5 anaerobic digesters, 2 belt presses for dewatering, and sludge drying beds for air drying (as required).

4. The RRWQCP treats domestic and industrial wastewater from the City of Riverside and from the following sewage collection agencies:

   a. Edgemont Community Services District
   b. Jurupa Community Services District, and
   c. Rubidoux Community Services District.

5. A revised Water Quality Control Plan (Basin Plan) became effective on January 24, 1995. The Basin Plan contains beneficial uses and water quality objectives for waters in the Santa Ana Region.

6. The requirements contained in this Order are necessary to implement the Basin Plan.

7. The RRWQCP discharges tertiary treated wastewater into Reach 3 of the Santa Ana River at the following discharge points:

Discharge Serial No.	Latitude	Longitude	Description
001	33°57'55"	117°27'28"	Effluent metering structure at dike
002	33°57'48"	117°28'30"	Splitter box discharge
003	33°57'48"	117°29'52"	Wetland effluent structure 1
004	33°57'52"	117°29'36"	Cottonwood diversion structure
005	33°58'01"	117°30'03"	Wetland effluent structure 2

8. The beneficial uses of Reach 3 of the Santa Ana River include:

   a. Agricultural supply,
   b. Groundwater recharge,
   c. Water contact recreation,
   d. Non-contact water recreation,
   e. Warm freshwater habitat,
   f. Wildlife habitat, and
   g. Rare, threatened or endangered species.

9. The point of discharge also overlies the Chino III Groundwater Subbasin, the beneficial uses of which include:

   a. Municipal and domestic supply,
   b. Agricultural supply
   c. Industrial process supply, and
   d. Industrial service supply.

10. It is appropriate and necessary to control and limit the concentration of dissolved solids that may be discharged from the RRWQCP.

11. The limits contained in this Order for average concentrations of total dissolved solids are those that the discharger may reasonably be expected to achieve using methods such as, but not limited to a source control program and the control of water supply sources.

12. In conformance with the nitrogen wasteload allocation specified in the 1995 Basin Plan, this Order specifies a limit of 13 mg/l total inorganic nitrogen (TIN) for discharges up to 38 mgd; for discharges in excess of 38 mgd, the limit is 10 mg/l.

13. The 1995 Basin Plan includes a revised wasteload allocation for discharges of total dissolved solids (TDS) to the Santa Ana River system. In conformance with the wasteload allocation, this Order specifies a TDS limit of 650 mg/l for the discharge. An alternative limit based on the TDS quality of the water supply in the RRWQCP's service area plus a 250 mg/l TDS increment is also specified. The more restrictive of the two TDS limits applies.

14. The toxicity of copper, for which effluent limitations are specified in this Order, is dependent on water hardness. In this case, the effluent limit is calculated using equations[1] wherein water hardness is a variable. This Order uses a hardness value of 250[2] mg/l to calculate the effluent limits. A fixed effluent hardness value was utilized to facilitate determination of compliance. Federal regulations require that effluent limits for metals be expressed as the total recoverable form. To comply with this requirement, the calculated dissolved values were translated into total recoverable effluent limits using ratios of the total recoverable metal to dissolved metal (t/d) concentrations. The translator used for copper was developed in a recent study and reported in the "Santa Ana River Use-Attainability Analysis, Volume 10, Calculation of Total-to-Dissolved Metal Ratios to Translate Site-Specific Water Quality Objectives into NPDES Effluent Limits', Risk Sciences (March 1994).

15. As required by the Clean Water Act and regulations adopted thereunder, the chemical specific limitations contained in this Order are designed to prevent a violation of any applicable water quality standard for receiving waters adopted by the Regional Board, the State Board or U.S. EPA. If more stringent applicable water quality standards are approved pursuant to Section 303 of the Clean Water Act, or amendments thereto, the Regional Board will revise and modify this Order in accordance with such more stringent standards.

16. This Order contains requirements for the implementation of an effective pretreatment program pursuant to Section 307 of the Federal Clean Water Act; Parts 35 and 403 of Title 40, Code of Federal Regulations (40 CFR 35 and 40 CFR 403); and/or Section 2233, Title 23, California Code of Regulations.

17. The following sewering agencies are within the discharger's service area and have developed effective pretreatment programs. The discharger has signed contractual agreements with these agencies, giving the discharger the authority to implement and enforce the pretreatment program within the service areas if the agencies fail to properly implement their approved programs:

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1 *Equations were taken from the California Toxics Rule.*

2 *This hardness number is derived from the 5th percentile 4 day average of receiving water hardness downstream of the discharge point.*

a. Edgemont Community Services District
b. Jurupa Community Services District, and
c. Rubidoux Community Services District

18. This Order incorporates the requirements specified in the EPA and the Regional Board approved pretreatment programs for the discharger's service area as enforceable conditions of this Order.

19. Effluent limitations, national standards of performance, and toxic pretreatment effluent standards established pursuant to Section 208(b), 301, 302, 303(d), 304, 306, and 307 of the Clean Water Act, and amendments thereto, are applicable to the discharge.

20. Article 5, Section 60315 of Title 22, Chapter 3, "Reclamation Criteria" of the California Code of Regulations specifies that reclaimed water used as a source of supply in nonrestricted recreational impoundments shall be at all times an adequately disinfected, oxidized, coagulated, clarified, filtered wastewater (tertiary treated). The degree of treatment specified represents an approximately 5-log reduction in the virus content of the water. The State Department of Health Services has determined that this degree of virus removal is necessary to protect the health of people using these impoundments for water contact recreation.

21. The Department of Health Services has developed wastewater disinfection guidelines ("Wastewater Disinfection for Health Protection", Department of Health Services, Sanitary Engineering Branch, February 1987) for discharges of wastewater to surface waters where water contact recreation (REC-1) is a beneficial use. The disinfection guidelines recommend the same treatment requirements for wastewater discharges to REC-1 waters as those stipulated in Title 22 for supply of reclaimed water to nonrestricted recreational impoundments, since the public health risks under both scenarios are analogous. The disinfection guidelines are based on sound science and are widely used as guidance to assure public health and beneficial use protection.

22. The Santa Ana River is not a "nonrestricted recreational impoundment," nor is "reclaimed water[3]" being used as a supply source for the River pursuant to the definitions in Title 22. However, except during major storms, most of the flow in the River is composed of treated municipal wastewater discharges. The River is used for water contact recreation and, accordingly, is designated REC-1 (water contact beneficial use). People recreating in the River face an exposure similar to those coming in contact with reclaimed water in an impoundment. Therefore, to protect the water contact recreation beneficial use and to prevent nuisance and health risk, it is necessary and appropriate to require the same degree of treatment for wastewater discharges to the River as would be required for the use of reclaimed water in a nonrestricted recreational impoundment.

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3 *As defined in the Reclamation Criteria, reclaimed water means water which, as a result of treatment of domestic wastewater, is suitable for a direct beneficial use or a controlled use that would not otherwise occur.*

23. On January 6, 1977, the State Board adopted a water reclamation policy regarding the issuance of wastewater reclamation requirements to primary users of reclaimed water. This Order incorporates requirements for the production and use of reclaimed water in conformance with the "Policy and Action Plan for Water Reclamation in California" adopted by the State Board and "Reclamation Criteria" (Title 22 Division 4 California Code of Regulations) adopted by the California Department of Health Services. The Regional Board has consulted with the Department of Health Services regarding these requirements and has incorporated its recommendations.

24. On April 17, 1997, the State Board adopted the General Industrial Storm Water Permit, Order No. 97-03-DWQ, NPDES No. CAS000001. This General Permit implements the Final Regulations (40 CFR 122, 123, and 124) for storm water runoff published on November 16, 1990 by EPA in compliance with Section 402(p) of the Clean Water Act (CWA). There are no stormwater discharges to surface waters from the RRWQCP facility site. All stormwater are captured and treated at the plant. Therefore, coverage under Order No. 97-03-DWQ is not necessary for this facility.

25. On March 2, 2000, the State Water Resources Control Board adopted the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California. This Policy includes implementation provisions for the California Toxics Rule.

26. On May 18, 2000, the U.S. Environmental Protection Agency issued a final rule for the establishment of Numeric Criteria for Priority Toxic Pollutants necessary to fulfill the requirements of Section 303(c)(2)(B) of the Clean Water Act for the State of California. This rule is commonly referred to as the California Toxics Rule.

27. On February 19, 1993, the U.S. Environmental Protection Agency (U.S. EPA) issued a final rule for the use and disposal of biosolids (40 CFR 503). This rule requires that producers of biosolids meet certain reporting, handling, and disposal requirements. The State of California has not been delegated the authority to implement this program. Therefore, the U.S. EPA is the implementing agency.

28. The Regional Board has considered antidegradation pursuant to 40 CFR 131.12 and State Board Resolution No. 68-16 and finds that the RRWQCP discharge is consistent with those provisions.

29. In accordance with Water Code Section 13389, the issuance of waste discharge requirements for this discharge is exempt from those provisions of the California Environmental Quality Act contained in Chapter 3 (commencing with Section 21100), Division 13 of the Public Resources Code.

30. The Regional Board has notified the discharger and other interested agencies and persons of its intent to prescribe waste discharge requirements for the discharge and has provided them with an opportunity to submit their written views and recommendations.

31. The Regional Board, in a public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED that the discharger, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. DISCHARGE SPECIFICATIONS:

1. The discharge of wastes containing constituent concentrations and mass emissions in excess of the following limits is prohibited:

   a. Conventional Pollutant Limitations:

EFFLUENT WITHOUT 20:1 DILUTION (RIVER FLOW[4] : WASTEWATER FLOW)				
Constituent	Average Weekly (mg/l)	Average Monthly (mg/l)	Average Weekly Emission Rate[5] (lbs/day)	Average Monthly Emission Rate (lbs/day)
Biochemical Oxygen Demand	30	20	10,008	6,672
Suspended Solids	30	20	10,008	6,672
EFFLUENT WITH 20:1 DILUTION (RIVER FLOW[5] : WASTEWATER FLOW)				
Constituent	Average Weekly (mg/l)	Average Monthly (mg/l)	Average Weekly Emission Rate (lbs/day)	Average Monthly Emission Rate (lbs/day)
Biochemical Oxygen Demand	45	30	15,012	10,008
Suspended Solids	45	30	15,012	10,008

4 *Exclusive of discharges to surface waters from upstream publicly owned treatment works.*

5 *Except where noted, mass emission rates for this and all other tables in this permit are based on 40 mgd.*

b. Ammonia-Nitrogen/Chlorine Residual Limitations:

Constituent	Instantaneous Maximum (mg/l)	Average Monthly (mg/l)	Average Monthly Emission Rate (lbs/day)
Ammonia-Nitrogen		5.0	1,668
Total Chlorine Residual[6]	0.1		

c. TDS Limitations:

i. The 12-month average total dissolved solids concentration shall not exceed 650 mg/l and 12-month average mass emission rate shall not exceed 216,840 lbs/day. [7] , and

ii. The 12-month average total dissolved solids concentration shall not exceed the 12-month average total dissolved solids concentration in the water supply by more than 250 mg/l.

The lower of the two total dissolved solids limits is the limit.

d. Total Inorganic Nitrogen (TIN) Limitation:

The 12-month average total inorganic nitrogen concentration for flows up to 38 million gallons per day shall not exceed 13 mg/l and for flows exceeding 38 mgd shall not exceed 10 mg/l. The 12-month average emission rate shall not exceed the computed value using the equation:

TIN 12-month emission rate (lbs/day) = 4120 lbs[8] + (flows above 38 mgd x 8.34 x 10 mg/l)

6 *See Section G.6., "Compliance Determination"*

7 *See Section G.8. and G.9., "Compliance Determination"*

8 *Derived from 38 mgd x 8.34 x 13 mg/l*

e. Toxic Pollutant Effluent Limitations:

Constituent	Maximum Daily Limit (µg/l)	Average Monthly Limit (µg/l)	Maximum Daily Mass Rate (lbs/day)	Average Monthly Mass Rate (lbs/day)
Copper[9]	82.7	41.2	27.6	13.8

2. The discharge shall at all times be an adequately filtered and disinfected wastewater (tertiary treated effluent) if the flow in the Santa Ana River, Reach 3 is less than that required for a dilution of 20:1 (receiving water flow[10] : wastewater flow) at the point of discharge. Filtered wastewater means an oxidized, coagulated, and clarified wastewater which has been passed through natural undisturbed soils or filter media, such as sand or diatomaceous earth (or equivalent as determined by the State Department of Health Services). The discharge shall be considered adequately filtered if the turbidity does not exceed an average of 2.0 turbidity units nor exceeds 5.0 turbidity units more than 5 percent of the time during any 24-hour period. The discharge shall be considered adequately disinfected if the median number of coliform organisms does not exceed 2.2 per 100 milliliters and the number of coliform organisms does not exceed 23 per 100 milliliters in more than one sample within any 30-day period. The median value shall be determined from the bacteriological results of the last 7-days for which analyses have been completed.

3. The discharge of secondary treated wastewater when the flow[11] in Santa Ana River Reach 3 results in a dilution of 20:1 (receiving water flow : wastewater flow) or more at the point of discharge shall be an adequately disinfected and oxidized wastewater. The discharge shall be considered adequately disinfected if at some location in the treatment process, the median number of coliform organisms does not exceed 23 per 100 milliliters. The median value shall be determined from the bacteriological results of the last 7-days for which analyses have been completed. The discharge shall be considered adequately oxidized if it complies with the average weekly and average monthly effluent limitations for BOD and suspended solids as specified in Discharge Specification A.1.a., above.

   The discharger shall make provisions for the measurement of the receiving water flow[11] at a suitable location upstream of the discharge point and determine whether a 20:1 dilution exists before discharging secondary treated effluent. A dilution of 20:1 or more is required at the point of discharge.

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9 *Limits for hardness dependent metals were computed based on a 250 mg/l hardness value.*

10 *Exclusive of discharges to surface waters from upstream publicly owned treatment works.*

4. The monthly average biochemical oxygen demand and suspended solids concentrations of the discharge shall not be greater than fifteen percent (15%) of the monthly average influent concentrations.

5. The discharge of any substances in concentrations toxic to animal or plant life in the affected receiving water is prohibited.

6. There shall be no visible oil and grease in the discharge.

7. The pH of the discharge shall be within 6.5 and 8.5 pH[11].

B. <u>TOXICITY REQUIREMENTS</u>:

1. This Order contains no numeric limitation for toxicity. However, the discharger shall conduct chronic toxicity monitoring as specified in Monitoring and Reporting Program (M&RP) No. 01-3.

2. The discharger shall implement the accelerated monitoring as specified in Section D.4. of M&RP No. 01-3 when the result of any single chronic toxicity test of the effluent exceeds 1.0 TUc.

3. The discharger shall develop an Initial Investigation Toxicity Reduction Evaluation (IITRE) work plan that describes the steps the discharger intends to follow if required by Toxicity Requirement No. 4, below. The work plan shall include at a minimum:

   a. A description of the investigation and evaluation techniques that will be used to identify potential causes/sources of the exceedance, effluent variability, and/or efficiency of the treatment system in removing toxic substances. This shall include a description of an accelerated chronic toxicity testing program.

   b. A description of the methods to be used for investigating and maximizing in-house treatment efficiency and good housekeeping practices.

   c. A description of the evaluation process to be used to determine if implementation of a more detailed TRE\TIE is necessary.

4. The discharger shall implement the IITRE work plan whenever the results of chronic toxicity tests of the effluent exceed:

   a. A two month median value of 1.0 TUc for survival or reproduction endpoint or,

   b. Any single test value of 1.7 TUc for survival endpoint.

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11 *See Section G.7., "Compliance Determination"*

5. The discharger shall develop a detailed Toxicity Reduction Evaluation and Toxicity Identification Evaluation (TRE/TIE) work plan that shall describe the steps the discharger intends to follow if the implemented IITRE fails to identify the cause of, or to rectify, the toxicity.

   The discharger shall use as guidance, at a minimum, EPA manuals *EPA/600/2-88/070* (industrial), *EPA/600/4-89-001A* (municipal), *EPA/600/6-91/005F* (Phase I), *EPA/600/R-92/080* (Phase II), and *EPA-600/R-92/081* (Phase III) to identify the cause(s) of toxicity. If during the life of this Order the aforementioned EPA manuals are revised or updated, the revised/updated manuals may also be used as guidance. The detailed TRE/TIE work plan shall include:

   a. Further actions to investigate and identify the cause of toxicity;
   b. Actions the discharger will take to mitigate the impact of the discharge and to prevent the recurrence of toxicity; and
   c. A schedule for these actions.

6. The discharger shall implement the TRE/TIE workplan if the IITRE fails to identify the cause of, or rectify, the toxicity, or if in the opinion of the Executive Officer the IITRE does not adequately address an identified toxicity problem.

7. The discharger shall assure that adequate resources are available to implement the required TRE/TIE.

C. BIOSOLIDS REQUIREMENTS:

1. Collected screenings, biosolids, and other solids removed from liquid wastes shall be disposed of in a manner that is consistent with Chapter 15, Division 3, Title 23, of the California Code of Regulations and approved by the Executive Officer.

2. The use and disposal of biosolids shall comply with existing Federal and State laws and regulations, including permitting requirements and technical standards included in 40 CFR 503. (see also Section K.6. – Permit Re-opening, Revision, Revocation, and Re-issuance).

3. Any proposed change in biosolids use or disposal practice from a previously approved practice shall be reported to the Executive Officer and EPA Regional Administrator at least 90 days in advance of the change.

4. The discharger shall take all reasonable steps to minimize or prevent any discharge or biosolids use or disposal which has the potential of adversely affecting human health or the environment.

D. RECEIVING WATER LIMITATIONS[12]:

1. The discharge of wastes shall not cause a violation of any applicable water quality standards for receiving waters adopted by the Board or State Board, as required by the Clean Water Act and regulations adopted thereunder.

2. The discharge shall not cause any of the following:

   a. Coloration of the receiving waters which causes a nuisance or adversely affects beneficial uses.

   b. Deposition of oil, grease, wax or other materials in the receiving waters in concentrations which result in a visible film or in coating objects in the water, or which cause a nuisance or affect beneficial uses.

   c. An increase in the amounts of suspended or settleable solids in the receiving waters which will cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors.

   d. Taste or odor producing substances in the receiving waters at concentrations which cause a nuisance or adversely affect beneficial uses.

   e. The presence of radioactive materials in the receiving waters in concentrations which are deleterious to human, plant or animal life.

   f. The depletion of the dissolved oxygen concentration below 5.0 mg/l.

   g. The temperature of the receiving waters to be raised above 90°F (32°C) during the period of June through October, or above 78°F (26°C) during the rest of the year.

   h. The concentration of pollutants in the water column, sediments, or biota to adversely affect the beneficial uses of the receiving water. The discharge shall not result in the degradation of inland surface water communities and populations, including vertebrate, invertebrate, and plant species.

3. Pollutants not specifically mentioned and limited in this Order shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health.

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12 *Receiving water limitations are specific interpretations of water quality objectives from applicable water quality control plans. As such they are a required part of this Order. A receiving water condition not in conformance with any of these receiving water limitations, is not necessarily a violation of this Order. The Regional Board may require an investigation to determine the cause and culpability prior to asserting a violation has occurred, or requiring that corrective action be taken.*

E. PRETREATMENT REQUIREMENTS:

1. The discharger shall update as necessary and appropriate the contractual agreements with all governmental agencies[13]. The contractual agreements shall give the discharger the authority to implement and enforce the EPA approved pretreatment program within the sewer service areas of the treatment facility. The discharger shall assure that any other steps necessary to provide this implementation and enforcement authority (e.g. adoption of ordinances, etc.) are taken by all governmental agencies. If a governmental agency has an EPA approved pretreatment program for any portion of the service area of the treatment facility, the discharger's pretreatment program shall contain provisions ensuring that that governmental agency's program is implemented. In the event that any contributory agency fails to effectively implement its individual EPA approved pretreatment program, the discharger shall implement and enforce its approved program within that agency's service area.

2. The discharger shall ensure that the POTW[14] pretreatment programs for all contributory agencies to the treatment facility are implemented and enforced. The discharger shall be responsible and liable for the performance of all Control Authority pretreatment requirements contained in 40 CFR 403, including any subsequent regulatory revisions to Part 403. Where Part 403 or subsequent revisions place mandatory actions upon the discharger as Control Authority but does not specify a timetable for completion of the actions, the discharger shall submit for approval of the Regional Board's Executive Officer, a schedule for implementation of the required actions and shall implement the approved schedule. The schedule for implementation shall be submitted within six months from the date that such mandatory actions are established. For violations of pretreatment requirements, the discharger shall be subject to enforcement actions, penalties, fines and other remedies by the EPA, or other appropriate parties, as provided in the CWA, as amended (33 USC 1351 et seq.). The EPA or the Regional Board may also initiate enforcement action against an industrial user (IU) for non-compliance with applicable standards and requirements as provided in the CWA.

3. The discharger shall enforce the requirements promulgated under Sections 307(b), 307(c), 307(d), and 402(b) of the CWA with timely, appropriate and effective enforcement actions. The discharger shall cause industrial users (IUs) subject to the Federal Categorical Standards to achieve compliance no later than the date specified in those requirements or, in the case of a new IU, upon commencement of the discharge.

4. The discharger shall perform the pretreatment functions as required in 40 CFR Part 403 including, but not limited to:

   a. Enforce the pretreatment requirements under 40 CFR 403.5 and 403.6;

   b. Implement the necessary legal authorities as provided in 40 CFR 403.8(f)(1);

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13 *Member agencies and sewering agencies discharging wastewater into the facility.*

14 *Publicly owned treatment works*

c. Implement the programmatic functions as provided in 40 CFR 403.8(f)(2);

d. Publish a list of significant non-compliance as required by 40 CFR 403.8(f)(2)(vii), and

e. Provide the requisite funding and personnel to implement the pretreatment program as provided in 40 CFR 403.8(f)(3).

5. The following wastes shall not be introduced into the treatment works:

a. Wastes which create a fire or explosion hazard in the treatment works;

b. Wastes which will cause corrosive structural damage to treatment works, but, in no case, wastes with a pH lower than 5.0 unless the works are designed to accommodate such wastes;

c. Wastes at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency;

d. Solid or viscous wastes in amounts which would cause obstruction to the flow in sewers or otherwise interfere with the proper operation of the treatment works.

6. The discharger shall ensure compliance with any existing or future pretreatment standard promulgated by EPA under Section 307 of the CWA or amendments thereto for any discharge to the municipal system.

7. The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this Order has not yet been modified to incorporate the requirement. The discharger shall require each user not in compliance with any pretreatment standard to submit periodic notice (over intervals not to exceed nine months) of progress toward compliance with applicable toxic and pretreatment standards developed pursuant to the CWA or amendments thereto. The discharger shall forward a copy of such notice to the Regional Board and to the EPA Regional Administrator.

F. WATER RECYCLING REQUIREMENTS:

1. The discharger shall be responsible for assuring that recycled water is delivered and utilized in conformance with this Order, the reclamation criteria contained in Title 22, Division 4, Chapter 3, Sections 60301 through 60355, California Code of Regulations, and the "Guidelines for Use of Reclaimed Water" by the California Department of Health Services. The discharger shall conduct periodic inspections of the facilities of the recycled water users to monitor compliance by the users with this Order.

2. The discharger shall establish and enforce rules and regulations for recycled water users, governing the design and construction of recycled water use facilities and the use of recycled water in accordance with the uniform statewide reclamation criteria established pursuant to the California Water Code Section 13521.

3. The storage, delivery, or use of recycled water shall not individually or collectively, directly or indirectly, result in a pollution or nuisance, or adversely affect water quality, as defined in the California Water Code. The use of recycled water shall be in conformance with the wastewater reclamation plan specified in the Basin Plan (Table 5-7). Proposed large scale wastewater reclamation activities which are not in conformance with the Basin Plan shall be considered for approval by the Regional Board on a case by case basis (see also Section F.5., below).

4. Prior to delivering recycled water to any new user, the discharger shall submit to the Regional Board, the California Department of Health Services and the Riverside County Health Department a report containing the following information for review and approval:

    a. The average number of persons estimated to be served at each use site area on a daily basis.
    b. The specific boundaries of the proposed use site area including a map showing the location of each facility, drinking water fountain, and impoundment to be used.
    c. The person or persons responsible for operation of the recycled water system at each use area.
    d. The specific use to be made of the recycled water at each use area.
    e. The methods to be used to assure that the installation and operation of the recycled system will not result in cross connections between the recycled water and potable water piping systems. This shall include a description of the pressure, dye or other test methods to be used to test the system.
    f. Plans and specifications which include following:
        1) Proposed piping system to be used.
        2) Pipe locations of both the recycled and potable systems.
        3) Type and location of the outlets and plumbing fixtures that will be accessible to the public.
        4) The methods and devices to be used to prevent backflow of recycled water into the potable water system.
        5) Plan notes relating to specific installation and use requirements.

5. Proposed large scale reclamation activities which are not in conformance with the Basin Plan shall be initiated only with the prior approval of the Regional Board. The Executive Officer may require the submission of additional information in order to evaluate the water quality impacts of the proposal.

6. An on-site supervisor responsible for the operation of the recycled water distribution system shall be designated by the user. The supervisor shall be responsible for enforcing this Order, prevention of potential hazards, the installation, operation and maintenance of the distribution system, maintenance of the distribution and irrigation system plans in "as-built" form, and for the distribution of the recycled wastewater in accordance with this Order.

G. COMPLIANCE DETERMINATION:

1. The "maximum daily" concentration is defined as the measurement made on any single grab sample or composite sample.

2. Compliance with average weekly and monthly discharge limitations specified under Discharge Specifications A.1.a., A.1.b., and A.1.e. shall be determined from the average of the analytical results of all samples collected during a calendar week or month, respectively.

3. Compliance with the 12-month average limits specified in Discharge Specifications A.1.c. and A.1.d. shall be determined monthly by the arithmetic mean of the last twelve monthly averages.

4. The discharger shall be deemed out of compliance with an effluent limitation if the concentration of the priority pollutant in the monitoring sample is greater than the effluent limitation.

   a. Until July 1, 2001, compliance determination shall be based on the practical quantitation levels[15] (PQL) specified in Attachment "A" of M&RP No. 01-3 or on the lower reporting level(s) that may reasonably be achieved by the discharger. (with prior approval by the Executive Officer of the Regional Board)

   b. As of July 1, 2001, compliance determination shall be based on the quantification levels specified in Attachment "B" of the Monitoring and Reporting Program No. 01-3, unless an alternative minimum level[16] (ML) is approved by the Regional Board's Executive Officer. The Executive Officer is authorized to extend the July 1, 2001 date provided that the discharger demonstrates good cause and that the extension is as short as possible.

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15 *PQL is the lowest concentration of a substance which can be determined within ± 20 percent of the true concentration by 75 percent of the analytical laboratories tested in a performance evaluation study. Alternatively, if performance data are not available, the PQL is the method detection limit (MDL) x 5 for carcinogens and MDL x 10 for noncarcinogens.*

16 *Minimum level is the concentration at which the entire analytical system must give a recognizable signal and acceptable point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.*

c. When determining compliance with an average monthly limit and more than one sample result is available in a month, the discharger shall compute the arithmetic mean unless the data set contains one or more reported determinations of detected but not quantified (DNQ) or not detected (ND). In those cases, the discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

1) The data set shall be ranked from low to high, reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.

2) The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ. If a sample result, or the arithmetic mean or median of multiple sample results, is below the reported ML, and there is evidence that the priority pollutant is present in the effluent above an effluent limitation and the discharger conducts a pollutant minimization program (PMP)[17] (as described in Section J.8.), the discharger shall not be deemed out of compliance.

5. Compliance with effluent limitations for all constituents is determined at the RRWQCP effluent metering structure (Discharge Serial 001), except for toxicity and TIN. Toxicity shall be determined at the splitter box (discharge Serial 002) when effluent is being delivered to the wetlands or from the channel at the Van Buren crossing when effluent is not being delivered to the wetland. Compliance with TIN limits shall be calculated based on the discharge from the effluent metering structure minus losses at the Hidden Valley wetlands using methods approved by the Executive Officer of the Regional Board.

6. Compliance determinations for total chlorine residual shall be based on 99% compliance. To determine 99% compliance with the effluent limitation specified in Discharge Specification A.1.b. for total chlorine residual, the following conditions shall be satisfied:

a. The total time during which the total chlorine residual values are above 0.1 mg/l (instantaneous maximum value) shall not exceed 7 hours and 26 minutes in any calendar month;

b. No individual excursion from 0.1 mg/l value shall exceed 30 minutes; and

c. No individual excursion shall exceed 5.0 mg/l.

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17 *The goal of the PMP shall be to reduce all potential sources of a priority pollutant(s) through pollutant minimization (control) strategies, including pollution prevention measures as appropriate, to maintain the effluent concentration at or below the water quality-based effluent limitation.*

7. Pursuant to 40 CFR 401.17, the discharger shall be in compliance with the pH limitation specified in this Order (Discharge Specification A.7., above), provided that both of the following conditions are satisfied:

   a. The total time during which the pH values are outside the required range of 6.5-8.5 pH values shall not exceed 7 hours and 26 minutes in any calendar month; and

   b. No individual excursion from the range of pH values shall exceed 60 minutes.

8. The Regional Board will not initiate enforcement action for violations of the TDS limit specified in Discharge Specifications A.1.c.i., except as required in Sections 13385 (h) and (i) of the California Water Code, provided that:

   a. The discharger demonstrates to the satisfaction of the Regional Board's Executive Officer that:

      1) the violation is due to the TDS quality of water supply sources utilized in the discharger's service area; and

      2) that all reasonable steps, as agreed upon by the Executive Officer, have been taken to ensure that best TDS quality supplies are obtained and utilized in the discharger's service area; and

   b. The discharger develops and implements, with the approval of the Executive Officer, a plan to mitigate the effects of the violation on the affected receiving waters.

9. The Regional Board will not initiate enforcement action for violations of the TDS limits specified in Discharge Specifications A.1.c.i. or A.1.c.ii., except as required in Sections 13385 (h) and (i) of the California Water Code, provided that:

   a. The discharger demonstrates to the satisfaction of the Executive Officer that:

      1) The TDS violation(s) are due solely to chemical additions in the treatment process needed to meet waste discharge requirements or other valid regulatory requirements; and

      2) The discharger has taken all steps to optimize chemical additions so as to minimize the TDS increases;

   b. The discharger develops and implements, with the approval of the Executive Officer, a plan to mitigate the effects of the violation on the affected receiving waters.

10. Compliance determinations shall be based on available analyses for the time interval associated with the effluent limitation. Where only one sample analysis is available in a specified time interval (e.g., monthly or weekly average), that sample shall serve to characterize the discharge for the entire interval. If quarterly sample result shows noncompliance with the average monthly limit and that sample result is used for compliance determinations for each month of the quarter, then three separate violations of the average monthly limit shall be deemed to have occurred.

11. For non-priority pollutants, compliance based on a single sample analysis shall be determined where appropriate, as described below:

    a. When the effluent limitation is greater than or equal to the PQL, compliance shall be determined based on the effluent limitation in either single or multiple sample analyses.

    b. When the effluent limitation is less than the PQL, compliance determinations based on analysis of a single sample shall only be undertaken if the concentration of the constituent of concern in the sample is greater than or equal to the PQL.

12. For non- priority pollutants, the discharge shall be considered to be in compliance with an effluent limitation which is less than or equal to the PQL specified in Attachment "A" of M&RP No. 01-3 if the arithmetic mean of all test results for the monitoring period is less than the constituent effluent limitation. Analytical results that are less than the specified PQL shall be assigned a value of zero.

13. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with effluent limitations in this Order because of factors beyond the reasonable control of the discharger. An upset does not include noncompliance caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, failure to implement an appropriate pretreatment program, or careless or improper action. A discharger that wishes to establish the affirmative defense of an upset in an action brought for noncompliance shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

    a. an upset occurred due to identifiable cause(s) and that the discharger can identify the cause(s) of the upset;

    b. the permitted facility was being properly operated at the time of the upset;

    c. the discharger submitted notice of the upset as required in Section H.15., below;

    d. the discharger complied with any remedial measures required under Section J.11., below.

No determination made before an action for noncompliance, such as during administrative review of claims that noncompliance was caused by an upset, is final administrative action subject to judicial review. In any enforcement proceeding, the discharger seeking to establish the occurrence of an upset has the burden of proof.

H. REQUIRED NOTICES AND REPORTS:

1. Reporting Provisions:

   a. All applications, reports, or information submitted to the Regional Board shall be signed and certified in accordance with 40 CFR 122.22 except as otherwise specified by the Regional Board's Executive Officer.

   b. The discharger shall furnish, within a reasonable time, any information the Regional Board or EPA may request to determine compliance with this Order or whether cause exists for modifying, revoking and reissuing, or terminating this Order. The discharger shall also furnish to the Regional Board, upon request, copies of records required to be kept by this Order.

   c. Except for data determined to be confidential under Section 308 of the CWA, all reports prepared in accordance with the terms of this Order shall be available for public inspection at the offices of the Regional Board and the Regional Administrator of EPA. As required by the CWA, effluent data shall not be considered confidential. Knowingly making any false statements on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the CWA and Section 13387 of the California Water Code.

2. By April 2, 2001, the discharger shall notify the Executive Officer of its continuous involvement with the comprehensive mercury investigation program currently being conducted by a group of Santa Ana River system dischargers. If the discharger discontinues its involvement with this comprehensive program, the discharger shall, within 60 days of that date, submit for the approval of the Executive Officer its plan for the annual testing of mercury levels in fish flesh samples collected from the Santa Ana River, upstream of, at, and downstream of the point of discharge. Upon approval, the discharger shall implement the plan.

3. By April 2, 2001, the discharger shall submit an updated written description of electrical power failure safeguards. Such safeguards may include alternate power sources, standby generators, retention capacity, operating procedures, or other means. The description of the safeguards provided shall include an analysis of the frequency, duration, and impact of power failures experienced over the past year(s) of treatment plant operation on effluent quality and on the capability of the discharger to comply with the requirements of this Order. Deficiencies in present safeguards must be identified together with a plan for any necessary corrective actions. The adequacy of the safeguards and the corrective action plan (if necessary) is subject to the approval of the Executive Officer.

4. By April 2, 2001, the discharger shall submit an updated technical report on the discharger's preventive (failsafe) and contingency (response and cleanup) plans for controlling accidental discharges and for minimizing the effect of such events. This technical report may be combined with that required under Section H.3., above. The technical report shall:

   a. Identify the possible sources of accidental loss, untreated waste bypass, and contaminated drainage. Loading and storage areas, power outage, waste treatment outage, and failure of process equipment, tanks, and pipes should be considered.

   b. Evaluate the effectiveness of present facilities and procedures and state when they become operational.

   c. Describe any new facilities and procedures needed. Predict the effectiveness of the proposed facilities and procedures and provide an implementation schedule containing interim and final dates when they will be constructed, implemented, or operational.

   d. Describe proposed and completed training programs and schedules to train and familiarize plant operating personnel with the discharger's preventive (failsafe) and contingency (response and cleanup) plans for controlling accidental discharges and for minimizing the effect of such events.

5. By April 2, 2001, the latest signed copy of the pretreatment contractual agreements with the Edgemont Community Services District, Jurupa Community Services District, and Rubidoux Community Services District shall be submitted to the Regional Board Office and to the U.S. EPA, Region 9.

6. By April 2, 2001, the discharger shall submit a copy of the Initial Investigation Toxicity Reduction Evaluation work plan specified in Toxicity Requirement B.3 of this Order.

7. By April 2, 2001, the discharger shall submit a copy of the TRE/TIE work plan specified in Toxicity Requirement B.5 of this Order.

8. By May 1, 2001, the discharger shall submit for approval by the Executive Officer, a report which details the manner in which sampling, monitoring and reporting will be performed as required in this Order.

9. The discharger shall orally notify the Executive Officer of the Regional Board, or designee, within 24 hours of a discharge of secondary treated and disinfected wastewater into Santa Ana River.

10. The discharger shall give advance notice to the Regional Board of any planned physical alterations or additions to the permitted facility or changes in operation or activity that may result in noncompliance with these waste discharge requirements.

11. The discharger shall provide adequate notice to the Regional Board of:

    a. Any new introduction of pollutants into the POTW from an indirect discharger that would be subject to Sections 301 or 306 of the CWA if it were directly discharging those pollutants.[18]

    b. Any change in the volume or character of pollutants being introduced by an existing or new source into the treatment facility that will cause or threaten to cause a violation of this Order.

    c. Any planned changes in the discharger's biosolids use or disposal practice, or provision of additional disposal sites not reported during the permit application process.

    d. Any proposed change in the character, location, or method of disposal of the discharge, or any proposed change in ownership of the facility.

    e. All instances of noncompliance. Reports of noncompliance shall be submitted with the discharger's next scheduled self-monitoring report or earlier, as specified in this Order, or if requested by the Executive Officer, or if required by an applicable standard for biosolids use and disposal.

12. The discharger shall file with the Regional Board the documents required in Section F.4., above, prior to delivering recycled water to any new user.

13. The discharger shall file a written report with the Regional Board within ninety (90) days after the average dry-weather waste flow for any month equals or exceeds 75 percent of the design capacity of the waste treatment and/or disposal facilities. The discharger's senior administrative officer shall sign a letter which transmits that report and certifies that the policy making body is adequately informed about it. The report shall include:

    a. Average daily flow for the month, the date on which the instantaneous peak flow occurred, the rate of that peak flow, and the total flow for the day.

    b. The discharger's best estimate of when the average daily dry-weather flow rate will equal or exceed the design capacity of the treatment facilities.

    c. The discharger's intended schedule for studies, design, and other steps needed to provide additional capacity for the waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units.

14. The discharger shall file with the Regional Board a Report of Waste Discharge at least 180 days before making any material change in the character, location, or volume of the discharge. A material change includes, but is not limited to, the following:

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18 *Adequate notice shall include information on the quality and quantity of effluent introduced, and any anticipated impact of the change on the quantity or quality of the discharger's effluent and/or sludge.*

a. Adding a major industrial waste discharge to a discharge of essentially domestic sewage, or adding a new process or product by an industrial facility resulting in a change in the character of the waste.

b. Significantly changing the disposal method or location, such as changing the disposal to another drainage area or water body.

c. Significantly changing the method of treatment.

d. Increasing the treatment plant design capacity beyond that specified in this Order.

15. The discharger shall immediately report any condition related to the discharger's collection, treatment or disposal facilities that may endanger human health or the environment including any unauthorized discharge not regulated by this Order of treated, partially treated, or untreated wastewater from the discharger's collection, treatment, or disposal system in excess of 1000 gallons. All available information concerning the condition and/or unauthorized discharge shall be provided to the Executive Officer or the Executive Officer's designee (909-782-4130) and the Office of Emergency Services (1-800-852-7550), as soon as the discharger becomes aware of the circumstances. A written report shall be submitted within 5 days and shall contain a description of the condition and its cause; the duration of the condition, including exact dates and times, and, if the condition has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent recurrence of the condition, with a schedule for their implementation. The following shall be included as information that must be reported within 24 hours under this paragraph:

a. Any unanticipated bypass that exceeds any requirement of this Order.

b. Any upset that exceeds any requirement of this Order.

c. Any violation of a maximum daily discharge limitation for any of the pollutants listed in this Order.

d. Any unauthorized discharge not regulated by this Order of treated, partially treated, or untreated wastewater resulting from the intentional or unintentional diversion of wastewater from the discharger's collection, treatment or disposal system.

e. The Executive Officer or the Executive Officer's designee may waive the above-required written report on a case-by-case basis.

Discharges of less than 1000 gallons that do not endanger human health or the environment shall be reported to the Executive Officer's designee no later than the last day of the month following the month the discharges occurred.

I. PENALTIES:

1. Violation of any of the provisions of the NPDES program or of any of the provisions of this Order may subject the violator to any of the penalties described under Section 309(c) of the CWA, or any subsequent amendments to Section 309(c). The violator may be subjected to any combination of the penalties described herein at the discretion of the prosecuting authority; however, only one kind of penalty may be applied for each kind of violation.

2. The CWA provides that any person who violates any portion of this Order implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the CWA, or any Order requirement or limitation implementing any such sections in this Order, is subject to a civil penalty not to exceed $25,000 per day for each violation. The CWA provides that any person who willfully or negligently violates this Order with regard to these sections of the CWA is subject to criminal penalties of $2,500 to $25,000 per day of violation, or imprisonment of not more than 1 year, or both. Any person who knowingly violates a provision implementing these sections is subject to criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment of not more than 3 years, or both.

3. The CWA provides that any person who knowingly falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this Order shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 2 years per violation, or by both.

4. The CWA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this Order, including monitoring reports or reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 2 years per violation, or by both.

5. The California Water Code provides that any person who violates an order of the Regional Board is subject to civil penalties of up to $25,000 per day of violation, and when the violation involves the discharge of pollutants, additional civil penalties of up to $25 per gallon.

J. PROVISIONS:

1. This Order shall serve as a National Pollutant Discharge Elimination System permit pursuant to Section 402 of the CWA, or amendments thereto, that shall become effective 10 days after the date of adoption, provided the Regional Administrator of the EPA has no objection. If the Regional Administrator objects to its issuance, this Order shall not serve as an NPDES permit until such objection is withdrawn.

2. Neither the treatment nor discharge of waste shall create, or threaten to create, a nuisance or pollution as defined by Section 13050 of the California Water Code.

3. Order No. 95-18 is hereby rescinded.

4. This Order expires January 1, 2006 and the discharger must file a Report of Waste Discharge in accordance with Title 23, Division 3, Chapter 9 of the California Code of Regulations not later than 180 days in advance of this expiration date. The Report of Waste Discharge shall serve as the application for issuance of new waste discharge requirements.

5. The discharger shall comply with M&RP No. 01-3 as issued by the Executive Officer. This monitoring and reporting program may be modified by the Executive Officer at any time during the term of this Order, and may include a reduction or an increase in the number of parameters to be monitored, the frequency of the monitoring or the number and size of samples to be collected.

6. The discharger shall immediately implement the approved contingency plan for mercury investigation (see Section H.2., above), if a single effluent monitoring result for mercury shows a concentration level at or above the PQL specified in Attachment "A" of the M&RP No. 01-3.

7. The discharger shall maintain a copy of this Order at the site so that it is available to site operating personnel at all times. Key operating personnel shall be familiar with its content.

8. The discharger shall conduct a Pollutant Minimization Program (PMP) when there is evidence that the priority pollutant is present in the effluent above an effluent limitation (e.g., sample results reported as detected but not quantified (DNQ) when the effluent limitation is less than the MDL, sample results from analytical methods more sensitive than those methods included in the permit, presence of whole effluent toxicity, health advisories for fish consumption, results of benthic or aquatic organism tissue sampling) and either: (i) A sample result is reported as DNQ and the effluent limitation is less than the reported ML; or (ii) A sample result is reported as ND and the effluent limitation is less than the MDL. The PMP shall include, but not be limited to, the following actions and submittals acceptable to the Regional Board:

   a. An annual review and semi-annual monitoring of potential sources of the reportable priority pollutant(s), which may include fish tissue monitoring and other bio-uptake sampling;
   b. Quarterly monitoring for the reportable priority pollutant(s) in the influent to the wastewater treatment system;
   c. Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable priority pollutant(s) in the effluent at or below the effluent limitation;
   d. Implementation of appropriate cost-effective control measures for the reportable priority pollutant(s), consistent with the control strategy; and
   e. An annual status report that shall be sent to the Regional Board including:
      1) All PMP monitoring results for the previous year;
      2) A list of potential sources of the reportable priority pollutant(s);
      3) A summary of all actions undertaken pursuant to the control strategy; and
      4) A description of actions to be taken in the following year.

9. The discharger shall conduct a controlled and intensive monitoring program for bis (2-ethylhexyl) phthalate for one year until March 1, 2002, using methods, equipment and processes that will prevent contamination of effluent samples during sampling and testing and assure reliability of testing results. The discharger's testing laboratory shall be able to achieve a minimum detection level of 5 micrograms per liter for quantifying bis (2-ethylhexyl) phthalate concentrations in the effluent.

10. The discharger must comply with all of the requirements of this Order. Any violation of this Order constitutes a violation of the California Water Code and may constitute a violation of the CWA and its regulations, and is grounds for enforcement action, termination of this Order, revocation and re-issuance of this Order, denial of an application for re-issuance of this Order; or a combination thereof.

11. The discharger shall take all reasonable steps to:

    a. minimize or prevent any discharge that has a reasonable likelihood of adversely affecting human health or the environment.

    b. minimize any adverse impact to receiving waters resulting from noncompliance with any requirements specified in this Order, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

12. The discharger shall provide safeguards to assure that should there be reduction, loss, or failure of electric power, the discharger will comply with the requirements of this Order.

13. The discharger shall, at all times, properly operate and maintain all facilities and systems of treatment and control including biosolids use, disposal facilities, and related appurtenances which are installed or used by the discharger to achieve compliance with this Order. Proper operation and maintenance includes adequate laboratory controls, appropriate quality assurance procedures, effective performance, adequate funding, adequate staffing and training, and adequate process controls. This provision requires the operation of back up or auxiliary facilities or similar systems which are installed by a discharger only when the operation is necessary to achieve compliance with the requirements of this Order.

14. The discharger shall update as necessary, the "Operation and Maintenance Manual (O&M Manual)" which it has developed for the Riverside Regional Water Quality Control Plant to conform with latest plant changes and requirements. The O&M Manual shall be readily available to operating personnel onsite. The O&M Manual shall include the following:

    a. Description of the treatment plant table of organization showing the number of employees, duties and qualifications and plant attendance schedules (daily, weekends and holidays, part-time, etc). The description should include documentation that the personnel are knowledgeable and qualified to operate the treatment facility so as to achieve the required level of treatment at all times.

b. Detailed description of safe and effective operation and maintenance of treatment processes, process control instrumentation and equipment.

c. Description of laboratory and quality assurance procedures.

d. Process and equipment inspection and maintenance schedules.

e. Description of safeguards to assure that, should there be reduction, loss, or failure of electric power, the discharger will be able to comply with requirements of this Order.

f. Description of preventive (fail-safe) and contingency (response and cleanup) plans for controlling accidental discharges, and for minimizing the effect of such events. These plans shall identify the possible sources (such as loading and storage areas, power outage, waste treatment unit failure, process equipment failure, tank and piping failure) of accidental discharges, untreated or partially treated waste bypass, and polluted drainage.

15. The discharger's wastewater treatment plant shall be supervised and operated by persons possessing certificates of appropriate grade pursuant to Title 23, Division 3, Chapter 14, California Code of Regulations.

16. The discharge of any radiological, chemical, or biological warfare agent or high level radiological waste is prohibited.

17. The provisions of this Order are severable, and if any provision of this Order, or the application of any provisions of this Order to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Order shall not be affected thereby.

18. The filing of a request by the discharger for modification, revocation and re-issuance, or termination of this Order or a notification of planned changes or anticipated noncompliance does not stay any requirements of this Order.

19. The requirements prescribed herein do not authorize the commission of any act causing injury to the property of another, nor protect the discharger from liabilities under federal, state, or local laws, nor guarantee the discharger a capacity right in the receiving waters.

20. This Order does not convey any property rights of any sort, or any exclusive privilege.

21. This Order is not transferable to any person except after notice to, and approval by the Executive Officer. The Regional Board may require modification or revocation and re-issuance of this Order to change the name of the discharger and incorporate such other requirements as may be necessary under the CWA.

22. Failure to provide a required BOD or Coliform analysis based on tests failure to meet laboratory QA/QC requirements shall not be considered a violation of the terms of this Order.

23. Collected screenings, biosolids, and other solids removed from liquid wastes shall be disposed of in a manner approved by the Regional Board's Executive Officer.

24. If the discharger demonstrates a correlation between the biological oxygen demand (BOD) and total organic carbon (TOC) concentrations in the effluent to the satisfaction of the Executive Officer, compliance with the BOD limits contained in this order may be determined based on analyses of the TOC of the effluent.

25. In the event of any change in control or ownership of land or waste discharge facility presently owned or controlled by the discharger, the discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to the Regional Board.

26. It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the requirements of this Order.

27. Bypass (the intentional diversion of waste streams from any portion of a treatment facility or collection system) is prohibited unless it is permitted under the terms of this Order. The Regional Board may take enforcement action against the discharger for unpermitted bypass unless:

    a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage. (Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.);

    b. There were no feasible alternative to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment down time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment down time or preventive maintenance; and

    c. The discharger submitted a notice to the Regional Board at least ten days in advance of the need for a bypass. The discharger may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if the by-pass is required for essential maintenance to assure efficient operation, and neither effluent nor receiving water limitations are exceeded. In such a case, the above bypass conditions are not applicable. The discharger shall promptly notify the Regional Board and the EPA within 24 hours of each such bypass.

28. The Regional Board, EPA, and other authorized representatives shall be allowed:

    a. Entry upon premises where a regulated facility or activity is located or conducted, or where records are kept under the requirements of this Order;

    b. Access to copy any records that are kept under the requirements of this Order;

    c. To inspect any facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and

    d. To photograph, sample and monitor for the purpose of assuring compliance with this Order, or as otherwise authorized by the CWA.

K. PERMIT RE-OPENING, REVISION, REVOCATION, AND RE-ISSUANCE:

1. This Order may be modified, revoked and reissued, or terminated for cause.

2. This Order may be reopened to address any changes in State or federal plans, policies or regulations that would affect the quality requirements for the discharges.

3. This Order may be reopened to include effluent limitations for pollutants determined to be present in the discharge in concentrations that pose a reasonable potential to cause or contribute to violations of water quality objectives.

4. This Order may be reopened to include an appropriate bioconcentration based limit for mercury, if test results (as required in M&RP No. 01-3) show that the concentration levels of mercury in the edible portions of fish are at or above 0.35 milligram per kilogram of fish tissue.

5. This Order may be reopened and modified in accordance with the requirements set forth at 40 CFR 122 and 124, to include the appropriate conditions or limits to address demonstrated effluent toxicity based on newly available information, or to implement any EPA-approved new State water quality standards applicable to effluent toxicity.

6. This Order may be reopened to incorporate appropriate biosolids requirements if the State Water Resources Control Board and the Regional Water Quality Control Board are given the authority to implement regulations contained in 40 CFR 503.

I, Gerard J. Thibeault, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Santa Ana Region, on January 19, 2001.

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Gerard J. Thibeault
Executive Officer

APPENDIX B

THE PRADO AGREEMENT

A zero discharge strategy is contingent on the interpretation of the Prado Settlement, which was instigated by the Orange County Water District (OCWD) to keep groundwater from leaving the Santa Ana River Basin. In support of the Prado Settlement, an agreement between Western Municipal Water District and the City of Riverside (excerpts included herein) obligated an annual discharge of 15,250 acre feet from the RWQCP for maintenance of base flows at the Prado Dam. This volume may be slightly reduced by quality and credit adjustments.

Based on a meeting with the City Utilities Department in November 1991, however, the OCWD's Prado objective is to keep groundwater from leaving the basin, not necessarily to keep flow in the Santa Ana River. OCWD may be open to the idea of water reuse throughout the area which percolates into the groundwater; This needs to be verified. Pending an agreement with OCWD, the City can investigate zero discharge alternatives for NPDES/ISWP compliance.

AGREEMENT BETWEEN
WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY
AND CITY OF RIVERSIDE IN REGARD TO
PRADO SETTLEMENT.

AGREEMENT made this 20th day of November, 1968, between WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY, a public agency, hereinafter called Western, and the CITY OF RIVERSIDE, a municipal corporation, hereinafter called Riverside.

RECITALS

(a) A settlement has been negotiated terminating the stream system adjudication in the case of Orange County Water District v. City of Chino, et al., Orange County Superior Court No. 117628. This settlement, hereinafter called the "Prado Settlement," provides for a physical solution whereby certain Base Flows are jointly assured by Western and the Chino Basin Municipal Water District (Chino hereinafter) at Prado, and by the San Bernardino Valley Municipal Water District (San Bernardino hereinafter) at Riverside Narrows.

(b) As part of the Prado Settlement all defendants, except for the three municipal water districts mentioned above, will be dismissed from the suit without pumping restrictions. The judgment in the first Orange County suit, the Irvine Decree, and certain other restrictions in the area above Prado will also be set aside so long as such Settlement is carried out.

(c) In order to implement the Prado Settlement, and subject to final Court approval thereof, Western and Chino have further agreed between themselves as to the responsibility of each District for contributions to the flow at Prado.

(d) The primary purpose of this agreement is to provide for the commitment to Western and the Prado Settlement of certain quantities of Riverside sewage effluent.

(e) All terms specially defined in the Prado Settlement documents, and in the agreement between Western and Chino, are herein used in the context of such documents.

In consideration of the mutual covenants of the parties, and of the assumption by Western of the obligations imposed by the Prado Settlement, IT IS HEREBY AGREED AS FOLLOWS:

1. Contribution. Riverside shall be obligated to discharge annually to the Santa Ana River in the vicinity of Riverside Narrows 15,250 acre feet of effluent from its sewage treatment plant, adjusted for quality as hereinafter provided, and subject to the conditions of Paragraphs 5 and 8.

2. Quality Adjustment. The quantity of effluent actually delivered in any year shall be adjusted for quality in accordance with the following formula. The amount which results from the application of such formula shall constitute Riverside's "adjusted contribution", and such adjusted contribution shall be used to determine the City's compliance with its obligations hereunder.

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As used in the formula, TDS means the weighted average annual total dissolved solids in the effluent for the year in question.

Weighted Average TDS in ppm	Formula for Determining Adjusted Contribution
Greater than 800	$Q - \frac{16}{15,250} Q \ (TDS-800)$
700 - 800	Q
Less than 700	$Q + \frac{16}{15,250} Q \ (700-TDS)$

Where Q = the amount of effluent actually delivered.

3. Effective Date. Riverside's commitment of such effluent shall be effective October 1, 1970, and is contingent upon final Court approval of the Prado Settlement.

4. Measurements. Both the quantity and quality of the effluent discharged hereunder shall be measured and determined in such manner as to meet the requirements of the Prado Settlement and of Western's agreement with Chino. The point of measurement for quantity and quality shall be at Riverside's sewage treatment plant measuring flume. The cost of installing and maintaining any new measurement devices which may be required, and of obtaining necessary water quality analyses, shall be borne by Western. Records shall be kept of all such measurements and determinations, and these shall be available to both parties.

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5. Use of Credits. If Riverside delivers more effluent than is required under this Agreement, it may in any given year reduce its adjusted contribution by the amount of such excess deliveries, but in no event shall Riverside's adjusted contribution be less than 13,420 acre feet each year. However, if the minimum obligation under the Prado Settlement is lowered to 34,000 acre feet, then the amount of 13,420 in this paragraph shall be reduced to 12,420 acre feet.

6. Modification of Prado Settlement. In the event the Prado Settlement is modified by the Court under its continuing jurisdiction and the obligation of Western is affected thereby, or in the event of modification of the Western-Chino Agreement, appropriate adjustments if required shall be made in this agreement; provided that the unadjusted amount of 15,250 shall not be subject to increase.

7. Right of First Refusal. If Riverside proposes to sell, lease or otherwise transfer title to any of its sewage effluent not committed hereunder, Western shall have the right of first refusal to acquire such effluent.

8. Pumping Limitation. In the event Riverside should be required to reduce its pumping from any portion of the Santa Ana system, without replenishment being provided by Western, or without similar limitations being imposed upon all other substantial pumpers and diverters taking water for use within Western, Riverside shall have the right to withdraw up to 3000 acre feet annually, on a non-cumulative basis, from the effluent

commitment made herein; provided that such effluent is used to offset the reduction in pumping; or in the alternative, it shall have the right to offset such reduction by increasing its pumping elsewhere in the river system up to a maximum of 3000 acre feet per year without liability to Western for any pump tax on account of such increase.

CITY OF RIVERSIDE

By: _____
Mayor

ATTEST:

_____
City Clerk

WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY

By: _____
President

By: _____
Secretary

APPROVED AS TO FORM:

_____
LELAND J. THOMPSON, JR.
Special Counsel

APPENDIX C

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phase I, alternative 1, juction report

	ID	Demand (gpm)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	1	2,400.00	700.00	951.35	108.96
2	11	1,060.80	730.00	949.97	95.36
3	13	134.10	780.00	949.58	73.51
4	15	42.90	780.00	949.93	73.67
5	3	-5,700.00	700.00	951.68	109.10
6	5	89.40	735.00	950.61	93.47
7	7	548.70	826.00	949.65	53.60
8	9	930.00	778.00	943.05	71.55

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phase I, alternative 1, pipe report

	ID	From Node	To Node	Length (ft)	Diameter (in)	Flow (gpm)	Velocity (ft/s)
1	1	3	1	850.65	24.00	2,400.00	1.70
2	11	11	13	7,204.92	12.00	134.10	0.38
3	13	11	15	5,861.57	12.00	42.90	0.12
4	15	3	1000	1,790.68	6.00	494.10	5.61
5	3	3	5	2,085.90	24.00	2,805.90	1.99
6	5	5	7	6,104.25	24.00	1,478.70	1.05
7	7	7	9	3,382.28	12.00	930.00	2.64
8	9	5	11	5,614.17	24.00	1,237.80	0.88

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phase I, alternative 1, pipe report

		ID	Headloss (ft)	HL/1000 (ft/kft)	Roughness
1		1	0.33	0.39	140.00
2		11	0.39	0.05	140.00
3		13	0.04	0.01	140.00
4		15	31.68	17.69	140.00
5		3	1.07	0.51	140.00
6		5	0.96	0.16	140.00
7		7	6.59	1.95	140.00
8		9	0.64	0.11	140.00

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phase I, alternative 1, reservoir report

		ID	Demand (gpm)	Elevation (ft)	Grade (ft)	Pressure (psi)	% Full (%)
1		1000	494.10	700.00	920.00	95.37	11.00

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phase I, alternative 2, junction report

	ID	Demand (gpm)	Elevation (ft)	Grade (ft)	Pressure (psi)
1	1	2,400.00	700.00	944.68	106.07
2	11	1,060.80	730.00	943.39	92.50
3	15	42.90	780.00	943.19	70.74
4	17	0.00	800.00	943.01	61.99
5	19	466.80	790.00	942.35	66.04
6	21	126.60	810.00	942.76	57.55
7	3	-6,100.00	685.00	945.01	112.71
8	5	89.40	735.00	944.53	90.83
9	7	548.70	826.00	943.57	50.97
10	9	930.00	780.00	936.97	68.05

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phase I, alternative 2, pipe report

		ID	From Node	To Node	Length (ft)	Diameter (in)	Flow (gpm)	Velocity (ft/s)
1		1	3	1	850.65	24.00	2,400.00	1.70
2		13	11	15	5,861.57	24.00	636.30	0.45
3		15	3	1000	1,790.68	6.00	434.80	4.93
4		17	15	17	5,641.96	24.00	593.40	0.42
5		19	17	19	1,058.94	12.00	466.80	1.32
6		21	17	21	4,385.90	12.00	126.60	0.36
7		3	3	5	2,085.90	30.00	3,265.20	1.48
8		5	5	7	6,104.25	24.00	1,478.70	1.05
9		7	7	9	3,382.28	12.00	930.00	2.64
10		9	5	11	5,614.17	24.00	1,697.10	1.20

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phase I, alternative 2, pipe report

		ID	Headloss (ft)	HL/1000 (ft/kft)	Roughness
1		1	0.33	0.39	140.00
2		13	0.19	0.03	140.00
3		15	25.01	13.96	140.00
4		17	0.19	0.03	130.00
5		19	0.66	0.62	130.00
6		21	0.25	0.06	130.00
7		3	0.48	0.23	140.00
8		5	0.96	0.16	140.00
9		7	6.59	1.95	140.00
10		9	1.14	0.20	140.00

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phase I, alternative 2, reservoir report

		ID	Demand (gpm)	Elevation (ft)	Grade (ft)	Pressure (psi)	% Full (%)
1		1000	434.80	700.00	920.00	95.37	11.00

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1. PRINT COVER & ALL Figures at A-3 Printer

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3. PRINT DIVIDERS

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Figure-1 11X17
5-1 11X17
6-1 11X17
6-2 11X17

RWQCB Latest RS NPDES

State water Quality Board.

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APPENDIX D

WATER RECYCLING FUNDING GUIDELINES

April 17, 1997

California State Water Resources Control Board
Office of Water Recycling
WATER RECYCLING FUNDING GUIDELINES

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California State Water Resources Control Board
Office of Water Recycling

WATER RECYCLING FUNDING GUIDELINES

April 17, 1997[a]

PART ONE: BACKGROUND INFORMATION

I. INTRODUCTION

The State Water Resources Control Board (SWRCB) has three programs to provide financial assistance to local agencies for water recycling projects. The purpose of these guidelines is to explain the types of assistance available under each program and describe the procedures and funding criteria for applicants to obtain funds. Definitions of terms and abbreviations used in these guidelines are provided in Appendices A and B.

Grant funding assistance is available for water recycling project planning under the Water Recycling Facilities Planning Grant Program (FPGP). In addition, low interest loans are also available for planning under the State Revolving Fund (SRF). Low interest loan funds are available for design and construction of water recycling projects under the Water Recycling Loan Program (WRLP) or the SRF. The guidelines are presented in three parts. The first part includes background information applicable to all funding programs. A description of the FPGP is provided in the second part. Part Three has descriptions of the WRLP and SRF loan assistance programs.

These guidelines apply to all projects that have not received a preliminary grant or loan commitment from the SWRCB as of April 17, 1997. The provisions of these guidelines dealing with mandatory use ordinances for recycled water market assurances do not apply to agencies where their ordinances have received approval for the current loan application prior to June 16, 1994.

Funding for the WRLP is provided by three bond laws described below. The basis for the FPGP is the Safe, Clean, Reliable Water Supply Act (1996 Bond Law). The SRF is funded by federal grants and various state and local sources. These guidelines are also applicable to the SRF for all water recycling projects except those justified only on the basis of meeting pollution control needs (classified as Category II recycling projects later in these guidelines). In addition to these water recycling guidelines, the "Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment

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[a] These guidelines were adopted by the State Water Resources Control Board on April 17, 1997.

Facilities" (SRF Policy) also applies to agencies applying for an SRF loan. Because of some differences in the laws and policies governing the WRLP and SRF, an SRF applicant should refer to "State Revolving Fund Loan Program Funding for Water Recycling Projects." (Refer to Appendix E to obtain other SWRCB publications related to these programs.)

A. Clean Water Bond Law of 1984

A Water Reclamation Account was established under the Clean Water Bond Law of 1984 (1984 Bond Law) which authorized up to $25 million for low-interest loans to municipalities to assist in the design and construction of water recycling projects. Repayments of principal and interest are returned to the Water Reclamation Account to make additional loans. Also, the first $30 million in principal and interest repaid for loans for wastewater facilities from the Clean Water Construction Grant Account, provided for in the 1984 Bond Law, will be deposited in the Water Reclamation Account. Loans for water recycling projects can be for a period of up to 25 years at an interest rate equal to 50 percent of the rate paid by the State on the most recent sale of state general obligation bonds. A moratorium on payments of principal and interest is not permitted. No single project may receive more than a $10 million loan from this program. Loans can cover any part of a project up to 100 percent of eligible project design and construction costs.

B. Clean Water and Water Reclamation Bond Law of 1988

Up to $30 million was initially available under the Clean Water and Water Reclamation Bond Law of 1988 (1988 Bond Law) for low-interest loans to local public agencies to aid in the design and construction of water recycling projects. In addition, the SWRCB exercised authority under the 1988 Bond Law to transfer an additional $10 million into the Water Reclamation Account. "Local public agencies" do not include state agencies, which are included in the 1984 Bond Law as part of "municipalities". Loan repayments from these funds do not become part of a revolving fund as is the case of the 1984 Bond Law. The loan provisions are the same as for the 1984 Bond Law with the exceptions that the maximum loan period is 20 years instead of 25 years, no maximum loan amount per project is specified, and state agencies cannot receive loans.

C. Safe, Clean, Reliable Water Supply Act of 1996

A Water Recycling Subaccount was established in the Safe, Clean, Reliable Water Supply Act (1996 Bond Law) for low-interest loans for design and construction of water recycling projects and for grants for facilities planning of recycling projects. Loans for water recycling projects can be for a period of up to 20 years at an interest rate equal to 50 percent of the rate paid by the State on the most recent sale of state general obligation bonds. A moratorium on payments of principal and interest is not permitted. Loans may cover up to 100 percent of eligible project design and construction costs. Loan repayments are returned to the subaccount to make additional loans. Grants are limited to $75,000 per planning study.

D. State Revolving Fund

The State Revolving Fund Loan Program provides low interest loans for planning, design, and construction of collection, treatment, disposal and recycling of municipal wastewater, for implementation of nonpoint source and storm drainage pollution control management programs, and for the development and implementation of estuary conservation and management programs. SRF loan provisions are similar to those in the bond laws described above for the WRLP. A detailed description of SRF provisions is provided in the SRF Policy.

E. Water Recycling Project Categories

There are four sources of funding under two programs for providing loans for the design and construction of water recycling projects. Because each funding source has its own legal constraints and primary objectives, it is necessary to define four categories of water recycling projects. The categories and their funding sources are described below.

Category I. New Water Supply: A cost-effective alternative for augmenting the state water supply by offsetting new freshwater development by reclaiming municipal wastewater. Generally, this category would involve wastewater that is discharged into marine or brackish waters. The recycled water users served must be water users that were using or would have used fresh water without the availability of recycled water. Category I projects with an eligible cost of less than $15 million will be funded by the WRLP. SRF funds will be available if the eligible cost exceeds either the funds available in the WRLP or $15 million.

Category II: Pollution Control: An essential component of the cost-effective alternative for the treatment and disposal of municipal wastewater to meet waste discharge requirements imposed for water pollution control. Category II projects will be funded only by the SRF.

Category III: Local Water Supply: A cost-effective alternative that would augment a local water supply by reclaiming municipal wastewater but that may not augment the state's water supply. Development of a local recycled water supply for one area can reduce the availability of recycled water already being used in another area. A project in Category III must not result in a net decrease in the state's water supply. The recycled water users served must be water users that were using or would have used fresh water without the availability of recycled water. Generally, this category would involve wastewater that is being discharged into fresh water or a usable groundwater basin and is being reused indirectly. Category III projects will be funded only by the WRLP with 1996 Bond Law funds.

Category IV: Miscellaneous: Any water recycling project not included in the other categories. The source of water that is recycled may be municipal wastewater or groundwater that has become polluted primarily because of

human activities. The project must be cost-effective based on the project objective. Category IV projects will be funded by the WRLP with 1984 or 1996 Bond Law funds or by the SRF, depending on a case-by-case evaluation of eligibility under the specific funding source.

F. Further Information and Assistance

To apply for a recycling planning grant or construction loan, complete an application form and submit it and supporting documents to the Office of Water Recycling (OWR) of the SWRCB.

Additional information can be secured by use of the order form in Appendix E. The OWR is available to answer questions and advise the applicant during the planning process. An agency anticipating a possibility of seeking a loan in the future is encouraged to contact OWR early in the planning to ensure that the scope and content of planning will cover the key issues necessary for loan approval. Advice on which category a project would fall in can be provided. The OWR can be contacted by writing to

Office of Water Recycling
State Water Resources Control Board
P. O. Box 944212
Sacramento, California 94244-2120

This office can also be contacted by telephone at (916) 227-4580 or 227-4400 or by Fax at (916) 227-4595.

II. FACILITIES PLANNING CONCEPTS

The planning process generally comprises three levels of detail--conceptual, feasibility, and facilities. At the conceptual level, a potential project is sketched out, rough costs are estimated, and a potential recycled water market is identified. At this level little investigation has occurred and information is generally preliminary in nature.

At the feasibility level, a preliminary market assessment is performed, including direct consultation with potential recycled water users. Alternative facilities are screened, considering economics, technical constraints, and other factors. The most promising project is then investigated sufficiently to determine whether it is appropriate to proceed to the facilities planning stage.

The facilities planning level represents the final stage of the planning process. Agencies are expected to complete this stage of the planning process at the conclusion of a planning grant or before filing a loan application. At the facilities planning stage, a thorough cost-effectiveness analysis is conducted for all potential alternatives. Such an analysis includes evaluation of economics, environmental and social factors, and technical feasibility. Environmental, technical, and institutional issues are identified and potential obstacles are resolved. All necessary facilities of the recommended project have been identified, and the project is described with sufficient detail to seek funding

and approvals by regulatory agencies. Potential recycled water users have been informed of the conditions for using recycled water, including probable price. A detailed market assessment is performed, and a construction financing plan and revenue program are developed. Agencies initiate formal discussions with suppliers, wholesalers, retailers, and users of the recycled water, and institutional arrangements are decided upon. Market assurances, such as mandatory use ordinances or letters of intent from users, are obtained.

As part of the planning process the agency must conduct an environmental review. Environmental review should be consistent with requirements for obtaining SRF funding from the SWRCB. Guidance is provided in 'Environmental Review Process Guidelines for State Loan and Small Community Grant Applicants.' It will also be necessary to obtain clearance from the SWRCB's Division of Water Rights regarding compliance with Water Code Section 1211, if the proposed water recycling project will modify a current wastewater discharge to a surface water course by changing the point of discharge, place of use, or purpose of use of the treated wastewater. Because of the time involved in state water rights review, the Petition Unit of Division of Water Rights should be contacted early in the planning process. The SWRCB will not authorize a loan commitment until water recycling requirements have been issued by the Regional Water Quality Control Board (RWQCB).

The completed facilities planning should be documented in a report, which is to be submitted in fulfillment of a planning grant or with a loan application form. The information that should be contained in a facilities planning report is shown in Appendix C. Monetary analyses, market assessment, and market assurances are described in the following sections and Appendix D.

A. Monetary Analyses

An important factor in the cost-effectiveness analysis of water recycling is an analysis of monetary costs and benefits. Monetary costs and benefits can be analyzed in different ways depending on the use of the results. In water resources planning two general categories of monetary analyses have been established: economic analysis and financial analysis. The purpose of the economic analysis is to determine whether a project alternative is justified by quantifying all monetary costs and benefits regardless of who pays the costs or receives the benefits. The intent is to determine the alternative of least net cost. The economic analysis does not have the viewpoint of any particular public agency or private entity. A financial analysis is intended to determine who pays the costs and receives the benefits and to determine financial feasibility. This analysis should indicate costs and benefits to the recycled water user, the taxpayer, and the water retailer or wholesaler, and the sources of funds to implement the project alternatives being evaluated. A detailed discussion of monetary analyses can be found in Interim Guidelines for Economic and Financial Analyses of Water Projects (see Appendix F to order this).

1. Economic Analysis

The first step in an economic analysis is to identify all items of increased or decreased cost as a result of each alternative under consideration, including continuing without a project. The economic analysis should include the costs of all future components necessary to obtain the estimated recycled water yield for a project. If a proposed project or loan application is for system component that in itself would be insufficient to produce and transport recycled water to potential users, the costs for all associated facilities should be estimated. Costs experienced by entities other than the project sponsor must also be identified. For example, recycled water users may incur additional costs to convert to recycled water or may incur savings in fertilizer use because of nutrients in recycled water. If indirect reuse is taking place downstream from an effluent discharge, diversion of the effluent for direct reuse may result in increased water supply costs downstream.

The basis of comparison for justifying a water recycling project will depend on which category applies to the project. Some general principles apply to the analysis regardless of category. All monetary values are expressed in current dollars, excluding inflation. Because the debt service or fixed operating costs of existing facilities would not be reduced by use of recycled water, these costs are not included in the economic analysis. In an economic analysis, the present value of all immediate and future cost increases and decreases is calculated, including those experienced by other entities. The present values should be computed using a discount rate (a type of interest rate) specified by the SWRCB. To be able to compare the net cost of recycling alternatives and proposed water supply developments on a common basis, dollars per acre-foot of water developed should be computed. A water recycling alternative is considered economically justified if its net cost is less than the least net cost of other alternatives to achieve the same project objective.

Category I: For Category I the basis of comparison for justifying a water recycling project is a new freshwater supply that will be needed to serve the area of the recycled water project. The appropriate freshwater alternative for comparison is established in the facilities planning report in which the freshwater needs are projected and available facilities are discussed. The costs for use in the economic analysis of the new freshwater supply consist primarily of the capital and operation and maintenance costs of the new freshwater facilities and the variable costs of operating any existing water facilities that are needed in conjunction with the new facilities to deliver the new supply to the same market area as of the recycled water.

Category II: The basis of comparison for Category II projects is the least cost alternative pollution control project that would be needed to meet Regional Water Quality Control Board waste discharge requirements for the protection of receiving waters.

Category III: The basis of comparison for Category III projects is existing or new freshwater supplies, analyzed similarly to Category I projects. If the effect

of recycling would be to reduce the water supply to another agency, the economic effects of this must be included in the analysis.

Category IV: The factors to include in economic analyses will be determined on a case-by-case basis because the basis of Category IV projects may include objectives that do not include water supply, such as environmental enhancement. In general terms the economic analysis will include a comparison with appropriate alternatives to achieve the same project objectives. The economic effects of reduced water supply to another agency must be included, if appropriate.

2. Financial Analysis

The financial analysis actually consists of several analyses. An agency developing a water recycling project must determine the costs and savings it will experience for each potential alternative to determine whether an alternative is financially feasible. It must identify sources of funds to finance proposed alternatives. The construction financing plan and revenue program demonstrate the basic financial feasibility from the perspective of the agency. These are described in Appendix D.

Important information for the recycled water users is the cost or savings they will experience. Recycled water prices must be compared to the cost of fresh water that the users would otherwise use. The costs of on-site conversion to recycled water use must be estimated. Savings in fertilizer use should be considered.

In performing financial analyses, it is appropriate to use inflated dollars for future costs and to use an interest rate in present value analyses that is based on an agency's borrowing cost.

B. Recycled Water Market Assessment

The completion of a detailed recycled water market assessment is a critical element of the facilities planning process and crucial to the success of any water recycling project. A market assessment involves the identification of potential recycled water users, collection of information related to the users, and evaluation of the suitability of the recycled water to serve the potential market. Information is needed about and from the users to determine design criteria for a recycled water system, a recycled water pricing policy, financial feasibility, the amount and source of fresh water displaced, the institutional framework for the project, and the capability and willingness of users to take recycled water. The suitability of the recycled water is governed both by health and water pollution concerns and by the water quality needs of the users. Costs are a key element in bringing together recycled water and the potential water market. The general expectations of users is that the conditions of recycled water service will be comparable to alternative freshwater supplies, particularly for users already accustomed to taking potable water.

The recycled water market assessment process generally includes two levels of detail--preliminary and detailed. Agencies typically perform a preliminary market assessment during the feasibility planning stage. The preliminary market assessment is developed through consultation with users and provides general data, such as the number of potential users, and the amount and type of potential recycled water use. While this information is adequate to allow an agency to determine whether a project warrants further consideration, additional information is necessary to determine the economic and financial feasibility of the project.

Agencies are required to conduct a detailed market assessment as part of the facilities planning process. The market assessment shall include, as a minimum, all of the users or service area for the capacity of the facilities for which loan funding is or may be requested. Like the preliminary market assessment, the detailed market assessment must be developed through direct consultation with potential users. The following information should be included in the detailed market assessment:

A. General Information

1. List and map of potential users in the study area and types of uses.

2. State and local health department recycled water quality requirements and delivery requirements (backflow prevention, irrigation methods, levels of treatment, etc.) for each type of use.

3. Regional Water Quality Control Board recycled water quality and delivery requirements for each type of use and any restrictions in certain geographical areas for protection of ground water or surface water.

4. An estimate of the probable water quality of recycled water that could be made available in the future and a comparison of this quality to the health and water quality requirements of potential users.

5. An estimate of future freshwater supply costs to users.

6. An estimate of costs for facilities or modifications needed on user sites to accept recycled water for each type of user site.

B. Individual User Information

1. Specific potential uses of recycled water.

2. Location of user.

3. Present and future quantity needs. (For existing water users, present water use should be documented with three previous years of water usage.)

4. Timing of needs (seasonal, daily, hourly demands).

5. Quality needs.

6. Reliability needs regarding availability and quality of recycled water.

7. Needs regarding disposal of used recycled water.

8. Internal capital investment for on-site treatment or plumbing retrofit needed to accept recycled water (also gather data to develop an independent estimate to compare with user's estimate). (This item is required for planning grant recipients only.)

9. Needed savings on recycled water to recover on-site costs or desired pay-back period and rate of return on investment. (This item is required for planning grant recipients only.)

10. Present source of water, present water retailer, cost of present source of water.

11. When user would be prepared to begin using recycled water.

12. Future land use trends that could eliminate recycled water use, such as conversion of farm lands to urban development.

13. For undeveloped future potential sites, the year in which water demand is expected to begin, current status and schedule of development (with supporting evidence, such as subdivision maps, land use permits, general plan land use designations, irrigated acreages, etc.).

14. Evidence that the prospective user was informed of a potential water recycling project, was asked for a preliminary impression of willingness to use recycled water, and what response the prospective user gave regarding willingness. This evidence may be presented in the forms of a table with a list of users, correspondence from users, or some other record of user response. Users should be informed of applicable health and RWQCB restrictions, potential recycled water quality available depending on treatment level, future cost, and quality of fresh water. (This item is required for planning grant recipients only.)

15. The data listed above may be grouped into categories for numerous small users of similar characteristics. However, please consult with OWR before doing so.

Determination of the market for recycled water in future development depends upon various sources of information of varying reliability. For near-term development that is proposed for inclusion in the ninth-year eligible capacity, information will generally be expected directly from land developers of their intentions, following the model format available from the Office of Water Recycling. This information shall be submitted for review before facilities plan approval is issued. Undeveloped sites may be included as part of the first year delivery commitment if the development has proceeded sufficiently through design and received sufficient approvals and permits that the SWRCB can safely assume that the user will be ready to accept recycled water upon completion of construction of the recycling project.

The preparation of the market assessment should not be viewed as a data collection exercise, but as an integral step in the recycled water marketing process. Potential customers should be familiarized with details of the proposed project, including the proposed project schedule, the projected water quality and reliability, and the projected price of recycled water in comparison with alternative water supplies (if such water supplies would be available to the customer). An agency that has adopted a mandatory use ordinance should also provide information about the ordinance and the customer's responsibility under the ordinance. Evidence of this effort to inform potential users (e.g., a copy of the information package provided to potential users) should be included in the detailed market assessment. The detailed market assessment should be documented in the facilities planning report.

C. Market Assurances

Reclaimed water market assurances serve to ensure that the water produced by a project will be utilized within the time frame envisioned in the facilities planning documents. Market assurances take the forms of 1) binding measures to ensure the participation of recycled water users upon initial project operation and 2) the agency□s plans for connecting additional users later to fulfill the entire eligible capacity of the project. The binding measures for securing the initial recycled water users generally take two forms: 1) mandatory use ordinances in which potential users are mandated to participate in the project or 2) user contracts in which potential users voluntarily commit themselves to participate in the project. The two forms of assurances are described in Section IX in Part Three. Which approach to take should be evaluated during facilities planning.

PART TWO: PLANNING GRANT PROGRAM

III. WATER RECYCLING FACILITIES PLANNING GRANT PROGRAM

A. Introduction

The Water Recycling Facilities Planning Grant Program (FPGP) provides grants to public agencies for facilities planning studies for water recycling. The program is administered by the Office of Water Recycling (OWR) of the SWRCB. The grant program's statutory requirements, policies and procedures are provided in this section.

B. Purpose

The purpose of the FPGP is to assist local agencies in the preparation of facilities planning studies for water recycling using treated municipal wastewater. In addition to encouraging new recycling planning studies, the SWRCB intends that these funds be used to supplement local funds to enhance the quality of local planning efforts and to produce documents needed by the SWRCB to evaluate applications for design and construction loans if a cost-effective project is identified.

C. General Guidelines

Public agencies may apply for the grants. Grants will be provided for facilities plans to determine the feasibility of using recycled water that will offset new freshwater development and augment the state's or a local water supply. Pollution control studies, in which water recycling is an alternative, will not be eligible for a grant. The grant will cover 50 percent of eligible costs up to a maximum grant of $75,000.

Each grant must result in a complete facilities planning report. The report will include an analysis of all of the essential components of potential operable projects. The plan will designate a potential recycled water service area and analyze the feasibility of serving all or portions of the designated study area. An agency may receive more than one grant. The OWR will not recommend approval of a grant application if the scope of the study is not sufficiently distinct from previous studies performed by an agency.

The SWRCB will establish a time limit in its resolution of grant approval for submitting a final facilities planning report. The allowable time will be the time estimated by the agency in the grant application to prepare and submit a final facilities planning report. This limit will be the basis of the grant contract term. At any point during a grant an agency may submit one request for an extension of the grant term and an increase in costs accompanied by a justification. After review of the request, OWR may approve an extension of the grant contract of up to twelve months from the date specified in the SWRCB resolution or an increase in maximum grant by up to 50 percent from the amount authorized in the resolution. OWR staff shall bring to the SWRCB for approval 1) any increases in grant contract term or amount beyond these amounts or 2) additional requests for changes after the first one. After approval, a grant contract

amendment will be processed, subject to approval, if necessary, by the Department of General Services.

D. Grant Process

The overall process of a FPGP grant is illustrated in the following flow chart.

Request grant application for package	Grant application is distributed to interested party upon request.
Grant application submittal	Agency submits grant application, including plan of study.
OWR reviews application	OWR reviews grant application.
Application review meeting	OWR and agency meet to discuss the plan of study and grant program procedures
SWRCB authorizes grant	SWRCB approves proposed grant, authorizes a grant commitment and subsequent grant contract to agency.
Grant contract execution	OWR drafts grant contract, agency and SWRCB execute contract, contract approved by Department of General Services.
Agency submits draft facilities plan	Agency undertakes facilities planning study, drafts a plan, and submits draft to OWR.
Plan review	OWR reviews draft plan for clarity and completeness, submits comments to agency.
50% payment	OWR processes 50 percent grant payment.
Final facilities plan submittal	Agency revises draft facilities plan and submits final plan to OWR.
Facilities plan approval and final payment	OWR approves final facilities planning report and processes 100 percent grant payment.

E. Grant Application

The grant application will consist of an application form, a resolution by the agency authorizing the grant application, and a plan of study.

The plan of study should describe the nature and scope of the proposed facilities planning study. The following components should be included:

1. A description of the recycled water service area that will be investigated.

2. The sources of recycled water that will be investigated and a brief summary of the unit processes currently in use at existing treatment facilities.

3. A description of the current fate of the effluent that could be recycled.

4. A map of the study area showing the sources of recycled water and potential service area.

5. Identification of the water supply and wastewater agencies having jurisdictions over the sources of recycled water or the potential service area.

6. General description of water recycling and freshwater supply alternatives that will be evaluated.

7. A description of the opportunities for participation of the public, potential recycled water users, and other affected agencies in the study.

8. A schedule with the starting and completion dates of specific tasks associated with the facilities planning study.

9. A list of potential problems that could cause delays in the progress of the study and description of the means to reduce the impact of these potential problems.

10. Identification of the entities that will be conducting the study and description of their roles; description of proposed subcontracts with consultants or interagency agreements with other agencies, and any force account work.

11. Proposed budget for study, including estimated costs of specific tasks, sources of financing, sources of funds for cash flow until grant reimbursement.

After an initial review of the application, the OWR will schedule a meeting with the agency to discuss the plan of study and grant program procedures. Upon completion of application review by OWR, the application will be presented to the SWRCB with staff recommendation whether to approve and authorize execution of a grant contract.

F. Facilities Plan Review and Approval

The facilities planning study consists of facilities planning and associated environmental impact analysis. Where a recommended project has been identified, completion of the study for the purposes of the grant consists of submittal of the following items:

1. a final facilities planning report that fully documents all aspects of the study

2. a copy of a resolution certifying or adopting the environmental document as required under the California Environmental Quality Act.

Background information on facilities planning, monetary analyses, recycled water market assessment, and recycled water market assurances is found in Part One of these guidelines. Appendix C includes an outline of information that should be obtained or issues that should be addressed during facilities planning. The information and analysis of issues are documented in the facilities planning report. The report must include an analysis of all of the essential components of potential operable projects. The level of detail should be commensurate with the size and complexity of the proposed project. While some factors listed in the outline may not be relevant to a particular project, all should at least be considered. If the conclusion of the study is a recommendation to proceed with implementation of a water recycling project, the agency should have completed initial work on assuring a recycled water market and drafted any necessary water recycling ordinances and/or interagency agreements.

During the course of planning, it may be concluded that a viable recycling project cannot be recommended. In this case, after consultation with the OWR and approval, the planning may be terminated before completion of all of the tasks specified in these guidelines. The results of the work completed and the basis for the conclusion should be documented in a report. After submittal of the report, the agency will receive grant funds for the work completed in the study and preparation of the report.

While it is appropriate to extract information from previous studies, the product submitted for a grant should not be an assemblage of copied material. Any extracted material should be revised and made consistent as needed prior to incorporation in a facilities planning report.

Environmental review should be consistent with requirements for obtaining SRF funding from the SWRCB. Guidance is provided in 'Environmental Review Process Guidelines for State Loan and Small Community Grant Applicants.'
An essential component of facilities planning is to identify the potential recycled water users that will participate in the recommended project. The agency should have determined how it will secure the recycled water market, generally through recycled water user contracts or use of a mandatory use ordinance. At the conclusion of facilities planning, the agency should either have obtained letters of intent to use recycled water from potential users or drafted a water recycling mandatory use ordinance and contacted all potential users regarding the project.

G. Funding Restrictions and Eligible Costs

An agency may conduct the facilities planning study by force account with its own resources or by contract with consulting firms or another public agency. Costs incurred either way are eligible insofar as they are for work within the scope of work approved in the grant application. A billing code should be established by the agency to assign grant eligible costs. In general, force account eligible costs will be limited to direct costs, including labor overhead, chargeable to the planning study. More specific guidance is provided in WRLP 'Guidelines on Force Account Eligible Costs.' If the agency uses consulting services, the scope of work for the services should distinguish between grant-eligible and ineligible work and such work should be billed separately. It is recommended that the agency provide an opportunity for the OWR to review the consultant contracts prior to their execution to ensure that the scope of work separates grant-eligible tasks from other tasks for billing purposes.

Eligible costs are costs incurred after execution of the grant contract.

A grant will be provided to reimburse the agency for 50 percent of eligible costs up to a maximum grant of $75,000. The remaining 50 percent share of costs is the responsibility of the agency, but may include grants or loans from other entities, such as federal, state, or regional agencies. To prevent duplication of funding, the grant will be reduced if the agency receives more than 50 percent financial assistance from other sources.

H. Disbursement of Grant Funds

Grant funds will be provided in two disbursements. Disbursement of 50 percent of the total estimated grant will be made upon submittal of a draft facilities plan. A final disbursement will be made after approval by the OWR of the final facilities plan, including associated documents, such as the environmental impact analysis.

Requests for disbursement will be made on forms provided by the OWR. The requests must be accompanied by documentation, including a copy of consulting contracts, billings from consulting firms, and a monthly summary of agency staff hours and associated costs.

PART THREE: LOAN FUNDING PROGRAMS

IV. LOAN FUNDING PROGRAMS

The Water Recycling Loan Program (WRLP) and the State Revolving Fund Loan Program (SRF) provide low interest loans to local agencies to design and construct water recycling projects. Water recycling loan applications are processed by the Office of Water Recycling (OWR) of the SWRCB. The purpose of the WRLP is to encourage the development of cost-effective water recycling projects by providing low interest loans to local agencies to lower the cost of reclaiming and reusing treated wastewater.

A. Program Funding Criteria

Generally, available funds will be committed to projects for which facilities planning is complete, provided the project meets the loan program requirements and is ready to proceed. However, the SWRCB reserves the right to manage the program to achieve the best use of loan funds. For example, the SWRCB may reserve funds for projects deserving special consideration or offer partial loans to achieve the maximum use of available loan funds.

Multiple-purpose projects may consist of components in more than one category. The components will be analyzed in accordance with the criteria of the applicable category and eligibility will be established accordingly.

Depending on the source of loan funds, there may be a cap on the total amount of a loan. The SWRCB establishes a cap on SRF loan funds annually based on the availability of SRF funds. There is a $10 million statutory cap per project for loans made from 1984 Bond Law funds. The SWRCB has established a $15 million cap per project for loans made from 1996 Bond Law funds.

B. General Eligibility

The general basis of eligibility of a water recycling project is established in the various bond laws and the SRF statutes, regulations, and policies. Projects for reclaiming ground water, including desalting and nitrate removal projects, are eligible under the WRLP (1996 Bond Law funds only) if the water to be treated has become unusable primarily because of human activities. Under the SRF, funding is restricted to projects reusing water of municipal wastewater origin. All projects must be cost-effective based on the project objective and the available alternatives to achieve the objective.

While the loan terms for the WRLP and the SRF are essentially the same, such as interest rate, there are some important procedural and eligibility differences that can jeopardize funding under one program or the other if applicants are not alert to program requirements from the commencement of project planning through completion of construction. As an agency begins planning, it may not be possible for the SWRCB to assure the agency of which program might be available for funding for Category I and IV

projects. In addition, because the SWRCB incorporated the Water Reclamation Account of the 1984 Bond Law into the SRF as a subaccount in order to secure additional federal matching funds, certain SRF requirements will apply to 1984 Bond Law loans. Therefore, all potential loan applicants for Category I, II, and IV projects should place their proposed projects on the SRF priority list and follow SRF environmental procedures.

It is the policy of the SWRCB that loans from the WRLP or the SRF shall be provided to cover 100 percent of eligible costs, excepting annual loan caps that may be established by the SWRCB. The agency may receive funds from other local, state, or federal programs to pay for ineligible costs or a share of eligible costs, provided that there is no duplication of funding of eligible components.

All applicants will be subject to the SWRCB 'Environmental Review Process Guidelines for State Loan and Small Community Grant Applicants.' The SWRCB cannot authorize a loan until the environmental review process is complete. The SWRCB must be notified immediately of any change in the project after completion of the environmental review process or after facilities plan approval (also called concept approval) by the SWRCB. Such changes may result in the need to revise environmental documents.

V. WATER RECYCLING LOAN PROGRAM PROCESS

The WRLP loan application process begins with the OWR staff distributing loan application packages to interested agencies upon request. The completed applications, including project planning documents, are submitted by the applicant for review. The OWR staff make a preliminary determination regarding the appropriate category assignment and which source of funds is most appropriate to fund the proposed project.

After the OWR staff has determined that the loan application is complete, that is, that project planning is complete and all other application requirements have been met, that the project is ready to proceed, and that loan funds are available, staff will issue facilities plan approval. The application will then be presented to the SWRCB for approval of a preliminary loan commitment and subsequent loan contract. If loan funds are not currently available, consideration may be given to reserving future repayments returning to one of the revolving funds.

If OWR determines that a proposed project is not cost-effective, OWR will provide a written explanation to the agency. Upon request by the agency, the OWR will bring the proposed project before the SWRCB with the explanation of the decision of OWR and the agency's request for review and authorization for facilities plan approval.

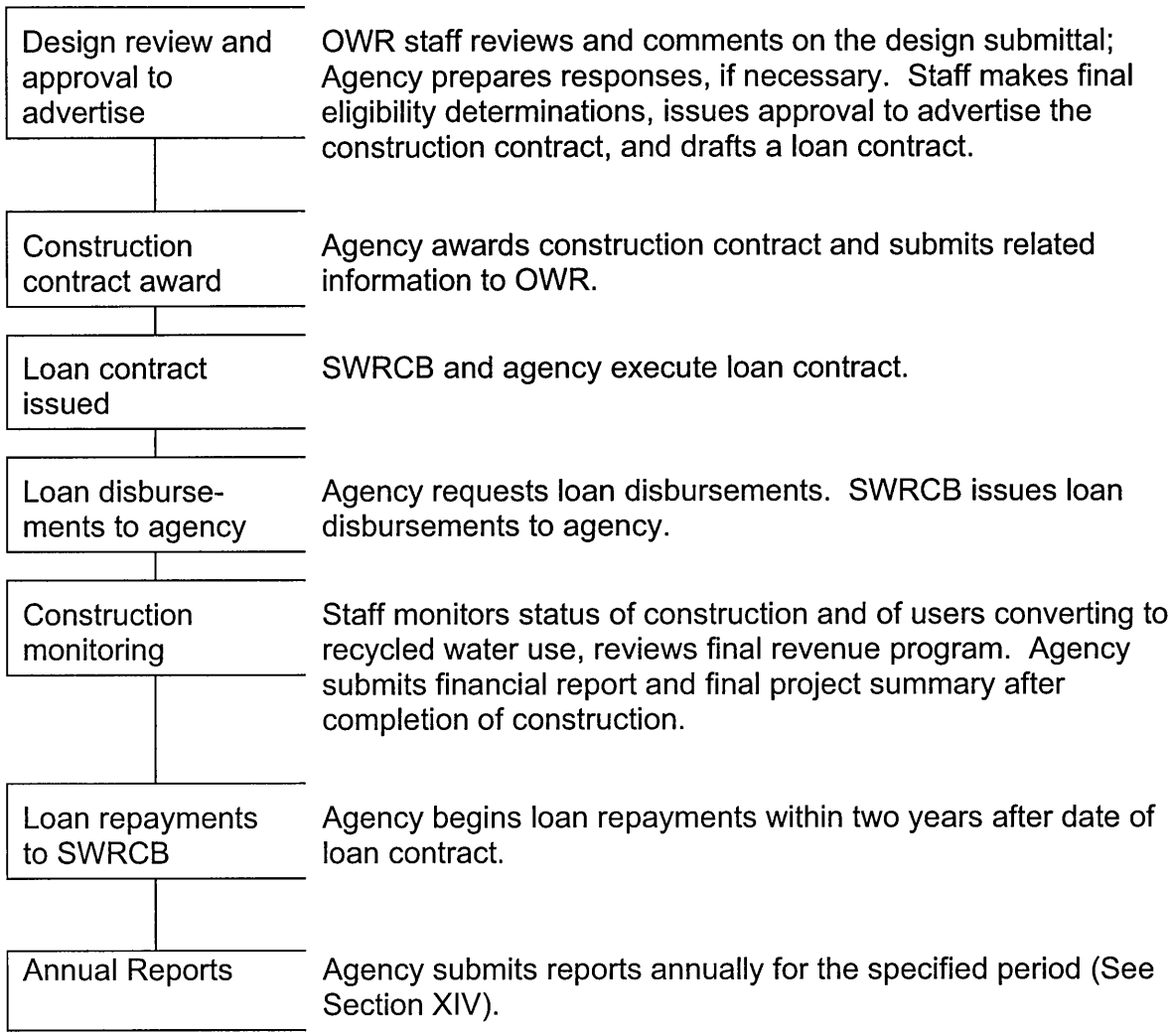
The preliminary loan commitment will expire at the end of the time period specified in the SWRCB resolution approving the loan commitment. The end of the period will be 8 weeks after the applicant's scheduled date for submittal to the state of final plans and specifications to account for time for the Division of Clean Water Programs (Division) to review plans and specifications. If biddable plans and specifications are not received

and approved by the expiration date of the preliminary loan commitment, the OWR may approve up to a 90 day extension for a good cause.

The procedures and administration of the SRF differ somewhat from the WRLP. Refer to the "Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment Facilities" (SRF Policy) for projects funded under the SRF. **The procedures described below apply to the WRLP.**

Submittal of preliminary design plans for review by the OWR is encouraged, but not required. Once the project design is completed, OWR reviews and approves the plans and specifications, final market assurances, construction financing plan, and revenue program. An approval to advertise is then issued to the applicant, and a loan contract is drafted. When the applicant has awarded the construction contract, the loan contract is executed and loan disbursements may commence. Loan repayments from the applicant to the SWRCB must begin within two years after the date of the loan contract. The entire application process is summarized below.

Request for application package	Application is distributed to interested party upon request.
Facilities planning and environmental compliance by applicant	Agency does planning without financial assistance from the Loan Program. OWR staff is available for meetings and guidance. Agency must comply with environmental review, water rights, State Health Department, and other requirements.
Application completed	Agency submits completed application, authorizing resolution, and planning documents to SWRCB.
SWRCB review	OWR staff reviews and comments on the application and planning documents. Agency prepares responses, if necessary.
Project facilities plan approval and eligibility determination	OWR staff issues project facilities plan approval, makes preliminary eligibility determination and determines availability of loan funds.
SWRCB authorizes loan	SWRCB approves the proposed project, authorizes a loan commitment and subsequent loan contract to the agency.
Design submittals	Agency submits 100% design submittal, including cost estimate, construction financing plan, revenue program, final market assurances, and plan for the use of remaining project capacity.



VI. STATE REVOLVING FUND PROCESS

The procedures and administration of the SRF are described in the SRF Policy. Category II recycling projects are administered under the SRF Policy only. In addition to the SRF Policy, the Water Recycling Funding Guidelines are applicable to the Category I and IV water recycling projects funded under the SRF. A copy of the SRF Policy may be obtained by request (refer to Appendix E).

VII. PLANNING REVIEW CRITERIA

In order for a project to be approved for a loan, a project must be cost-effective. A water recycling project will be considered cost-effective when, compared with the development of other alternatives to achieve the project objective, the proposed project will result in the minimum total resources costs over time to meet project objectives. Resource costs to be evaluated include monetary costs as well as nonmonetary factors, including social and environmental effects. An economic analysis, which considers all monetary costs associated with each alternative, is given primary consideration unless other factors are overriding. Other important factors include an assessment of the

recycled water market, availability of recycled water, financial feasibility, energy consumption, and engineering.

VIII. FACILITIES PLANNING

OWR staff will not consider a loan application for funding until the facilities planning process has been completed. Agencies are encouraged to notify OWR staff of their interest in applying for a loan early in the planning process. OWR staff can then advise agencies about the availability of funding and assist agencies in developing facilities planning documents that comply with funding guidelines and preparing loan applications. The facilities planning concepts discussed in Part One will be applicable. If the loan application and supporting documents are incomplete, the applicant will be advised about what additional information is necessary. Funds are available to assist in facilities planning either through the FPGP or an allowance under the SRF. No planning cost allowance is available under the WRLP.

IX. MINIMUM USE REQUIREMENTS

Existing users are expected to begin use in the first year of operation unless phasing of these users is justified. Projects are expected to reach certain minimum usage levels during the operating life of the project. These minimum levels are based on the eligible project capacity determined in accordance with Section XI.A.6. These minimum usage levels are explained below.

A. At least 50 percent of the total eligible project capacity must serve users that will exist by the time of completion of construction. (See Appendix A for definition of 'existing user'.)

B. Generally, all existing water users proposed to be included in the eligible project capacity will be expected to be connected to the system upon initial project operation. Proposals to connect existing users after initial project operation must be approved in the facilities plan approval based on the market assurances explained in Section X.C.

C. During the first year of project operation, the agency will be expected to use at least 25 percent of the eligible project capacity. The agency will also be expected to reach use of the total project capacity in accordance with the schedule of project usage approved in the facilities plan approval.

X. RECLAIMED WATER MARKET ASSURANCES

Documentation is required to provide an assurance of participation of users in the project. Existing users must be covered by a mandatory use ordinance or user contract. Documentation must be provided if phasing of project usage is proposed. These provisions are explained below.

A. Mandatory Use Ordinances

A mandatory use ordinance is a law adopted by a retail water purveyor requiring the use of recycled water in place of another source of water. For the ordinance to be an acceptable form of market assurance, it shall contain certain provisions:

1. Specification of the types of use of water for which recycled water must be used.

2. Specification of the conditions under which recycled water must be used or new development must be plumbed for future recycled water use.

3. Procedure for determining which water users are required to either convert to recycled water service or be plumbed to accept recycled water upon new water service.

4. Procedure to provide notice to potential users that they are subject to the ordinance and specification that the notice include information about the project, the responsibilities of the users under the ordinance, the price of the recycled water, and description of the on-site retrofit facilities requirements.

5. Procedure for request by the users for a waiver.

6. A penalty for noncompliance with the ordinance. Acceptable penalties are discontinuance of freshwater service, a freshwater rate surcharge of at least 50 percent of the freshwater rate, or an equally effective penalty.

If the agency implementing the recycled water project does not have the legal authority to enforce a mandatory use ordinance (for example, a sewerage agency), the mandatory use ordinance may be implemented by the retail water purveyor.

The OWR staff will review a copy of the adopted ordinance along with the loan application. Facilities plan approval of the project will establish the eligible capacity of the project based on the market assessment.

The SWRCB's resolution approving a loan commitment will include a requirement that the local public agency submit either 1) copies of letters of intent to participate in the project or 2) copies of the notifications to the users subject to the ordinance, a statement of whether any notified users appealed the conditions of recycled water use, and documentation showing the disposition of any appeals. The resolution will require that these items be submitted to the OWR staff before approval to advertise for construction, but in no case later than six months from the date of the resolution. The OWR staff will have 60 days from the date of receipt of submittals to approve or reject them, otherwise the submittals will be considered adequate. The SWRCB's resolution will include a provision that if the agency does not submit these items within six months or if the submittal is considered inadequate by the OWR staff, the resolution is null and void, and the project will need to be resubmitted for approval. Submittal of copies of letters of intent or notifications of users may be waived by OWR for users that have their

sites already plumbed and metered for use of recycled water, but are temporarily using potable water. Considerations for a waiver will include, but not be limited to, the number of years of successful recycling experience of the agency and the type of water use.

There may be limitations on the application of mandatory use ordinances. Certain potential users may not be subject to the ordinance for various reasons, for example, a user may not be obtaining water service from the agency with the ordinance or the user may be outside of the service area of the agency. In such situations, user contracts may be expected to cover users intending to take recycled water during the first year of operation. The ordinance shall apply to sufficient users such that in aggregate they represent most of the recycled water deliveries for water users that will exist by the time of completion of construction.

B. User Contracts

A user contract is a binding agreement between recycled water purveyors and users, signed by both parties. For the OWR staff to accept a user contract as an acceptable form of market assurance the contract must contain certain provisions:

1. A commitment to use the recycled water for a minimum period of 10 years.

2. The amount of recycled water the user intends to take annually.

3. The sites and the types of use of the recycled water.

4. Specification of the conditions of recycled water use, including the water quality.

5. The price of the recycled water.

6. Description of the regulatory and water purveyor requirements for on-site retrofit facilities needed to convert from freshwater to recycled water.

7. Date when recycled water use will commence.

User contracts are required from sufficient users such that in aggregate they represent most of the recycled water deliveries for water users that will exist by the time of completion of construction. The agency must submit with the loan application letters of intent from the proposed recycled water users intended to execute user contracts. The content of the letters should follow the model format provided by the Office of Water Recycling. The user contracts shall be submitted before OWR approval to advertise for construction.

C. Documentation of Future Connections

If the agency proposes to connect users after initial project operation, market assurances should include a description and schedule of the future connection of users to the eligible project facilities. Anticipated delay in connection of existing users after

initial project operation should be supported by adequate reasons for the delay in connection and a firm schedule for the construction of facilities to make the connections. The plan for use of the full eligible project capacity or pipeline capacities should be submitted with the loan application and updated, if necessary, with the submittal of final plans and specifications. An approved schedule of deliveries to reach the eligible project capacity will be included in the facilities plan approval.

XI. ELIGIBILITY CRITERIA

The following eligibility policies have been established by the SWRCB regarding costs and types of projects eligible and ineligible for loans.

A. Eligible Costs

1. Costs of construction for water recycling treatment, storage, and distribution systems shall be eligible for loans.

2. Allowances:

   a. WRLP: The eligible cost may include an allowance, if requested by the loan recipient, to cover engineering, legal and administrative services associated with the design and construction of the eligible recycling project. The amount of such allowance shall be up to 15 percent of the eligible cost of construction.

      In addition, the eligible cost may include an allowance, if requested by the loan recipient, to cover design services only for design costs of future phased expansions of facilities on the same site as facilities to be constructed as part of the loan. The phased expansions may include a capacity for up to 20 years after completion of construction. The amount of the allowance shall be up to 10 percent of the engineer's estimate of the construction cost of expansions based on 100 percent design.

   b. SRF: The eligible cost may include allowances for facilities planning, design, construction management, administration, and prime engineering. The SRF Policy should be consulted for details.

3. Project facilities which are eligible must remain in public ownership and have provision for adequate operation and maintenance and adequate right-of-way.

4. Reclaimed water distribution systems from the source of supply to the property line of the reuse sites shall be eligible for a loan. Eligibility of a system on the property of the user should be limited to:

   - Reclaimed water service line up to and including the water meter if the meter is located in the proximity of the property line.

- Reclaimed water service line up to a main storage facilities serving the user on the reuse site or, if there are more than one use areas that are widely separated on the property, up to the point of initially dividing the water flow.

5. A recycled water distribution pipeline shall be eligible if the terminal point serves a user that is committed by mandatory use ordinance or by user contract to take recycled water during the initial operation of the project. If only a portion of a pipeline serves users secured by a firm commitment, then eligibility shall extend to the most downstream user secured by a firm commitment.

6. The capacity of a project eligible for a loan shall be that capacity which can be used within nine years of completion of construction. However, pump station wet wells and buried pipelines at the treatment facility or in the distribution system shall have an eligible capacity of up to twenty years when documented by a market assessment showing the twenty year service area and identifying and analytically projecting all existing and future uses to be served by the recycled water pipeline proposed for loan funding. These eligible capacities are measured in terms of annual recycled water deliveries. Eligible sizes of facilities components are based on reasonable design criteria, including peaking factors, to serve these annual deliveries. There shall not be any restriction on the capacity of a project. Capacity in excess of the eligible project shall be funded with funds other than the SWRCB loan. Eligible costs for partially eligible capacity will be determined on an incremental cost rather than pro rata cost basis.

7. Agencies constructing pipelines or treatment facility capacity in excess of that which can be utilized within five years of completion of construction must demonstrate that adequate reclaimable water supplies will be available to support that future capacity. This documentation may take the form of: 1) an urban water management plan or equivalent water supply planning document which specifically identifies measures intended to assure that, in a year of normal supply and demand, an adequate supply of water will be available to support the projected growth in wastewater flows or, 2) certification by the agency that existing tributary wastewater flows will meet or exceed the capacity of the proposed recycling project at the time of the completion of the project.

8. Reasonable costs to provide an emergency backup water supply for the recycled water system are eligible.

B. Ineligible Costs

1. The following costs are not eligible for WRLP loan funds:

   - costs of planning for a project
   - costs of applying for a loan
   - costs of land, easements, and rights of way
   - costs for operation and maintenance of project facilities

- legal and court costs resulting from violation of state and federal laws, excluding the cost of capital facilities required to be built as a condition or result of a legal or court settlement.

2. Eligible costs of construction performed by the loan recipient's work force shall not include indirect costs, that is, expenses not readily identifiable with the eligible recycling project, such as ordinary operating expenses of the loan recipient. A more detailed discussion may be found in "Water Reclamation Loan Program Guidelines on Force Account Eligible Costs."

C. Miscellaneous

1. Multiple-purpose projects shall be eligible in proportion to the costs allocated to water recycling. In addition, projects utilizing supplemental sources of water are eligible in proportion to the costs allocated to the recycled water. An example of a multiple-purpose project would be a ground water recharge project that percolates both storm water runoff and treated wastewater. For projects using multiple sources of water, costs will be allocated to each source on a pro rata basis.

2. Projects for reclaiming ground water, including desalting and nitrate removal projects, are eligible under the WRLP (1996 Bond Law funds only) if the water to be treated has become unusable primarily because of human activities. This includes municipal, industrial, or agricultural activities. The degraded source water may be provided to the project directly, such as from a wastewater treatment plant, or indirectly, such as pumping from a brackish or polluted ground water basin. Projects for desalting naturally occurring saline or brackish waters are not eligible for a loan.

3. Recycling of industrial wastewater is eligible for a loan provided the loan applicant is a municipality, public agency, or a local public agency, depending on the source of loan funds, as defined in Appendix A. In-plant recycling projects are not eligible for a loan.

4. Project changes are permitted after approval of the project by the SWRCB, provided that there is no change in the scope of the project. If there is a change in scope of a project, the OWR staff shall bring the project to the SWRCB for reapproval. The scope of a project is considered to have changed if there is any of the following:

   a. A decrease in the recycled water deliveries projected for the ninth year following completion of construction by more than 15 percent.

   b. A change required in the environmental documents prepared under the California Environmental Quality Act such that the SWRCB is required to reconsider the environmental documents.

c. An increase in the total economic cost of the project such that the cost exceeds the alternative benchmark, such as the freshwater cost, by more than 15 percent.

d. An increase in the total eligible project cost such that it exceeds the preliminary loan commitment amount by more than 50 percent.

e. An adverse effect on the engineering or financial feasibility of the project.

The SWRCB Project Manager shall be promptly informed of project changes during construction. Because changes may affect project eligibility or require reapproval by the SWRCB, substantial changes during construction should be approved before initiating the change.

The maximum loan amount will be based on bid amount at the time of award of the construction contract, as described in Section XII. All project changes during construction that result in cost increases above the maximum loan amount shall be the responsibility of the loan recipient. Changes during construction may result in decreases in eligible costs. Such decreases may offset cost increases for eligible project costs. Eligible cost increases may result from 1) overruns in quantities beyond estimates in original bids for eligible work specified at the time of bid or 2) change orders for changed work which has been approved for eligibility. The final loan amount will be adjusted downward for any decreases in eligible cost items less any eligible offsetting cost increases, up to the maximum loan amount. Change orders will be reviewed for eligibility only if there is a request from the loan recipient and there is an offsetting cost decrease.

5. Retroactive funding of construction is not eligible for loan funds under the WRLP, with the exception that eligibility may be reserved for advance construction of minor portions of a proposed project with prior approval by OWR staff. Advance construction is not eligible for any facilities commencing construction before submittal of the loan application. Advance construction shall be justified based on the cost savings or time coordination with the main portion of the project. Prior approval does not constitute an assurance of final eligibility. Such eligibility is determined at the time of plans and specifications approval of the main project. The SRF Policy should be consulted for the retroactive funding policy under the SRF.

XII. LOAN FINANCIAL PROVISIONS

The provisions for the disbursement and repayment of loan funds under the SRF are discussed in the SRF Policy. The following discussion on loan provisions applies only to the WRLP. Successful loan applicants will receive loan funds during project construction based on evidence of satisfactory construction progress. No loan funds will be advanced during design. Interest charges on loan funds begin to accrue as soon as loan funds are disbursed. The maximum loan amount will be based on bid amount at the time of award of the construction contract. An allowance for design costs and

engineering, legal, and administrative costs may be included. Increases in the loan amount will not be permitted due to changes in cost during construction. The standard loan provisions will provide for equal annual repayments for a 20-year term following the date of the loan contract. However, shorter repayment periods are encouraged and may be imposed. The repayment will consist of principal and interest. The initial repayment shall be made not later than two years after the date of the loan contract. Additional details regarding the financial aspects, as well as general contractual requirements, can be found in Appendix D and in the model loan contract, which can be obtained upon request (refer to Appendix E).

XIII. DESIGN AND CONSTRUCTION

Before a project can receive approval to advertise the construction contract under the WRLP or plans and specifications approval under the SRF, Division staff must ensure that:

1. The design is consistent with the project described in the facilities plan approval;

2. The construction contract documents comply with all state and, if applicable, federal administrative requirements and contain provisions specified in the loan contract;

3. Agency has the required market assurances; and

4. All other state and facilities plan approval conditions have been met.

The procedures applicable to design, plans and specifications review, and approval to award construction for the SRF are described in the SRF Policy. The following discussion applies only to the WRLP. Staff must review final plans and specifications and other documents before issuing approval to advertise. The final design submittal consists of the following: 1) complete, biddable, and signed plans and specifications; 2) a detailed, itemized engineer's cost estimate; 3) updated revenue program; 4) updated construction financing plan and; 5) recycled water market assurances.

Promptly upon award of the construction contract or contracts, the agency shall notify the SWRCB Project Manager of the award. The notice shall be accompanied by a tabulation of bids received, the most recent engineer's estimate of project cost, a copy of the lowest acceptable bid proposal, a description of any bid protest received together with a description of how the protest was resolved, a copy of any project changes or addenda issued since approval to advertise was given, and a copy of the signed construction subcontract. If the agency awarded to anyone other than the apparent low bidder, the reasons for not awarding to the apparent low bidder shall be provided.

XIV. OPERATION

Agencies are encouraged to adopt a recycled water ordinance or regulation to ensure the long term successful operation of a recycling project in compliance with health, safety, and water quality requirements. A recycled water ordinance can include conditions under which users accept recycled water and define the requirements for on-

site facilities design, construction, operation, monitoring and inspection, connection fees and service charges, enforcement, and penalties. An ordinance can ensure that certain design criteria and standards incorporated into the original project can be carried on in project expansion as new users are added.

Agencies are also encouraged to prepare a recycled water user manual. The manual is used by personnel employed by users of recycled water who handle recycled water on a daily basis, such as park maintenance staff. The manual, usually a two to ten page guide, would cover in simplified language such topics as irrigation scheduling, precautionary measures, emergency procedures, control of runoff, and routine maintenance. It can also include a simplified description of the treatment that recycled water receives before reuse and the overall recycled water system.

Once the project begins operation, the project will be monitored for progress in connecting recycled water users and delivering recycled water. Annual reports must be submitted by the loan recipient until at least one full year after all proposed users are connected up to a maximum of nine years.

APPENDIX A DEFINITIONS

Award of Construction Contract: The formal approval of selection of a construction contractor by the governing board of the agency.

Completion of Construction: The date, as determined by the Division of Clean Water Programs after consultation with the loan recipient, that the construction of the project is substantially complete.

Construction Financing Plan: The demonstration of the financial capability to design and construct a project.

Cost-Effectiveness Analysis: An analysis to determine which project alternative will result in the minimum total resources cost (opportunity cost) over time to meet the project objectives, including local, state and federal requirements.

Economic Analysis: The procedure to determine the total monetary costs and benefits of all the resources committed to a project regardless of who in the society contributes them or who in the society receives the benefits.

Eligible Water Recycling Project: A water recycling project that is cost-effective based on the project objective when compared to the appropriate alternatives to achieve the objective. The project shall comply with applicable water quality standards, policies, and plans.

Existing user: An entity that currently exists or will exist before the completion of project construction and is using or would be expected to use fresh water if recycled water were not made available.

Financial Analysis: The procedure to determine financial feasibility through the determination of expenditures and incomes of or other financial impacts on the agency implementing the project, recycled water users, or others affected by the project.

Future user: An entity that currently does not exist and will not exist before the completion of project construction.

Local Public Agency: Any city, county, district, joint powers authority, or any other local public body or political subdivision of the state created by or pursuant to state law and involved with water or wastewater management (based on 1988 Bond Law). State agencies are not included in this term.

Municipality: Municipality shall have the same meaning as in the federal Clean Water Act (33 U.S.C. Sec. 1251 et. seq.) and shall also include the state or any agency, department, or political subdivision thereof (based on 1984 Bond Law).

Planning Period: The period over which a water development project is evaluated for cost-effectiveness. This period is not necessarily the same as the useful lives of the facilities under consideration. The planning period begins with the system's initial operations and is defined to be 20 years for the Water Recycling Loan Program.

Preliminary Grant Commitment or Preliminary Loan Commitment: A formal action by the SWRCB approving and reserving funds for a study or project.

Public Agency: Public agency shall have the same meaning as municipality.

Recycled Water: Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur. (This term is synonymous with 'reclaimed water'.) (Based on California Water Code, Section 13050(n).)

Revenue Program: The demonstration of the financial feasibility of a project for the period after operation has begun.

Water Recycling: The process of treating wastewater to produce water for beneficial use, the storage and distribution of recycled water to the place of use, and the actual use of recycled water.

APPENDIX B LIST OF ABBREVIATIONS

CEQA	California Environmental Quality Act
Division	Division of Clean Water Programs
FPGP	Water Recycling Facilities Planning Grant Program
OWR	Office of Water Recycling
RWQCB	Regional Water Quality Control Board
SRF	State Revolving Fund Loan Program
SRF Policy	"Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment Facilities"
SWRCB	California State Water Resources Control Board
WRLP	Water Recycling Loan Program
1984 Bond Law	Clean Water Bond Law of 1984 (Proposition 25 on the November 6, 1984 ballot)
1988 Bond Law	Clean Water and Water Reclamation Bond Law of 1988 (Proposition 83 on the November 8, 1988 ballot)
1996 Bond Law	Safe, Clean, Reliable Water Supply Act (Proposition 204 on the November 5, 1996 ballot)

APPENDIX C RECOMMENDED PLANNING OUTLINE FOR WATER RECYCLING PROJECTS

This outline contains the components of a facilities planning report for water recycling. The facilities planning report outline emphasizes the information relevant to water recycling and its application for water supply purposes. For water pollution control facilities plans, additional information would be required to define the water quality problem and planning constraints and analyze the appropriate pollution control alternatives in addition to water recycling.

Facilities Plan/Project Report

A. Maps and diagrams

1. Vicinity Map.
2. Detailed map of study area boundaries.
3. Topographic map.
4. City boundaries.
5. Wholesale and retail water supply entity boundaries within study area and adjacent to study area.
6. Wastewater agency boundaries within and adjacent to study area.
7. Existing recycled water distribution pipelines, storage, and customers.
8. Ground water basin boundaries, major streams, streams receiving waste discharges.
9. Present and projected land use.
10. Each recycled water facilities alternative (including recommended project), showing locations of potential customers and approximate pipeline routes.
11. Wastewater treatment schematic--existing and proposed.

B. Study Area Characteristics

1. Hydrologic features.

2. Ground water basins, including quantities extracted by all users, natural and artificial recharge, losses by evapotranspiration, inflow and outflow of basins, and safe yield or overdraft.

3. Water quality--ground water and surface water.

4. Land use and land use trends.

5. Population projections of study area.

6. Beneficial uses of receiving waters and degree of use, portion of flow that is effluent.

C. Water Supply Characteristics and Facilities

1. Description of all wholesale and retail entities.

2. All sources of water for study area and major facilities, their costs, (costs should be broken down into fixed and variable), subsidies, and customer prices.

3. Capacities of present facilities, existing flows, estimated years when capacities to be reached for major components (water treatment plants, major transmission and storage facilities).

4. Ground water management and recharge, overdraft problems.

5. Water use trends and future demands, prices and costs.

6. Quality of water supplies.

7. Sources for additional water and plans for new facilities (for both the local entity and the wholesalers).

D. Wastewater Characteristics and Facilities

1. Description of entities.

2. Description of major facilities, including capacities, present flows, plans for new facilities, description of treatment processes, design criteria.

3. Water Quality of effluent and any seasonal variation.

4. Additional facilities needed to comply with waste discharge requirements.

5. Sources of industrial or other problem constituents and control measures.

6. Existing recycling, including users, quantities, contractual and pricing arrangements.

7. Existing rights to use of treated effluent after discharge.

8. Wastewater flow variations--hourly and seasonal.

E. Treatment Requirements for Discharge and Reuse

1. Required water qualities for potential uses.

2. Required health-related water qualities or treatment requirements for potential uses, operational and on-site requirements (such as backflow prevention, buffer zones).

3. Wastewater discharge requirements, anticipated changes in requirements.

4. Water quality-related requirements of the RWQCB to protect surface or ground water from problems resulting from recycled water use.

F. Recycled Water Market

1. Description of market assessment procedures.

2. Descriptions of all users or categories of potential users, including type of use, expected annual recycled water use, peak use, estimated internal capital investment required (on-site conversion costs), needed water cost savings, desire to use recycled water, date of possible initial use of recycled water, present and future source of water and quantity of use, quality and reliability needs, and wastewater disposal methods.

3. Summary tables of potential users and related data.

4. Definition of logical service area based on results of market assessment.

G. Project Alternative Analysis

1. Planning and design assumptions:
   a. Delivery and system pressure criteria.
   b. Peak delivery criteria.
   c. Storage criteria.
   d. Cost basis: cost index, discount rate, useful lives, etc.
   e. Planning period.

2. Water Recycling Alternatives to be Evaluated
   a. Treatment alternatives:
      i. Alternative levels of treatment.
      ii. Alternative unit processes to achieve a given level of treatment.
   b. Pipeline route alternatives.
   c. Alternative markets:
      i. Based on different levels of treatment.
      ii. Geographical areas.
   d. Alternative storage locations.
   e. Subalternatives of selected alternative:
      i. Marginal analysis for selected alternative for certain categories of users or certain geographic areas.
      ii. Varying storage, pump rates, and pipeline diameters.
      iii. Use of fresh water blending during peak irrigation months.

3. Non-recycled water alternatives.
   a. Discussion of other potentially viable new sources of water.
   b. Provide economic costs.

4. Water conservation/reduction analysis.
   a. Analysis.
   b. Impact on recycling, if any.
   c. Recommendation.
   d. Implementation.

5. Pollution control alternatives (if applicable) needed to comply with waste discharge requirements, and possible allocation of costs between recycling and pollution control.

6. No project alternative.

7. Information supplied for each alternative to include, but not be limited to:
   a. Cost tables for each alternative with breakdown of costs by total capital (without grants), O&M, unit processes, and with equivalent annual cost and per acre-foot cost.
   b. Lists of potential users assumed for each alternative.
   c. Economic analysis.
   d Energy analysis for each alternative, including direct and construction energy.
   e. Water quality impacts:
      i. Effect on receiving water by removing or reducing discharge of effluent, including effect on beneficial uses resulting from reduced flow.
      ii. Ground water impacts.

8. Comparison of above alternatives and recommendation of specific alternative.

H. Recommended Plan

1. Description of all proposed facilities and basis for selection.

2. Preliminary design criteria and refined pipeline routes.

3. Cost estimate based on time of construction.

4. List of all potential users, quantity of recycled water use, peak demand, commitments obtained.

5. Reliability of facilities as compared to user requirements.

6. Implementation plan:
   a. Coordination with water suppliers, determination of recycled water supplier and needed agreements or ordinances.
   b. Ability and timing of users to join system and make on-site investments.
   c. Tentative water recycling requirements of RWQCB.
   d. Commitments from potential users.
   e. Water rights impact.
   f. Permits, right-of-way, design, construction.
   g. Detailed schedule.

7. Operational plan--responsible people, equipment, monitoring, irrigation scheduling, etc.

I. Construction Financing Plan and Revenue Program

1. Sources and timing of funds for design and construction.

2. Pricing policy for recycled water.

3. Costs which can be allocated to water pollution control.

4. Annual projection of:
   a. Fresh water prices for each user or category of users.
   b. Recycled water used by each user.
   c. Annual costs (required revenue) of recycling project.
   d. Allocation of costs to users.
   e. Unit costs to serve each user or category of users.
   f. Unit price of recycled water for each user or category of users.
   g. Sensitivity analysis assuming portion of potential users fail to use recycled water.

5. Sunk costs and indebtedness.

J. Appendices

1. Tables of all abbreviations.

2. Copies of letters of interest or intent from recycled water users, or other documentation of support from potential users.

3. Draft of recycled water mandatory use ordinance or model user contract.

4. Drafts of necessary agreements, such as wholesale-retail agreement, joint powers agreement, etc.

APPENDIX D LOAN REPAYMENT AND FINANCIAL ANALYSES

I. Introduction

Typically, money is an essential ingredient for a feasible water recycling project. It must be raised to finance design and construction, to provide positive cash flow during construction, and, once operation has commenced, to repay debts and pay for operation and maintenance. These guidelines contain the repayment provisions for loans from the Water Recycling Loan Program and the desired documentation to demonstrate financial feasibility. More detailed information on financial analyses can be found in the SWRCB's Interim Guidelines for Economic and Financial Analyses of Water Reclamation Projects.

Two financial reports are required: a construction financing plan and a revenue program, which covers the period commencing with initial facilities operation. These two reports must be submitted with the loan application (as part of the facilities plan) and updated and submitted with the 100 percent design submittal. A final revenue program must be submitted at completion of construction.

II. Loan Repayment Provisions

Loans from the Water Recycling Loan Program will have an interest rate set at 50 percent of the average interest rate paid by the State on the most recent sale of general obligation bonds. The term of the loans may be for a period of up to 20 years. The loan term begins from the loan contract date. Repayments will begin on the last day of the month following two years after award of the prime construction contract.

III. Construction Financing Plan

It must be demonstrated that there are sufficient financial resources to finance the design and construction of the project. The construction financing plan generally consists of at least the following items:

1. An up-to-date capital cost estimate, including construction, engineering, legal, and administrative costs with a reasonable allowance for contingencies.

2. A cash flow analysis consisting of a monthly forecast of expenses during design and construction and sources of funds to meet those expenses.

3. The sources and amounts of funds for capital costs, including the status and timing in securing those funds.

There will be no disbursements of loan funds from the Water Recycling Loan Program until the award of construction contracts. Thus, the loan recipient must carry design costs until the initiation of construction. Loan disbursements will be made during construction in proportion to eligible costs incurred. If there are multiple construction

contracts, the loan disbursements will be proportioned amongst each construction contract.

The cash flow analyses should be based on the above procedures for loan disbursements and the assumption that receipt of loan funds will take 60 days from date of request.

IV. Pricing Policy

There are a variety of potential methods for determining the price customers will pay for recycled water. The most typical include:

1. The recycled water price is set to match exactly production costs.

2. The recycled water price is set at a given percentage discount from whatever potable water prices are.

3. The recycled water price is set at a given dollar discount from whatever potable prices are.

Some agencies charge a meter charge or have multiple rates if they have both wholesale and retail sales.

Some of the considerations involved in establishing recycled water rates are:

1. The costs that are expected to be recovered by recycled water revenue.

2. The costs and inconvenience to recycled water customers resulting from switching part of their water use to recycled water.

3. Whether the water agency will pay for on-site conversion costs of recycled water customers.

4. The degree of integration of the recycled water supply into the water agency's overall sources of supply, and thus the integration of costs and revenue from the various sources of supply.

Within the limits of financial feasibility, it is the recommendation of the Office of Water Recycling that the price of recycled water be as high as reasonable, taking into consideration the value of recycled water as compared to the price of fresh water. A reasonable discount from fresh water prices is often the most equitable.

V. Revenue Program

The financial feasibility of a project once it has started operation is shown in a revenue program. In general, a period of 10 years should be forecast. The following items should generally be included for each year:

1. recycled water demand by each user
2. fresh water prices applicable to the recycled water users
3. recycled water prices
4. total recycled water revenue
5. debt repayment
6. operation and maintenance costs, broken down by category with fixed and variable costs separated
7. supplementary funds provided to accommodate any revenue deficiency
8. sensitivity analysis assuming portion of potential users fail to use recycled water.

The assumptions and bases for all numbers should be fully stated and referenced. The pricing policy for the recycled water should be explained. It may be necessary to allocate project costs between pollution control and water supply or between categories of users.

Water supply agencies frequently have more than one source of water. The finances for these various sources are usually integrated, and customers are charged a common melded price, even if they receive water from only one of the sources. Likewise, recycled water should not be viewed as an alien source of water, but rather as simply an added supply to meet the overall water demands of a water supply agency. Its only distinction is that its quality restricts its uses. As such, it is desirable that the finances for a recycled water system be integrated with those for the fresh water sources of supply. Once it has been determined that recycled water costs are justifiable compared to other sources of supply, the recycled water supply should not be treated as an independent system financially.

With recycled water viewed as a complement to a water system, Recycled water prices should be established using the same standards as fresh water, taking into consideration some of the peculiarities mentioned in the previous section. If revenues from recycled water are insufficient to cover all expenses from the recycled water system, as is common in the initial years of operation, the shortfall can be made up with revenue from the fresh water system. Likewise, excess recycled water revenues can be used to cover other agency expenses, allowing all customers to benefit.

Because recycled water is serving as a replacement for fresh water, there inevitably is an effect on fresh water costs and revenue. It is desirable to quantify these effects and include them in the revenue program to describe fully the costs and benefits derived from the recycled water. This is often useful to provide justification for using fresh water revenue to help pay for a recycled water system.

APPENDIX E ORDER FORM FOR ADDITIONAL INFORMATION

Please review the below list of additional documents relating to the Water Recycling Loan Program. If you wish to obtain any of the documents, please provide the requested information.

A. Check the items desired:

[ ] 1. Clean Water Bond Law of 1984
[ ] 2. Clean Water and Water Reclamation Bond Law of 1988
[ ] 3. Safe, Clean, Reliable Water Supply Act (1996 Bond Law)
[ ] 4. Sample Letter of Intent for Use of Reclaimed Water
[ ] 5. Desirable Provisions of Reclaimed Water User Contracts
[ ] 6. Model Recycling Loan Contract
[ ] 7. Interim Guidelines for Economic and Financial Analyses of Water Reclamation Projects
[ ] 8. Background Information on Economic Analyses of Reclamation Projects
[ ] 9. Loan Application Package (Application Form, Water Recycling Funding Guidelines, and Environmental Review Process Guidelines for State Loan and Small Community Grant Applicants
[ ] 10. Policy for Implementing the State Revolving Fund for Construction of Wastewater Treatment Facilities

B. Provide the mailing address:

NAME:_____

TITLE:_____

AGENCY:_____

MAILING ADDRESS:_____

CITY, STATE, ZIP CODE:_____

C. Fold this order form in half, affix postage, and mail to pre-printed address on reverse side.

Place
Stamp
Here

Office of Water Recycling
Division of Clean Water Programs
State Water Resources Control Board
P. O. Box 944212
Sacramento, CA 94244-2120

WATER RECYCLING FUNDING GUIDELINES, April 17, 1997
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APPENDIX E

PROPOSITION

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WATER QUALITY, SUPPLY AND SAFE DRINKING WATER PROJECTS. COASTAL WETLANDS PURCHASE AND PROTECTION. BONDS. INITIATIVE STATUTE.

OFFICIAL TITLE AND SUMMARY

Prepared by the Attorney General

WATER QUALITY, SUPPLY AND SAFE DRINKING WATER PROJECTS. COASTAL WETLANDS PURCHASE AND PROTECTION. BONDS. INITIATIVE STATUTE.

- Authorizes $3,440,000,000 general obligation bonds to fund a variety of water projects, including:
  - Specified CALFED Bay-Delta Program projects including urban and agricultural water use efficiency projects;
  - Grants and loans to reduce Colorado River water use;
  - Purchasing, protecting and restoring coastal wetlands near urban areas;
  - Competitive grants for water management and quality improvement projects;
  - Development of river parkways;
  - Improved security for state, local and regional water systems;
  - Grants for desalination and drinking water disinfection.
- Appropriates money from state General Fund to pay off bonds.

SUMMARY OF LEGISLATIVE ANALYST'S ESTIMATE OF NET STATE AND LOCAL GOVERNMENT FISCAL IMPACT:

- State cost of up to $6.9 billion over 30 years to pay off both the principal ($3.44 billion) and interest ($3.46 billion) costs on the bonds. Payments of about $230 million per year.
- Reduction in local property tax revenues, ranging from a few million dollars to roughly $10 million annually, about one-half of which would be offset by state payments to schools to make up their revenue loss.
- Unknown costs to state and local governments to operate or maintain properties or projects purchased or developed with these bond funds.

ANALYSIS BY THE LEGISLATIVE ANALYST

BACKGROUND

Coastal Protection and Water Resources Programs. The state administers a number of programs to acquire and protect coastal wetlands and watersheds, conserve and protect water resources, and develop and improve the reliability of water supplies. The state also provides grants and loans to local agencies and nonprofit organizations for similar purposes. These programs are for a variety of specific purposes, including:

- *Coastal Wetlands and Watersheds.* The state has provided funds to acquire and restore coastal wetlands and watersheds.
- *Safe Drinking Water.* The state has provided funds for loans and grants to public water systems for facility improvements to meet safe drinking water standards.
- *Bay-Delta Restoration.* The state has also funded the restoration and improvement of fish and wildlife habitat in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (the Bay-Delta). Additionally, the state has funded water quality and supply projects in the Bay-Delta region which supplies a substantial portion of the water used in the state for domestic, industrial, agricultural, and environmental purposes. These funds have been provided through the CALFED Bay-Delta Program which is a joint state and federal effort to better manage water resources in this region.
- *Other Water Quality and Water Supply Projects.* The state has also provided funds for various other projects throughout the state that improve water quality and/or supply. For example, the state has provided loans and

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ANALYSIS BY THE LEGISLATIVE ANALYST (CONT.)

grants to local agencies for the construction and implementation of wastewater treatment, water recycling, and water conservation projects and facilities. Also, the state has provided funds to line canals to conserve Colorado River water.

Funding for Coastal Protection and Water Resources Programs. Funding for these programs has come from various sources, including the state General Fund, federal funds, and general obligation bonds. Since 1990, voters have approved about $3 billion in bonds that are primarily for water-related purposes. It is estimated that about $1.9 billion of the bonds authorized by these previous bond acts will have been spent or committed to specific projects as of June 2002, leaving a balance of about $1.1 billion for future projects. In addition, in March 2002, voters approved a $2.6 billion resources bond measure. A majority of the funds from that bond are for park-related projects, although some funds are available for water conservation and water quality projects.

PROPOSAL

This measure allows the state to sell $3.44 billion in general obligation bonds for various water-related programs. Figure 1 summarizes the purposes for which the bond money would be available for expenditure by various state agencies and for loans and grants to local agencies and nonprofit associations. It shows that more than half of the funds would be allocated to two purposes—coastal protection and the CALFED Bay-Delta Program.

FISCAL EFFECTS

Bond Costs. The cost of these bonds would depend on their interest rates and the time period over which they are repaid. If the bonds were sold at an interest rate of 5.25 percent (the current rate for this type of bond) and repaid over 30 years, the cost would be about $6.9 billion to pay off both the principal ($3.44 billion) and interest ($3.46 billion). The average payment would be about $230 million per year.

However, total costs to the state will be somewhat less. This is because the measure requires that loans made for coastal nonpoint source pollution control (up to $100 million) be repaid to the General Fund. The repayment of these loans could reduce the General Fund costs by up to $100 million (not including interest payments) over the life of the bonds.

Property Tax-Related Impacts. The measure provides funds for land acquisition by governments and nonprofit organizations, for various purposes including coastal protection. Under state law, property owned by government entities, and by nonprofit organizations under specified conditions, is exempt from property taxation. To the extent that this measure results in property being exempted from taxation due to acquisitions by governments and nonprofit organizations, local governments would receive reduced property tax revenues. We estimate these reduced property tax revenues would range from a few million dollars to roughly $10 million annually. Because existing law requires the state to make up for any property tax losses experienced by schools, we estimate about one-half of any losses resulting from this change would be offset by the state.

Operational Costs. State and local governments may incur additional costs to operate or maintain a property or project that is purchased or developed with the bond funds. The amount of these additional costs is unknown.

FIGURE 1

PROPOSITION 50
USES OF BOND FUNDS

(In Millions)	Amount
Coastal Protection	**$950**
• Wetlands acquisition, protection, and restoration	750
• Watershed protection	200
CALFED Bay-Delta Program	**$825**
• Water use efficiency and conservation	180
• Water supply reliability	180
• Ecosystem restoration	180
• Watershed protection	90
• Water conveyance	75
• Delta levee restoration	70
• Water storage planning and studies	50
Integrated Regional Water Management	**$640**
• Various water supply, pollution reduction, water treatment, flood management, and wetlands restoration projects	500
• Land and water acquisitions to improve/protect water quality, water supply reliability, and fish and wildlife habitat	140
Safe Drinking Water	**$435**
• Small community drinking water system upgrades, contaminant removal and treatment, water quality monitoring, drinking water source protection	
Clean Water and Water Quality	**$370**
• Water pollution prevention, water recycling, water quality improvements	100
• River parkway projects	100
• Coastal nonpoint source pollution control	100
• Lake Tahoe water quality improvements	40
• Land and water acquisitions to protect water quality in the Sierra Nevada-Cascade Mountain Region	30
Desalination and Water Treatment Project	**$100**
• Desalination projects, treatment/removal of specified contaminants, drinking water disinfecting projects	
Colorado River Management	**$70**
• Ecosystem restoration	50
• Canal lining	20
Water Security	**$50**
• Protection of drinking water systems from terrorist attacks and other deliberate acts of destruction or degradation	
Total	**$3,440**

For text of Proposition 50 see page 75.

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PROP
50

WATER QUALITY, SUPPLY AND SAFE DRINKING WATER PROJECTS. COASTAL WETLANDS PURCHASE AND PROTECTION. BONDS. INITIATIVE STATUTE.

ARGUMENT IN FAVOR OF PROPOSITION 50

YES ON 50. PROTECT OUR DRINKING WATER SUPPLY AND COASTLINE.

Our water supply is threatened by pollution, recurring drought, population growth, and inadequate security.

Proposition 50 will help overcome these threats and provide every California family a safe, reliable supply of clean drinking water by:

- Removing dangerous, cancer causing pollutants from our drinking water.
- Creating new water supplies to keep up with population growth.
- Keeping raw sewage and pollution out of our coastal waters and cleaning up beaches and bays.
- Protecting rivers, lakes and streams and preserving coastal wetlands.
- Protecting our reservoirs, dams, pumping stations and pipelines from terrorist threats and intentional contamination.

YES ON 50 KEEPS OUR WATER FLOWING

California's population is expected to nearly double in the next forty years. Proposition 50 funds state and local water system improvements needed to keep up with population growth by providing new water supplies and supporting water conservation programs.

YES ON 50 KEEPS OUR WATER CLEAN

Proposition 50 funds improved drinking water treatment to remove dangerous cancer causing chemicals, including arsenic, chromium and MTBE from our drinking water.

YES ON 50 KEEPS OUR WATER SAFE

Many of California's reservoirs, dams and pumping stations are protected by little more than a chain link fence. Proposition 50 protects local water delivery systems from terrorist threats and intentional contamination by funding early warning systems, alarms, fences, security systems, testing equipment and upgraded communications systems.

YES ON 50 PROTECTS OUR BEACHES, BAYS AND COASTLINE

Many of California's most beautiful beaches are unsafe for swimming because of pollution and raw sewage. Proposition 50 will fix aging local sewer and storm water systems that dump urban runoff into coastal waters. Proposition 50 also provides for protection and restoration of coastal wetlands vital to restoring the water quality, fisheries and wildlife of the San Francisco, Santa Monica and San Diego bays and of the coastal waters of the state.

YES ON 50 WILL NOT RAISE TAXES

Proposition 50 will use existing tax revenue where it is needed now—to protect our water supply and ensure safe drinking water for all Californians.

YES ON 50—SUPPORTED BY LOCAL WATER AGENCIES, CONSERVATION GROUPS, BUSINESS AND COMMUNITY GROUPS, INCLUDING:

- Metropolitan Water District of Southern California
- Contra Costa Water District
- East Bay Municipal Utility District
- League for Coastal Protection
- Heal the Bay
- Los Angeles Area Chamber of Commerce
- League of Women Voters of California
- The Nature Conservancy
- Southern California Agricultural Land Foundation
- National Wildlife Federation
- Audubon California
- American River Conservancy
- League to Save Lake Tahoe
- Clean Water Action

YES ON 50—PROTECT CALIFORNIA'S FUTURE:

California's future depends on investment in water supply and security, water quality and safe drinking water projects and on protecting our rivers, lakes, bays and coastal waters from contamination. Proposition 50 provides the funds that local water districts need to serve California's growing population.

Please join our campaign to protect California's water supply and coastline: *www.prop50yes.com*

BARBARA INATSUGU, *President*
League of Women Voters of California
DAN TAYLOR, *Vice President*
National Audubon Society
MARGUERITE YOUNG, *California Director*
Clean Water Action

REBUTTAL TO ARGUMENT IN FAVOR OF PROPOSITION 50

To say Proposition 50 creates *"new water sources to keep up with population growth"* is an outright lie. Just read Section 79560 of the initiative, it strictly prohibits bond funds from being spent for building new dams or reservoirs.

To say it *"will not raise taxes"* is another lie. Proposition 50 will cost California Taxpayers a total of $5.7 billion—that's $227 million each year for the next 25 years. Furthermore, this initiative does nothing to complete the California Water Project sponsored by Gov. Pat Brown to meet our long range water needs.

Millions of acre-feet of water flow down the Sacramento, through the Golden Gate, into the ocean each year. A canal is desperately needed to divert water around the Delta so it can flow down the California Aqueduct to drought stricken areas of our State. Proposition 50 does nothing to address this badly needed source of new water.

Proposition 50 is more about money than water. The proponents solicited various special interests and apparently traded bond monies for campaign cash. It's called *quid pro quo* and under normal circumstances, it's illegal. However, in the arena of initiative politics, it's not illegal. Some of the largest real estate developers in California are big investors in this scheme to extract $3.44 billion from the taxpayers.

The principals of the San Juan Company put up $50,000 for the effort at the same time they are trying to get approval to build 14,000 houses in an environmentally sensitive southern Orange County.

EDWARD J. (TED) COSTA, *Chairman*
California Taxpayers Coalition
RICHARD AHERN, *Vice President*
Waste Watchers, Inc.

Arguments printed on this page are the opinions of the authors and have not been checked for accuracy by any official agency.
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ARGUMENT AGAINST PROPOSITION 50

It seems like every time we have a general election, someone asks for a few billion dollars for safe drinking water. This time we are being asked to pass the largest water bond in history. A whopping $5.7 billion—when you consider the principal ($3.44 billion) and the interest ($2.24 billion).

In spite of all the water bonds California taxpayers have approved in the last 30 years, our Governor and Legislature have taken no action to develop new water storage facilities. In fact, the construction of dams and reservoirs has been at a virtual standstill for many years in California.

Most of water bond monies California voters have been approving have gone for endless studies of the problem, and to pander to unrealistic environmental demands.

It's time for all good taxpayers to say *"no dice"* to these bond schemes that do nothing to improve our long range water supply.

Yes, we are fast approaching a big water shortage crisis in California, the likes of which we have never seen before. Proposition 50 provides virtually no money to alleviate that crisis.

We need new dams on the American River at Auburn and on the upper San Joaquin River at Friant. $3.44 billion will build both of them and provide us with a much needed new water supply.

We need to build the Sites Reservoir in Colusa County, and the Los Banos Grande Reservoir in Merced County to store an additional 6 million acre feet of new water for drought protection and to accommodate all the new construction of the last 30 years. $3.44 billion would go a long way to build these worthwhile new reservoirs.

All of California desperately needs a diversion channel around the Delta so that excess water that now flows out the Golden Gate into the ocean can be sent to drought stricken areas of our State. $3.44 billion would substantially fund that project.

Proposition 50 does nothing to start, or plan for completion of any of the projects listed above.

Proposition 50 has been described as the *"stealth bond issue."* Proponents are trying to sell it as a clean drinking water initiative. However, all California taxpayers should know it was drafted by a Sacramento lobbyist for several environmental groups and the Metropolitan Water District of Southern California.

Supporters then hired professional signature gatherers and paid as much as $2.50 a signature to qualify this deceptive initiative for the ballot.

What Proposition 50 really does is dole out bond funds to the pet projects of those environmental groups that paid to put it on the ballot. And, you and your children will have to come up with $227 million each year for the next 25 years to pay for it.

Recently, a group of 30 taxpayer organizations from around the State met in Convention under the name California Taxpayer's Coalition and voted unanimously to oppose Proposition 50.

Vote no on Proposition 50.

For more information *tedcosta@tedcosta.com* or *peoplesadvocate.org* 1-800-501-8222.

ERNIE DYNDA, *President*
United Organizations of Taxpayers
EDWARD J. (TED) COSTA, CEO
People's Advocate
TOM C. ROGERS, *Chairman*
Citizens Against Unfair Taxation

50

REBUTTAL TO ARGUMENT AGAINST PROPOSITION 50

PROP 50 IS NEEDED NOW TO PROVIDE A CLEAN, RELIABLE AND SAFE WATER SUPPLY FOR OUR FAMILIES AND OUR FUTURE.

We've made progress in improving water quality and reliability, but there's a lot more that needs to be done *now*. Prop 50 supports vitally needed water projects critical to ensuring clean drinking water and a reliable water supply.

Even the small groups opposing Prop 50 agree that OUR LOOMING WATER CRISIS MUST BE RESOLVED. But their approach, coming from people claiming to represent taxpayers, would cost drastically more than Prop 50's cost-effective approach.

PROPOSITION 50 WILL:

- *Keep our drinking water clean* by removing toxic substances and protecting our rivers, lakes and streams.
- *Keep our water flowing* by providing new water supplies, improving local water systems, and supporting water efficiency and conservation programs.
- *Protect our beaches, bays and coastline* by repairing aging sewer and storm water systems.
- *Keep our water system safe and secure* by protecting against terrorist threats and intentional contamination.

"Local water agencies responsible for providing Californians with safe drinking water agree: Prop 50 is vitally needed to provide a reliable supply of clean drinking water."—James Pretti, President of the Board, Contra Costa Water District

"Nothing is more important than secure water supplies. Prop 50 can help avert attacks on and contamination of our drinking water supply."—Lieutenant Ed Gray, President, California Organization of Police and Sheriffs

JOIN public safety groups, public health experts, water agencies, conservation groups, businesses and community groups throughout California in voting YES ON 50.

DAN TERRY, *President*
California Professional Firefighters
BARBARA INATSUGU, *President*
League of Women Voters of California
PHILLIP J. PACE, *Chairman*
Metropolitan Water District of Southern California

SAWPA Project Information Form for Prop 50 Potential Funding

Edit Project Information

The information for your project is summarized below. Click the edit and then update, buttons to make any changes. Click 'Add Project Map', 'Add Project Schedule', or 'Add Cooperating Agency' to upload a new map or schedule for the project or add a Cooperating Agency.

Add Project Map | Add Project Schedule | Add Cooperating Agency

Edit

Agency Contact Information

Organization:	City of Riverside
Contact First:	Zahra
Contact Last:	Panahi
Address:	3900 Main Street, 4th Floor
City:	Riverside
State:	CA
Zip:	92522
Phone:	909 826 5612
Cell:	
Fax:	909 826 2498

IWP Projects

Edit

General Project Information

Project Name:	Water Recycling Project - Phase I
Project Cost:	12300000
Project Description:	The proposed project involves implementation of Riverside water recycling project - phase I. The project includes construction of a booster pump station and installation of over 31,000 feet of transmission pipeline raging in size from 12" through 30". The recycled water is to replace domestic water use for irrigation by the City of Riverside and Jurupa Community Service District (JCSD) for landscape and park irrigation.
Project Location:	The project facilities would be located near the Riverside Water Quality Control Plant along Van Buren Boulevard, Jurupa Avenue, Arlington Avenue, and Adams Street.
Annual Water Yield: (9999=Unknown)	2070
If outside watershed, impact on watershed resources:	In Watershed
Part of Larger Project:	False
Larger Project Start:	NA
Larger Project Finish:	NA
Institutional Barriers:	None
Constructed Similar Projects:	True

CEQA Complete:	False
CEQA Approval Date:	January 2004
Contract Award Date:	January 2005
Fund PreConstruction:	True
Other Funding:	None
Other Prop 50 qualifiers:	None
IWP Project Number:	None
Comments:	None

Prop 50 Purposes met by Project

IWP Purpose:
Programs for water supply reliablility, conservation, and efficiency

Edit

Your Project Information:
The project would provide water supply reliabity by providing additional source of water supply.

IWP Purpose:
Edit Storm water capture, storage, treatment, and management

Your Project Information:

IWP Purpose:
Edit Removal of non-native plants, creation and enchancement of wetlands

Your Project Information:

IWP Purpose:
Edit Non-point source pollution reduction, management and monitoring

Your Project Information:

IWP Purpose:
Edit Groundwater recharge and management

Your Project Information:

IWP Purpose:
Edit Contaminant and salt removal

Your Project Information:

IWP Purpose:
Edit Water banking, exchange, reclamation, and quality improvement

Your Project Information:

IWP Purpose:
Edit Planning, implementation of multipurpose flood control programs

Your Project Information:

IWP Purpose:
Edit Watershed management and planning

Your Project Information:

IWP Purpose:
Edit Projects to develop new water treatment and distribution methods

Your Project Information:

IWP Purpose:
Edit Provide other benefits to the watershed

Your Project Information:

	Fund Description	Fund Amount	Fund Percent
Edit	Prop 50	10300000	84
Edit	Local Matching Funds	2000000	16
Edit	Other Matching Funds		
Edit	Total Project Funds	12300000	100

	IWP Document	Part of IWP
Edit	Water Resources Component	No
Edit	Environmental and Wetlands Component	No
Edit	SARI Line Component	No

Winston H. Hickox
Secretary for Environmental Protection

State Water Resources Control Board

Division of Financial Assistance
1001 I Street • Sacramento, California 95814 • (916) 341-5700
Mailing Address: P.O. Box 944212 • Sacramento, California • 94244-2120
FAX (916) 341-5470 • Internet Address: http://www.swrcb.ca.gov

Gray Davis
Governor

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website at http://www.swrcb.ca.gov.

March 2003
ANNOUNCEMENT
Release of
CONSOLIDATED REQUEST FOR CONCEPT PROPOSALS
Watershed and Nonpoint Source Pollution Control Programs

The purpose of this document is to announce the availability of up to $138 million in Watershed/Nonpoint Source grants through the State Water Resources Control Board's (State Board) Division of Financial Assistance, in partnership with:

- California Bay/Delta Authority (CALFED)
- U.S. Environmental Protection Agency (USEPA)
- California Coastal Commission
- California Resources Agency

These grants are made available through funding from:

- Safe Drinking Water, Clean Water, Watershed Protection and Flood Protection Act of 2000 (Proposition 13)
- Federal Clean Water Act section 319
- Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 (Proposition 50)

GRANT PROGRAM SUMMARIES

- **Nonpoint Source Programs**

1. Nonpoint Source Pollution Control Program (Water Code, Division 26, Chapter 7, Article 2) (Proposition 13 = $25 million).
   The Nonpoint Source Pollution Control Program provides grant funding to local public agencies and nonprofit organizations formed by landowners for projects that protect the beneficial uses of water throughout the state through the control of nonpoint source pollution. Grants are available to local public agencies, or nonprofit organizations formed by landowners to prepare and implement local nonpoint source plans. Of the $25 million available, $18.5 million is available to projects within six designated counties, San Diego, Orange, Los Angeles, Ventura, Riverside, and San Bernardino Counties. $6.5 million is available for projects within the other 52 counties.

2. Coastal Nonpoint Source Pollution Control Program (Water Code, Division 26, Chapter 7, Article 5) (Proposition 13 = $11.1 million).
   The program provides grants to municipalities, local public agencies, nonprofit organizations, and educational institutions for coastal nonpoint source projects that restore and protect the water quality and environment of coastal waters, estuaries, bays, and near shore waters and groundwater. Of the $11.1 million available, $7 million is available to coastal projects within the geographic areas of Regional Water Quality Control Boards (Regional Boards) 1, 2, or 3. The remaining $4.1 million will go to coastal projects within Regional Boards 4, 8, or 9.

3. Nonpoint Source Implementation Program (Federal Clean Water Act Section 319) ($5-6 million).
   The 319 Nonpoint Source Implementation Program provides grant funding for projects to implement measures and practices that reduce or prevent nonpoint source pollution to ground and surface waters. In particular, proposals that implement measures to achieve pollutant load reductions and address TMDL implementation will be favored in the selection process. Grants are available to municipalities, local public agencies, educational institutions, nonprofit organizations or Indian tribes. Funds cannot be used for activities undertaken pursuant to a NPDES permit (including stormwater).

4. CALFED Drinking Water Quality Program (DWQP) (Proposition 13 = $12.7 million)
5. CALFED Drinking Water Quality Program (DWQP) (Proposition 50 = $18.5 million)
   Projects funded through Proposition 13 must meet the minimum requirements of both the Proposition 13 Nonpoint Source Pollution Control Program and the DWQP, whereas projects funded through Proposition 50 only need to meet the requirements of the DWQP. The DWQP is focused on improving the quality of Central Valley and Delta water sources used for drinking water. Thus, projects eligible for DWQP funding will generally be located in the watersheds of the Central Valley Regional Board (Region 5). However, projects outside of Region 5 may also be eligible for funding if the applicant can demonstrate that its project will improve or protect the quality of drinking water derived from the Central Valley-Delta system. For example, a project that addresses NPS pollution in the watersheds of the southern reservoirs of the State Water Project (which are primarily filled with Delta water) may be a viable project. In the end, it is the responsibility of the project proponent to demonstrate, in its application for funding, a substantive link to the goals and objectives of the DWQP.

- **Watershed Programs**

6. Watershed Protection Program (Water Code, Division 26, Chapter 6, Article 2) (Proposition 13 = $32.8 million)
   Special Consideration – $7.9 million of the above amount must go to small communities that meet financial hardship criteria outlined in the Request For Concept Proposal (RFCP). Grants are available to municipalities, local agencies, or nonprofit organizations to develop and implement local watershed management plans to reduce flooding, control erosion, improve water quality, and improve aquatic and terrestrial species habitats. Of the funds available, $1,000,000 are available for the development of watershed management or restoration plans.

7. CALFED Watershed Program (Proposition 13 = $12.1 million)
8. CALFED Watershed Program (Proposition 50 = up to $15-20 million).
   Special Consideration – $7.9 million of the Proposition 13 amount must go to small communities that meet financial hardship criteria outlined in the RFCP. Projects funded through the Proposition 13 allocation must meet the minimum requirements of both the Proposition 13 Watershed Protection and the CALFED Watershed Programs, whereas projects funded through Proposition 50 only need to meet the requirements of the CALFED Watershed Program. Of the Proposition 13 funds available, $800,000 is available for the development of watershed management or restoration plans. The Watershed Program will support activities that provide benefits to the areas within the CALFED Solution Area. Actions that would result in beneficial impacts on the resources of the Bay-Delta watershed and that support the goals and objectives of CALFED will be considered, regardless of the physical location of implementation. In addition to supporting the achievement of the goals and objectives outlined for CALFED and its Watershed Program, proposals should also be developed and implemented using the CALFED Watershed Program Principles of Participation.

Project proponents that have previously received funding from either State Board or CALFED programs will be considered subject to any performance assessments, restrictions or other special circumstances resulting from that earlier funding. Successful applications will make clear connections to nonpoint source, water quality, or watershed management issues, and the requirements outlined in this request for concept proposals.

A copy of the Request for Concept Proposals is available online at **www.swrcb.ca.gov/funding/docs/2003RFCP.doc**. We strongly encourage applicants to read the entire Request for Concept Proposals and review the reference materials before developing a grant proposal.

If, after reading these materials, you have any questions or need further assistance, please contact your Regional Board, State Board, Coastal Commission, or USEPA contacts listed in Attachment 6 of the RFCP. If you are unable to reach your Regional or State Board contact, you may call the following toll free number where a staff person will direct your call to the appropriate staff, 1-866-434-1083. You may also send an e-mail to **DFA_Grants@swrcb.ca.gov.**

WORKSHOPS

Workshops regarding this funding will be scheduled throughout the State during the month of April. Location and times will be posted on the State Board Web-site at **www.swrcb.ca.gov/funding/index.html**.

TEXT OF PROPOSED LAW

This initiative measure is submitted to the people in accordance with the provisions of Section 8 of Article II of the California Constitution.

This initiative measure adds sections to the Water Code; therefore, new provisions proposed to be added are printed in italic type to indicate that they are new.

PROPOSED LAW

WATER SECURITY, CLEAN DRINKING WATER, COASTAL AND BEACH PROTECTION ACT OF 2002

SECTION 1. Division 26.5 (commencing with Section 79500) is added to the Water Code, to read:

DIVISION 26.5. WATER SECURITY, CLEAN DRINKING WATER, COASTAL AND BEACH PROTECTION ACT OF 2002

CHAPTER 1. GENERAL PROVISIONS

79500. This division shall be known and may be cited as the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002.

79501. The people of California find and declare that it is necessary and in the public interest to do all of the following:

(a) Secure and safeguard the integrity of the state s water supply from catastrophic damage or failure from terrorist acts or other deliberate acts of destruction.

(b) Provide a safe, clean, affordable, and sufficient water supply to meet the needs of California residents, farms, and businesses.

(c) Provide adequate financing for balanced implementation of the CALFED Bay-Delta Program to:

(1) Provide good water quality for all beneficial uses.

(2) Improve and increase aquatic and terrestrial habitats and improve ecological functions in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary to support sustainable populations of diverse plant and animal species.

(3) Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system.

(4) Reduce the risk to land uses and associated economic activities, water supply, infrastructure, and ecosystems from catastrophic breaching of Delta levees.

(d) Establish and facilitate integrated regional water management systems and procedures to meet increasing water demands due to significant population growth that is straining local infrastructure and water supplies.

(e) Improve practices within watersheds to improve water quality, reduce pollution, capture additional storm water runoff, protect and manage groundwater better, and increase water use efficiency.

(f) Protect urban communities from drought, increase supplies of clean drinking water, reduce dependence on imported water, reduce pollution of rivers, lakes, streams, and coastal waters, and provide habitat for fish and wildlife.

(g) Invest in projects that further the ability of all Californians to live within Californias basic apportionment of 4.4 million acre-feet per year of Colorado River water pursuant to the Colorado River Water Use Plan.

(h) Protect, restore, and acquire beaches and coastal uplands, wetlands, and watershed lands along the coast and in San Francisco Bay to protect the qual ity of drinking water, to keep beaches and coastal waters safe from water pollution, and to provide the wildlife and plant habitat and riparian and wetlands areas needed to support functioning coastal and San Francisco Bay ecosystems for the benefit of the people of California.

79502. It is the intent of the people in enacting this division that it be administered and executed in the most expeditious manner possible, and that all state, regional and local officials implement this division to the fullest extent of their authority.

79503. It is the intent of the people that water facility projects financed pursuant to this division shall be designed and constructed so as to improve the security and safety of the state s drinking water system.

79504. It is the intent of the people that investment of public funds pursuant to this division should result in public benefits.

79505. As used in this division, the following terms shall have the following meanings:

(a) "Acquisition" means the acquisition of a fee interest or any other interest, including easements, leases, and development rights.

(b) "Board" means the State Water Resources Control Board. .

(c) "CALFED" means the consortium of state and federal agencies with management and regulatory responsibilities in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary.

(d) "CALFED Bay-Delta Program" means the undertaking by CALFED to develop and implement, by means of the final programmatic environmental impact statement/ environmental impact report, the preferred programs, actions, projects, and related activities that will provide solutions to identified problem

(e) "Department" means the Department of Water Resources.

(f) "Fund" means the Water Security, , Clean Drinking Water, Coastal and Beach Protection Fund of 2002 created pursuant to Section 79510.

(g) "Nonprofit organization" means any nonprofit corporation formed pursuant to the Nonprofit Public Benefit Corporation Law (Division 2 (commencing with Section 5000) of Title 1 of the Corporations Code) and qualified under Section 501(c)(3) of the United States Internal Revenue Code.

(h) "Secretary" means the Secretary of the Resources Agency.

(i) "Wetlands" means lands that may be covered periodically or permanently with shallow water and include saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps, mudflats, fens, and vernal pools.

79506. Every proposed activity to be financed pursuant to this division shall be in compliance with the California Environmental Quality Act (Division 13 (commencing with Section 21000)) of the Public Resources

Code.

79507. Watershed protection activities financed pursuant to this division shall be consistent with the applicable adopted local watershed management plan and the applicable regional water quality control plan adopted by the regional water quality control board.

79508. Watershed protection activities in the San Gabriel and Los Angeles River watersheds shall be consistent with the San Gabriel and Los Angeles River Watershed and Open Space Plan as adopted by the San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy and the Santa Monica Mountains Conservancy. Notwithstanding any other provision of law, this plan shall be implemented pursuant to Division 23 (commencing with Section 33000) of the Public Resources Code in the watershed of the Los Angeles River upstream of the northernmost boundary of the City of Vernon and pursuant to Division 22.8 (commencing with Section 32600) of the Public Resources Code in the San Gabriel River and in the lower Los Angeles River watershed.

79509. Except for projects financed pursuant to Chapter 6 (commencing with Section 79545) or Chapter 10 (commencing with Section 79570), to be eligible to be financed pursuant to this division, any project that will wholly or partially assist in the fulfillment of one or more of the goals of the CALFED Bay-Delta Program shall be consistent with the CALFED Programmatic Record of Decision, and shall be implemented, to the maximum extent possible, through local and regional programs.

CHAPTER 2. THE WATER SECURITY, CLEAN DRINKING WATER, COASTAL AND BEACH PROTECTION FUND OF 2002

79510. The Water Security, Clean Drinking Water, Coastal and Beach Protection Fund of 2002 is hereby created.

79511. All money deposited in the fund shall be used only for the purposes and in the amounts set forth in this division and for no other purpose.

79512. Except as otherwise expressly provided in this division, upon a finding by the agency authorized to administer or expend money appropriated from the fund that a particular project or program for which money has been allocated or granted cannot be completed, or that the amount that was appropriated, allocated, or granted is in excess of the total amount needed, the Legislature may reappropriate the money for other high priority needs consistent with this division.

CHAPTER 3. WATER SECURITY

79520. The sum of fifty million dollars ($50,000,000) shall be available for appropriation by the Legislature from the fund for the purpose of protecting state, local, and regional drinking water systems from terrorist attack or deliberate acts of destruction or degradation. This money may be expended or granted for monitoring and early warning systems, fencing, protective structures, contamination treatment facilities, emergency interconnections, communications systems, and other projects designed to prevent damage to water treatment, distribution, and supply facilities, to prevent disruption of drinking water deliveries, and to protect drinking water supplies from intentional contamination.

79521. The Legislature may enact such legislation as is necessary to implement this chapter.

CHAPTER 4. SAFE DRINKING WATER

79530. (a) The sum of four hundred thirty five million dollars ($435,000,000) shall be available for appropriation by the Legislature from the fund to the State Department of Health Services for grants and loans for infrastructure improvements and related actions to meet safe drinking water standards including, but not limited to, the following types of projects:

(1) Grants to small community drinking water systems to upgrade monitoring, treatment, or distribution infrastructure.

(2) Grants to finance development and demonstration of new technologies and related facilities for water contaminant removal and treatment.

(3) Grants for community water quality monitoring facilities and equipment.

(4) Grants for drinking water source protection.

(5) Grants for treatment facilities necessary to meet disinfectant by-product safe drinking water standards.

(6) Loans pursuant to the Safe Drinking Water State Revolving Fund Law of 1997 (Chapter 4.5 (commencing with Section 116760) of Part 12 of Division 104 of the Health and Safety Code) .

(b) Not less than 60 percent of the money appropriated pursuant to this section shall be available for grants to Southern California water agencies to assist in meeting the state's commitment to reduce Colorado River water use to 4.4 million acre feet per year.

79531. The Legislature may enact such legislation as is necessary to implement this chapter.

CHAPTER 5. CLEAN WATER AND WATER QUALITY

79540. (a) The sum of one hundred million dollars ($100,000,000) shall be available for appropriation by the Legislature from the fund to the board for competitive grants for the following purposes:

(1) Water pollution prevention.

(2) Water reclamation.

(3) Water quality improvement.

(4) Water quality blending and exchange projects.

(5) Drinking water source protection projects.

(6) Projects to mitigate pathogen risk from recreational uses at drinking water storage facilities.

(b) Priority shall be given to projects that assist in meeting water quality standards established by the board.

(c) The Legislature may enact such legislation as is necessary to implement this section.

79541. The sum of one hundred million dollars ($100,000,000) shall be available for appropriation by the Legislature from the fund to the secretary for the acquisition from willing sellers, restoration, protection, and

development of river parkways. The secretary shall allocate this money in accordance with Article 6 (commencing with Section 78682) of Chapter 6 of Division 24 or pursuant to any other statute that provides for the acquisition, restoration, protection, and development of river parkways. Priority shall be given to projects that are implemented pursuant to approved watershed plans and include water quality and watershed protection benefits. This money may also be used to acquire facilities necessary to provide flows to improve water quality downstream.

79542. The sum of forty million dollars ($40,000,000) shall be available for appropriation by the Legislature from the fund to the California Tahoe Conservancy for acquisition from willing sellers, restoration, and protection of land and water resources to improve water quality in Lake Tahoe.

79543. The sum of one hundred million dollars ($100,000,000) shall be available for appropriation by the Legislature from the fund to the board for the purpose of financing projects that restore and protect the water quality and environment of coastal waters, estuaries, bays and near-shore waters, and groundwater. All expenditures, grants, and loans made pursuant to this section shall be consistent with the requirements of Article 5 (commencing with Section 79148) of Chapter 7 of Division 26. Not less than twenty million dollars ($20,000,000) shall be expended to implement priority actions specified in the Santa Monica Bay Restoration Plan. Money made available pursuant to this section shall supplement, not supplant, money appropriated or available pursuant to that Article 5 (commencing with Section 79148) , and no money appropriated pursuant to this section shall be used for a project for which an appropriation was made pursuant to that Article 5 (commencing with Section 79148) .

79544. The sum of thirty million dollars ($30,000,000) shall be available for appropriation by the Legislature from the fund to the secretary for the purpose of grants to local public agencies, local water districts, and nonprofit organizations for acquisition from willing sellers of land and water resources to protect water quality in lakes, reservoirs, rivers, streams and wetlands in the Sierra Nevada-Cascade Mountain Region as defined in Section 5096.347 of the Public Resources Code.

CHAPTER 6. CONTAMINANT AND SALT REMOVAL TECHNOLOGIES

79545. The sum of one hundred million dollars ($100,000,000) shall be available for appropriation by the Legislature from the fund to the department for grants for the following projects:

(a) Desalination of ocean or brackish waters. Not less than fifty million dollars ($50,000,000) of the money appropriated by this chapter shall be available for desalination projects. To be eligible to receive a grant, at least 50 percent of the total cost of the project shall be met by matching funds or donated services from non-state sources.

(b) Pilot and demonstration projects for treatment or removal of the following contaminants:

(1) Petroleum products, such as MTBE and BTEX.

(2) N-Nitrosodimethylamine (NDMA).

(3) Perchlorate.

(4) Radionuclides, such as radon, uranium, and radium.

(5) Pesticides and herbicides.

(6) Heavy metals, such as arsenic, mercury, and chromium.

(7) Pharmaceuticals and endocrine disrupters.

(c) Drinking water disinfecting projects using ultraviolet technology and ozone treatment.

79546. The Legislature may enact such legislation as is necessary to implement this chapter.

CHAPTER 7. CALFED BAY-DELTA PROGRAM

79550. The sum of eight hundred twenty-five million dollars ($825,000,000) shall be available for appropriation by the Legislature from the fund for the balanced implementation of the CALFED Bay-Delta Program. Expenditures and grants pursuant to this chapter shall be limited to the following:

(a) Fifty million dollars ($50,000,000) for surface water storage planning and feasibility studies.

(b) Seventy-five million dollars ($75,000,000) for the water conveyance facilities described in subparagraph (B) of paragraph (2) of subdivision (d) of Section 79190.

(c) Seventy million dollars ($70,000,000) for Delta levee restoration. Money expended pursuant to this subdivision shall be subject to Section 79050.

(d) One hundred eighty million dollars ($180,000,000) for water supply reliability projects that can be implemented expeditiously and thereby provide near-term benefits, including, but not limited to, projects that facilitate ground water management and storage, water transfers, and acquisition of water for the CALFED environmental water account. In acquiring water, preference shall be given to long-term water purchase contracts and water rights. Money allocated pursuant to this subdivision shall be subject to Article 4 (commencing with Section 79205.2) of Chapter 9 of Division 26.

(e) One hundred eighty million dollars ($180,000,000) for ecosystem restoration program implementation of which not less than twenty million dollars ($20,000,000) shall be allocated for projects that assist farmers in integrating agricultural activities with ecosystem restoration.

(f) Ninety million dollars ($90,000,000) for watershed program implementation.

(g) One hundred eighty million dollars ($180,000,000) for urban and agricultural water conservation, recycling, and other water use efficiency projects.

79551. All appropriations pursuant to this chapter shall include money for independent scientific review, monitoring, and assessment of the results or effectiveness of the project or program expenditure.

79552. All projects financed pursuant to this chapter shall be consistent with the CALFED Programmatic Record of Decision including its provisions regarding finance and balanced implementation.

79553. Consistent with the CALFED Programmatic Record of Decision, priority shall be given to projects that achieve multiple benefits across CALFED program elements. Not more than 5 percent of the money available pursuant to this chapter may be used for administrative costs.

79554. All real property acquired with money appropriated or granted pursuant to subdivision (e) or (f) of Section 79550 shall be acquired from willing sellers.

CHAPTER 8. INTEGRATED REGIONAL WATER MANAGEMENT

79560. The sum of five hundred million dollars ($500,000,000) shall be available for appropriation by the Legislature from the fund for competitive grants for projects set forth in this section to protect communities from drought, protect and improve water quality, and improve local water security by reducing dependence on imported water. No project financed pursuant to this section shall include an on-stream surface water storage facility or an off-stream surface water storage facility other than percolation ponds for groundwater recharge in urban areas. No river or stream channel modification project whose construction or operation causes any negative environmental impacts may be financed pursuant to this chapter unless those impacts are fully mitigated.

79561. Money appropriated in Section 79560 shall be available for grants for water management projects that include one or more of the following elements:

(a) Programs for water supply reliability, water conservation, and water use efficiency.

(b) Storm water capture, storage, treatment, and management.

(c) Removal of invasive non-native plants, the creation and enhancement of wetlands, and the acquisition, protection, and restoration of open space and watershed lands.

(d) Non-point source pollution reduction, management, and monitoring.

(e) Groundwater recharge and management projects.

(f) Contaminant and salt removal through reclamation, desalting, and other treatment technologies.

(g) Water banking, exchange, reclamation, and improvement of water quality.

(h) Planning and implementation of multipurpose flood control programs that protect property; and improve water quality, storm water capture and percolation; and protect or improve wildlife habitat.

(i) Watershed management planning and implementation.

(j) Demonstration projects to develop new drinking water treatment and distribution methods.

79562. An amount, not to exceed 10 percent of the money available for appropriation in Section 79560, may be appropriated by the Legislature for facilities, equipment, and other expenses associated with the establishment of comprehensive statewide groundwater monitoring pursuant to Part 2.76 (commencing with Section 10780) of Division 6.

79563. At least 50 percent of the amount available for appropriation in Section 79560 shall be appropriated to the board. The board shall establish procedures for selecting among eligible projects specified in Section 79561 that use the procedures developed by the board for stakeholder-based accelerated selection and contracting pursuant to Section 79104.32.

79564. To be eligible for financing pursuant to Section 79563, a project shall meet both of the following criteria:

(a) The project is consistent with an adopted integrated water management plan designed to improve regional water supply reliability, water recycling, water conservation, water quality improvement, storm water capture and management, flood management, recreation and access, wetlands enhancement and creation, and environmental and habitat protection and improvement.

(b) The project includes matching funds or donated services from non-state sources.

79565. Notwithstanding Section 13340 of the Government Code, the sum of one hundred forty million dollars ($140,000,000) is hereby continuously appropriated from the fund to the Wildlife Conservation Board, without regard to fiscal years, for expenditure by the board and for grants, for the acquisition from willing sellers of land and water resources, including the acquisition of conservation easements, to protect regional water quality, protect and enhance fish and wildlife habitat, and to assist local public agencies in improving regional water supply reliability.

CHAPTER 9. COLORADO RIVER

79567. The sum of twenty million dollars ($20,000,000) shall be available for appropriation by the Legislature from the fund to the department for grants for canal lining and related projects necessary to reduce Colorado River water use pursuant to the California Colorado River Water Use Plan adopted by the Colorado River Board of California.

79568. (a) The sum of fifty million dollars ($50,000,000) shall be available for appropriation by the Legislature from the fund to the Wildlife Conservation Board for the acquisition, protection, and restoration of land and water resources necessary to meet state obligations for regulatory requirements related to California's allocation of water supplies from the Colorado River. No money allocated pursuant to this section may be used to supplant or pay for the regulatory mitigation obligations of private parties under state or federal law.

(b) All real property acquired pursuant to this section shall be acquired from willing sellers.

CHAPTER 10. COASTAL WATERSHED AND WETLAND PROTECTION

79570. The sum of two hundred million dollars ($200,000,000) shall be available for appropriation by the Legislature from the fund for expenditures and grants for the purpose of protecting coastal watersheds, including, but not limited to, acquisition, protection, and restoration of land and water resources and associated planning, permitting, and administrative costs, in accordance with the following schedule:

(a) The sum of one hundred twenty million dollars ($120,000,000) to the State Coastal Conservancy for coastal watershed protection pursuant to Division 21 (commencing with Section 31000) of the Public Resources Code.

(b) The sum of twenty million dollars ($20,000,000) to the State Coastal Conservancy for expenditure for the San Francisco Bay Conservancy Program for coastal watershed protection pursuant to Chapter 4.5 (commencing with Section 31160) of Division 21 of the Public Resources Code.

(c) The sum of forty million dollars ($40,000,000) to the Santa Monica Mountains Conservancy. Twenty million dollars ($20,000,000) of this sum shall be expended for protection of the Los Angeles River watershed upstream of the northernmost boundary of the City of Vernon, and twenty million dollars ($20,000,000) shall be expended for protection of the Santa Monica Bay and Ventura County coastal watersheds, pursuant to Division 23 (commencing with Section 33000) of the Public Resources Code.

(d) The sum of twenty million dollars ($20,000,000) to the San Gabriel and Lower Los Angeles Rivers and

Mountains Conservancy for protection of the San Gabriel and lower Los Angeles River watersheds pursuant to Division 22.8 (commencing with Section 32600) of the Public Resources Code.

79571. Ten percent of the money allocated in each of the categories in Section 79570 shall be used for grants for the acquisition and development of facilities to promote public access to and participation in the conservation of land, water, and wildlife resources. Eligible projects include, but are not limited to, the following:

(a) Training and research facilities for watershed protection and water conservation activities conducted by nonprofit organizations. Priority shall be given to projects operated by nonprofit organizations in collaboration with the University of California and public water agencies.

(b) Nature centers that are in or adjacent to watersheds and wetlands identified for protection pursuant to this chapter, that provide wildlife viewing, outdoor experiences, and conservation education programs to the public and to students. Priority shall be given to projects that are operated by or in cooperation with nonprofit organizations and are designed to serve children from urban areas that lack access to natural areas and outdoor education programs.

79572. (a) Notwithstanding Section 13340 of the Government Code, the sum of seven hundred fifty million dollars ($750,000,000) is hereby continuously appropriated from the fund to the Wildlife Conservation Board, without regard to fiscal years, for the acquisition, protection, and restoration of coastal wetlands, upland areas adjacent to coastal wetlands, and coastal watershed lands. Money appropriated pursuant to this section shall be for the acquisition, protection, and restoration of lands in or adjacent to urban areas. Eligible projects shall be limited to the following:

(1) Acquisition, protection, and restoration of coastal wetlands identified in the Southern California Coastal Wetlands Inventory as of January 1, 2001, published by the State Coastal Conservancy, located within the coastal zone, and other wetlands connected and proximate to such coastal wetlands, and upland areas adjacent and proximate to such coastal wetlands, or coastal wetlands identified for acquisition, protection, and restoration in the San Francisco Baylands Ecosystem Habitat Goals Report, and upland areas adjacent to the identified wet lands.

(2) Acquisition, protection, and restoration of coastal watershed and adjacent lands located in Los Angeles, Ventura, and Santa Barbara Counties. Any project financed pursuant to this paragraph within the Santa Monica Mountains Zone, as defined in Section 33105 of the Public Resources Code, shall be by grant from the Wildlife Conservation Board to the Santa Monica Mountains Conservancy. Any project financed pursuant to this paragraph within the Baldwin Hills area, as defined in Section 32553 of the Public Resources Code, shall be by grant from the Wildlife Conservation Board to the Baldwin Hills Conservancy.

(b) Not less than three hundred million dollars ($300,000,000) of the amount appropriated in this section shall be expended or granted for projects within Los Angeles and Ventura Counties. Of the remaining funds available pursuant to this section the Wildlife Conservation Board shall give priority to the acquisition of not less than 100 acres consisting of upland mesa areas, including wetlands therein, adjacent to the state ecological reserve in the Bolsa Chica wetlands in Orange County.

(c) Not more than two hundred million dollars ($200,000,000) of the amount appropriated in this section may be expended or granted for projects in the San Francisco Bay area, as described in Section 31162 of the Public Resources Code. Any project within the San Francisco Bay area may be by grant from the Wildlife Conservation Board to the State Coastal Conservancy.

79573. (a) The purchase price for each acquisition made pursuant to Section 79572 shall not exceed the fair market value of the property as defined in Section 1263.320 of the Code of Civil Procedure. Fair market value shall be determined by an appraisal that is prepared by a licensed real estate appraiser and approved by the Wildlife Conservation Board and the Department of General Services.

(b) All real property acquired pursuant to this chapter shall be acquired from willing sellers.

CHAPTER 11. FISCAL PROVISIONS

79580. Bonds in the total amount of three billion four hundred forty million dollars ($3,440,000,000), not including the amount of any refunding bonds issued in accordance with Section 79588, or so much thereof as is necessary, may be issued and sold to be used for carrying out the purposes set forth in this division and to be used to reimburse the General Obligation Bond Expense Revolving Fund pursuant to Section 16724.5 of the Government Code. The bond proceeds shall be deposited in the Water Security, Clean Drinking Water, Coastal and Beach Protection Fund of 2002 created by Section 79510. The bonds shall, when sold, be and constitute a valid and binding obligation of the State of California, and the full faith and credit of the State of California is hereby pledged for the punctual payment of both principal of and interest on the bonds as they become due and payable.

79581. The bonds authorized by this division shall be prepared, executed, issued, sold, paid, and redeemed as provided in the State General Obligation Bond Law (Chapter 4 (commencing with Section 16720) of Part 3 of Division 4 of Title 2 of the Government Code), and all provisions of that law shall apply to the bonds and to this division and are hereby incorporated in this division by this reference as though fully set forth in this division.

79582. (a) Solely for the purpose of authorizing the issuance and sale, pursuant to the State General Obligation Bond Law, of the bonds authorized by this division, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 Finance Committee is hereby created. For purposes of this division, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002 Finance Committee is the committee as that term is used by the State General Obligation Bond Law. The committee shall consist of the Controller, the Director of Finance, and the Treasurer, or their designated representatives. The Treasurer shall serve as chairperson of the committee. A majority of the committee may act for the committee.

(b) For purposes of this chapter and the State General Obligation Bond Law, the secretary is designated as the board.

79583. The committee shall determine whether or not it is necessary or desirable to issue bonds authorized pursuant to this division in order to carry out the actions specified in this division and, if so, the amount of bonds to be issued and sold. Successive issues of bonds may be authorized and sold to carry out those actions progressively, and it is not necessary that all of the bonds authorized to be issued be sold at any one time.

79584. There shall be collected annually in the same manner and at the same time as other state revenue is collected, in addition to the ordinary revenues of the state, a sum in an amount required to pay the principal of, and interest on, the bonds maturing each year, and it is the duty of all officers charged by law with any duty in regard to the collection of the revenue to do so and perform each and every act that is necessary to collect that additional sum.

79585. Notwithstanding Section 13340 of the Government Code, there is hereby appropriated from the

General Fund, for purposes of this division, an amount that will equal the total of the following:

(a) The sum annually necessary to pay the principal of, and interest on, bonds issued and sold pursuant to this division, as the principal and interest become due and payable.

(b) The sum which is necessary to carry out the provisions of Section 79586, appropriated without regard to fiscal years.

79586. For the purposes of carrying out this division, the Director of Finance may authorize the withdrawal from the General Fund of an amount or amounts not to exceed the amount of the unsold bonds that have been authorized to be sold for the purpose of carrying out this division. Any amounts withdrawn shall be deposited in the fund. Any money made available under this section shall be returned to the General Fund, plus the interest that the amounts would have earned in the Pooled Money Investment Account, from money received from the sale of bonds that would otherwise be deposited in that fund.

79587. All money derived from premium and accrued interest on bonds sold shall be reserved and shall be available for transfer to the General Fund as a credit to expenditures for bond interest.

79588. Any bonds issued or sold pursuant to this division may be refunded by the issuance of refunding bonds in accordance with Article 6 (commencing with Section 16780) of Chapter 4 of Part 3 of Division 4 of Title 2 of the Government Code. Approval by the electors of the state for the issuance of the bonds shall include approval of the issuance of any bonds issued to refund any bonds originally issued or any previously issued refunding bonds.

79589. The people of California hereby find and declare that inasmuch as the proceeds from the sale of bonds authorized by this division are not proceeds of taxes as that term is used in Article XIII B of the California Constitution, the disbursement of these proceeds is not subject to the limitation imposed by that article.

SEC. 2. If any provision of this act or the application thereof is held invalid, that invalidity shall not affect other provisions or applications of the act which can be given effect without the invalid provision or application, and to this end the provisions of this act are severable.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 1: EXISTING FACILITIES

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

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Chapter 1

EXISTING FACILITIES

1.1 PURPOSE

The purpose of this chapter is to summarize the existing solids handling facilities at the Regional Water Quality Control Plant (RWQCP). This chapter does not include the design and reliability criteria of the unit processes, which will be described in Volume 8, Chapter 3 - Design Criteria.

1.2 BACKGROUND

Treatment is provided at the RWQCP, which provides preliminary, primary, secondary, and tertiary treatment. The RWQCP currently treats approximately 33 mgd (annual average flow). The RWQCP has a rated capacity of approximately 40 mgd (annual average flow). The City of Riverside (City) seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs for up to the year 2025. Efficient solids handling processing is an integral part of the RWQCP operation. With proper planning and appropriate implementation of biosolids handling process improvements, the RWQCP will be able to cost-effectively treat and dispose of wastewater solids.

1.3 EXISTING SOLIDS HANDLING FACILITIES

The solids handling facilities that are part of the RWQCP consist of Dissolved Air Flotation Thickening (DAFT) of Waste Activated Sludge (WAS), mesophilic anaerobic digestion of primary and secondary solids, and belt press and centrifuge dewatering of digested sludge. The plant originally had 29 sludge drying beds (total area of 8 acres) as part of its sludge disposal practice, but they have been abandoned or demolished due to the odor complaints from neighboring businesses and due to their land requirement. Currently, solids are being disposed off-site and used as soil amendment.

1.3.1 Dissolved Air Flotation Thickening

DAFT is used to thicken the WAS from the secondary clarifiers. This process reduces the overall volume of the solids and concentrates them into a stream that can be more economically treated. Settled solids from the secondary clarifiers from Plant 1 and Plant 2 are combined and thickened in the DAFTs to a solids concentration of about 2 percent. The RWQCP has three DAFTs, but only DAFT No. 2 is in service. The RWQCP is in the process of rebuilding DAFT No. 1. DAFT No. 3 has been cannibalized for spare parts. Criteria for the DAFTs are shown in Table 1.1.

Table 1.1 Dissolved Air Flotation Thickeners Criteria Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
DAF Thickeners	
Number	2 (only 1 in service currently)
Diameter (feet)	37
Gross Surface Area (sq. ft.) each	1,018
Effective Surface Area (sq. ft) each	943
Total Surface Area w/one unit out of service (sq. ft.)	943
Air-to-Solids Ratio	0.025 to 0.04
Capture rate, %	95
TWAS Transfer Pumps	
Number	1 per DAF
Type	Progressive Cavity
Capacity, gpm/each	150
Recycle Pressurization Pumps (Duplex)	
Number	1 per DAF
Type	Duplex, Centrifugal
Flow Rate, gpm/each	1,000

1.3.2 Anaerobic Digesters

In anaerobic digestion, the solids from primary treatment and the DAF thickeners are processed in the absence of air. This reduces the solids volume, stabilizes the sludge, and produces methane gas as a byproduct that can be burned for energy.

The existing anaerobic digestion process includes five digesters ranging in size from 0.603 to 1.8 million gallons. The RWQCP currently operates the two 90-foot diameter tanks as active digesters. These are labeled Digester Nos. 1 and 2. Thickened primary and secondary sludge and primary scum are fed separately, directly to the digesters. WAS is thickened in the DAF, and primary sludge is thickened in the primary sedimentation tanks. Primary sludge from Plant 1 is sent to Plant 2 for thickening along with the raw wastewater coming to Plant 2. Currently, the RWQCP is adding restaurant grease to Digester No. 2 to increase gas production. After digestion, the stabilized solids are transferred into Digester No. 4, which serves as a holding tank for the dewatering belt presses and centrifuges. Digester Nos. 3 and 5 are no longer in service. However, the City is planning on placing Digester No. 3 back in service. Criteria for the existing anaerobic digestion equipment are shown in Table 1.2.

Table 1.2 Anaerobic Digesters Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Anaerobic Digesters	
Number of Units	5
Diameter (feet) Units 1 and 2	90
Diameter (feet) Unit 3	75 (out of service)
Diameter (feet) Unit 4	88 (storage)
Diameter (feet) Unit 5	60 (out of service)
Side Water Depth Units 1 and 2	32.0
Side Water Depth Unit 3	32.0
Side Water Depth Unit 4	38.5
Side Water Depth Unit 5	28.5
Total Current Digester Volume, MG (Units 1 and 2)	3.28
Total Current Storage Volume, MG (Unit 4)	1.8
Mixing Pumps	
Number	2 per Units 1 and 2; 1 per Units 3, 4, and 5
Type	Vortex Propeller, Centrifugal

1.3.3 Sludge Dewatering Facilities

Sludge dewatering is a physical (mechanical) unit operation used to reduce the moisture content of sludge. The RWQCP currently uses two belt presses and one centrifuge for the sludge dewatering process.

Dewatering belt filter presses are used to reduce the volume of material that requires off-site disposal. Polymer is first added to the sludge, and then it is introduced on a gravity drainage section, where it is allowed to thicken. Then low pressure is applied to the digested solids in between two wide belts where the solids are pressed with rollers to mechanically expel the excess water. The belts are arranged to perform the conveying, pressing, and dewatering functions. The final dewatered sludge cake is removed from the belts by scraper blades. The RWQCP produces a cake of about 16-percent solids. Drying beds were previously used to further reduce the volume of sludge to a solids-content greater than 60 percent, before disposal off-site. However, due to odor problems, the drying beds are no longer in service. Currently, the dewatered solids are discharged to a truck loading facility for off-site disposal.

Centrifuge thickening and dewatering is a high-speed process that uses the force from rapid rotation of a cylindrical bowl to separate wastewater solids from liquid. A high-speed centrifuge creating “G” forces in the range of 2,500 to 2,800 is producing a sludge cake of approximately 25 percent. Solids capture is slightly better for operating centrifuge systems than belt press operations. Electrical power load per machine is substantially higher with centrifuges, but this is largely offset by the following advantages: fewer number of operating machines required with centrifuges, less foul air ventilation horsepower required since centrifuge room air does not usually need foul air treatment, and cheaper hauling costs due to a higher percentage of solids. The City currently uses one centrifuge. The City is in the process of installing two additional centrifuges that will relegate the existing belt presses to standby status. Table 1.3 presents the dewatering facilities criteria.

Table 1.3 Sludge Dewatering Facilities Criteria
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Value
Dewatering Belt Presses	
Number	2 duty
Belt Width (meters)	2
Dewatered Cake Solids Concentration, %	16
Solids Capture (%)	95
Feed Rate (average), gpm	120
Belt Press Feed Pumps	
Number	2
Type	Variable Speed, Progressive Cavity
Capacity, gpm	250
Polymer System	
Polymer Bulk Transfer Pumps	
Number	1+1
Type	Constant Speed, Progressive Cavity
Capacity, gpm	10 (20 to 50% solution)
Polymer Recirculation Pump	
Number	1
Type	Constant Speed, Progressive Cavity
Capacity, gpm	10 (20 to 50% solution)

Table 1.3 Sludge Dewatering Facilities Criteria Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Description	**Value**
Polymer Solution Transfer Pumps	
Number	1 duty +1 standby
Type	Constant Speed, Progressive Cavity
Capacity, gpm	140
Polymer Solution Feed Pumps	
Number	1 duty +1 standby
Type	Variable Speed, Progressive Cavity
Capacity, gpm	4 to 25
Storage Tanks	
Type	Fiberglass
Numbers	2
Diameter, feet	10
Nominal Capacity, gallons	6,000
Centrifuge	
Number	1
Feed rate (average), gpm	200
Dewatered Cake Solids Concentration, %	25
Solids Capture (%)	96

1.3.4 Solids Disposal

The RWQCP currently produces "Class B" sludge. The RWQCP avoids on-site solids storage to reduce odors. Fleet transportation services sends trucks to the RWQCP daily to pick up the dewatered sludge and haul it to alfalfa and cotton farms in Arizona as soil amendment. According to the City, it fills about five trailers a day, averaging about 73,000 pounds each. In an emergency, solids are stored on the ground in the old sludge drying beds; otherwise, the plant must be shut down.

City of Riverside

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Chapter 2

SUMMARY OF PLANNING STUDIES

2.1 PURPOSE

The purpose of this chapter is to summarize the findings and recommendations from the 2003 Bio-Solids Handling Improvements report (2003 Report) that was completed for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) biosolids facilities. A copy of the report is included as Appendix A.

The 2003 Report includes descriptions of the RWQCP facilities at the time of study, while Volume 8, Chapter 1 - Existing Facilities, includes the facilities that the RWQCP currently has. A few changes have been observed since the 2003 Report, such as an installed centrifuge and discontinued usage of the sludge-drying beds.

While the 2003 Report included design criteria and evaluations of several biosolids management/processes as listed in Section 2.3, this master plan only includes the design criteria (Volume 8, Chapter 3 - Design Criteria) and evaluations of the thickening and digestion processes. The design criteria included in this master plan have been updated to meet the new planning period requirement.

2.2 OBJECTIVES OF THE 2003 REPORT

The following are the stated objectives of the 2003 Report:

1. To develop and to recommend necessary process improvements to treat wastewater solids removed for average dry weather wastewater flows of up to 40 mgd.
2. To provide space planning for facilities up to 50 mgd.
3. To provide the planning level costs for the recommended improvements.
4. To recommend project phasing and scheduled implementation of improvements.

2.3 ORGANIZATION OF THE 2003 REPORT

The 2003 Report consists of 11 chapters. Chapter 1 presented the recommended system. Chapters 2 and 3 provided the planning level cost for the recommended facilities and a recommended schedule for implementation of improvements. There were total of seven Technical Memoranda (TMs), which were prepared to evaluate options for handling wastewater solids production from the RWQCP for an ultimate plant capacity of 50 mgd. These TMs were included as part of the 2003 Report as Chapters 4 to 11. The titles of these seven chapters are listed as follows:

- Chapter 4: TM No. 1 - Solids Projections and Thickening Evaluation.

- Chapter 5: TM No. 2 - Digestion Options.
- Chapter 6: TM No. 3 - Heat Energy Options.
- Chapter 7: TM No. 4 - Dewatering and Air Drying Options.
- Chapter 8: TM No. 5 - Heat Drying Options.
- Chapter 9: TM No. 6 - Composting Options.
- Chapter 10: TM No. 7 - Side Stream Treatment Options.
- Chapter 11: TM No. 8 - Evaluation of Options. TM No. 8 evaluated all the options discussed in the seven TMs described above and developed a recommended system including a preliminary estimate of capital costs.

Summaries of Chapters 4 through 11 are provided in the following Sections.

2.4 CHAPTER 4: TM NO. 1 - SOLIDS PROJECTIONS AND THICKENING EVALUATION

This chapter discussed the evaluation of the RWQCP process performance and developed raw solids projections. It also discussed the raw solids thickening practices.

2.4.1 Objectives

The following objectives were addressed in this chapter of the 2003 Report:

1. Reviewed the plant sludge production and solids system operational data.
2. Confirmed the solids production at the time of the study.
3. Estimated the design flow of solids quantities for 40- and 50-mgd average raw wastewater influent flow and determined average, peak month, and peak day quantities.
4. Evaluated the thickening performance and assessed long-term improvement options for solids thickening.

2.4.2 Summary and Recommendations

At the time of the study, the RWQCP's raw solids processing facilities consisted of two Dissolved Air Flotation Thickeners (DAFTs). Chapter 4 provided a description of the equipment, which is also described in Volume 8, Chapter 1 - Existing Facilities, of this Master Plan.

The chapter also presented solids projections for the 40- and 50-mgd flow conditions. These are summarized below in Table 2.1.

Table 2.1 Solids Projections[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
	Average Primary Sludge	**Average Raw WAS**
40 mgd		
TSS 1,000 lbs/day	39	35
VSS 1,000 lbs/day	32	28
Flow, mgd	0.12	0.61
50 mgd		
TSS 1,000 lbs/day	49	44
VSS 1,000 lbs/day	40	35
Flow, mgd	0.15	0.76
Peak Daily Factors		
Solids	2.2	1.4
Flow	2.0	1.4

Notes:
(1) Table taken from Table 3 of TM No. 4 of the 2003 Report.

A comparison of DAFT solids loading for Waste Activated Sludge (WAS) thickening and co-thickening was included in the evaluation. Design criteria for these evaluations were described in the 2003 Report and can be found in Volume 8, Chapter 3 - Design Criteria, of this Master Plan. For the evaluation, it was assumed that the thickening system must be able to handle average daily loading with one unit out of service and a peak daily loading with all units in service.

Based on the evaluation, two additional DAFTs are required for both thickening options, two 39-foot DAFTs for WAS thickening or two 44-foot DAFTs for co-thickening, to handle the solids produced at the ultimate flow of 50 mgd. There are advantages in using co-thickening, such as increased digester detention time and production of a thicker sludge feed to the digester. A list of advantages and disadvantages of co-thickening can be found in Chapter 4.

Details of implementing either thickening system need to be developed in the design phase. The performance of the thickening process ties to the size and performance of the digestion process. As a result, the thickening process was further discussed in Chapter 5.

A list of equipment and process improvements, which were based on site visits made during the time of study, were recommended to improve DAFT plant performance. These are listed below:

1. Add a submerged weir for influent solids distribution and better float control.
2. Add turbidity monitoring on subnatant to better control capture efficiency.

3. Add a high-level switch, high-level alarm, and solenoid valve to prevent the pressurization tank from becoming water logged.
4. Replace the existing manually operated valve with an automatic air-operated throttling valve with flow controller and flow.
5. Resize the polymer storage and feed systems to closely match the required polymer usage.
6. Replace the bottom sludge removal system.

2.5 CHAPTER 5: TM NO. 2 - EVALUATION OF DIGESTION OPTIONS

This chapter evaluated the different digestion options including Mesophilic Digestion, Temperature-Phased Digestion (TPAD), and Class A TPAD.

2.5.1 Objectives

The following objectives were addressed in Chapter 5 of the 2003 Report:

1. Define digestion options using existing tankage at the RWQCP.
2. Define process schematics, key piping/equipment needs and estimated performance benefits of the top two options in terms of volatile solids destruction, gas production, dewatering impacts, recycle impacts, and product odor.
3. Define capital costs for the two options evaluated.

The process objectives for this study were to maximize solids destruction, increase gas production, minimize odor impacts, and consider Class A product requirements as defined by EPA 40 CFR Part 503 regulations.

2.5.2 Summary and Recommendation

The anaerobic digestion process consists of five digesters (Digester Nos. 1 to 5) ranging from 0.603 to 1.8 million gallons in size. Only the two biggest digesters are in service. A description of the existing anaerobic digestion equipment was included in the chapter.

A brief description of each proposed alternative (Mesophilic Anaerobic Digestion, Thermophilic Anaerobic Digestion, Temperature-Phased Digestion, and Acid/Gas-Phased Digestion) was included in the report. Both Thermophilic Anaerobic Digestion and Acid/Gas-Phased Digestion were dropped from further consideration due to their potential to cause odor problems.

A projection was made of the thickened solids loading at 40 and 50 mgd. Table 2.2, (information taken from Table 2 of the chapter) lists the design solids and hydraulic loading.

Table 2.2 Design Solids and Hydraulic Loading[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	Primary and WAS Flow, mgd	Co-Thickened Flow, mgd	TSS, lbs/day	VSS, lbs/day
Design Loading - 40 mgd				
Average	0.26	0.22	101,191	81,491
Peak 2 Week	0.37	0.31	141,667	114,087
Design Loading - 50 mgd				
Average	0.33	0.47	126,489	101,864
Peak Day	0.47	0.39	177,084	142,609

Notes:
(1) Table taken from Table 2 of TM No. 5 of the 2003 Report.

Design criteria for Mesophilic and TPAD were described in Chapter 5 of the 2003 Report.

The chapter included a discussion of each evaluated option, Mesophilic and TPAD. The additional required tankage was determined based on the existing facility and the design criteria. This was heavily dependant on the choice of thickening method. For this reason the additional required tank volumes were determined for both thickening choices (refer to Table 2.3).

Table 2.3 Additional Digester Volume Requirements[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Digester Option	Separate Thickening	Co-Thickening
Mesophilic System		
Additional Vol. Required, MG, Peak 2 Week	1.92	0.71
Additional Vol. Required, MG, Avg. Without Digester No. 4	2.72	1.68
Number Required	2	1
Depth, feet	32	32
Diameter Required, feet	85	95
Temperature-Phased System		
Thermophilic Digestion Phase		
Additional Vol. Required	None	None
Mesophilic Digestion Phase		
Additional Vol. Required, MG, Peak 2 Week	2.4	0.5
Additional Vol. Required, MG, Avg. Without Digester No. 4	2.36	1.74
Number Required	2	1

Table 2.3 Additional Digester Volume Requirements[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Digester Option	**Separate Thickening**	**Co-Thickening**
Depth, feet	32	32
Diameter Required, feet	79	94

Notes:
(1) Information extracted from Table 4 of the 2003 Report.

The same number and sizes of additional digesters would be required for both the TPAD and the mesophilic system for either thickening option. This means that the new facilities would have the flexibility to operate in either TPAD or in mesophilic mode. These new digesters would be constructed in the open area adjacent to the cogeneration facility behind Digester Nos. 1 and 2.

In order to meet Class A pathogen reduction requirements, thermally treated biosolids from the RWQCP must be subjected to one of the two temperature regimes that are applicable to the plant. For solids concentrations less than 7 percent, biosolids must be heated for at least 15 seconds, but less than 30 minutes, or the temperature of sludge must be 50 degrees C or higher with at least 30 minutes of contact time. Another key ingredient to meeting Class A facility requirements is there must be no possibility of short-circuiting. This is typically achieved by operating under batch mode. Additional tankage (i.e., thermophilic batch tanks) would be required if the RWQCP wants to achieve Class A TPAD.

Construction and capital costs for the new thickening and digestion alternatives were estimated and described in the chapter. The estimated capital cost for the co-thickening option was more expensive then the separate thickening option.

As discussed earlier, the required additional digestion facilities are heavily dependent on the thickening option. A present-worth cost analysis was included to evaluate the economic impact on the thickening and digestion system, for both thickening options, taking into account the required mesophilic digester facilities needed to support the respective option. The present worth cost for the WAS only thickening (with Mesophilic Digestion, based on a planning period of 20 years and with a 3 percent discount, rate) was less expensive than the co-thickening option. A life-cycle cost analysis showed that the TPAD and the Mesophilic Digestion options were nearly equal. Based on this information, the study recommended the continued operation of Mesophilic Digestion.

The study recommended implementation of additional DAFT facilities to continue separate thickening of primary sludge and WAS with DAFTs, based on the present worth analysis. It recommended installation of one new 50,000-gallon thickened solids blending tank and two 32-foot deep, 90-foot diameter digesters to match Digester Nos. 1 and 2. Conversion to TPAD could be considered in the future.

2.6 CHAPTER 6: - TM NO. 3 - HEAT ENERGY OPTIONS

This chapter discussed the additional heat required and the changes in gas production due to the changes to the RWQCP solids processing operation. It also evaluated the different heating and energy options for the proposed solids system modifications.

2.6.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Reviewed the design and operational information of the existing facilities.
2. Reviewed the existing digester gas and the landfill gas (LFG) system and gas characteristics.
3. Defined the plant heating needs, including digestion changes.
4. Reviewed applicable air quality limitations.
5. Defined and evaluated options for meeting the future RWQCP heat needs and energy performance requirements.

2.6.2 Summary and Recommendations

2.6.2.1 Existing Conditions

A summary of existing conditions in regards to the heating and energy system at the RWQCP was included in the chapter. The RWQCP's cogeneration system converts the fuel energy in the digester gas, LFG, and natural gas into electricity and heat energy. Each cogeneration engine is cooled by water circulating through the engine cylinder jacket, and this hot engine jacket water is used to heat the RWQCP together with heat recovered from the hot engine exhaust gases.

Table 1 in Chapter 6 of the 2003 Report summarized the digester gas flow rates and projected flow rates from 1991 to 2025. The energy value for the mesophilic digesters ranged from 6.5 million Btu/hour (MMBtuh) in 1991 for a flow of 28.5 mgd to 19.4 MMBtuh in 2025 for a flow of 50 mgd. The projected energy from TPAD for 2025 is 23.3 MMBtuh. A summary of the gaseous fuels the RWQCP receives and burns was included in the study. This included the digester gas, natural gas, and LFG.

2.6.2.2 Heating and Cooling System and Equipment

The three Caterpillar cogeneration engines use about 34 MMBtuh of energy, of which 3.5 MMBtuh of jacket water heat and about 8.3 MMBtuh of engine exhaust heat are recovered and available for use. The RWQCP also has several hot water boilers that have a little over 15 MMBtuh of heating capacity. It also has a steam generator with unknown heating capacity for steam cleaning purposes. The RWQCP heating system is interconnected with the laboratory chilled water system, which uses a nominal 150-ton

absorption chiller that is “powered” by heating water from the cogeneration system. This absorption chiller requires heat at the highest possible temperature in order to function. This requirement forces the heat loop to deliver 190- to 200-degree Fahrenheit hot water.

The RWQCP is within the jurisdiction of the South Coast Air Quality Management District (SCAQMD). The cogeneration engines are subjected to emissions limits as shown in Table 2.4.

Table 2.4 Emission Limits for Existing Cogeneration Engines[(1)]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Air Contaminant	Emission Limit, lbs/hour each
Reactive Hydrocarbons	2.1
Nitrogen Oxide, as NO_2	2.3
Sulfur Dioxide	0.4
Carbon Monoxide	8.0
PM10 Particulate Matter	1.0

Notes:
(1) Information extracted from Table 6 of the 2003 Report.

The engines are equipped with a continuous emission monitoring system, to ensure compliance with the NO_x emissions limit.

2.6.2.3 Projected Heat Needs

The chapter showed that implementation of the TPAD options, as discussed in the previous chapter, would make maximum usage of the available heat produced by the cogeneration facility. As recommended, the projected additional heat required for the new sludge digestion system was estimated to be about 25 MMBtuh for raw sludge heating, with another 2 MMBtuh required for mesophilic digester shell heat losses and 2 MMBtuh required for thermophilic digester and sludge holding tank shell heat losses. The engines can provide only up to a maximum of 12 MMBtuh of heat, leaving 17 MMBtuh short.

Nine heat production options were evaluated and they are listed below:

1. Recovering engine after cooler heat.
2. Replacing the Laboratory Building absorption chiller.
3. Adding engine exhaust after-burners.
4. Adding more boilers.
5. Adding compressor heat recovery.
6. Recovering digester sludge heat.
7. Using water-source heat pumps.

8. Adding a solar hot water heating system.

9. Adding natural gas-fired fuel cells.

Of the nine options, only Option 4: addition of boilers and Option 6: digester sludge heat recovery were deemed promising and attractive options. The estimated construction cost for each heat production option was very similar, $3.58 million for Option 4 and $3.92 million for Option 6. The estimated annual Operation and Maintenance (O&M) cost for the sludge heat recovery option, however, was only one third the cost of the additional boilers option. Therefore, the study recommended implementation of the sludge heat recovery option.

2.7 CHAPTER 7: TM NO. 4 - DEWATERING AND AIR DRYING OPTIONS

Chapter 7 discussed the evaluation of belt press and centrifuge dewatering options to handle the anaerobically digested solids. It also included a discussion on the sludge-drying beds, which the RWQCP has since phased out due to odor problems.

2.7.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Reviewed performance and operational data of the existing dewatering equipment at the time of the study.

2. Assessed dewatering improvements/options in light of thickening and digestion options.

3. Evaluated improvements to air-dried storage to address wet weather storage needs, air-dried product uses, and Class A sampling issues.

4. Defined capital costs for dewatering and air-dried storage.

2.7.2 Summary and Recommendations

2.7.2.1 Existing Dewatering and Sludge-Drying Facilities

This chapter included a description of the existing dewatering facilities and the Sludge-Drying Facilities at the time of the study. The RWQCP has discontinued the use of the 29 sludge-drying beds due to the continuous odor problems. The RWQCP had two 2.2-meter Andritz SMX belt presses with an average capacity of 120 gpm each and a peak capacity of 220 gpm each, at the time of the study. The biosolids material was considered to be Class B product at the time of the study.

The following digested sludge characteristics were anticipated based on the thickening and digestion performance:

1. Depending on the specific thickening and digestion process, a total solids content of between 1.9 and 3.2 percent.
2. Depending on the specific digestion option used, a volatile solids content of 62 to 67 percent.

The anticipated digester sludge flow rates (based on 5 days/week, 16 hours/day operation) for the ultimate plant size of 50 mgd for the two thickening options were:

1. Separate Thickening - average flow of 477 gpm and a peak 2-week flow of 667 gpm.
2. Co-Thickening - average flow of 402 gpm and a peak 2-week flow of 563 gpm.

2.7.2.2 Dewatering Options

The two dewatering options considered in the study were the Andritz SMX belt presses and high-speed centrifuges. A centrifuge dewaters to a higher solids content than a belt press, but the electrical power load per machine is substantially higher with a centrifuge. Fewer numbers of operating machines and less foul air ventilation horsepower, however, would be required with centrifuges. Performance data for each option was included in Table 2 of the report.

A cost and non-cost assessment for two dewatering options was included:

- Option 1:
  Refurbished and new belt presses.
- Option 2:
  All centrifuge dewatering.

Based on the performance data and the dewatering design criteria, a total of five belt presses (two new, two existing, plus one spare) or three centrifuges (two operating and one spare) would be required.

Layout and configuration of each option was provided in the chapter. Both options would require an addition to the west side of the existing dewatering building.

The study also concluded that if centrifuges were used, the centrifuge dewatered cake has to be sent to heat drying facilities or taken off-site for land application, because odor from air-drying digested centrifuge biosolids is expected to be considerably greater than air drying of belt press cake.

The recommendation called for upgrading the two existing belt presses and installing one centrifuge for 40 mgd. Installation of two additional centrifuges was recommended for 50 mgd. Heat-drying capacity would be provided for centrifuge-dewatered cake.

2.7.2.3 Sludge-Drying Bed Improvements

Sludge-drying bed improvements were discussed in the chapter, but since sludge-drying beds have since been phased out, these are not described in this report.

2.8 CHAPTER 8: TM NO. 5 - HEAT DRYING OPTIONS

This chapter discussed the different heat-drying options to ensure that the RWQCP biosolids meet Class A biosolids quality and allow for phasing out of the sludge-drying beds.

2.8.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Identified heat-drying vendor systems, including systems that were lower-cost and may not produce commercial grade granules or pellets.
2. Summarized product beneficial use markets.
3. Prepared schematics, equipment sizing and layouts, as well as heat/energy requirements for drying. Identified heat source options and costs.
4. Defined air emission and odor control limitations and provided necessary control equipment.
5. Determined condensate characteristics and recycle impacts.
6. Developed a cost estimate for an alternate capacity/size of a thermal-drying system to replace the sludge-drying beds.

2.8.2 Summary and Recommendation

Drying systems are categorized into “direct” or “indirect” dryers, in which direct dryers normally use heated air as a heating source, and indirect dryers use steam or hot oil as a heating source. The dry product from the dryer is generally valued based on its nitrogen content for use as a fertilizer amendment. It is important to minimize the temperature and moisture content of the final product, as well as the oxygen content in the air/gas that is in contact with the heat-dried product to prevent auto-heating. The exhaust air stream organics from the sludge would also need to be controlled to limit the concentrations of air contaminants.

Eight heat-drying systems (a mixture of direct and indirect systems) were described in the chapter. Five of these systems were well suited for plants that are at least the RWQCP size, and their final products were all pellet or granules of uniform size. However, these systems would cost tens of millions of dollars for handling the RWQCP drying needs.

The remaining three systems were more economical, but would produce a less uniform and contain a much larger variety of particle size in the finished products. These three options were:

1. Fenton.
2. InnoDry.
3. Komline-Sanderson processes.

The chapter included detailed descriptions of the systems.

The Fenton dryer runs in batch operation and has a capacity of 13.7 cubic-yards per batch (cu-yd/batch), while the InnoDry and Komline-Sanderson are continuous-feed dryers and both have a capacity of 10 dry tons per day (dtpd). The Fenton dryer requires the most heat energy (1,600 Btu/lb of water), while the Komline-Sanderson dryer requires the least energy (1,130 Btu/lb). Based on these energy requirements, it would take approximately 1.5 to 2.2 million Btu of heat to dry a wet ton of 20-percent solids sludge to a 90-percent dry product.

All three sludge dryers required use of a hot oil or thermal fluid to indirectly heat the sludge. The temperature requirement for the hot oil is about 340 to 420 degrees Fahrenheit. Compared to the hot water heat recovery potential from the RWQCP cogeneration system (modifications can be made to increase the cogeneration system heating water to 200 degrees Fahrenheit), the hot oil temperature is much higher.

For the study in this chapter, it was assumed that a portion of the cogeneration heat would be used to warm the oil heater burners' combustion air, thus, reducing the amount of natural gas fuel needed.

A list of dryer system components was included in the chapter, as well as the sludge dryer auxiliary systems for all three options.

The RWQCP heat-drying alternatives criteria and costs were estimated, based on the projected dewatered sludge production and each of the alternatives drying capacity. The number of heat dryers required depended on the type of operation (7 days versus 5 days a week). Table 2.5 lists the heat-drying criteria and capital cost estimates.

The estimates showed that both capital and life-cycle costs for all three systems were very similar. The study suggested that the initial heat-drying facility would not need to include all the units as shown above. It suggested that the installation be split into two phases where Phase 1 assumed a combination of belt press and centrifuge dewatering and Phase 2 assumed all centrifuge dewatering and complete phase out of the sludge-drying beds.

Table 2.5 Heat Drying Criteria and Capital Cost Estimate (50-mgd Facility)[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Process Design Criteria	Fenton	InnoDry	Komline-Sanderson
No. of units (7-day operation)	5	3	3
No. of units (5-day operation)	6	4	4
Average evaporation capacity, lb/hr (7-day operation)	6,157	6,157	6,157
Average evaporation capacity, lb/hr (5-day operation)	8,620	8,620	8,620
Peak evaporation capacity, lb/hr (7-day operation)	7,697	7,697	7,697
Peak evaporation capacity, lb/hr (5-day operation)	10,775	10,775	10,775
Total Capital Costs	**$19,860,000**	**$20,970,000**	**$15,510,000**
Total 20 Year Life-Cycle Cost in 2002 Dollars (4% interest)	**$20,770,000**	**$17,330,000**	**$15,510,000**

Notes:
(1) Information extracted from Table 3 of TM No. 5.

2.9 CHAPTER 9: TM NO. 6 - COMPOSTING OPTIONS

This chapter evaluated the composting option as a solids treatment alternative to produce Class A biosolids. The study evaluated two enclosed processes: aerated static pile and in-vessel composting.

2.9.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Defined biosolids composting arrangements and costs.
2. Defined green waste quantities and characteristics available for composting.
3. Developed alternative composting arrangements, schematics, and layouts, providing fully-contained and fully-controlled systems for odor control.
4. Developed construction and capital cost estimates for alternative composting systems.

2.9.2 Summary and Recommendations

The primary objectives of composting systems are to destroy pathogenic organisms and to reduce moisture of the sludge to around 40 to 50 percent. Composting also stabilizes the organic wastes in the biosolids and produces a stable, manageable, and marketable end product.

The primary feedstocks to a composting system are the dewatered biosolids and bulking agents such as woodchips or green waste. The bulking agents adjust the carbon to nitrogen ratio (C:N) of the mixture and provide the structure and porosity required to allow adequate air movement throughout the mixture. The bulking agents also increase the surface area for biological reactions to occur.

As mentioned earlier, the two alternatives considered for evaluation were Aerated Static Pile Composting and In-Vessel Composting. Detailed descriptions of each alternative were included in the chapter.

The study estimated that the RWQCP produces an average of 80 wet tons/day of biosolids and about 125 tons/day of green waste, which are available for composting. Based on these estimations, a composting facility with an operating capacity of 40 wet tons/day of biosolids is feasible. Both composting processes are capable of handling this feed rate. The advantages and disadvantages were described in the chapter.

The study recommended the use of the In-Vessel process based on the proven track record and its adaptability to enclosed composting. The estimated space requirement for the composting facility was 4.9 acres, which included a process area, curing area, and biofilter

areas. The estimated total capital cost (including odor control for the entire building and composting ventilation) was approximately $34.8 million.

The study concluded that composting was a possible solution for recycling biosolids and green waste for the RWQCP. However, due to the high costs and amount of labor involved in the composting process, it should only be considered to supplement other solids handling alternatives rather than be designed to handle the entire solids production at the RWQCP.

2.10 CHAPTER 10: TM NO. 7 - SIDE STREAM TREATMENT OPTIONS

This chapter documented the evaluation of side stream treatment options, which would reduce the oxygen demands in the activated sludge process by treating the dewatering process liquid separately.

2.10.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Reviewed recycle stream treatment technology.
2. Provided preliminary sizing criteria and costs for the selected alternative.
3. Developed a process schematic and equipment needs for the side stream treatment alternative.

2.10.2 Summary and Recommendations

Six alternatives were evaluated for the side stream treatment. These included:

1. Steam Stripping:
   Involves passing the filtrate through a stripper containing mass transfer media and in contact with steam.
2. Activated Sludge Process:
   A conventional activated sludge plant built specifically to treat the side stream flow. A low SRT can be used due to the warm temperature of the waste stream.
3. Short SRT Process:
   Similar to conventional activated sludge process, but with an additional feature. The waste nitrifying sludge from this process is added to the effluent from the process and returned back to the mainstream process, which accelerates the nitrification process in the mainstream process.
4. SBR Process:
   A variant of the activated sludge process, where both aeration and settling are provided in a single tank.

5. SHARON Process:
   An activated sludge process operating at an elevated temperature. The process operates without a clarifier, thus all solids formed pass on into the effluent, which must be returned to mainstream process for further treatment. The nitrification stops at the formation of nitrite, which requires less oxygen.

6. Trickling Filter:
   This process has been used for nitrification of side streams and in this application would require a high degree of solids removal to prevent coating onto the biofilm surface, which might displace the nitrifiers.

The study compared the advantages and disadvantages of the six technologies and recommended the use of a conventional activated sludge process since it would make the best usage of the available tankage at the RWQCP. It would incorporate flexibility into the design to allow operation in either “Short SRT” or SHARON process modes.

The following lists the major design assumptions/requirements that are necessary to convert the existing tankage to an activated sludge facility for side stream treatment:

1. All available tankage would be necessary to accomplish nitrification.
2. No reactor volume is available for denitrification.
3. Old secondary clarifiers have sufficient structural integrity to level the floors to support diffuser installation.
4. One of the old secondary clarifiers would be converted to its original duty with the addition of a new mechanism.
5. DO control for both air modulation and pH control for pacing the caustic addition would be required.
6. For the short SRT process, waste nitrified sludge piping is needed for both combinations with the main plant’s waste sludge and for addition to the mainstream plant’s influent.
7. For the SHARON process, provisions for bypass of the secondary clarifier would be required.
8. Return sludge pumping would be upgraded to have variable speed capability and be designed for 100 percent of average daily flow.

The estimated capital cost for the side stream recycle treatment facilities was $6.4 million for reusing existing structures and $6.9 million to demolish the existing structures and build new facilities. Table 2.6 lists the preliminary design data for the centrate treatment facility, as presented in the chapter.

Table 2.6 Preliminary Centrate Treatment Facility Design Criteria[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Item	Value
Average Future Centrate Loadings	
Flow, mgd	1.08
Ammonia Nitrogen, mg/L	560
Assumed Daily Load Peaking Factor	1.5
Centrate Clarifier	
Number	1
Diameter, feet	40
Sidewater Depth, feet	10
Average Surface Overflow Rate, gpd/sf	680
Aeration Tank Volume	
Number	3
Volume, mil gallons/each	0.375
Sidewater Depth, feet	10
Aerobic SRT, days	5
MLSS, mg/L	900 to 3,700
DO Control, mg/L	2.0
Average/Peak Air Requirement, scfm	12,600/19,000
Number of Blowers (variable speed)	3
pH Control, units	7.2 to 8.0
Average Causing Requirement, gpd/50% soln.	4,400
Min. Storage Requirement, based on 14 days, gal	62,000
Secondary Clarifier	
Number	1
Diameter, feet	80
Sidewater Depth, feet	10
Average Surface Overflow Rate, gpd/sf	210
Return Sludge Capacity, mgd	1
Number RAS Pumps	1 duty + 1 standby

Notes:
(1) Information extracted from Table 2 of the 2003 Report.

2.11 CHAPTER 11: TM NO. 8 - EVALUATION OF OPTIONS

This chapter summarized and evaluated the recommendations from the previous chapters and developed recommended solids handling process facilities for the RWQCP. It also provided a preliminary estimate of capital costs.

2.11.1 Objectives

The objectives of this chapter, as stated in the 2003 Report, are listed below:

1. Reviewed and compared options presented in the previous chapters.
2. Recommended facilities including immediate improvements needed to address capacity problems, as well as phasing options for facilities up to 40 mgd.
3. Developed costs for the recommended facilities and improvements.

2.11.2 Summary and Recommendations

The chapter recapped the RWQCP existing facilities and the treatment plant's capacity at the time of the study. As stated above, it also summarized the evaluations and recommendations from each of the previous chapters. A brief summary of the recommendations of each chapter is listed below:

1. Thickening Process:
   The study recommended construction and conversion to co-thickening, addition of a new DAFT to be constructed for co-thickening, and retrofit of the other existing DAFTs to be part of the co-thickening system.
2. Digestion Options:
   The chapter evaluated two options:
   Mesophilic Digestion and TPAD. It recommended continued operation of Mesophilic Digestion based on the similar life-cycle cost of both options. TPAD could be considered at a later date.
3. Heat Energy Usage Options:
   Since TPAD was not recommended; there is enough heat energy to continue to operate the digesters in the mesophilic mode. A shortfall of heat from cogeneration was predicted when the plant is operated at 50 mgd. The shortfall could be provided by adding a new boiler or replacing the absorption chiller with an electric chiller. About 2 to 4 MMBtuh of surplus heat would be available to warm the oil before it is brought up to the necessary heat-drying temperatures.
4. Dewatering and Sludge-Drying Bed Options:
   The chapter recommended the use of centrifuges to supplement belt press dewatering to provide for additional dewatering capacity. Ultimately three new high-capacity (200-gpm) centrifuges would be needed to provide sufficient capacity

with adequate redundancy. It also recommended that the sludge-drying beds be phased out and replaced with heat-drying.

5. Heat-Drying Options:
   Three indirect drying systems were evaluated. The costs of all three systems were similar. The study recommended implementing heat-drying facilities and further evaluation during final design.

6. Composting Options:
   Composting requires significant odor control and it is a labor and land intensive process; therefore it was not recommended for the RWQCP.

7. Side Stream Recycle Treatment:
   The study recommended the use of conventional activated sludge, using the four old sedimentation tanks and one gravity thickener as the process tankage. The City decided at a review meeting not to implement this process.

The chapter developed options for the solids handling facilities expansion in two phases, Phase 1 for 40 mgd and Phase 2 for 50 mgd. The list of recommended facilities and improvements can also be found in Chapter 1 - Recommended System of the 2003 Report. The total capital cost for Phase 1 was estimated to be $26.8 million and $32 million for Phase 2. A site plan for the ultimate 50-mgd facilities was also included in the report.

Appendix A

BIO-SOLIDS HANDLING IMPROVEMENTS FINAL REPORT

16735 Von Karman Avenue
Suite 200
Irvine, California 92606

Tel: (949) 660-1070
Fax: (949) 474-0940

www.brownandcaldwell.com

BROWN AND CALDWELL

March 18, 2003

Mr. John Claus
Waste Water Operations Manager
Public Works Department
Water Quality Control Plant
City of Riverside
5950 Acorn Street
Riverside, California 92504

12/2276-009

Subject: Final Report on Bio-Solids Handling Improvements at Riverside Regional Water Quality Control Plant

Dear Mr. Claus:

In accordance with out contract, we are pleased to submit 10 copies of the final report on Bio-solids Handling Improvements at the Riverside Regional Water Quality Control Plant. This report has been prepared to serve as a planning document for design and construction of solids handling improvements at the treatment plant.

We have recommended a two-phase approach for the construction of improvements at the plant:

- Phase One will focus on immediate improvements to existing facilities and construction of new facilities to treat up to 40 MGD.
- Phase Two addresses solids treatment needs up to 50 MGD.

Our recommended approach would reduce the odors coming from the existing sludge drying beds by phasing out the drying beds over time and would ensure that Riverside's bio-solids meet all Class A bio-solids requirements. This is very important due to increasing restrictions of disposal of Class B bio-solids. The modifications to the thickening and dewatering operations and the addition of the heat drying process will give the operations team the treatment capacity and reliability to continue to economically meet the permit requirements.

Should you have any questions or need additional information, please do not hesitate to contact me at (949) 660-1070.

Very truly yours,

BROWN AND CALDWELL

Azee Malik
Project Manager

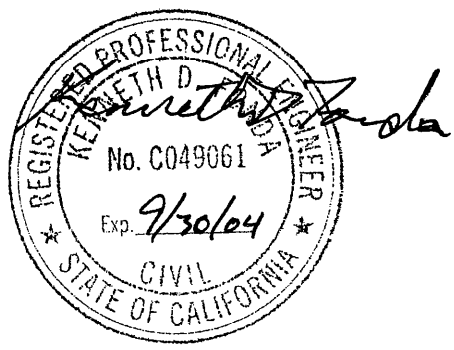
cc: Bob Finn, Brown and Caldwell

CITY OF RIVERSIDE
REGIONAL WATER QUALITY CONTROL PLANT

BIO-SOLIDS HANDLING IMPROVEMENTS FINAL REPORT

Submitted by:
Brown and Caldwell

March 2003



EXECUTIVE SUMMARY

INTRODUCTION

This report has been prepared to serve as a planning document for design and construction of solids handling improvements for the City of Riverside Regional Water Quality Control Plant (RWQCP). This report addresses solids handling facility needs to treat up to 50 MGD with an earlier phase to treat up to 40 MGD. Proper planning and appropriate implementation of biosolids handling process improvements and additions will ensure the cost effective treatment and disposal of wastewater biosolids.

The recommended plan is intended to enable the RWQCP to continue to reliably process biosolids as wastewater flow increases. The intent is to construct Phase One (40 MGD) and then build the additional facilities over several years as they are needed. To facilitate this phased approach, individual process improvements are expressed in terms of the equivalent plant influent flow capacity they can handle.

Previous Planning

The original target influent flow rates of 40 and 50 MGD were previously established in a Master Plan Update prepared in May 1992. It was agreed with City staff to use these projections as a basis for scheduling design and construction of necessary process improvements. The plant may reach 40 MGD by the year 2010 and 50 MGD by 2030. Due to uncertain growth patterns, individual processes may need to be expanded at different times. Planning for new facilities should begin far enough in advance to allow sufficient time for engineering and construction of needed capacity.

Objectives

The objectives of this report are to:

- Develop and recommend necessary process improvements to treat wastewater solids removed for up to 40 MGD average dry weather wastewater flows and provide space planning for facilities up to 50 MGD.
- Provide planning level costs for these improvements.
- Recommend project phasing and scheduled implementation of improvements.

Existing Conditions

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 31 MGD. Existing solids handling processes include:

- Primary sludge thickening within primary sedimentation basins
  - Primary sludge from Plant 1 is thickened in the Plant 2 primary sedimentation tanks.
  - Primary sludge concentration is limited to approximately 4.0 % solids.

- Dissolved air flotation thickening (DAFT) of waste activated sludge (WAS)
  - Two – 36 ft diameter DAFTs.
  - Capacity is limited because there is no redundant unit.
  - Thickened solids concentration is approximately 3.5 to 4%.

- Mesophilic anaerobic digestion
  - Two – 90 ft diameter (1.64 million gallon) digesters (digesters 1 & 2) operating.
  - One – 88 ft diameter (1.8 million gallon) digester (digester 4) out of service.
  - One – 75 ft diameter (1.06 million gallon) digester (digester 3) used for digested sludge storage.
  - Low thickened solids concentration produces a higher hydraulic loading on the anaerobic digestion system reducing the available solids retention time. This makes it more difficult to meet EPA Part 503 requirements.
  - Peak 2-week required solids retention time of 15 days cannot be met without bringing digester 4 back on line.
  -
- Belt filter press dewatering
  - Two – 2 meter (100 gpm) belt presses.
  - No redundant unit.
  - Average dewatered cake solids concentration is 12%.
  - Increased hydraulic loading forces units to operate at the upper end of their operating range thus reducing performance.
  - High moisture content cake prolongs air drying time increasing the potential for nuisance odors.

- 29 sludge air drying beds (total area 8 acres)
  - Air drying beds are a source of nuisance odors.

Heat used for anaerobic digestion is supplied from waste heat recovered from the cogeneration facility. The cogeneration facility burns a combination of natural gas, landfill gas and digester gas. Boilers are provided to supplement cogeneration heat when needed.

Process Evaluation and Options

As a part of this study, seven technical memoranda (TMs) have been developed to evaluate solids handling process options. These memoranda are included in this report as Chapters 4 through 10. These seven Chapters included the following:

- Chapter 4 – Solids Projections and Thickening Options
- Chapter 5 – Digestion Options
- Chapter 6 – Heat Energy Options
- Chapter 7 – Dewatering and Air Drying Options
- Chapter 8 – Heat Drying Options
- Chapter 9 – Composting Options
- Chapter 10 – Sidestream Treatment Options

An additional eighth technical memorandum was prepared to evaluated the options presented in the chapters listed above and is included as Chapter 11 - Evaluation of Options.

Thickening Options

Two DAFT options were evaluated:

- WAS thickening.
- Primary sludge and WAS co-thickening.

To improve thickened solids concentration and delay future digester expansion, co-thickening was chosen as the recommended thickening option.

Digestion Options

Three anaerobic digestion options were evaluated:

- Mesophilic digestion.
- Temperature phase digestion (TPAD).
- Class A TPAD.

The two TPAD options were evaluated as a means of increasing volatile solids reduction, increasing gas production and providing a means of achieving higher quality solids. Since life cycle costs for TPAD and current mesophilic digestion options were nearly equal, continued

operation of mesophilic digestion is recommended. Conversion to TPAD could be considered in the future.

Heat Energy Options

Heat usage options related to the advanced digestion options were evaluated. Implementation of the TPAD options discussed above would make maximum usage of available heat produced by the cogeneration facility. Although the heat required to operate TPAD would actually exceed available heat production, additional heat could be provided by supplemental boilers and sludge heat recovery between the thermophilic and mesophilic phases.

Dewatering and Air Drying Options

Two dewatering options to handle the anaerobically digested solids were evaluated

- Belt press dewatering.
- Centrifuge dewatering.

As noted above, capacity deficiencies were identified with the existing dewatering system that require immediate attention. Supplemental capacity could be provided by using a rental or purchasing a used belt press or centrifuge. Conversion of the dewatering facility to centrifuges is recommended to increase dewatered cake solids content from 12 to 25%. Increased cake solids content will reduce ultimate disposal costs.

Current air drying practices were also evaluated in light of the monitoring required to certify Class A quality biosolids. Dried product storage was considered to provide a means of keeping the dried product from becoming wet during the rainy season. An important drawback of continuing the practice of air drying is nuisance odors. Therefore, to promote a good neighbor relationship with the surrounding community and improve reliability, heat drying is recommended.

Heat Drying Options

Three different indirect heat drying options were evaluated as a means of producing Class A quality biosolids and allow for phasing out current air drying process. Benefits of heat drying are:

- Overall reduction of nuisance odors.
- Reliable drying during wet weather.
- Reliable production of Class A biosolids making beneficial use options more readily available.

- Free up space currently occupied by air drying beds for other liquid processes or provide a larger buffer zone on the west side of the plant site.

Implementing heat drying would also utilize surplus heat from the cogeneration facility, but would require supplemental heat from another fuel source. Air emissions and odor control would need to be addressed when this option is implemented.

Composting Options

Two enclosed composting processes were evaluated, aerated static pile and in-vessel composting, as alternate methods of producing a Class A product. This option did not prove to be cost effective compared to the other options available for producing Class A material because of its higher capital and operating costs, as well as land requirements.

Sidestream Treatment Options

To address sidestream recycle impacts on the aeration process, treatment options for liquid removed in the dewatering process were evaluated. This sidestream treatment would reduce oxygen demands in the existing activated sludge process by treating this flow separately. The recommended process was the activated sludge process utilizing existing tanks that had been abandoned. During the project status meeting held on October 31, 2002, the City stated that this option was not needed because the sidestream would be handled by process improvements being made to the liquid treatment system.

More detailed discussion of all the options can be found in the Chapters noted above.

Recommended Project

The recommended project is divided into two phases. Phase One and Phase Two facilities are summarized below. Figure ES – 1 shows space planning for ultimate buildout of the solids handling facilities. Figure ES - 2 shows the recommended implementation schecule.

Phase One Facilities

Existing DAFT and Digester 4 Improvements

DAFT improvements

- Pressurization system and control modifications to prevent water logging.
- Polymer system modifications to optimize polymer usage to improve thickened sludge concentration.
- Bottom sludge removal modifications to increase bottom sludge removal.
- Conversion of two existing DAFTs to co-thickening.

Digester 4 improvements

- Digester feed system valve control automation.
- Digester gas collection and conveyance.
- Digester mixing improvements to ensure complete digestion and avoid short circuiting.
- Replace existing boilers with new boiler and possibly replace existing heat exchanger.

New DAFT (Co-thickening)

- One 48 ft diameter DAFT.
- Control building and ancillary equipment.
- Odor control facilities.
- One 20,000 gallon thickened solids blending tank and digester feed pumps.

Dewatering

- Supplemental rental or used belt press.
- One new 200 gpm centrifuge.
- Ancillary equipment and conveyance to heat drying.

Heat Drying

- Dewatered cake surge bin(s).
- 20 dry ton per day heat drying equipment.
- Dried product storage and truck loading.

Phase Two Facilities

New DAFT (Co-thickening)

- One 48 ft diameter DAFT.
- Ancillary equipment.

Dewatering

- Remove existing belt press facilities.
- Two new 200 gpm centrifuges (one duty and one standby).
- Ancillary equipment and conveyance to heat drying.

Heat Drying

- Dewatered cake surge bin(s).
- Another 20 dry ton per day heat drying equipment.

The recommended project is described in more detail in Chapters 1 and 11.

Project Costs

Table ES –1 summarizes Phase One estimated project costs. Detailed cost estimates for the 40 and 50 MGD facilities are included in Appendix C. Vendor quotes for dewatering and heat drying equipment are included in Appendix D.

Table ES – 1 Estimated Project Costs

Item/Process	Costs ($1,000)[a]			
	Construction	Contingencies 30%	Admin/ Engr 25%	Total Capital
Phase One (40 MGD)				
DAFT and Digester 4 Improvements (allowance)[b]	600	200	200	1,000
DAFT Process	4,200	1,300	1,400	6,900
Dewatering Process	1,500	500	500	2,000
Heat Drying	10,100	~~3,000~~	~~3,~~300	16,400
Total Cost Phase One	16,400	5,000	5,400	~~26,800~~
Phase Two (50 MGD)				
Total Cost Phase Two	32,000			

a. All costs are shown in 2003 dollars.

b. No detailed costs have been developed for DAFT and Digester 4 Improvements. Detailed costs will be developed in final design.

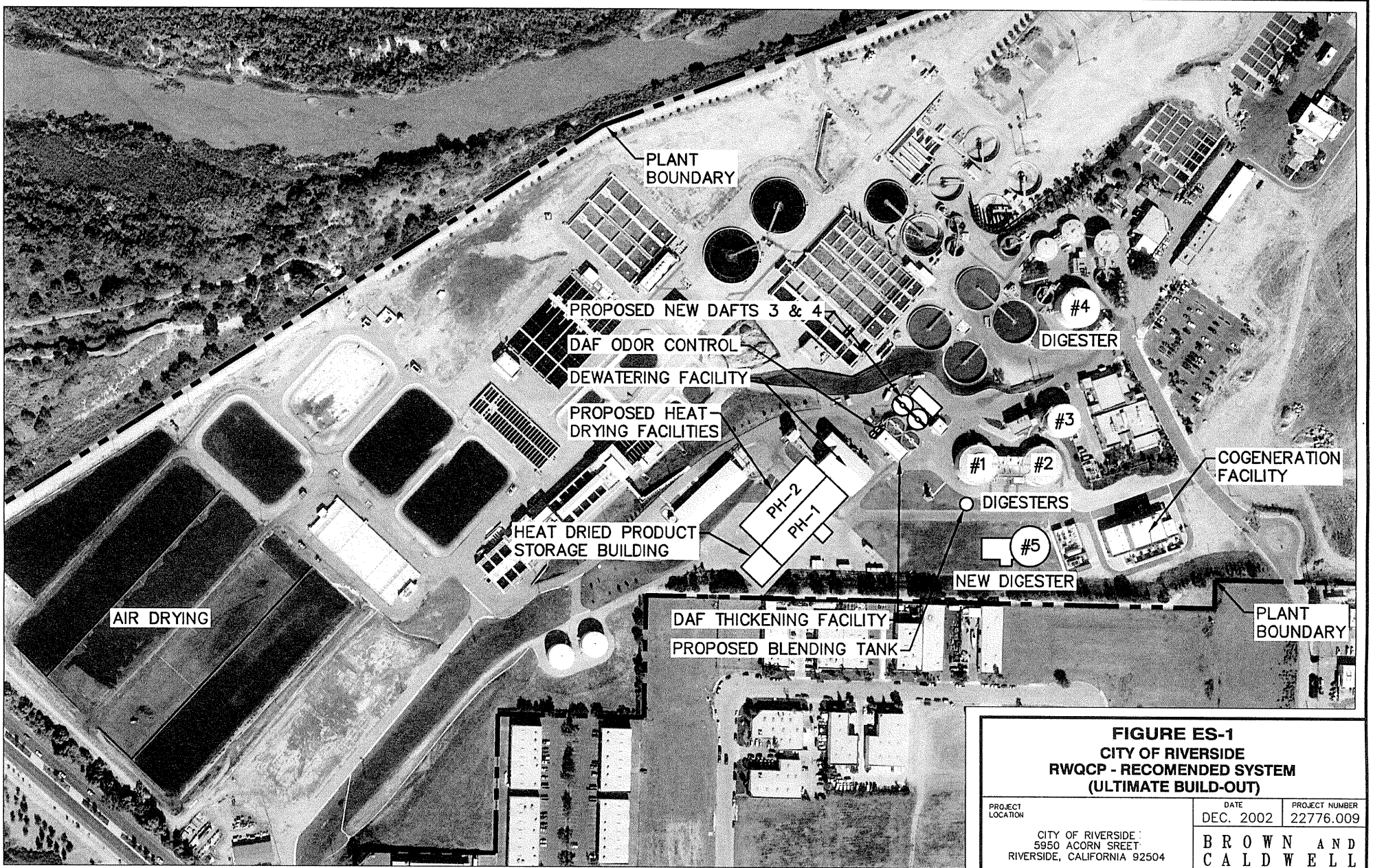


FIGURE ES-1
CITY OF RIVERSIDE
RWQCP - RECOMENDED SYSTEM
(ULTIMATE BUILD-OUT)

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	DEC. 2002	22776.009

BROWN AND CALDWELL
IRVINE, CALIFORNIA

P:\FONDA\RIVERSIDE BIOSOLIDS\CAD\22776_ES-1.DWG

RIVERSIDE REGIONAL WATER QUALITY CONTOL PLANT
BIO-S0LIDS HANDLING IMPROVEMENTS IMPLEMENTATION SCHEDULE

Biosolids Handling Process Improvements	Preliminary Capital Costs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2020	2025
Phase One Facilities Design and Construction																
Digestion (Bring digester 4 on line allowance)	1,000															
DAF thickening	7,000															
Dewatering	2,000															
Heat Drying	14,800															
Total capital cost Phase One ($1,000)	24,800															
Phase Two Facilities Design and Construction																
DAF thickening																
Digestion																
Dewatering																
Heat Drying																
Total capital cost Phase Two ($1,000)	32,000															

FIGURE ES - 2 IMPLEMENTATION SCHEDULE

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CHAPTER 1 – RECOMMENDED SYSTEM

INTRODUCTION

Project Background

The City of Riverside Regional Water Quality Control Plant (RWQCP) is a tertiary wastewater treatment plant that currently treats approximately 31MGD. Brown and Caldwell was retained to study current solids handling facilities operation and develop options for future expansion in two phases to process solids removed from 40 and 50 MGD average dry weather influent flows. These capacity requirements were established by the City at the kickoff meeting held on June 4, 2002. At the draft report review meeting held on February 14, 2003, the City revised these target phases to align with current budget planning. Proper planning and appropriate implementation of biosolids handling process improvements and additions will ensure the cost effective treatment and disposal of wastewater biosolids. The recommended plan is intended to enable the RWQCP to continue to reliably handle solids for both phases. The intent is to phase in new facilities over several years rather than bring them on all at the same time. To facilitate this phased approach, individual process improvements are expressed in terms of the equivalent plant influent flow capacity they can handle.

The original target influent flow rates of 40 and 50 MGD were previously established in a Master Plan Update prepared in May 1992. The current plant influent flow was projected to occur by 1995. It was agreed with City staff to use these projections as a basis for scheduling design and construction of necessary process improvements. Assuming only a small percentage of this reduced growth in wastewater flow is attributed to water conservation, the plant may reach 40 MGD by the year 2010 and 50 MGD by 2030. Due to uncertain growth patterns, individual processes may need to be expanded at different times. Planning for new facilities should begin far enough in advance to allow sufficient time for engineering and construction.

Objectives and Report Organization

Objectives

As stated in the scope of work for this project and as discussed at the kickoff and subsequent draft report review meetings, the objectives of this report are to:

- Develop and recommend necessary process improvements to treat wastewater solids removed for 40 MGD and 50 MGD average dry weather wastewater flows.
- Provide planning level costs for these improvements.
- Recommend project phasing and scheduled implementation of improvements.

Report Organization

This report is organized to address the objectives listed above. Chapter 1 presents the recommended system. Chapter 2 provides planning level costs for facilities recommended in Chapter 1. Chapter 3 provides a recommended schedule for implementing planned facilities. As a part of this study, eight technical memoranda (TMs) have been developed to evaluate solids handling options. These eight technical memoranda are briefly summarized as follows:

- **Technical Memorandum 1 – Solids Projections and Thickening Evaluation**
  This TM evaluated existing process performance and developed raw solids projections as a basis for developing the other solids handling options. This technical memorandum also evaluated existing raw solids thickening practices. Since thickening process performance directly impacts process sizing of anaerobic digestion facilities, the two dissolved air flotation thickening (DAFT) options discussed in TM1 were further evaluated in TM2.

- **Technical Memorandum 2 – Digestion Options**
  This TM developed anaerobic digestion options including mesophilic digestion, temperature phase digestion (TPAD) and Class A TPAD. The two TPAD options were developed as a means of increasing volatile solids destruction, increasing gas production, and to provide a means of achieving higher quality solids. The life cycle cost analysis showed that the TPAD and current mesophilic digestion options were nearly equal. Therefore, continued operation of mesophilic digestion is recommended. Conversion to TPAD could be further considered in the future.

- **Technical Memorandum 3 – Heat Energy Options**
  This TM evaluated heat usage options related to the advanced digestion options developed in TM2. This TM showed that implementation of the TPAD options discussed in TM2 would make maximum usage of available heat produced by the cogeneration facility. As noted in TM3, the heat required to operate TPAD would actually exceed available heat production at times and would require some additional heat to be provided by supplemental boilers. Air emissions limits would need to be discussed with the South Coast Air Quality Management District, (SCAQMD) at that time.

- **Technical Memorandum 4 – Dewatering and Air Drying Options**
  This TM evaluated belt press and centrifuge dewatering options to handle the anaerobically digested solids. Current air drying practices were also evaluated in light of the monitoring required to certify Class A quality biosolids. Dried product storage was considered to provide a means of keeping the dried product from becoming wet during the rainy season. Mitigation measures for odor from air drying are also discussed in this TM. Centrifuge dewatering is recommended to provide additional dewatering capacity to supplement belt press dewatering. Use of centrifuges for dewatering would be best linked to heat drying.

- **Technical Memorandum 5 – Heat Drying Options**
  This TM evaluated three different indirect heat drying options as a means of producing Class A quality biosolids and allow for phasing out the current air drying process. Implementing heat drying would also utilize surplus heat from the cogeneration facility, but would also require supplemental heat provided by another source of fuel. Air emissions and odor control would need to be addressed when this option is implemented. Heat drying is recommended to provide a means of producing Class A biosolids and phase out air drying.

- **Technical Memorandum 6 – Composting Options**
  This TM evaluated two enclosed composting processes, aerated static pile and in-vessel composting, as alternate methods of producing Class A biosolids. This option did not prove to be cost effective compared to the other options available for producing Class A material because of its higher capital and operating costs, as well as land requirements. Composting is not recommended.

- **Technical Memorandum 7 – Sidestream Treatment Options**

This TM evaluated treatment options for liquid removed in the dewatering process. This sidestream treatment would reduce oxygen demands in the existing activated sludge process by treating this flow separately. The recommended process was the activated sludge process utilizing existing tanks that had been abandoned. During the project status meeting held on October 31, 2002, the City stated that this option would no longer be needed because the sidestream would be handled by process improvements being made to the liquid treatment system.

- **Technical Memorandum 8 – Evaluation of Options**
  This TM evaluated all the options discussed in the preceding TMs and developed a recommended system including preliminary estimate of capital costs. Further discussion of the recommended system is included in this Chapter.

These technical memoranda have been revised to incorporate comments from the City during the project status meeting held on October 31, 2002. Detailed discussions of all the options are found in the technical memoranda that are included as chapters of this report following Chapter 3.

Existing Facilities

The solids handling facilities that are a part of this plant are shown in Figure 1-1 and consist of the following:

- Dissolved air flotation thickening (DAFT) of waste activated sludge (WAS).
  - Mesophilic anaerobic digestion.
  - Belt press dewatering.
  - Air drying.

Heat used for anaerobic digestion is supplied from waste heat recovered from a cogeneration facility. The cogeneration facility burns a combination of natural gas, landfill gas, and digester gas. Boilers are provided to supplement cogeneration heat when needed. Air quality limits discussed in TM3 indicate that the cogeneration facility is nearing its NO_X emission limits that would need to be addressed if additional combustion equipment was proposed. Table 1-1 summarizes each of these unit processes, operating criteria and current capacity. Table 1-2 summarizes current solids production quantities and flows based on plant influent flow stated previously. Values shown in Table 1-2 were updated to reflect DAFT performance improvements reported at the October 31, 2002 status and February 14, 2003 draft report review meetings.

Table 1-1 – Summary of Solids Handling Processes[a]

Process Facility/Operating Criteria	Value
DAF Thickening	
Number of Units[b]	2
Gross Surface Area (sq. ft.), ea	1,018
Effective Surface Area (sq. ft.), ea	943
Total Surface Area (sq. ft.)	1886
Total Surface Area w/one unit out of service (sq. ft.)	943
Solids Loading (lb/sq. ft./day) WAS thickening (current approach) Co-thickening (future) Average Peak day	 14.5 30.0 45.0
Hydraulic Loading (gpm/sq. ft.)	1.0 –2.0
Allowable solids loading, avg w/one unit out, (lb/day) WAS thickening (current approach) Co-thickening (future)	 13,700 28,300
Allowable solids loading, peak day w/all units, (lb/day) WAS thickening (current approach) Co-thickening (future)	 27,300 84,900
Allowable hydraulic loading, avg w/one unit out	943 gpm (1.36MGD)
Allowable hydraulic loading, peak day w/all units	1886 gpm (2.71 MGD)
Air-to-Solids Ratio	.025-.04
Capture rate, %	95
Thickened solids concentration, % WAS thickening (current approach) Co-thickening (future)	 4.0 5.0 – 6.0

(table continues)

Table 1-1 (continued)

Process Facility/Operating Criteria	Value			
Anaerobic Digesters				
Digester No.	1	2	3	4
Diameter, ft	90	90	75	88
Sidewater Depth, ft	32	32	32	38.5
Volume, million gal	1.64	1.64	1.06	1.8
Status	In service	In service	Digested Storage	Out of service
Total Current Digester Volume, million gal (excluding No. 3 and 4)	3.28			
Total Current Digester Volume, million gal (excluding No. 3)	5.08			
Allowable Average flow for min. 18 day solids retention time with one unit out, MGD	0.18			
Allowable Peak 2-week flow for min. 15 day solids retention time with all units in service, MGD	0.33			
Volatile Solids Reduction,%[c]	53			
Digester Gas Production, cu ft/lb VS removed[c]	13			
Dewatering				
Number of Belt filter presses	2			
Belt width, meters	2			
Unit capacity[d]				
Average, gpm	100			
Peak, gpm	150			
Dewatered cake solids conc., %[d]	12			
Air Drying				
Number of drying beds	29			
Total drying area, acres	8			
Dried product solids conc., %	90+			

a. Unless otherwise noted, all information stated in this table was obtained from the plant O&M manual.
b. Number of DAFTs includes only DAFT 1 & 2. Thickened WAS concentration reported by the City.
c. VSR and gas production obtained from plant performance data.
d. Belt Press performance based on plant data.

Table 1-2 – Summary of Current Solids Production at 31 MGD

Parameter	Values				
	TSS		VSS		Flow
	%	Lb/day	% of TSS	Lb/day	MGD
Thickened Primary Sludge					
Average daily	4.15	30,500	82	25,000	0.09
Peak daily	3.42	37,100	82	30,300	0.13
Unthickened WAS					
Average daily	0.53	27,400	79	21,600	0.61
Peak daily	0.54	38,300	80	30,700	0.85
Thickened WAS[a]					
Average daily	4.0	24,700	79	19,500	0.07
Peak 2-week	3.5	34,500	82	28,300	0.12
Combined Thickened Sludge					
Average daily	4.1	55,200	80.5	44,400	0.16
Peak 2-week	3.4	71,600	81.9	58,600	0.25
Digested Biosolids[b]					
Average	2.6	34,700	66	24,000	0.16
Peak 2-week	2.3	48,600	68	33,600	0.25
Dewatered Biosolids[c]					
Average daily feed	2.6	58,400	66	38,500	0.27
Peak 2-week feed	2.3	81,700	68	55,600	0.42
Average cake, tpd (dry)	12	27.7			
Peak cake, tpd (dry)	12	38.8			
Average cake, tpd (wet)	12	227			
Peak cake, tpd (wet)	12	323			

a. Assumes 90% capture by DAFT and stated float concentration.
b. Assumes 53% VSR in digestion, 7days per week operation.
c. Assumes 95% capture by dewatering, 5 days per week, 16 hour per day operation.

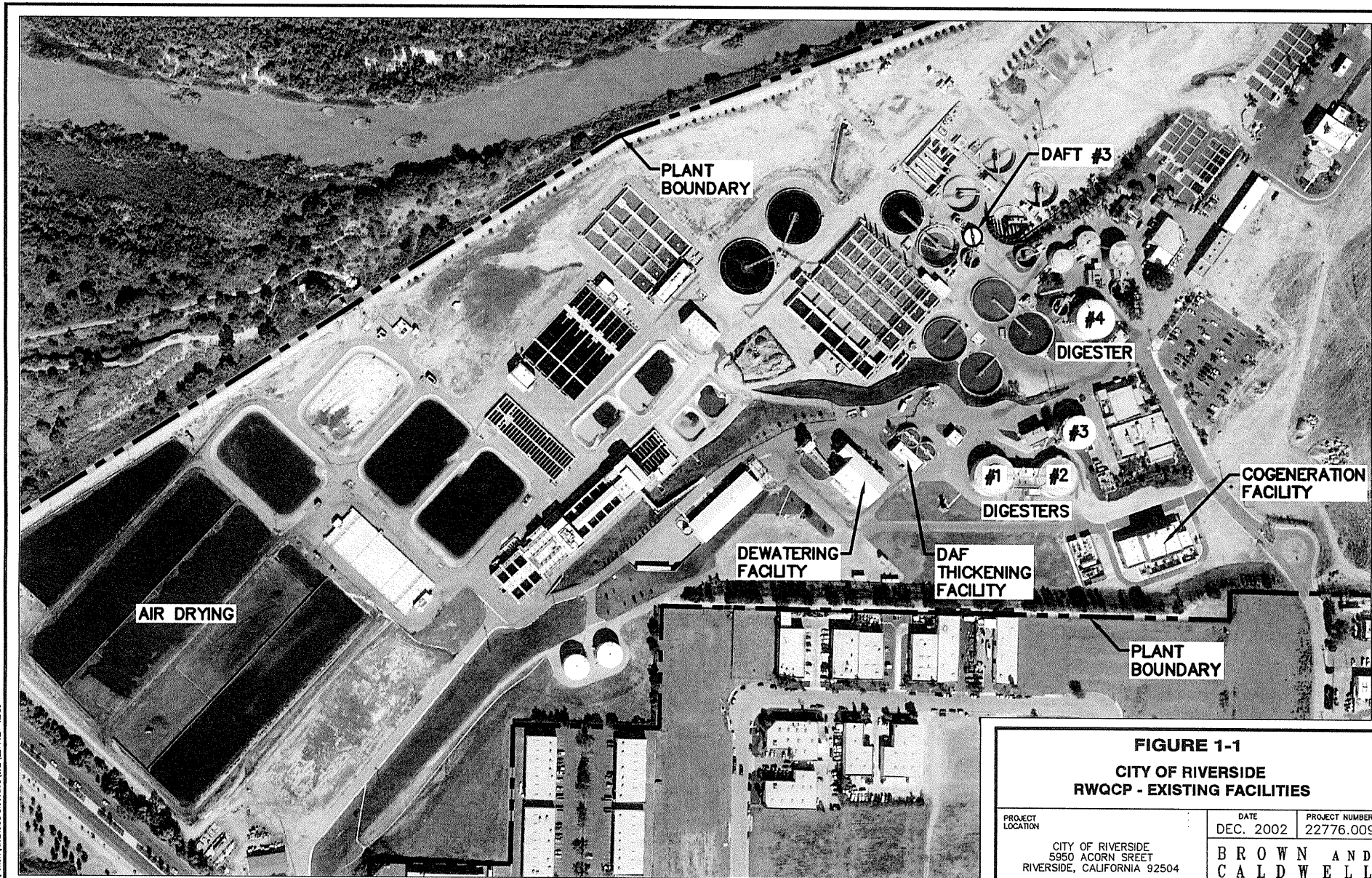

FIGURE 1-1

CITY OF RIVERSIDE
RWQCP - EXISTING FACILITIES

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	DEC. 2002	22776.009

BROWN AND CALDWELL
IRVINE, CALIFORNIA

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Recommended Project

Technical Memorandum 8 evaluated solids handling options presented in Technical Memoranda 1 through 7. The outcome of this evaluation identified recommended facilities for 40 and 50 MGD plant capacities. This section summarizes recommended improvements for solids handling processes Phase One (approximately 40 MGD) and Phase Two facilities. Figure 1-2 shows the site plan for the ultimate 50 MGD facilities.

Phase One Facilities

Existing DAFT and Digester 4 Improvements

DAFT Improvements

- Add a high level switch, high level alarm, and solenoid valve to prevent the pressurization tank from becoming water logged.
- Automate the existing pressurization pumps manually operated valve with air operated throttling valves with flow controller and flow meter.
- Optimize the polymer system to more closely match required polymer dosage.
- Modify the bottom sludge removal system to improve efficiency.
- Convert DAFTs 1 and 2 to co-thickening.

Digester 4 Improvements

- To provide sufficient detention time at peak 2-week flow, Digester 4 needs to be brought back into service. Bringing this digester back into service would require the following:
    - Automate thickened sludge feed valves.
    - Modify controls for thickened sludge feed and digested sludge withdrawal to a PLC based system coordinated with Digesters 1 and 2.
    - Digester gas piping should be evaluated before placing this unit back into service.
    - A new hot water boiler and possibly a new heat exchanger are required.
    - Automate mixing pump system valves and replace the mixing pump.

New DAFT (Co-thickening)

- One – 48 ft diameter DAFT.
- Distribution box.
- Control building sized for ultimate needs.

- Pumps, piping, controls for one new DAFT and two converted DAFTs.
- One 20,000 gallon thickened sludge blending tank.
- Digester feed pumps, piping and controls to feed existing digesters. Provide space for future thickened sludge preheating.

Addition of these facilities will increase thickened solids feed concentration to digestion. This will allow construction of additional digestion capacity to be deferred until plant influent flow nears 43 MGD. Equivalent plant influent flow capacity for the thickening system will be approximately 39 MGD with one unit out of service.

Dewatering

Dewatering facilities assume 5 days per week, 16 hour per day operation.

- Refurbish existing belt filter presses.
- Supplement existing capacity with rental press or purchase used BFP for next several years service.
- One – 200 gpm high solids centrifuge installed in space provided for future belt press 3.
- Dewatering feed pump, polymer feed pump, piping and controls.
- Dewatered cake conveyance to heat drying.

Combined capacity of centrifuge and belt press dewatering will provide plant influent flow capacity for approximately 45 MGD with one belt press out of service. One centrifuge alone would be capable of handling approximately 40 MGD plant influent flow.

Heat Drying

Heat drying facilities assume 5 days per week, 16 hour per day operation. No redundant units are recommended. Critical spare parts will be kept on hand to repair unit that is down. Wet cake from belt presses can be sent to air drying during down time.

- 20 dry ton per day heat drying equipment.
- 125 ft x 90 ft building with provisions for expansion.
- Two – 20 cubic yard dewatered cake surge bins[a].
- Dried product conveyance and loading.
- Odor control facilities.
- Dried product storage for two weeks production.

Note:

a. Surge bin provided for variation in dewatered cake production.

Future Phase Two Facilities

Thickening (constructed before 38 MGD is reached)

- One – 48 ft diameter DAFT.
- Pumps, piping, and controls for one new DAFT.

Anaerobic Digestion (constructed before 43 MGD is reached)

- One – 90 ft diameter, 32 ft sidewater depth digester (to match digesters 1 and 2).
- Pumps, piping, heat exchanger, backup boiler, controls, etc in new control building.

Dewatering (constructed before 40 MGD is reached)

Dewatering facilities assume 5 days per week, 16 hour per day operation.

- Remove existing belt presses.
- Two more – 200 gpm high solids centrifuges (one duty and one standby).
- Dewatering feed pumps, polymer feed pumps, piping, and controls.
- Dewatered cake conveyance to heat drying.

Heat Drying (constructed before 40 MGD if operating hours not extended)

Heat drying facilities assume 5 days per week, 16 hour per day operation. No redundant units are recommended. Critical spare parts will be kept on hand to repair unit that is down. Extended operating hours may be used to increase system capacity when one unit is out of service to continue to produce Class A material.

- A second 20 dry ton per day of heat drying equipment, (see note above for Phase One system if operating hours not revised – See TM8).
- Expansion of Phase One building to house additional equipment provided for Phase Two.
- Two – 20 cubic yard dewatered cake surge bins.
- Dried product conveyance to truck loading.
- Expansion of odor control facilities for Phase Two.

Equipment Criteria

Design data and criteria for the Phase One and Phase Two facilities are shown in Table 1-3 for the recommended solids handling facilities listed above.

Preliminary Layouts

As noted above, the site plan for the recommended project is shown on Figure 1-2. A preliminary layout of the recommended dewatering facilities is shown on Figure 1-3. Manufacturer's equipment drawings for drying equipment are included in Appendix B for reference. More detailed equipment layouts and Piping and Instrumentation Diagrams will be developed during detailed design.

Table 1-3 – Design Data and Performance Criteria

Item/Criteria	Phase One	Phase Two
DAFT Co-thickening		
Avg daily, Solids Loading, lb/day	100,700	117,000
Peak daily, Solids Loading, lb/day	151,000	152,000
Thickened solids concentration, %	5.0 – 6.0	
Capture, %	90	
Surface Loading, lb/sf/day	30-45	
Hydraulic Loading (including recycle), gpm/sf	1.0 – 2.0	
Number of units added	1[a]	1[b]
Diameter, ft	48	48
a. Number of DAFTs added for Phase One is based on no additional equipment provided to meet current capacity deficiencies. b. Total number of DAFTs at 50 MGD = 2 existing + 2 new = 4		
Anaerobic Digestion		
	Phase One - Digester 4 on-line	
	Phase Two	
	Flow MGD	TSS Lb/d	VSS Lb/d
Thickened solids flow, avg [c]	0.30	126,000	102,000
Thickened solids[c] flow, peak 2-week	0.42	177,100	143,000
Avg HRT (one unit out), days	18		

(table continues)

Table 1-3 (continued)

Anaerobic Digestion			
	Phase One - Digester 4 on-line		
	Phase Two		
	Flow MGD	TSS Lb/d	VSS Lb/d
Peak HRT (all units), days	15		
Volatile solids reduction, %	53		
No, of units added	1		
Diameter, ft	90[d]		
Sidewater depth, ft	32[d]		

c. Thickened solids flow assumes co-thickened sludge concentration of 5.0%.
d. Future new digester sized to match existing digesters.

Dewatering						
	Phase One			**Phase Two**		
	Flow MGD	TSS Lb/d	VSS Lb/d	Flow MGD	TSS Lb/d	VSS Lb/d
Digested solids flow, avg [e]	0.26	58,001	38,301	0.30	72,500	48,000
Digested solids[e] flow, peak 2-week	0.38	81,201	53,621	0.42	101500	67,200
Dewatering feed solids[f] flow, avg	0.55	121,802	80,431	0.63	152,300	100,800
Dewatering feed solids[f] flow, peak 2-week	0.46	170,523	112,604	0.88	213,200	141,100
No, of centrifuges added	1			2		
Average centrifuge unit capacity, gpm	200			200		
Peak 2-week centrifuge unit capacity, gpm	250			250		
Avg belt press unit capacity, gpm	100			Removed		
Peak belt press unit capacity, gpm	150			Removed		
Cake solids concentration, %						
Belt press	15 to 18					
Centrifuge	25 to 27					

(table continues)

Table 1-3 (continued)

Dewatering						
	Phase One			Phase Two		
	Flow MGD	TSS Lb/d	VSS Lb/d	Flow MGD	TSS Lb/d	VSS Lb/d
Capture, %	95					
Cake conveyance to heat drying surge bin(s)	Positive displacement piston pump or enclosed conveyance system.					
e. Digested solids flow based on 53% VSR, 7 day/week. f. Dewatering feed solids flow assumes 5 days per week, 16 hrs per day operation.						

Heat Drying		
Plant design flow	**Phase One**	**Phase Two**
Avg daily Dewatered cake, dry ton per day[g]	39	48
Peak 2-week Dewatered cake, dry ton per day[g]	54	67
Average evaporation capacity, lb/hr 5 days per week, 16 hours per day operation	6,157	7,697
Peak evaporation capacity, lb/hr 5 days per week, 16 hours per day operation	8,620	10,775
Minimum unit capacity	10 dtpd	
Number of units[h]	Two	Two
Cake conveyance to dryers	Positive displacement pump	
Dried product conveyance to truck loading	Screw conveyor, (water cooled)	
Biofilter – Odor Control Max. H_2S conc, ppm Air residence time, sec. Biomedia depth, ft Air velocity thru media, ft/min Air humidity Foul air blower Drive	 25 90 3-4.5 min 3 saturated centrifugal, fiberglass Variable speed, flow controlled	
g. Dryer feed solids flow assumes 5 day/week, 16 hr/day dewatering operation. h. Number of units based on 10 dtpd drying units.		

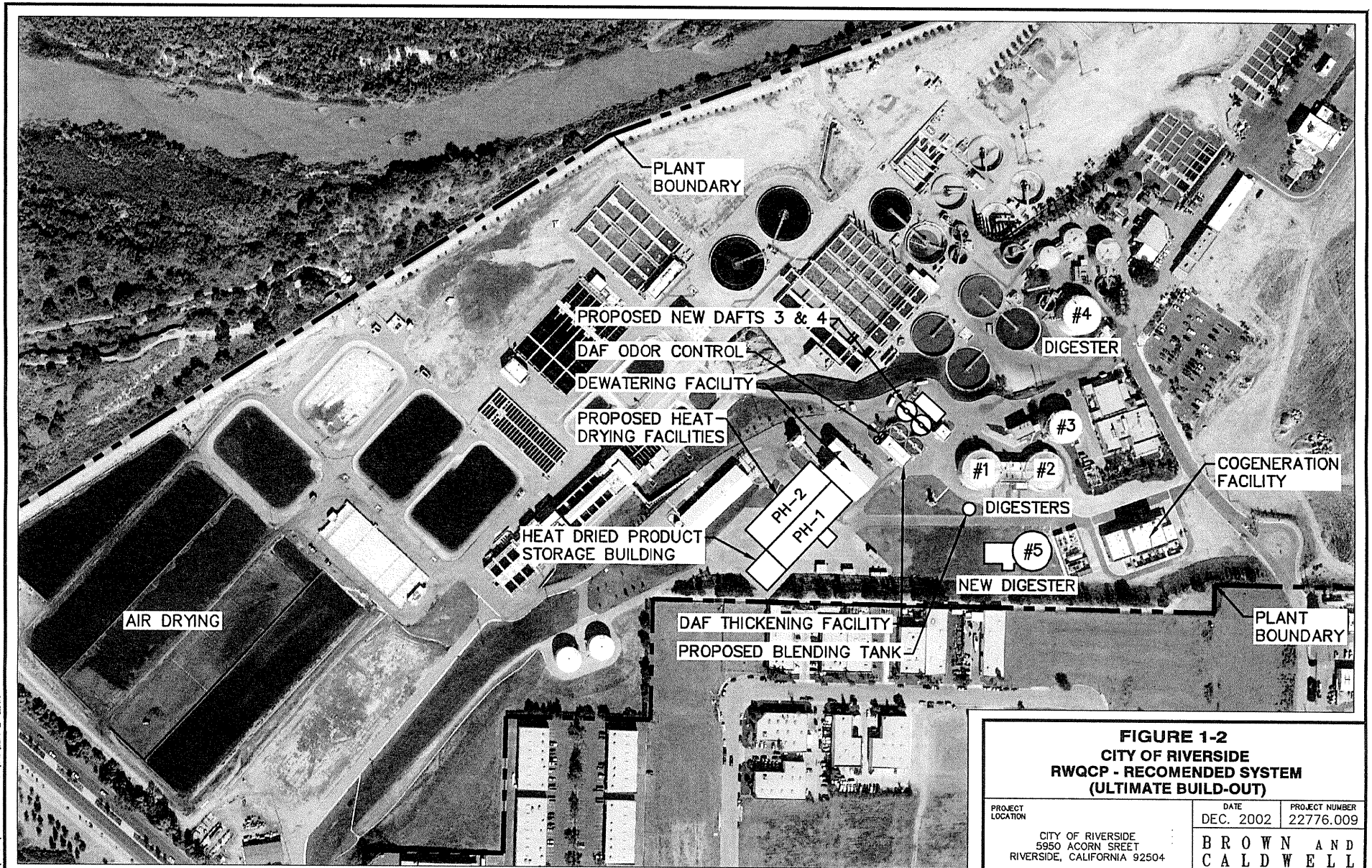

FIGURE 1-2
CITY OF RIVERSIDE
RWQCP - RECOMENDED SYSTEM
(ULTIMATE BUILD-OUT)

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	DEC. 2002	22776.009

BROWN AND CALDWELL
IRVINE, CALIFORNIA

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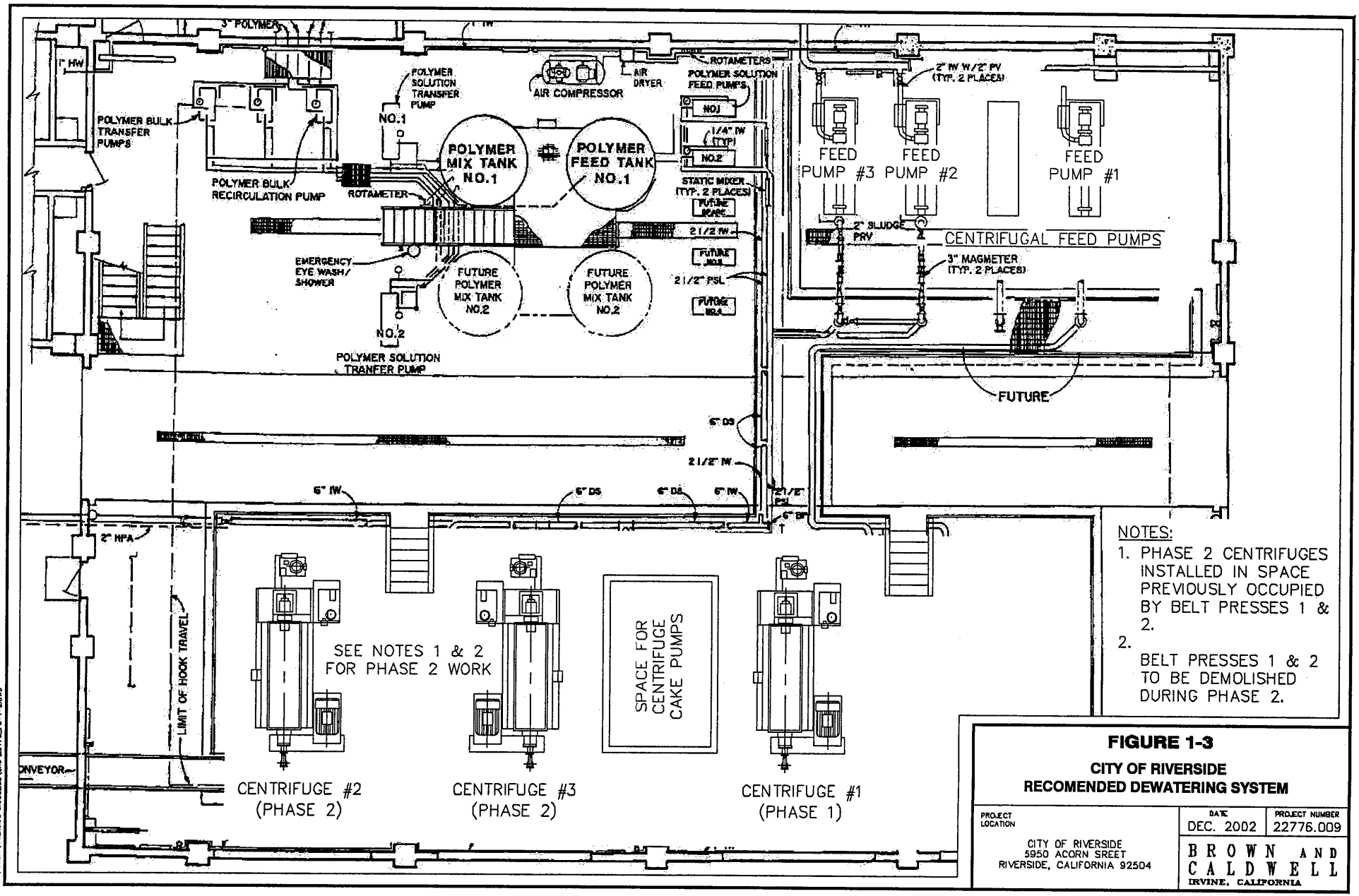


NOTES:

1. PHASE 2 CENTRIFUGES INSTALLED IN SPACE PREVIOUSLY OCCUPIED BY BELT PRESSES 1 & 2.
2. BELT PRESSES 1 & 2 TO BE DEMOLISHED DURING PHASE 2.

FIGURE 1-3

CITY OF RIVERSIDE
RECOMENDED DEWATERING SYSTEM

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	DEC. 2002	22776.009

BROWN AND CALDWELL
IRVINE, CALIFORNIA

P:\FINDA\RIVERSIDE BIOSOLIDS\CAD\22776_FIG-1-2.DWG

CHAPTER 2 – PROJECT COSTS

Capital costs have been developed for each process system for both the Phase One and Phase Two systems recommended in Chapter 1. Table 2-1 summarizes estimated capital costs. Detailed cost estimates for the 40 and 50 MGD (Phase One and Phase Two) facilities are included in Appendix C. Vendor quotes for dewatering and heat drying equipment are included in Appendix D.

Table 2-1 – Estimated Project Costs

Phase One (40 MGD)				
Item/Process	**Costs ($1,000)[a]**			
	Construction	**Contingencies 30%**	**Admin/ Engr 25%**	**Total Capital**
DAFT and Digester 4 Improvements (allowance)[b]	600	200	200	1,000
DAFT Process	4,200	1,300	1,400	6,900
Dewatering Process	1,500	500	500	2,000
Heat Drying	10,100	3,000	3,300	16,400
Total Cost of Phase One	16,400	5,000	5,400	26,800
Phase Two (50 MGD)				
Total Cost of Phase Two	32,000			

c. All costs are shown in 2003 dollars.

d. No detailed costs have been developed for DAFT and Digester 4 Improvements. Detailed costs will be developed in final design.

CHAPTER 3 – PROJECT IMPLEMENTATION

On June 4, 2002, Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Water Quality Control Plant management and operations staff to further define the basis for facility planning for the solids handling facilities. At that meeting, the City directed Brown and Caldwell to evaluate facility needs for 40 and 50 MGD rather than specific planning periods. At the draft report review meeting held on February 14, 2003, the City revised these target phases to align with current budget planning. Technical Memorandum 8 defined Phase One facilities in terms of equivalent plant influent flow capacity. Intermediate phases may follow based on the capacity of each process unit.

As described in Chapter 1, facilities have been defined for both 40 and 50 MGD. In 1992, a Master Plan update was prepared for the RWQCP that projected future flows up to the year 2040 (see Appendix E. for copy of Master Plan update flow projections). Current plant average dry weather flow was projected to occur by the year 1995. Reduced flows may be a result of both economic factors and water conservation. While water conservation efforts tend to reduce wastewater flow, they tend to increase solids concentrations, with the net effect being that wastewater solids removed would remain as projected. Therefore, it was agreed with City staff to use these projections as a basis for scheduling design and construction of necessary process improvements. To facilitate long range planning it may be assumed that growth within the Riverside service area may occur at a similar rate as previous projections. Based on this assumption, flow projections could be made starting at the current reduced flow and parallel the projected growth rate. This would result in an average dry weather flow of 40 MGD to occur by year 2013 and 50 MGD to occur by the year 2040. Therefore, design and construction of facilities needed for Phase One should begin immediately. Design and construction of other phases should begin far enough in advance to ensure engineering and construction can be completed in time to provide needed capacity. This implementation schedule should be reviewed again every three years. Figure 3-1 shows an implementation plan.

RIVERSIDE REGIONAL WATER QUALITY CONTOL PLANT
BIO-S0LIDS HANDLING IMPROVEMENTS IMPLEMENTATION SCHEDULE

Biosolids Handling Process Improvements	Preliminary Capital Costs	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2020	2025
Phase One Facilities Design and Construction																
Digestion (Bring digester 4 on line allowance)	1,000															
DAF thickening	7,000															
Dewatering	2,000															
Heat Drying	14,800															
Total capital cost Phase One ($1,000)	24,800															
Phase Two Facilities Design and Construction																
DAF thickening																
Digestion																
Dewatering																
Heat Drying																
Total capital cost Phase Two ($1,000)	32,000															

FIGURE 3 -1 IMPLEMENTATION SCHEDULE

4

CHAPTER 4 - TECHNICAL MEMORANDUM NO. 1, ASSESS CURRENT SOLIDS OPERATION, THICKENING SYSTEM AND DETERMINE SOLIDS PROJECTIONS

City Of Riverside Water Quality Control Plant Assess Current Solids Operation, Thickening System and Determine Solids Projections Technical Memorandum No. 1

Prepared By: Brown and Caldwell

Date: Revised December 20, 2002

Introduction

Assessing current conditions and making projections of future solids quantities is the basis of a sound solids handling master plan. Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Water Quality Control Plant management and staff on June 4, 2002 to further define concepts and criteria that would be a part of this master planning effort. The City established 40 and 50 MGD influent flow conditions rather than a specific design year as the basis for all concepts being developed. Currently, another engineering firm is evaluating the liquid process to address liquid stream capacity and treatment requirements. Solids projections presented in this technical memorandum are based on current levels of treatment. Enhancements and modifications to thickening, digestion, dewatering, drying and recycle stream treatment will have some impact on future solids quantities. Changes to solids quantities from these processes will be addressed in other technical memorandums.

Objectives

As stated in the scope of work for this project and as discussed at the project kickoff meeting, the following objectives are addressed in this technical memorandum.

1. Review plant sludge production and current solids system operational data

2. Confirm existing solids production

3. Estimate design flow solids quantities for 40 and 50 MGD average raw wastewater influent flow and determine average, peak month, and peak day quantities.

4. Evaluate future thickening performance and assess long-term improvement options for solids thickening.

Existing Conditions and Solids Projections

Existing Conditions

The existing raw solids processing facilities at the Riverside Water Quality Control Plant (RWQCP) consist of dissolved air floatation thickeners (DAFT)s. A description of current solids processing equipment is included in Table 1.

Table 1. Existing Raw Solids Processing Facilities[(a)]

ITEM	VALUE
Dissolved Air Flotation Thickeners (DAFT)s	
Number of Units	2
Tank Diameter (ft.)	37
Sidewater Depth (ft.)	10
Gross Surface Area (sq. ft.)	1,018
Effective Surface Area (sq. ft.)	943
Solids Loading (lb/sq. ft./day)	9.5-14.5
Hydraulic Loading (gpm/sq. ft.)	0.8-1.0
Air-to-Solids Ratio	.025-.04
TWAS Transfer Pumps	Thickeners Nos. 2 & 3
Number of Units	1 per DAF
Type	Progressive Cavity
Capacity (gpm)	150
Recycle Pressurization Pumps (Duplex)	
Number of Units	1 per DAF
Type	Duplex, centrifugal
Flow Rate (gpm)	1,000

(a) Information obtained from Plant O&M manual provided by the City

Solids Projections

The City provided both wastewater and solids data spreadsheets for the years 1997 to October 2001. Brown and Caldwell evaluated recent data for the year 2001 as the basis for solid projections for 40 and 50 MGD influent flow. Table 2 summarizes raw solids data for 2001. Table 3 summarizes raw solids projections for the 40 and 50 MGD flow condition. Solids projections are made based on current levels of treatment.

Table 2. 2001 Raw Solids Summary

Month	Primary Sludge %TS	Primary Sludge flow	Primary Sludge TSS	Primary Sludge VSS	DAFT Influent Flow	WAS TSS	DAFT Influent TSS	DAFT Influent VSS
	%	MGD	LB/D	LB/D	MGD	mg/l	LB/D	LB/D
Monthly flows								
January	4.59	0.06	22,823	19,359	0.61	6,099	33,170	26,852
February	4.46	0.07	26,432	21,654	0.62	6,063	35,025	28,938
March	4.78	0.08	33,194	27,242	0.64	5,518	27,643	20,126
April	4.58	0.07	28,300	23,294	0.65	5,600	30,189	24,596
May	4.17	0.09	29,592	23,994	0.65	5,518	27,359	21,110
June	4.12	0.09	30,435	24,779	0.64	5,974	31,261	25,582
July	4.02	0.09	30,425	24,658	0.62	4,762	24,429	19,789
August	3.80	0.12	36,694	29,764	0.55	4,710	21,655	17,300
September	3.56	0.13	37,090	30,347	0.56	4,388	20,298	16,869
October	3.47	0.10	30,029	24,444	0.56	4,737	21,979	17,861
Average	4.15	0.09	30,529	24,953	0.61	5,337	27,392	21,908
Max mo	4.78	0.13	37,090	30,347	0.65	6,099	35,028	28,938
Peak daily								
January	5.03	0.08	32,955	24,531	0.63	7,800	40,373	32,181
February	4.51	0.26	96,026	78,261	0.63	8,114	42,582	34,065
March	4.60	0.11	43,957	35,695	0.67	6,240	34,676	27,048
April	4.30	0.09	33,023	27,574	0.66	6,420	34,267	27,498
May	4.61	0.10	38,713	31,938	0.65	6,240	33,648	26,582
June	4.06	0.10	33,831	27,309	0.65	6,640	35,326	27,599
July	4.03	0.11	35,294	29,118	0.63	5,760	29,400	22,932
August	3.19	0.14	37,626	30,542	0.61	5,510	27,197	21,486
September	3.99	0.14	45,086	36,970	0.59	4,850	22,716	18,094
October	4.76	0.13	50,282	39,723	0.59	5,550	25,262	19,413
Avg day	4.31	0.12	44,679	36,166	0.63	5,982	31,611	24,377
Peak day	5.03	0.26	96,026	78,261	0.67	8,114	42,582	34,065

Primary removal rates were evaluated based on influent strength and primary sludge quantities and were calculated to be approximately 53%. This is within industry norms and is most likely due to primary sludge from Plant 1 being blended with Plant 2 influent. Waste activated sludge quantities appeared to slightly lower than calculated values based on reported thickened sludge quantities going to the digester. This apparent discrepancy may be due to multiple WAS flow meters compounding errors. Since the thickened sludge quantities were higher than they would be calculated to be from WAS quantities, reported thickened sludge quantities will be used for evaluating digester options.

Table 3. Solids Projections

	Average Primary sludge	Average Raw WAS
40 MGD		
TSS 1000 lb/day	39	35
VSS 1000 lb/day	32	28
Flow, MGD	0.12	0.61
50 MGD		
TS 1000 lb/day	49	44
VS 1000 lb/day	40	35
Flow, MGD	0.15	0.76
Peak Daily Factors		
Solids	2.2	1.4
Flow	2.0	1.4

Peak Factors

Peak factors are the ratio of the maximum observed sludge and flow quantities observed within a defined time period to the average sludge quantities for that period. The data used to project future sludge quantities was also used for developing these peak factors. Peak month and peak day factors are also shown in Table 3. These peak factors have been compared to industry norms and appear to be reasonable. These factors will be used to evaluate the existing thickening system capability of handling future solids loading and make recommendations for future expansion to the thickening system.

Sludge Thickening

Design Criteria.

The existing thickening system thickens primary solids in the primary sedimentation basins and waste activated sludge is thickened in DAFTs described above. This thickening system evaluation assumes that primary solids will continue to be thickened in the primary sedimentation basins when thickened separately. During the kickoff meeting, operations staff indicated that fresher primary sludge appears to digest better and reduces potential process impacts on the secondary treatment system. Brown and Caldwell noted its experience with co-thickening primary and secondary solids in DAFTs at San Louis Obispo and other facilities and the City asked that the co-thickening option be considered as well. Solids loading rates of up to 40 lb/sf/day or higher with thickened solids at 5.5% with polymer addition have been achieved consistently at the King County Washington South Plant at Renton for over a decade. A comparison DAFT system solids loading for both WAS thickening and co-thickening is also included in this evaluation. It is assumed that the thickening system must be able to handle average daily loading with one unit out of service and peak daily loading with all units in service. Design criteria for both WAS thickening and co-thickening are summarized in Table 4.

Table 4. Existing DAFT Design Criteria

Parameter	Value
Number of DAFTs	2
Diameter (ft)	37
Effective surface area (sq. ft)	943
Solids loading - Separate thickening [(a)] (lbs/sf/d) - Co-thickening [(b)] (lbs/sf/d)	 9.5 to 14.5 22 to 30
Solids Capture	95%
Float solids concentration (without polymer addition) - Separate thickening [(c)] - Co-thickening [(d)]	 4.5 – 5.0 5.0 - 5.5

(a) Solids loading for separate thickening taken for Plant O&M manual
(b) Solids loading for co-thickening taken from Brown and Caldwell recent experience.
(c) Solids concentration reported by City staff at October 31, 2002 review meeting
(d) Solids concentration taken from Brown and Caldwell recent experience. Some polymer addition may be required.

Evaluation of Thickening System

The WAS thickening capacity is determined by the solids loading rate and the number of units on line. Based on the criteria shown in Table 4, the existing two DAF thickeners will have inadequate capacity to thicken peak monthly flow with both units on line. Table 5 shows the solids loading and required surface area for the DAFTs at the 50 MGD flow condition.

Table 5. Future DAFT Solids Loading

	WAS thickening	Co-thickening
50 MGD		
Average daily solids loading, lb/day	44,180	93,000[(a)]
Average daily hydraulic loading, gpm	528	790[(a)]
Peak daily solids loading, lb/d	61,851	194,800[(a)]
Peak daily hydraulic loading, gpm	593	1,089[(a)]
Solids Loading criteria lb/sf/d	14.5	40
Hydraulic Loading criteria gpm/sf	0.8 – 1.0	1.0 – 2.5
Required Surface Area (avg. solids), sf	3,047	2,325
Required Surface Area (avg. hydraulic), sf	528	790
Required Surface Area (peak. solids), sf	4,265	4,870
Required Surface Area (peak.hydraulic), sf	740	436
Existing Surface Area, sf (1 unit out of service)	943	943

	WAS thickening	Co-thickening
Existing surface area, sf (all units in service)	1,886	1,886
Additional area required, sf (based on avg)	2,104	1,382
Additional area required, sf (based on peak)	2,379	2,984
Additional units required	2 (39 ft diameter)[(b)]	2 (44 ft diameter)[©]

(a) Co-thickening solids and hydraulic loading based on primary sludge concentration at 0.5 to 1.0 % with bottom sludge recycle equal to 25% raw solids loading for average and 15% raw solids loading for peak.
(b) WAS thickening unit size based on peak daily solids loading including effluent launder.
(c) Co-thickening unit size based on peak daily solids loading.

Based on the comparison shown in Table 5 two additional DAFT will be needed for both options. Sizes shown will handle solids produced by an ultimate flow of 50 MGD. The existing auxiliary equipment would also need to be duplicated.

As shown in Table 5, co-thickening could also be handled with the same number of units as WAS only thickening with a slightly larger tank to handle peak daily solids loading. The advantages and disadvantages for using DAFTs to co-thicken primary and secondary solids are:

√ Advantages

- All solids can be processed with no concern over the amount of liquid they bring with them. Primary and secondary scum could be thickened prior to digestion thereby reducing hydraulic loading on the digesters.
- Higher float concentration can be achieved which would reduce required digester volume thereby reducing the cost of new digester facilities.
- Primary solids removal rate could be increased simplifying primary sludge withdrawal and reducing possible septic conditions and other impacts on downstream secondary processes.
- Primary sedimentation surface overflow rates could be increased to 2400 gpd/sf at peak flow which could reduce the number of primary sedimentation basins needed to meet future flow conditions.
- Grit could be removed from primary sludge prior to digestion reducing the frequency of digester cleaning.
- Simplified and more homogenous solids feed to digesters. This is more significant with advanced digestion options.

√ Disadvantages

- DAFTs would need to be covered to control odors reducing operator visibility.
- Foul air scrubbing would need to be added to treat odors.

- Dissolution air would need to be increased to meet air to solids ratios
- Sludge grinders or chopper pumps would be needed for primary sludge (this would be recommended regardless of implementation of co-thickening to improve digester operation and produce a more pleasing end product)
- Primary sludge piping would need to be routed to DAFTs, primary sludge pumps would need to be upgraded for higher flows and pump programming would need to be revised.
- Thickened solids pumps and piping would need to be upsized.
- Float collection systems would need to be upgraded.
- Bottom solids degritting cyclones would be needed (primary sludge degritting would be recommended regardless of implementation of co-thickening to reduce grit accumulation in the digesters)

The details of implementing either system would need to be developed in the design phase.

Process Improvements

During the site visit done following the kickoff meeting observations of the existing DAFT equipment were made. Analysis of the data provided indicates that the average float solids concentration is approximately 3.5%. This concentration is on the low end of industry norms for this process. Information obtained from Operations staff indicates that no polymer is currently being used in the thickening system. This could account in part for the lower float solids concentration. Information obtained at the October 31, 2002 review meeting indicated recent modifications have been made to equipment that has improved thickening performance and the average float solids concentration is now in the range of 4.5 to 5.0 %. Other modifications that could be made to process equipment that could improve process performance include:

- Submerged weir for influent solids distribution and better float control.
- Possible addition of turbidity monitoring on subnatant to better control capture efficiency.

A recent site visit by one of Brown and Caldwell's senior operations specialist identified several other modifications that could improve plant performance and simplify operation. Based on these observations the following additional improvements are recommended.

- To prevent the pressurization tank from becoming water logged the addition of a high level switch, high level alarm and solenoid valve is recommended

- Replace the existing manual operated valve with an automatic air operated throttling valve with flow controller and flow.

- In general, the polymer storage and feed systems appear to be oversized. Further evaluation of the polymer system should be done during detailed design to more closely match required polymer usage.

- A more efficient bottom sludge removal system is recommended. Further evaluation of more efficient bottom sludge removal should be done during detailed design

Recommendations

The size and performance of the digestion process is intimately tied to the performance of the thickening process and thickened solids concentration. Therefore, further consideration of recommendations for the thickening process will be discussed in Technical Memorandum 2 – Digestion Options. Life cycle costs will be developed for both thickening options as a part of that Technical memorandum that will allow recommendation of the system that provides the most advantageous solution for the solids handling process.

CHAPTER 5 - TECHNICAL MEMORANDUM NO. 2, EVALUATION OF DIGESTION OPTIONS

City of Riverside Water Quality Control Plant Evaluation of Digestion Options Technical Memorandum 2

Prepared By: Brown and Caldwell
Date: Revised December 20, 2002

Introduction

Project Background

Efficient digestion of raw wastewater solids protects the environment and public health and reduces solids disposed of from the facility. Solids reduction lowers plant operating costs saving the rate payers money. On June 4, 2002, Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Regional Water Quality Control Plant management and operations staff to further define the scope and design criteria for this digestion options study. Process objectives for this study would maximize solids destruction, increase gas production, minimize odor impacts and consider Class A product requirements as defined by EPA 40CFR Part 503 regulations. Several anaerobic digestion options were discussed during the meeting including mesophilic, thermophilic, temperature phased, and acid/gas phased digestion as well as pasteurization. Data from several plants operating these processes were provided to show the levels of volatile solids destruction and gas production. Each of these options is described in greater detail later in this technical memorandum. Because of their tendency to produce a solids that are more odorous, thermophilic only and acid/gas digestion options have been dropped from further consideration. The ability to produce a Class A product was also discussed and determined to be of secondary importance. On October 31, 2002, a status and review meeting was held with with the City of Riverside Public Works Department Regional Water Quality Control Plant management and operations staff to discuss any comments they may have on the draft technical memorandum. Information received at that meeting is being incorporated into this revised technical memorandum. The most significant comment received at that meeting was on the performance of the existing DAFs. Plant staff reported that thickened sludge concentration has increased from the 3.5% reported in data previously provided to 4.5 to 5%. Plant staff felt that this performance level was achievable on a regular basis since modifications to the existing DAF bottom scrappers and air compressor system had been made.

Objectives.

As stated in the scope of work for this project and as discussed at the project kickoff meeting, the following objectives are addressed in this technical memorandum.

1. Define digestion options using existing tankage at the Riverside Regional Water Quality Control Plant (RWQCP) including options discussed at the kickoff meeting.

2. Develop process schematics, key piping/equipment needs and estimate performance benefits of the top two options in terms of volatile solids destruction, gas productions, dewatering impacts, recycle impacts and product odor.

3. Define capital costs for the two options evaluated

Existing Digestion Facilities

The existing anaerobic digestion process includes five digesters ranging in size from 0.603 to 1.8 million gallons. The smallest of these digesters is no longer in service. The next smallest digesters is currently being used for storage prior to dewatering. This digester is normally unheated and unmixed although it has the equipment necessary to do both. Thickened primary and secondary sludge and primary scum are fed separately directly to the digesters. As discussed in Technical Memorandum 1 (TM1), WAS is thickened in two DAFTs and primary sludge is thickened in the primary sedimentation tanks. Primary sludge from Plant 1 is sent to Plant 2 for further thickening along with the raw wastewater coming to Plant 2. Primary sludge from Plant 2 is fed sequentially to the operating digesters on a time basis every 15 minutes. Operations has indicated that when times between pumping have been extended beyond 15 minutes that holes have developed in the sludge blanket and the sludge can become septic and float. The average primary sludge concentration as shown in TM1 is approximately 4.5%. The average thickened WAS (TWAS) concentration as shown in TM1 is approximately 4.5 to 5.0% (reported by City at October 31, 2002 meeting). The thickened sludge pumps located at the DAFTs transfer TWAS sequentially to the digesters on a timed basis.

Necessary digester heating is provided by individual spiral heat exchangers located in the digester control buildings located at the digesters. Hot water is provided primarily from hot water produced by waste heat at the cogeneration facility. Backup boilers are provided to supply necessary heat when the cogeneration facility cannot provide sufficient hot water to run the plant. Currently most of the plant's hot water needs are provided from the engine generator's jacket water and after cooler water heat exchangers with exhaust heat exchangers supplementing the system occasionally. Use of available heat energy will be addressed in a separate technical memorandum.

A description of the existing anaerobic digestion equipment is shown in Table 1.

TABLE 1 – EXISTING DIGESTER EQUIPMENT

ANAEROBIC DIGESTERS

Digester No.	1	2	3	4
Diameter, ft	90	90	75	88
Sidewater Depth, ft	32	32	32	38.5
Volume, million gal	1.64	1.64	1.06	1.8
Total Digester Volume, million gal (excluding No. 3)			5.08	

MIXING PUMPS

Digester No.	1	2	3	4
No. of Units	2	2	1	1
Type	Vortex Propeller, centrifugal			

Process Alternatives

In addition to considering mesophilic digestion options similar to the approach currently in use at the RWQCP, several other technologies have developed over the last decade that may improve digester performance, obtain Class A biosolids and provide other benefits. Across the country data being gathered from processes now in operation or being pilot tested are showing varying levels of success in increasing volatile solids reduction resulting in increased digester gas production. Several of these technologies were discussed briefly at the kickoff meeting. These processes are described in more detail below.

Mesophilic Anaerobic Digestion

Mesophilic anaerobic digestion is the most common stabilization process used today, and is the process that has been used at the existing RWPCF. Historically, the process was implemented in a 2-stage system where the first tank was used for stabilization and the second for storage and concentration of digested sludge. Modern high-rate digesters are typically single-stage reactors, such as used at Riverside. Organic matter is converted to methane, carbon dioxide, and water; pathogen densities are reduced; and a stabilized sludge is produced. Mesophilic anaerobic digesters is typically operated at temperatures between 35 and 38 degrees C. EPA estimates that over 50 percent of the wastewater treatment plants in the US use this process. Mesophilic digestion at the RWQCP produces a Class B (pathogen) product and easily meets vector attraction reduction requirements for stabilized biosolids.

Two-stage mesophilic digestion could be a process option. This process typically involves a second-stage reactor that has less solids retention time (SRT) than the first stage. The advantage of the process is slightly improved VSR and a product with reduced pathogen content and a product with less odor potential. Some repiping would be required to implement this process variation at the RWPCF.

Thermophilic Anaerobic Digestion

Thermophilic anaerobic digestion is similar to mesophilic anaerobic digestion except that the reactors are operated at temperatures ranging from 50 to 60 degrees C. At present, there are at least a dozen full-scale wastewater plants using thermophilic anaerobic digestion in the US. The major differences between thermophilic and mesophilic digestion are the requirements for sludge heating, temperature control, feed control, and digester gas management. The major advantages of thermophilic digestion are additional VSR and gas production, and the potential to meet Class A requirements. Thermophilic digestion can be undertaken in single-stage systems or in multiple-stage systems. Multiple stage systems have advantages in pathogen control and reducing volatile fatty acid (VFA) concentrations in the product. Some locations report a slightly more odorous product from thermophilic digestion (over mesophilic digestion) and this is largely due to the VFA concentrations. Recent studies by the City of Los Angeles at the Hyperion plant showed that thermophilic digested biosolids were less odorous than mesophilic digested biosolids at the land application site, however they were more odorous at the plant site (Hyperion Advanced Digestion Pilot Program, Hernandez, et al, 2002)

Temperature Phased Digestion

The temperature phased digestion process includes anaerobic digestion systems whereby digestion occurs at two different temperatures – mesophilic and thermophilic. Since each phase has largely different sets of bacteria and since thermophilic reactions proceed at a faster rate, greater total VSR can be achieved. Within each phase, all digestion processes of hydrolysis, acidification, and methane formation occur and should be in balance. Therefore, the pH is not depressed and acid/alkalinity ratios are monitored to show proper health of each phase of the process. The phases can be in either order, but sufficient SRT must be provided in each phase for full methane production.

The more common process order for temperature phased digestion is for the thermophilic system to come before the mesophilic system. This is primarily because of the desire to reduce volatile acids to as low a level as possible in the product, and thereby have a digested product with minimum odor level. The process evolved in Germany in the 1980s and some process developers there have promoted minimum SRT in the thermophilic phase of only 2 to 3 days. However, essentially all German facilities using the process (about 10 are reported to exist) have thermophilic phase SRTs greater than this (Dichtl, 1997).

In the USA, the process has been promoted and developed largely by Iowa State University (ISU), which holds a patent on it. ISU calls the process Temperature Phased Anaerobic Digestion or TPAD. About 8 TPAD systems are now operating in the USA; however, several of these have just recently come on-line and data at others are quite limited. Most of the USA plants are located in the Upper Midwest and Great Plains states (Iowa, Wisconsin, Nebraska). Omaha Nebraska's Papillion Creek WWTP (about 55 mgd) has one of the largest temperature phased digestion systems in the USA.

Significant increases in VSR are being achieved by moving from a single-stage mesophilic system to a temperature phased process. Plants seem to be achieving between 15 and 25 percent additional VSR by making this change. For instance, a plant which had been recording 50 percent VSR with single-stage mesophilic digestion, may achieve about 60 percent VSR by changing to this temperature phased process (a 20 percent increase in VSR).

An advantage of the process is that it operates well at a wide variety of retention times for each phase. In the USA, to implement the process, existing digesters have often been converted from mesophilic to thermophilic service, thereby providing fairly long retention times for thermophilic digestion (greater than 12 to 15 days, typically). For plants wishing to maximize performance, thermophilic retention times in the range of 3 to 8 days may be more appropriate. Mesophilic retention times may be reduced to as low as 10 to 12 days, although at these low-end SRTs, product volatile acid levels may be high enough to cause concern for final product quality.

Acid/Gas Phased Digestion

The anaerobic digestion process proceeds through definable phases. These phases include: hydrolysis - the solubilization of particulate material; acidification - production of volatile acids; and methanogenesis - the production of methane gas. Each phase has groups of micro-organisms which are primarily responsible for these activities. To some extent, these phases can be separated so that the bacteria are grown within desirable or even optimum conditions. The most workable process separation developed to date is to create an acid-phase and a methane or gas-production phase.

The primary characteristics of this phasing approach are the following:

- The first phase (acid-generation) has a short SRT to maximize acid production within an acidic environment – generally pH 6 or less. The result is that little methane gas and little total gas is produced. High concentrations of volatile acids occur in this phase.

- The second phase (gas-generation) has considerably longer SRT because methane-generating bacteria require longer growth times. The pH is above neutral and the vast majority of methane, and total gas, is produced in this phase.

The primary advantage of this approach is that greater volatile solids reduction is possible (over single stage mesophilic digestion) and the approach seems to limit foam production within the process. The process was originally developed at mesophilic temperatures for both phases, but either phase can be at thermophilic temperatures.

This process evolved in the 1970s under the name Acimet, and patents were developed for the process. The treatment plant which has the longest history of using this process is the Woodridge-GreenValley WWTP in DuPage County, Illinois. For about 10 years this plant has operated with acid/gas phased digestion. More recently, a few other facilities in the USA are moving toward

using the process or are pilot testing the process. For instance, full-scale testing work at the Inland Empire District in California is underway. A specially built and specially operated acid phase reactor is normally required to achieve the short SRTs and the maximum benefit from the process.

The gas from the first phase reactor at DuPage County contains about 3000 to 10,000 ppm of hydrogen sulfide. This gas is burned directly in a flare. Other options may be required at plants located in areas where SO_x limits are more severe. Also, any leakage of the gas from the acid-phase reactor is likely to be a significant odor problem, due to its extremely high odor level (much more odorous than typical digester gas from mesophilic digestion).

Process Development and Comparison

Solids loading

Raw solids projections were presented in TM1 for both primary sludge and WAS for 40 MGD and 50 MGD design condition. Table 2 shows thickened solids loading projected for use in this digester option evaluation. Flows for primary and WAS thickening assume no changes to current performance (primary sludge concentration 4.5% average and TWAS concentration 4.5% average). Co-thickened flow assumes 5.5% float concentration. Flows and loads were derived from ten months of existing plant data.

TABLE 2 – DESIGN SOLIDS AND HYDRAULIC LOADING

Design loadings - 40 MG	Primary & WAS Flow, MGD	Co-thickened Flow, MGD	TSS, lb/d	VSS, lb/d
Average day	0.26	0.22	101,191	81,491
Peak 2 week	0.37	0.31	141,667	114,087
Design loading – 50 MGD				
Average day	0.33	0.28	126,489	101,864
Peak day	0.47	0.39	177,084	142,609

Digester options design criteria

As noted in the descriptions of the different digester options, different design criteria would apply to each option. Digester options that increased the potential for odors have been dropped from further consideration. Only Mesophilic and Temperature Phased Anaerobic Digestion are being considered at this time. Table 3 summarizes design and operating criteria for candidate digestion processes. These criteria are developed to meet regulatory requirements, collect digester gas reliably, keep odor emissions to a minimum and provide maximum stabilization for the biosolids product. The required tank volume for each option is heavily dependant on the choice that is made for thickening.

TABLE 3 – DIGESTER DESIGN AND OPERATING CRITERIA

Parameter	Mesophilic System	Temperature Phased System
Retention time in thermophilic digestion	N/A	3.5 days minimum at peak load (5 days minimum at average load)
Retention time in mesophilic digestion	18 days minimum average load (18 days minimum at peak month with all tanks in service)	10 days minimum at peak load (12 days minimum at average load with one tank out of service)
Digester temperatures	35 to 38 C	Thermo 53 to 60 C Meso 35 to 38 C
Vol. Solids loading rate (lb VS/ft^3/day	<0.3	System < 0.3
Digester operation	High-rate complete-mix, all tanks	High-rate complete-mix, all tanks
Cover configuration	Fixed cover, all tanks	Fixed cover, all tanks
Liquid level variation	Range of 4 feet maximum	Thermo-no liquid level variation Meso-range of 4 feet maximum
Bottom configuration	Cone - shape	Cone – shape
Mixing	Hydraulic	Hydraulic on thermo and meso
Heating	Hot water/sludge HEX units	Hot water/sludge HEX units plus heat recovery from thermo to meso
Vol. Solids reduction	53%	61%
Methane production (ft^3 gas/lb VS destroyed)	13 to 17	13 to 17

For this reason, required tank volumes for each option are shown for both thickening choices for comparison. Table 4 summarizes these tank requirements for the ultimate plant capacity of 50 MGD.

TABLE 4 – DIGESTER VOLUME REQUIREMENTS

Digester Option	Separate Thickening	Co-Thickening
Mesophilic System		
Required volume, peak 2 week- MG	7.0	5.79
Required volume, avg w/1 unit out – MG	6.0	4.96
Available volume, peak 2 week	5.08	5.08
Available volume, avg w/o digester 4	3.28	3.28
Additional volume required, peak 2 week	1.92	0.71
Additional volume required, avg w/o digester 4	2.72	1.68

Number required	2	1
Depth required	32	32
Diameter required	85	95
Temperature Phased System		
Thermophilic Digestion phase		
Required volume, avg	1.2	0.98
Additional volume required (assumes using existing 1.64 MG digester)	None	None
Mesophilic Digestion phase		
Required volume, peak 2 week – MG	5.6	4.68
Required volume, avg w/1 unit out – MG	4.0	3.31
Available volume, peak 2 week	3.2	3.2
Available volume, avg w/o digester 4	1.64	1.64
Additional volume required, peak 2 week	2.4	0.50
Additional volume required, avg w/o digester 4	2.36	1.74
Number required	2	1
Depth required	32	32
Diameter required	79	94

Mesophilic Digestion System

Table 4 shows that either one additional digesters would be needed if either separate thickening is continued or co-thickening of primary and secondary sludge in DAFTs is implemented. Required digester volumes shown in Table 4 will provide sufficient volume for 18 days of detention time at average flow with the largest digester (Digester No. 4) out of service and 15 days detention time at peak flow with all digesters in service. Digester No. 3 will remain as a storage tank and may function as a part of the two-stage mesophilic digestion process. Digester No. 3 has heating and mixing equipment and may provide additional digester capacity if needed. At half full, Digester 3 would provide an additional 1.3 to 1.9 days detention time for separate or co-thickened sludge flows respectively. This is extremely valuable and adds flexibility to the dewatering process operation to keep dewatering costs down and minimize adverse impacts associated with final use/disposal of the product. Future digesters would be constructed in the open area adjacent to the Cogeneration facility behind Digester No.s 1 and 2. Figure 1 provides a process schematic for mesophilic digestion at RWQCP.

This option could also includes a relatively small (approximately 50,000 gallon – 20 foot diameter) thickened raw sludge-blending tank. This tank accepts all thickened raw solids and blends these materials so that each digester receives the same feedstock blend. Pumps dedicated to each of the primary digesters, pump raw sludge on a continuous basis at a rate to keep the blending tank at set liquid levels. Equalization of raw sludge pumping can also occur, depending on the size of the blending tank. Digesters provide the greatest performance when fed continuously and when the diurnal feed cycle is largely equalized. TWAS

pumping problems can also be largely resolved by pumping to this tank rather than through a valving complex.

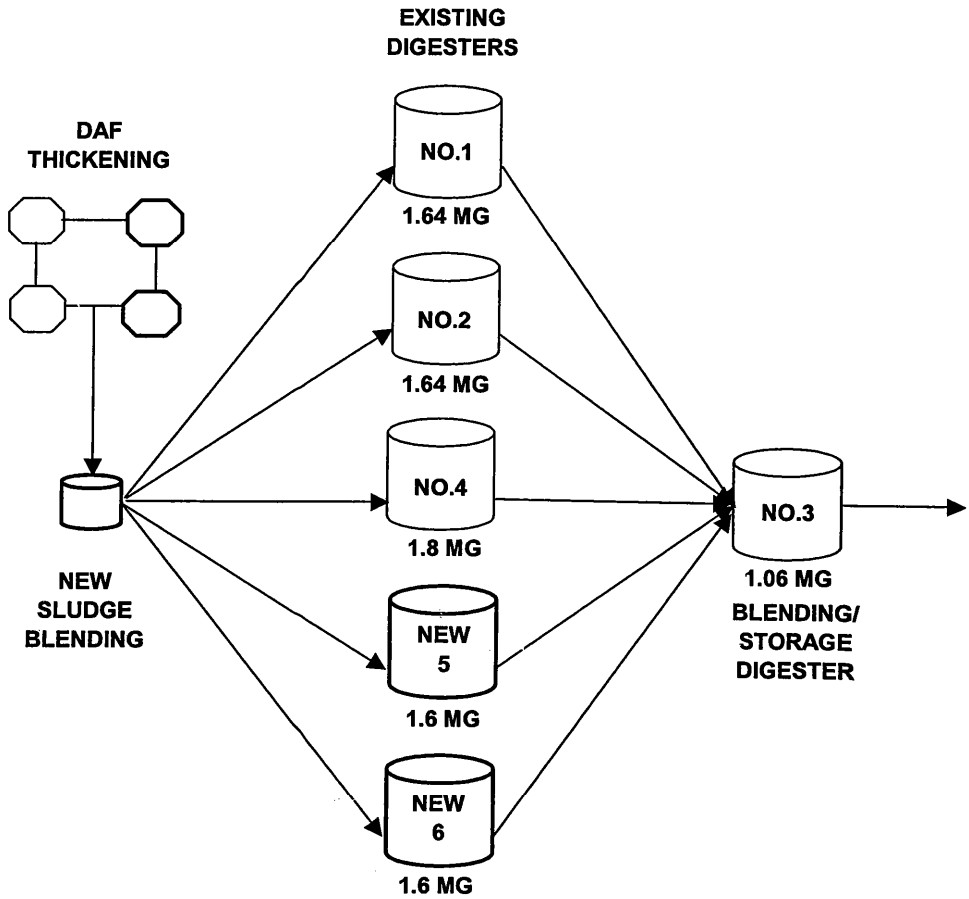


FIGURE 1 – MESOPHILIC DIGESTION

Temperature Phased Digestion (TPAD) System

Table 4 shows that the same number of additional digesters would be required for the TPAD system as the Mesophilic digestion system for the two thickening options. By providing additional digesters that are the same size as the mesophilic digester option greater reliability and flexibility in the digestion system may be achieved. What this means is that the digestion system would have the flexibility to operate either in the TPAD mode when the thermophilic digester is in service or in the mesophilic mode when the thermophilic digester is out of service.

Because the thermophilic digester operates at a higher temperature than the mesophilic digester sludge leaving this digester would need to be cooled prior to entering the mesophilic digesters. Heat recovery could be done in the thickened sludge blending tank by using a sludge to sludge heat exchanger to cool sludge going to the mesophilic digesters. Heat recovery is included in the cost analysis

presented later. A more detailed analysis will be necessary during project design. Reliable and consistent temperature control is essential for proper TPAD operation. Future digesters for this option would also be constructed in the open area adjacent to the cogeneration facility behind digester No.s 1 and 2. Figure 2 provides a process schematic for the TPAD system. Figure 3 shows a possible layout for either mesophilic or thermo/meso digestion.

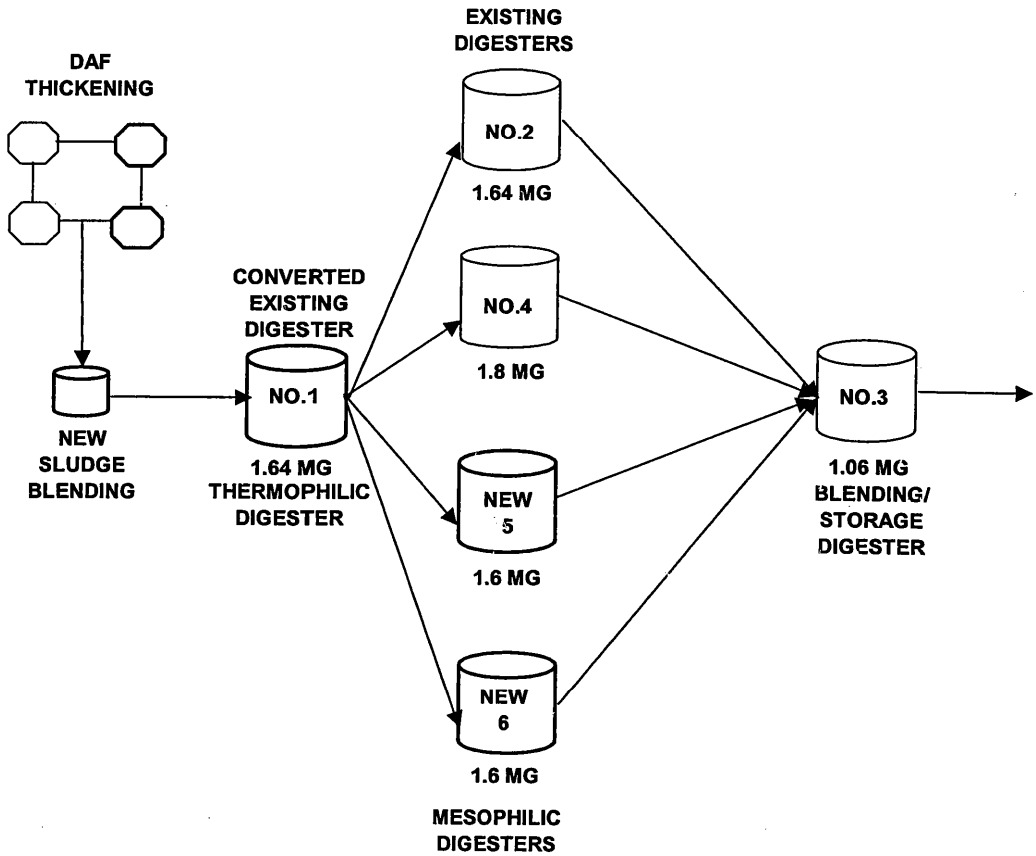


FIGURE 2 – TEMPERATURE PHASED DIGESTION

Initial Temperature Phased Digestion Implementation.

Initial implementation of temperature phased digestion could be accomplished by modifying digester No. 1 or 2 to operate at thermophilic temperatures, and utilize digester No. 4 and the remaining digester as mesophilic digesters. This would be a positive way to confirm the performance of temperature-phased digestion in the near term. Conversion to temperature-phased digestion would involve the following activities:

- Add heat exchange and hot water supply capacity to bring the temperature up to 55 C on a reliable basis for one digester. All raw sludge would be fed to this one reactor and retention time would be about 6 to 7 days under current average conditions.

- Add digester gas condensing capacity for the thermophilic digester gas since the gas will contain considerably more moisture than the existing mesophilic digester gas. Also, confirm that digester gas piping is sufficiently large enough to handle the extra gas production anticipated from the thermophilic reactor in peak loading periods.

- Pump and piping modifications will be required to pump the thermophilically digested sludge to both of the mesophilic digesters. Only one mesophilic digester is actually needed with current loads (providing about 14 to 15 days total retention time under average conditions), but in case one digester is off-line, there should be capability to pump to the other one.

- Modify the operation of the existing heat exchange units on the two mesophilic digesters to be "cooling" exchange units by running cool water through them instead of hot water. This is satisfactory only if the additional heat can be dumped to the plant effluent or another heat sink.

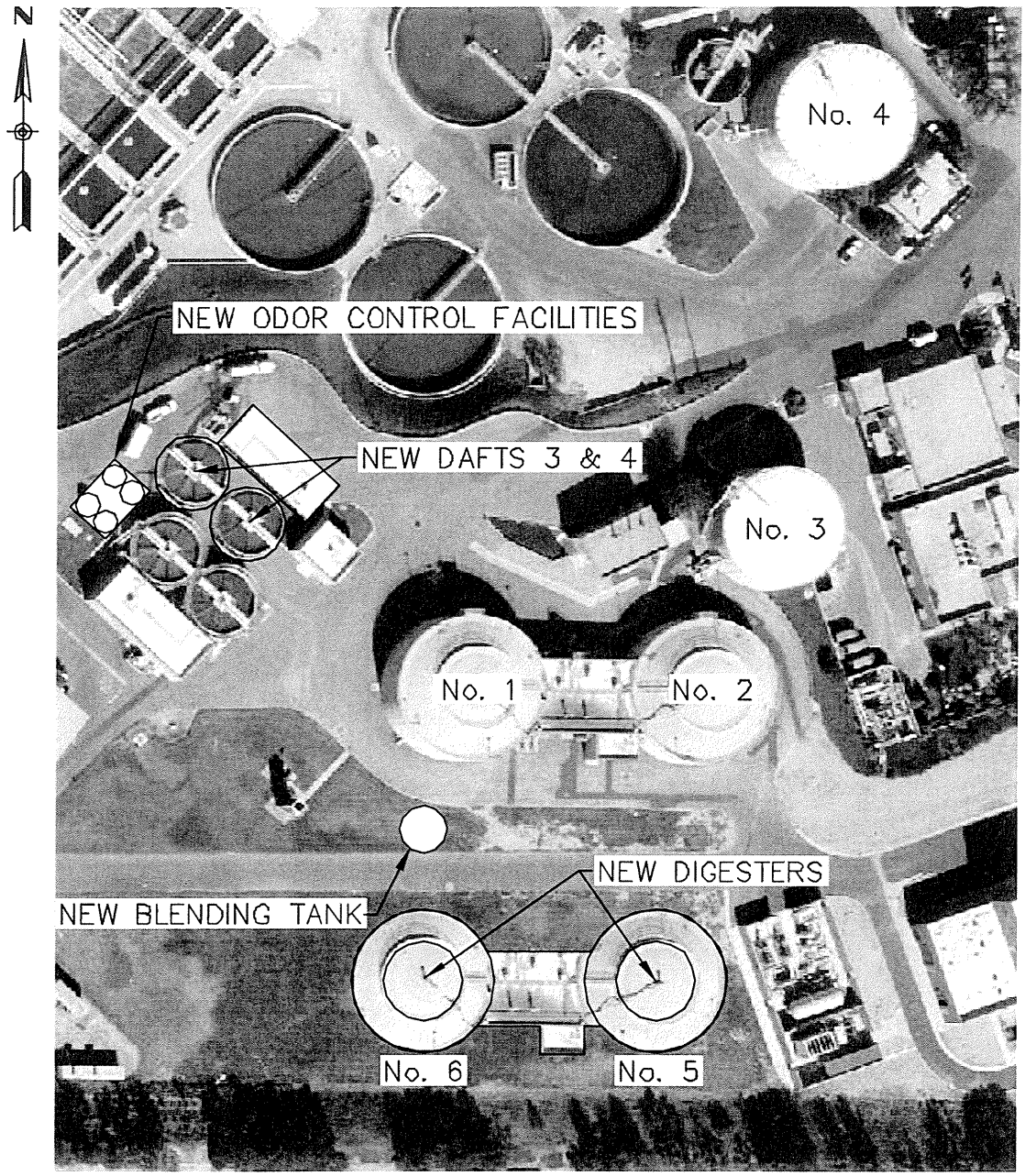
- If the above item is not workable due to the lack of a heat sink, then sludge-to-sludge heat exchange/recovery is needed (recovery of the thermophilic sludge heat to partially heat up the raw incoming sludge). This would require two sludge-to-sludge heat exchanger units (assuming spiral design), for reliability and performance needs.

- Any exposed materials within the thermophilic digester need to be evaluated to confirm that they can function under the thermophilic temperature range anticipated.

The construction cost to complete the above changes is anticipated to be in the range of $2.5M to $3.0M, including engineering and administration.

Class A Facilities.

Class A facilities are defined by the USEPA regulations 40 CFR Part 503. These regulations set maximum allowable limits of pathogens, vector attraction and heavy metals in biosolids that may be land applied in various applications. These regulations list six alternatives for pathogen reduction, the first of which deals with thermally treated biosolids. To meet Class A pathogen reduction requirements, thermally treated biosolids must be subjected to one of four temperature regimes. Of these four temperature regimes listed in the 503 regulations, only two may apply to the RWQCP. For solids concentrations less than 7%, biosolids must be heated for at least 15 seconds but not less than 30 minutes where D (detention time in days) = $131{,}700{,}000/10^{0.14t}$ (temperture in degrees C) or the temperature of sludge must be 50 degrees C or higher with at least 30 minutes or longer of contact time where $D = 50{,}070{,}000/10^{0.14t}$. Another key ingredient of this alternative is that there must be no possibility for short circuiting.



NOTE:
DIGESTER LAYOUT SHOWN ASSUMES CONTINUED SEPERATE THICKENING. DIGESTER 6 NOT NEEDED FOR CO-THICKENING OPTION.

DATE	PROJECT NUMBER	
09/12/02	22776.002	PROPOSED MESOPHILIC OR THERMOPHILIC DIGESTER PLAN
BROWN AND CALDWELL SAN DIEGO, CALIFORNIA	PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT RIVERSIDE, CALIFORNIA	0 50 100 SCALE IN FEET
		FIGURE 3

22776_FG-3

The previously described temperature phased digestion system will not meet Class A requirements because the thermophilic digester is not operated in a batch mode. With continuous or near-continuous feeding and withdrawal, short-circuiting of pathogens through the reactor prevents Class A designation. Therefore, specific additional tankage would be required to meet the Class A standards. Normally, thermophilic batch tanks are expected to meet the Class A requirement and these are described in the first section below. Also described is another option involving a continuous flow pasteurization process, which has been approved by the EPA as Class A.

Class A Process-Batch Tanks.

Class A facilities include a set of batch tanks, which are, in essence, digesters operating in the thermophilic temperature range. For this option, we currently envision operation at temperatures within the range of 57 to 58 C (about 135 to 136 F). This range is suggested because of the following factors:

- By operating thermophilic batch tanks at a temperature of at least 57 C, the time required can be limited to 12 hours. This keeps individual tank sizes down to 305,000 gallons each, to accommodate expected peak daily sludge flowrates for an ultimate plant size of 50 MGD.

- Operating at temperatures higher than about 60 C appears to be detrimental for peak thermophilic digestion performance. The exact temperature at which digestion performance begins to drop is not quantified accurately through current research and development work since few facilities have operated above 55 to 56 C. Research has shown that active anaerobic digestion takes place at 60 C and even 65 C, however, digestion effectiveness is believed to be reduced when reaching temperatures at and above the 60 C range since these high temperatures are likely to stress some thermophilic bacteria.

Multiple tanks are required for batch operation, and one tank is required for a backup or spare tank. An example configuration is provided below using 3 tanks for a given batch period of 12 hours (a fourth tank would be required for backup):

- Tank 1 is being filled

- Tank 2 is in batch storage mode (12 hours minimum at 57.2 C)

- Tank 3 is being drawn down and solids moved to the next process downstream

This operating sequence changes during the next 12 hours, whereby Tank 1 is in batch storage mode, Tank 2 is being drawn down, and Tank 3 is being filled. Valves are automatically reset every 12 hours to provide constant withdrawal of

sludge from one of the 3 tanks of this system and so that subsequent heat recovery can take place on a continuous 24 hour/day basis. This arrangement has no adverse operating impact upstream or downstream in the digestion process. Figure 4 provides a process schematic for a TPAD system with Class A batch tanks.

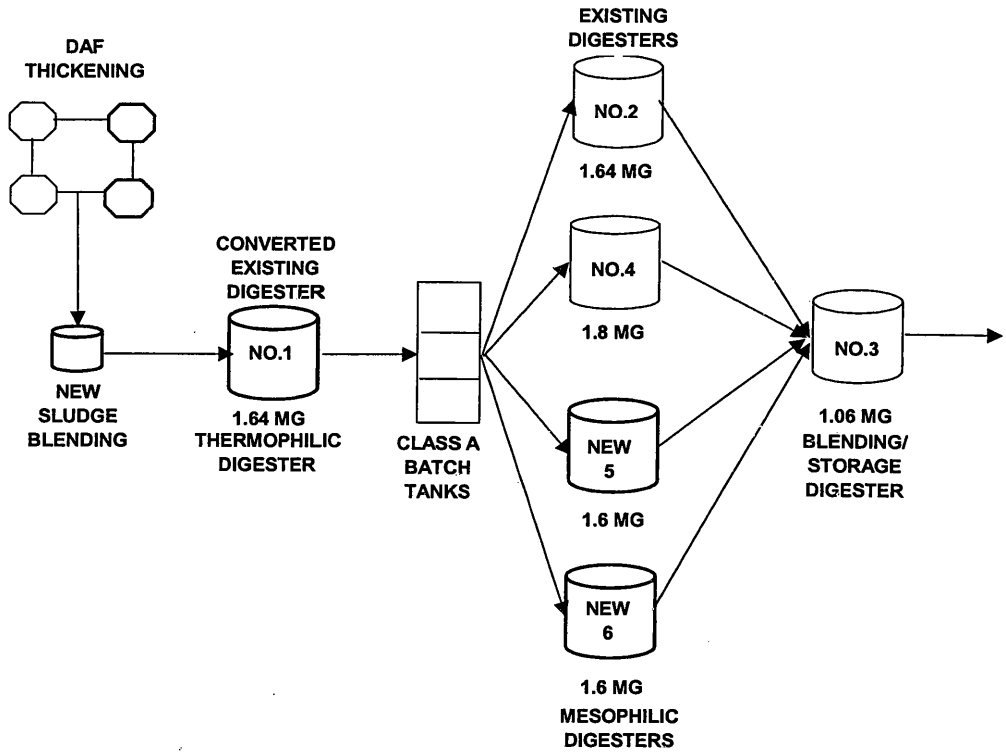


FIGURE 4 – CLASS A TEMPERATURE PHASED DIGESTION

Class A Continous Flow Tanks.

The USEPA has not yet approved continuous flow thermophilic digestion in multiple-stage, complete-mix tanks as a Class A process. However, there is mounting pressure for the EPA to set ground rules for this approach since batch operation, particularly at larger plants, may be cumbersome. The ground rules for such an approach are likely to be affected by the new thermophilic digestion facility at the Annacis Island WWTP in Vancouver, Canada. In using the same pathogen die-off modeling approach for RWQCP that was used at the Annacis Island thermophilic digestion facility, (5 log reduction in pathogen densities), we find that the following system should achieve Class A at the RWQCP without batch operation:

- Thermophilic digestion at 3 to 4 - day retention time (minimum) at 57.2 C

- Subsequent 3 smaller complete mix digesters operated in series at 12-hour retention time and temperature of about 57.2 C (minimum).

Therefore, the same tankage described for the batch operation could serve in the future in a continuous flow (non-batch) system. This provides an improved system and would be flexible in meeting Class A more easily in the future

Alternative Class A Facilities

As described above, batch processes have typically been required to ensure there is no short circuiting. A continuous plug flow pasteurization system has recently been approved by USEPA Region 9 for installation by the Eastern Municipal Water District at the Hemet, CA WWTP. The process that has been approved for this facility is the Ashbrook Eco-Therm ™ Pasteurization process. This process is a continuous plug flow system, which treats liquid biosolids by heating the material above 70 degrees C and maintains that temperature for a period of 30 minutes or longer without short circuiting. The process installed at the 11 MGD Hemet WWTP is located immediately upstream of their anaerobic digesters. To bring the temperature of the pasteurized sludge down to the temperature needed in the digesters, a sludge cooling system has been provided to recover the heat from the pasteurization system. The anaerobic digesters provide the necessary volatile solids destruction to meet the vector attraction requirement to meet Class A biosolids. The cost of the system installed at the Hemet WWTP was approximately $750,000

Cost for Anaerobic Digestions and Thickening Options

Construction and capital costs for new thickening and digestion alternatives are identified in Tables 5 and 6 respectively. New DAFT and digestion costs are taken from recent projects across the Western United States. Construction costs for thermophilic digesters are similar to the cost of mesophilic digesters, although proper design requires materials compatibility at higher operating temperatures. Gas handling for thermophilic digestion needs to accommodate the increased water content of the gas and resulting moisture condensing requirements. Heating systems must provide reliable temperature and temperature control must be able to keep digester temperatures within a narrow range (± 0.5 C), especially for Class A operation. Continuous temperature monitoring and automatic control on the recycle-heating loop are required, along with a backup heat exchanger.

TABLE 5 ESTIMATED COSTS FOR THICKENING ^($1,000)

Work Element	Thickening Options	
	Separate Thickening	Co-thickening
New DAFT – (two 39 ft diam)	2,700	NA
New DAFT w/covers– (two 44 ft diam)	NA	3,000
Rehab Existing DAFTs	NA	500
Primary sludge pumps & piping	NA	1,000
Air scrubbers (22,500 scfm)	NA	1,200
DAFT control building (8,000 sf)	1,000	1,000

Bottom sludge degritting	NA	100
Subtotal	3,700	8,800
Contingency 30%	1,100	2,600
Construction Costs	4,800	11,400
Project Costs @ 25% (engr, admin, etc)	1,200	2,800
Total Capital Costs	6,000	14,200

TABLE 6 ESTIMATED COSTS FOR ANAEROBIC DIGESTION ^ (1,000)

Work Element	Mesophilic Digestion	Temperature Phased Digestion	Temperature Phased Digestion + Class A system
Separate Thickening			
Raw sludge blending Tank & pumps	250	250	250
New Digesters	10,000	10,000	10,000
Class A System	NA	NA	3,000
Convert Existing digester to Thermophilic	NA	3,000	3,000
Subtotal	10,250	13,250	16,250
Contingency 30%	3,100	4,000	4,800
Construction Costs	13,350	17,250	21,050
Project Costs 25% (engr, admin, etc.)	3,300	4,300	5,300
Total Capital Cost (Separate Thickening)	16,650	21,550	26,350
Co-thickening			
Raw sludge blending Tank & pumps	250	250	250
New Digesters	5,000	5,000	5,000
Class A System	NA	NA	3,000
Convert Existing digester to Thermophilic	NA	3,000	3,000
Subtotal	7,690	10,690	13,690
Contingency 30%	2,300	3,200	4,100
Construction Costs	9,990	13,890	17,790
Project Costs 25% (engr, admin, etc.)	2,500	3,500	4,500
Total Capital Cost (Co- thickening)	12,496	17,496	22,290

Present Worth Cost Analysis of Thickening and Digestion

As noted in TM1 and as shown in Table 4 the required additional digestion facilities is heavily dependant on the selected thickening option. To evaluate the economic impact on the thickening and digestion system a present worth cost analysis has been prepared for both thickening options taking into account the

required mesophilic digester facilities needed to support that options. A list of general economic assumptions made for the two thickening options is provided below.

- Planning period is 20 years
- Net discount rate is 3 percent
- Polymer cost is $1.50 per active pound

Present worth costs for the two thickening options are identified in Table 7. Present worth costs for the three digester alternatives are identified in Table 8.

TABLE 7 PRESENT WORTH COSTS FOR THICKENING OPTIONS ^(1,000)

Cost Element	Separate Thickening	Co-thickening
Annual operating cost		
New & upgraded DAFT		
Power @$0.075/KWH	238	739
Polymer @ $1.50/lb	0	1
Maintenance @ 1% equip cost	25	64
Air Scrubber		
Power	0	7
Chemicals	0	2
Maintenance	0	11.6
New Digesters O&M 5% equipment cost	500	500
Total Annual Cost	763	824
Present Worth Cost		
Total Capital Costs	18,500	26,700
Present Worth Annual Cost, 20 yr @ 3% net discount	15,300	16,600
Total Present Worth Cost	33,800	43,300

TABLE 8 PRESENT WORTH COSTS COMPARISON FOR DIGESTION ALTERNATIVES ^(1,000)

Cost Element	Mesophilic Digestion	Temperature Phased Digestion	Temperature Phased Digestion + Class A
Co-thickening Option			
Annual operating costs			
Annual O&M costs	400	450	500
Gas Energy value	NA	(170)	(170)
Biosolids cost savings over Meso	NA	(180)	(180)
Total Annual cost	400	100	150
Present Worth Cost			
Total Capital Cost	12,500	17,500	22,300
Present Worth Annual Cost, 20 yr @ 3% net discount	6,000	1,500	2,250
Total Present Worth	18,500	19,000	24,550
Separate Thickening			
Annual operating costs			
Annual O&M costs	400	450	500
Gas Energy value	NA	(170)	(170)
Biosolids cost savings over Meso	NA	(180)	(180)
Total Annual cost	400	100	150
Present Worth Cost			
Total Capital Cost	16,650	21,550	26,350
Present Worth Annual Cost, 20 yr @ 3% net discount	6,000	1,500	2,250
Total Present Worth	22,650	23,050	28,700

Thickening and Digestions Recommendations

TM1 offered two thickening options, WAS only thickening and co-thickening of primary and WAS. Implementation of WAS only thickening would require construction of two (2) 39 foot diameter DAFTs. Implementation of co-thickening would require construction of two (2) 44 foot diameter covered DAFTs, new primary sludge pumps and piping to pump thinner primary sludge, bottom sludge degritting and new odor control.

The present worth value for the two thickening options when digestion is also considered is $ 33.8 million for WAS only thickening and $43.3 million for co-thickening. As noted in TM1 other benefits of co-thickening would include possible increased primary sedimentation surface overflow rates and grit removal prior to digestion.

Based on the present worth analysis we recommend that Riverside proceed with the following thickening and digestion system plan

- Plan on implementing addition of DAF facilities to continue separate thickening of primary sludge and WAS with DAFTs
- Plan on implementing a 50,000 gallon thickened solids blending tank and two 32 foot deep, 90 foot diameter digester to match digesters 1 and 2 as a mesophilic digesters.
- Defer a decision on implementing Class A digestion at this time. However, continue to plan for future temperature phased digestion as a part of Class A facilities.

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CHAPTER 6 - TECHNICAL MEMORANDUM NO. 3, HEAT AND ENERGY OPTIONS

City of Riverside Water Quality Control Plant Heat and Energy Options Technical Memorandum No. 3

Prepared by: Brown and Caldwell
Date: October 25, 2002

Introduction

Changes to the City of Riverside solids processing operation will require added heat and may change the digester gas production. This Technical Memorandum evaluates the RWQCP heating and energy options for the proposed solids system modifications.

Objectives

The following objectives are addressed in this technical memorandum:

1. Review the design and the operational information
2. Review the existing digester gas and the landfill gas (LFG) system and gas characteristics
3. Define plant future heating needs, including digestions changes
4. Review applicable air quality limitations
5. Define and evaluate options for meeting the future RWQCP heat needs and energy performance requirements

Existing Conditions and Heating and Cooling Needs

Existing Conditions

The existing RWQCP solids processing facilities are well integrated into and interwoven with the cogeneration system.

The cogeneration system is an energy conversion system. Large engine-generators converted the fuel energy in the digester gas, LFG and natural gas into electricity and heat energy. Some of this heat energy is radiated from the hot engine bodies into the room, or is wasted to the engine lubrication oil, but most of the engine heat energy is collected and used at the RWQCP.

Each cogeneration engine is cooled by water circulating through the engine cylinder jacket, and this hot engine jacket water is used to heat the RWQCP, together with heat recovered from the hot engine exhaust gases.

Digester Gas

The RWQCP digesters are mesophilic, anaerobic digesters, and the digester gas is generally similar to that from other municipal wastewater treatment plant sludge anaerobic digester systems. The current and projected gas flow rates are shown in Table 1.

Table 1. Digester Gas Flow rates and Future Flow Projections

Year	Plant flow, mgd	Design system type	Digester gas production		
			Cubic feet per day	Cubic feet per hour	Energy value, million Btu per hour
1991	28.5	Meso	277,379	11,577	6.5
2002	33	Meso	330,000	13,800	7.7
2005 to 2010	40	Meso	664,000	27,700	15.5
2005 to 2010	40	TPAD	799,000	33,000	18.6
2020 to 2025	50	Meso	830,000	34,600	19.4
2020 to 2025	50	TPAD	999,000	41,600	23.3

Notes:
1. Meso = mesophilic; TPAD = temperature-phased anaerobic digestion
2. The hourly gas production is averaged over a 24-hour day.
3. The energy value, million Btu per hour, is based on 560 Btu per cubic foot, LHV.
4. Data from 1991 was taken from the May 1992 JMM TM-1 Master Plan.
5. Current year 2002 data are approximate.

Landfill Gas and Natural Gas

The RWQCP receives and burns three gaseous fuels: digester gas, natural gas, and landfill gas (LFG). The LFG is produced by the Tequesquite Sanitary Landfill, located about 4 miles northeast of the RWQCB. The Tequesquite Landfill is a mature, closed and inactive sanitary landfill. The production of LFG is diminishing over time and is expected to continue to slowly dwindle until it is completely depleted, possibly in about the year 2022 to 2024.

The typical composition of digester gas, landfill gas and natural gas is shown below in Table 2. Note that he landfill gas is blended with some natural gas prior to use, and the natural gas is blended with air prior to use as RWQCP engine fuel.

Table 2. Typical Composition of Individual Fuel Gases

Gas Constituent	Landfill Gas	Digester Gas	Natural Gas
Methane, (CH_4) percent	38 to 58	50 to 62	85 to 96
Carbon dioxide, (CO_2), percent	30 to 50	32 to 45	0 to 2.5
Ethane (C_2H_6), percent	0 to 1	none	4 to 15
Propane (C_3+) and higher, percent	0 to 0.07	none	0.3 to 3
Nitrogen, (N_2) percent	5 to 15	0.5 to 2	0.5 to 2
Oxygen (O_2), percent	0 to 2	0 to 0.2	0
Water in the gas, as produced	variable	saturated	dry
Hydrogen sulfide, (H_2S), ppm	Up to 2000	300 to 2000	0 to 2
Caloric value, Btu per cubic foot (LHV)	350 to 500	500 to 600	930
Caloric value, Btu per cubic foot (HHV)	400 to 550	550 to 650	1020
Temperature, degree F	60 to 75	90 to 98	60 to 75

Notes:
1. The abbreviation "ppm" is parts per million by volume
2. LHV is the low heating value, or the heating value without the formation of free water.
3. HHV is the high heating value, or the heating value with the formation of free water.

Heating System and Equipment

1. Engines. The three Caterpillar cogeneration engines are the heart of the RWQCP heating system. These clean-burn engines burn fuel, and produce power and heat. Each engine is equipped with an exhaust heat recovery silencer to warm water and thus capture the heat in these 900 degree F engine exhaust gases. The engine body radiation is heat that is not captured. Likewise the engine turbocharger aftercooler heat and the engine lubrication oil heat is too "cool" to use, and is wasted, and not recovered. The full engine energy or heat balance is shown below in Table 3.

Table 3. Cogeneration Engine Heat Balance

	Energy, million Btu per hour	
	Each engine	Total for 3 engines
Fuel input energy, at full load	11.34	34.0
Work (driving the generator)	4.07	12.2
Jacket water heat	1.16	3.5
Engine exhaust heat	4.41	13.2
Engine lube oil heat **plus** Engine turbocharger heat	0.66	2.0
Radiation heat	0.47	1.4
Missing or heat accounted for	0.57	4.7
Total	11.34	34.0

Caterpillar has been very guarded with their engine data and the above heat balance data are based on nominal, or expected engine performance values.

The usable engine heat is recovered or extracted from the engine jacket water, and the engine exhaust gases. The engine jacket water is part of the engine cooling system, so this heat removal is essential or the engine will overheat.

The engine exhaust heat is an optional or voluntary form of engine heat recovery. At times when this engine exhaust heat is not needed, an exhaust bypass valve inside the silencer bypasses the heat recovery from the engine exhaust. The exhaust gases leave the engine at a temperature of about 943 degrees F. Normally, the gases are cooled as they travel through the engine exhaust heat recovery silencer, and they leave this silencer at a temperature of about 368 degrees F. The available engine heat is listed in Table 4.

Table 4. Available Engine Heat

Usable, or recoverable engine heat	Energy, million Btu per hour	
	Each engine	Total for 3 engines
Engine jacket water heat	1.16	3.5
Engine exhaust heat, maximum	2.77	8.3
Total	3.93	11.8

2. Boilers. Several hot water boilers are also located in various buildings throughout the RWQCP. Some of these boilers are fully permitted with the Air District and are in working condition, while others are fully disassembled, and are not useable. These boilers, and a steam generator for steam cleaning, are summarized in Table 5.

   This boiler total below does not include the exhaust heat recovery silencers on the cogeneration engine exhaust piping. Occasionally these engine heat recovery silencers are incorrectly called boilers. They are not fired by any fuel and their heat output is included with the engine heat recovery equipment.

Table 5. Existing RWQCP Boiler Summary

Location or Number	Heating Capacity, MMBtuh	Manufacture and Model	Apparent Condition	Status
Zone 4, boiler 1	4.18	Cleaver Brooks NCB 700-100	Good	Operational, standby duty
Zone 4, boiler 2	4.18	Cleaver Brooks NCB 700-100	Good	Operational, standby duty
Zone 4, boiler 3	4.18	Cleaver Brooks NCB 700-100	Good	Operational, standby duty

Boiler 5	1.275	Ajax WGGFD-1275	Good	Emergency use only
Boiler 6	1.275	Ajax WGGFD-1275	Good	Emergency use only
	unknown	Clayton	Good	Steam generator
Boiler Plant 1, Boiler 1	small	Ajax	disassembled	Completely unusable
Boiler Plant 1, Boiler 2	small	Ajax	disassembled	Completely unusable
Boiler Plant 1, Boiler 3	small	Ajax	disassembled	Completely unusable

Notes:
1. MMBtuh is million Btu per hour
2. The Clayton steam generator is a portable steam-cleaning unit and is technically not a boiler. This item is rarely used.

Each of the three Cleaver-Brooks standby boilers in Zone 4 has a heat output approximately equal to one of the three Caterpillar cogeneration engines.

Cooling System and Equipment

The RWQCP hot water heating system is interconnected with, and to a certain extent, driven by the Laboratory Building chilled water system.

The Laboratory Building has a nominal 150-ton absorption chiller that is "powered" by heating water from the cogeneration system. This absorption chiller has a design full load heat input of approximately 2.6 million Btuh. Because the absorption chiller requires heat at the highest possible temperature in order to function, this chiller forces the heat loop to deliver 190 to 200 degree F hot water.

Air Quality Concerns

The RWQCP is located in the City of Riverside, and is within the jurisdiction of the South Coast Air Quality Management District (SCAQMD).

The SCAQMD has enacted detailed and stringent air quaity standards for stationary combustion sources, including large internal combustion engines and fired boilers. A summary of relevant and potentially applicable air quality standards follows.

The three Caterpillar cogeneration engines are subject to emissions limits and operating requirements. Table 6 shows the emissions limits for each criteria pollutant in pounds per hour.

Table 6. Emissions Limits for Existing Cogeneration Engines

Air Contaminant	Emission Limit, pounds/hour each
Reactive Hydrocarbons	2.1
Nitrogen Oxide, as NO_2	2.3
Sulfur Dioxide	0.4
Carbon Monoxide	8.0
PM_{10} Particulate Matter	1.0

In addition, the engines are outfitted with a continuous emission monitoring system (CEMS) to demonstrate compliance with the NO_x emissions limit. The CEMS measures and records NO_x exhaust gas concentrations, corrected to 15 percent oxygen on a dry basis. Moreover, the total sulfur compounds of the fuel gas used at the facility, calculated as hydrogen sulfide, is limited to 5 pounds per day. The RWQCP currently keeps daily records to prove compliance with this total sulfur emissions limit.

The SCAQMD has also adopted rigorous requirements for boilers in two size categories. "Small" and "large" boilers are classified as boilers with rated fuel input capacities between 2 to 5 million Btu per hour and greater than 5 million Btu per hour (Btuh), respectively. Surprisingly, the regulations for "small" boilers are more stringent than for "large" boilers. The following standards apply to boilers with rated fuel input capacities over 5 million Btuh.

The SCAQMD prohibits the proposed boilers from discharging more than 400 ppm CO and 40 ppm or 0.052 pounds of NO_x per million Btu of input. Furthermore, if the annual heat input is less than or equal to 9 billion Btu per year per boiler, the boilers must also comply with one of the following:

1. Operate the boiler such that the stack-gas oxygen concentrations are always less than or equal to 3 percent on a dry basis for any 15-minute average averaging period; OR

2. Conduct tuning per SCAQMD methods, up to twice per year.

Given the size of the proposed boilers described later in this technical memorandum of 9 billion Btu per year per boiler translates into 818 hours of operation at capacity per boiler. Thus, depending on the duration of the peak heating demands during a given year, the boilers may or may not be subject to the additional operating or tuning requirements outlined above. Moreover, if multiple gaseous fuels are used, a non-resettable, totalizing fuel meter is required per boiler per fuel type.

Projected Heating and Cooling Needs

Sludge Digesters

The RWQCP contains several large tanks constructed as sludge digesters, but only four are currently used for this role. These anaerobic sludge digesters are mesophilic digesters that are maintained at an operating temperature of 98 degrees F to enhance solids reduction and gas production.

Some of the recommended solids digestion project options involve thermophilic sludge digesters. These digesters require heating the sludge to about 57 degrees C, (135 degrees F). This will require far more process heat than is now supplied for the mesophilic sludge digesters digesters, currently operating at about 37 degrees C (98.6 degrees F).

Anaerobic sludge digester heat needs include two components:

- The heat required to warm the cold incoming raw or the feed sludge up to the digester's operating temperature.
- The make-up heat required to offset the heat losses from the warm digester to the cold ground and to the air. This is also called the digester shell heat loss.

Both of these components vary seasonally, in accordance with sludge, air and ground temperatures. Typically, for nearly all municipal wastewater treatment plants, the raw sludge heating component is by far the larger of the two digester heat loads. This raw sludge heat load is computed as follows:

$$Q = m \times Cp \times \text{delta } T$$

where:

Q	=	The required heat or heat load, expressed as Btu per hour
m	=	The sludge mass flow rate, in pounds per hour
Cp	=	The specific heat of the item to be heated, expressed as Btu per pound per degree F. For the clean water, the Cp equals 1.00 Btu per pound per degree F, by definition
delta T	=	The temperature difference between the cold inlet sludge and the heated outlet sludge, in degrees F.

Thus, for heating sludge to a digester:.

m	=	Sludge flow, gpm x specific gravity, pounds per gallon x 60 minutes per hour.
Cp	=	1.0 Btu per pound per degree F, because even thickened

sludge is still 94 to 98 percent water.

delta T = Raw sludge temperature (this is usually the same as the plant influent effluent temperature) minus the digester operating temperature, degrees F.

For the RWQCP at a plant flow of 50 mgd, the calculation parameters are:

- Primary sludge flow = 141,000 gallons per day
- Raw waste activated sludge (WAS) flow = 958,000 gallons per day
- Thermophilic digester temperature = 135 degrees F
- Minimum sludge temperature = 69 degrees F, per February records

Thus,

$$m = \left(\frac{141{,}000 \text{ gpd (primary)} + 958{,}000 \text{ gpd (WAS)}}{24 \text{ hours/day}}\right) \times 8.34 \text{ pounds per gallon}$$

m = 382,000 pounds per hour

Q =

(382,000 pounds per hour)(1.0 Btu/pound-degree F)(135 - 69) degrees F

Q = 25 million Btu per hour

The digester shell heat loss is a much more complex, and a much smaller number.

Laboratory Building

The Laboratory Building was constructed in 1999, and the heating and cooling system for the lab were connected to the cogeneration heat recovery system.

The building cooling system is an important issue here because the building is cooled by an absorption chiller, and this special type of water chiller uses hot water as its energy source.

Current and Proposed Heat Needs

Plans for future RWQCP sludge digestion needs are outlined in Technical Memorandum 2, dated August 2002. This document, Technical Memorandum 3, provides the increased heat needs for the proposed 50-mgd plant with a modified sludge digestion system, including thermophilic sludge digestion followed by mesophilic digestion. The current and proposed RWQCP heat needs are summarized in Table 7:

Table 7. Current and Future Plant Heat Needs

Item or Parameter	Heat needs, million Btuh		Remarks
	Current 30+ MGD plant	Proposed 50 MGD plant with modified digestion	
Sludge digestion basic type	Mesophilic	Thermophilic + mesophilic	As per BC's Tech Memo 2
Raw sludge heating needs, maximum	8	25.2	At a minimum 69 degrees F sludge temperature
Mesophilic digester shell heat losses, maximum	2	2	Based on adding new, insulated, traditional type sludge digesters
Thermophilic digester and sludge holding tank shell heat losses, total, maximum	N/A	2	Based on converting Digester 1 to a thermophelic digester at 135 degrees F, plus a 50,000 gallon holding tank
Absorption chiller, summer heat needs, maximum	2.6	N/A	Maximum heat need is in the summer. This is not additive to the above
Winter maximum heat need, total	10	29	At minimum February temperatures
Available engine heat recovery, maximum	12	12	From the three current cogeneration engines
Heat shortfall	none	**17**	At the minimum February temperatures

Heat Production Alternatives

The 17 million Btuh heat shortfall for the proposed modified digestion system must be met. Several options for adding heat were considered:

1. Recover and use the engine aftercooler heat
2. Replace the absorption chiller and use the chiller's heat allocation
3. Add engine exhaust duct burners to the cogeneration engine exhaust
4. Add more gas fired hot water boilers
5. cover and use air or gas compressor heat
6. over and use heat from the warm thermophilic digested sludge
7 new water-source heat pumps
8. Add a solar hot water heating system
9. Add natural gas-fired fuel cells

Evaluation

Initial Screening

The initial nine possible heat production alternatives were initially screened based on a subjective review of the positive and the negative features or advantages and disadvantages of that alternative. This is summarized in Table 8.

Table 8. Added Heat Sources, Initial Screening

Alternative summary	Principal Advantages	Important Disadvantages	Screening Status
1. Recover the engine aftercooler heat	• Readily available heat source • Produces no added emissions	Low temperature heat Engine NOx emissions will increase with warmer aftercooler water	Not workable due to added engine NOx emissions concerns, and the low source temperature
2. Replace the Laboratory Building absorption chiller	• Supplies high temperature heat • Reduced chiller maintenance • Produces no added emissions	• The chiller heat savings is reduced in the winter, when we need heat the most • Consumes slightly more electricity than existing	A viable option, but only a partial solution. Possibly a side feature of another option.
3. Add engine exhaust afterburners	• High fuel combustion efficiency	• New and unusual technology and this is not well proven • Generates NOx emissions	Probably not workable due to possible increased engine NOx emissions
4. Add more boilers	• Simple and proven • Boilers can be located where most needed	• Costly • Difficult air permitting requirements • Wastes natural resources	Straightforward but more difficult to permit. A viable option.
5. Compressor heat recovery	• Energy efficient • Produces no added emissions	• Complex • Only a small amount of heat is available • Costly	The quantity of heat is probably too small to meet our needs
6. Digester sludge heat recovery	• Much greater heat capacity than some of the options • Energy efficient • Produces no added emissions	• Complex • Limited success elsewhere • The amount of available heat is great, but it is at a low temperature	Might be possible with water to sludge heat exchangers
7. Water source heat pumps	• Energy efficient • Produces no added emissions	• Very costly • Complex • Heat is at a low temperature	Possible and expensive, but a viable option
8. Solar collectors	• Product no added emissions	• Very costly • Limited to daytime	Possible but an expensive and

	• Energy efficient	operation • Output is reduced in winter when need is greatest	unreliable heat source
9. Fuel cells	• Extremely low emissions • Energy efficient	• Exceptionally costly • Limited heat output	Too expensive to be viable

Alternative Heat Supply Quantified Analysis

1. Engine aftercooler heat. As previously shown in Table 3, each engine produces about 0.66 million Btuh of aftercooler plus lube oil heat. For all three Caterpillar engines, this totals about 2 million Btuh of heat. Caterpillar has been somewhat secretive of their engines for this project and may not be open to any changes to them, particularly changes that potentially could produce more NOx. This option is too risky, with benefits that are too small for further consideration.

2. Laboratory absorption chiller. The 150-ton RWQCP laboratory chiller is a single stage, or single effect, lithium bromide absorption chiller. Replacing the absorption chiller with a conventional high efficiency electric motor driven water chiller would simplify this chilled water system and would free up about 2.6 million Btuh of heat for use elsewhere with very little added electrical energy. While this quantity is not adequate to meet all of our sludge heating needs, it does offer some practical advantages to the RWQCP, and might be used in conjunction with some other heating option.

3. Engine exhaust afterburners. The exhaust gases leaving the cogeneration engines are at a temperature of about 938 degrees F. This exhaust temperature is well below the 1200 degree F minimum NOx formation temperature. Adding exhaust afterburners to each of the three engines could provide about 1.3 million Btuh of heat, or a total of about 4 million Btuh for all three engines. Technically, this could be done, but it would be extremely challenging to do this without creating more NOx. Other heating options are more attractive with fewer risks.

4. Additional boilers. Traditionally, the simplest technique for adding heat is to provide more gas fired hot water boilers. Using natural gas fueled boilers with new low-emissions or burners, two or three 9 million Btuh could be added and permitted for operation at the RWQCP. One of the three boilers is a standby boiler. This is a sound option to evaluate.

5. Compressor heat recovery. Very large air or gas compressors would likely be required to produce the required quantity of heat needed previously noted in Table 7, of about 17 million Btuh.

   The maximum recoverable heat from a compressor is as follows:

   Q = compressor motor HP x 0.75 x 2545 Btuh per HP,

Or, for example, from a 100 HP compressor, the heat is as follows:

Q = 100 HP x 0.75 x 2545 Btuh per HP or

Q = 191,000 Btuh

Thus, to produce 17 million Btuh we need 90 times this amount, or all the heat from about 9,000 HP of compressors. This enormous size is clearly impractical, if not totally impossible. Some heat could be recovered from the existing air and gas compressors, but this small amount of heat might not be worth the effort required to utilize it. Other heat recovery options are more economical.

6. Digested sludge heat recovery. The digested sludge leaving the warm thermophilic digester represents one of the largest energy "resources" at the RWQCP. This 135 degree F digested sludge must be cooled down to about 98 degrees F for the mesophilic digesters. Thus, this thermophilic digested sludge heat must be used or wasted in any event. Cooling the 135 degree F thermophilic sludge to 98 degrees represents an energy resource of 14 million Btuh. This is a very substantial quantity and probably the best alternative to simply adding boilers.

7. Water source heat pumps. A water source heat pump is very similar to a conventional air conditioning unit operating in reverse. Heat pumps can be very energy efficient and are typically 3 to 5 times more efficient than electric resistance heating. A heat pump takes low temperature energy or heat from one source, and raises the temperature of that energy so that it becomes usable in another application. Possible low temperature energy sources at the RWQCP include the treated final plant effluent and the digested thermophilic sludge. The final treated plant effluent is a very large, but relatively unconventional heat source. For example, if the temperature of 40 mgd of plant effluent is reduced by just 1 degree F, the available heat totals 14 million Btuh. The Renton WWTP in suburban Seattle uses this technique for heating their digesters. Heat pumps could also be used in conjunction with the sludge heat recovery in Option 6.

8. Solar collectors. Solar energy is a free energy source that is often used in similar but much smaller hot water applications, such as heating swimming pools. Solar energy is a non-polluting, renewable energy resource that can easily provide hot water at 200 degrees F in sufficient quantity to meet the added sludge heating needs. Solar heating systems are handicapped by two fundamental problems: (a) incoming solar radiation is fairly diffuse and thus requires very large, expensive solar collectors, and (b) solar energy is unreliable and non-existent at night. The output of a solar energy system drops off considerably in cold, rainy winter weather when heat is most needed so that a complete standby boiler system would be needed to back up any solar heating system. For these reasons, solar energy is considered too unreliable to be a viable option.

9. Fuel cells. Fuel cells are an exciting new technology that is attracting considerable interest. Fuel cells are very fuel-efficient, quiet, and produce essentially no exhaust emissions. Fuel cells are, however, extremely expensive. Fuel cells are primarily an electric power source, and heat production is secondary. A 1-MW fuel cell system would cost $10 to $12 million, but would only produce 2 to 3 million Btuh of heat. Fuel cells are not well suited for this application.

Economic Comparison

1. Cost estimates. Cost estimates were developed for two of the more promising and attractive heat supply options. These two options are the additional boilers option, and the digested sludge heat recovery option. The two options are shown schematically on Figure 3-1.

   The estimate construction costs of these two options are as shown in Table 9.

   As shown in Table 9 the estimated construction cost for the two different heat production options is very similar.

Table 9. Heating System Cost Estimate

Item	Capacity or Sizing Parameters	More Boilers Option	Digested Sludge Heat Recovery	Remarks
Hot water boilers, low NOx burner (30 ppm)	Three at 9 million Btuh	$300,000	$100,000	One standby boiler
Hot water pumps	Various	$50,000	$40,000	
Raw sludge heat exchangers	13 million Btuh	$250,000	$250,000	Concentric tube
Thermophilic sludge heat exchange	12 million Btuh	$250,000	$250,000	Concentric tube
Sludge heat recovery heat exchangers	13 million Btuh	N/A	$300,000	Concentric tube
Sludge cooling heat exchangers, complete	15 million Btuh	$150,000	N/A	Spiral type
Waste heat exchanger	9 million Btuh	N/A	$100,000	Summer use only
Heat recovery water piping, insulated	10-inch-diameter, steel, insulated	N/A	$80,000	
Heat recovery water pumps	1800 gpm	N/A	$100,000	Centrifugal pumps
Hot water piping, insulated	6-inch-diameter, steel, insulated	$50,000	$50,000	
Natural gas piping	2-inch-diameter, steel	$50,000	$40,000	Includes buried pipe
Plant 2W and 3W water piping	2-inch and 4-inch diameter, copper/PVC	$50,000	$50,000	Estimated
Electrical allowance		$500,000	$500,000	Estimated

Instrumentation and controls, allowance		$50,000	$50,000	Estimated
Building allowance	4000 square feet	$500,000	$500,000	Estimated
Subtotal		$2,200,000	$2,410,000	
Contingency	30% allowance	$660,000	$723,000	
Construction Cost		$2,860,000	$3,133,000	
Engineering, admin	25% allowance	$715,000	$783,000	
Total Capital Costs		$3.58 million	$3.92 million	Rounded

Notes:
1. The heat recovery alternative also includes one standby hot water boiler.
2. Boilers are hot water type fueled with natural gas only and with low-NOx burners.
3. Based on a new heating equipment building for the boilers or for the heat recovery heat exchanges. The location of this building is not established.

2. Economic analysis. The annual operating cost of the two different heat production alternatives is shown in Table 10.

With an annual operating cost of only 1/3 the cost of the other heat production alternatives, the sludge heat recovery option pays back the extra cost in about 1 year and the heat recovery option clearly has the lower and more attractive long-term overall operating cost, and the lowest life cycle cost. This option is recommended.

Table 10. Annual Operating Cost Comparison

Equipment Item	Additional Boilers Option			Sludge Heat Recovery Option		
	Size, HP approx, and number	Annual Hours	Annual Cost	Size, HP, approx and number	Annual Hours	Annual Cost
Hot water pumps	15	4200	$4,700	25	4200	$7900
Boiler burner fans	40 x 3	4200	$12,600	40 x 1	-	---
Heat rec water pump	-	-	---	200	8760	$131,000
Sludge pumps	60	4200	$18,900	75	4200	$23,600
Boiler natural gas	9 mmBtuh	6000	$400,000	-	-	---
Boiler chemicals	-	-	$4,000	-	-	$2,000
Total, per year			**$440,000**			**$165,000**

Notes:
1. The pump motor and burner motor operating costs are based on electricity valued at $0.10 per kWhr.
2. The natural gas cost is based on purchased natural gas at $0.45 per therm and a 78% efficient, low-NOx hot water boiler.
3. The annual operating hours for each alternative is the estimated equivalent full load annual operating hours.
4. The annual boiler chemical cost is an estimate only, based on 1 percent of the annual fuel cost.

5. This estimate assumes that only one pump operates at a time, for pump equipment.

Recommendations

The proposed 50-mgd sludge digestion modifications will require an added maximum of 17 million Btuh of heat in the winter. This is in addition to the capacity of the existing cogeneration system. The recommended heat production option for the needed additional heat is Option 6, the digested sludge heat recovery system. This option has a roughly equivalent construction cost and a much lower annual operating cost than the additional boilers alternative.

Some of the features of the recommended digested sludge heat recovery system are as follows:

- Heat recovery from the digested 135 degree F thermophilic sludge is captured in a water-to-sludge concentric pipe heat exchanger and this warm heat recovery water is used to heat the incoming raw sludge. This heat recovery captures about 13 million Btuh.
- Final raw sludge heating for the thermophilic sludge digester is provided by a second heat exchanger in series that is supplied with heat from the cogeneration system.
- The remaining 4 million Btuh winter and springtime heat load is supplied by the standby boiler.
- In the late summer, when sludge heating needs are at their lowest, excess recovered sludge heat is wasted to the treated final plant effluent.
- Replacing the absorption chiller with an electric motor-driven chiller is also an option of value, and this could provide some of the required heat.
- All heat exchangers are conventional design concentric tube or spiral type sludge heat exchangers similar to those in dozens of similar wastewater treatment plants.
- Two of the three required heat exchangers for the sludge heat recovery option are required for both options evaluated.
- A standby boiler is provided with the heat recovery equipment for exceptionally cold weather or reduced system performance.
- Equipment will be housed in a new single-story building.
- The overall cost of the heat production system, and a building to house it, will be about $4 million.

CHAPTER 7 - TECHNICAL MEMORANDUM NO. 4, EVALUATION OF DEWATERING AND AIR DRYING OPTIONS

DRAFT
City of Riverside Water Quality Control Plant Evaluation of Dewatering and Air Drying Technical Memorandum 4

Prepared By: Brown and Caldwell
Date: Revised December 20, 2002

Introduction

Project Background

For digested sludge dewatering, a major decision for the RWQCP is whether to change to newer equipment for higher cake solids concentration. Improvements to cake concentration can have a significant impact on existing air drying facilities by reduction in volume being hauled to the drying beds, reduced drying time and labor costs. With increasing restriction for disposal of Class B biosolids, Riverside must look toward the future to develop ways of meeting Class A biosolids requirements by modifying existing operations and monitoring practices. On June 4, 2002, Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Water Quality Control Plant management and operations staff to further define the scope and design criteria for this dewatering and air drying options study.

Dewatering options discussed at this meeting focused on the use of centrifuges to replace existing belt press dewatering. Replacing or upgrading of existing dewatering equipment could be important in the near term. Optimizing dried product storage area is important for achieving sufficient air drying capacity. During wet months, from December to April, having a place to store dried material would avoid the need to re-dry material. Ways of improving existing air drying system would consider covering a portion of the beds.

Objectives

As stated in the scope of work for this project and as discussed at the project kickoff meeting, the following objectives are addressed in this technical memorandum.

1. Review current performance and operations data of existing dewatering equipment.
2. Assess dewatering improvements/options in light of thickening and digestion options. Dewatering options should consider odor control

requirements, power and polymer usage, and the benefits of increased cake dryness.
3. Improvements to air-dried storage in light of wet weather storage needs, air dried product uses and Class A sampling issues.
4. Define capital costs for dewatering and air-dried storage.

Existing Dewatering and Air Drying Facilities

Dewatering Facilities

The existing dewatering facilities include two (2) 2.2 meter Andritz SMX belt presses with an average capacity of 120 gpm each and a peak capacity of 220 gpm each. Operations staff indicated that this equipment operates 4 days a week from 5 AM to Midnight and 1 day a week for 24 hours. Both machines operate together without a redundant unit. Maintenance of this equipment must be completed during down time periods or on weekends to ensure sufficient capacity. Dewatered cake is discharged onto a belt conveyor that discharges into a loading hopper then into standard 6 cubic yard dump trucks. Once a truck is loaded, it transports its load to the air-drying beds located on-site. At current digested solids concentration of approximately 2% solids and an average feed rate of 150 gpm, the existing machines have a total capacity of 36 dry tons per day. Based on an analysis of recent data, it appears that these machines have reached their capacity limit and additional dewatering capacity is needed immediately. Currently there are no odor control facilities for either the dewatering or truck loading building. Due to sufficient buffer zone surrounding the dewatering and truck loading buildings, odors are diluted adequately to avoid odor complaints. However, increased solids production could mean increased odors. Plans for expanded dewatering facilities should include some method of odor control to be conservative.

Air Drying Facilities

The existing air drying facilities include twenty nine (29) drying beds covering a total area of approximately 8 acres. These drying beds are located on the west side of the site adjacent to Jarupa Street, which is a major thoroughfare adjacent to the site. Very little buffer zone is available between this roadway and the western edge of the drying beds. The loading rate reported in the plant O&M manual is 10 to 12 lbs/sf/yr at a depth of 12 to 18 inches. Operations staff have indicated that dewatered cake can be piled as high as 4 feet as long as it is turned over periodically. As stated above, dewatered cake is normally transported to these drying beds and spread with front-end loaders. To promote drying, the dewatered cake is turned frequently (approximately 40 hours per week). During the hotter dry summer months this schedule may be increased to make drying more rapid. Water drained form the wet cake drains to an underdrain pump station that pumps to the waste backwash water lagoons. Air dried biosolids at about 90% solids concentration can be achieved using this process. During wet weather periods, there has been a problem with storm drainage that has caused some rewetting problems at the northwest corner of the site. Improvements to drainage and dried product storage should be considered as improvements to the air-drying facilities. Once the product is dried it is piled onsite and occasionally

trucked by a contractor to off-site land application sites. Off-site contractor trucking operations are typically conducted only 2 to 3 times per year.

To date, this biosolids material has been classified as Class B biosolids product and the City's contractor has land applied the material in accordance with Class B pathogen requirements. However, during 2001 and 2002 the City has sampled this product on a few occasions and had these samples analyzed for the required Class A pathogens in EPA's Part 503 rules. On all occasions, the analysis has shown that the biosolids meet Class A pathogen density requirements, which are listed here:

Fecal coliform density less than 1000 MPN/gram dry solids
(or salmonellae less than 3 MPN/4 grams dry solids)

Enterovirus density less than 1 PFU/4 grams dry solids

Viable helminth ova less than 1 viable ovum/4 grams dry solids

Most agencies which have attempted to achieve Class A biosolids from direct air drying of anaerobically digested dewatered biosolids have not been successful. A Water Environment Research Foundation (WERF) study on low-technology methods of achieving Class A biosolids (lagooning and air drying, primarily) has been underway since the late 1990s and led by Brown and Caldwell (Perry Schafer as Principal Investigator). This research program has shown that the few agencies which have been successful in producing Class A biosolids through air drying of anaerobically digested dewatered biosolids have been successful because of the following methods:

1. Some agencies have air dried the biosolids in windrows and have achieved temperature increases within the windrows, achieving a semi-composting operation without adding carbonaceous bulking agents.
2. Some agencies in desert regions have dried the material to such an extent (90 to 95 percent solids) that the pathogens (and perhaps most other microorganisms) are killed by desiccation – i.e., there is insufficient moisture remaining in the material to support good microbial life.
3. When agencies have air dried their biosolids slowly (while retaining moisture longer), they have had better pathogen kill. This success in slow drying is likely to be related to additional biological activity and better stabilization that can occur with longer drying times.

Also, because of hot summer conditions, temperatures within the biosolids on the drying beds at the Riverside plant may reach elevated levels, particularly when little moisture remains in the material. This could provide additional pathogen destruction. The actual reasons or mechanisms for the high degree of pathogen reduction at Riverside are probably a combination of the above factors, but the extremely dry nature of the final product (about 90 % solids is reported) is expected to be important in meeting Class A pathogen density levels.

Digested sludge flow and characteristics

Digested sludge characteristics are anticipated to be as follows, based on anticipated raw sludge thickening performance and digestion performance:

- Total solids content between 1.9 and 3.2 percent, depending on the specific thickening and digestion process used.
- Volatile solids content in digested sludge of 62 to 67 percent (of total solids) depending on the specific digestion option used

Digested sludge flow rates vary depending on the thickening method used and the operating hours for dewatering. Table 1 shows the digested sludge flow rates for the ultimate plant size of 50 MGD for the two thickening options discussed in TM1.

Table 1 – Digested Sludge Flowrates for Dewatering
(All values within table are gpm)

Operating options	Separate Thickening		Co-thickening	
	Avg	Peak 2 week	Avg	Peak 2 week
5 days/week, 16 hrs/day	477	667	402	563

Dewatering Options

Estimated performance of dewatering options is shown on Table 2. The Andritz SMX belt presses are currently achieving approximately 12% cake solids at an average feed rate of 150 gpm. Performance could be improved if the feed rate was reduced to 100 gpm that would provide a longer detention time on the belts. More frequent doctor blade and belt maintenance could also improve cake solids, but this would be at the expense of increased labor for maintenance and increased parts costs. Other modifications could be made to the belt presses, such as adding rollers, but Andritz indicated that these modifications would probably only add 1 to 1.5% dryer cake. Andritz estimates that a 2% improvement in cake concentration could be expected from an increase of 1% in feed solids concentration. The increased feed solids concentration could also reduce polymer usage as well. For purposes of this analysis, a 15 % cake is possible from improved existing belt presses at lower flows and 18% from new belt presses.

High-speed centrifuges creating "G" forces in the range of 2500 to 2800 are estimated to produce dewatered solids content of 25 to 28 percent for mesophilically digested sludge for medium size to large size machines, respectively. For temperature phased digested sludge, these estimated cake solids percentages should increase slightly because of lower volatile solids content of the digested material. Solids capture is slightly better for operating centrifuge systems over belt press operations. Electrical power load per machine is substantially higher with centrifuges, but this is largely offset by the fewer

number of operating machines required with centrifuges and less foul air ventilation horsepower required since centrifuge room air does not usually need foul air treatment.

Table 2 - Dewatering Performance Options

Parameter	Current belt press	New Belt press	High-speed Centrifuge[a]	
			Medium size	Large size
Feed rate, gpm Average Peak	 100 200	 150 225	 175 250	 200 300[b]
Cake solids content, estimate for mesophilic digestion	15%	18%	25%	28%
Cake solids content, estimate for temp phased digestion	16%	19%	27%	29%
Solids capture	90 to 95%	90 to 95%	96%	96%
Estimate polymer dose (lb active/dry ton)	12	12	20	20
Typical power load per machine, kW	20	25	90[c]	110[c]
Typical raw purchase cost per machine ($000)	250	300	450	650

[a] Does not include foul air ventilation power.
[b] The City of San Diego currently operates at this higher rate with no reduction in performance.
[c] Assumes no energy recovery from DC backdrive

A cost and non-cost assessment for two dewatering options was conducted. Dewatering Criteria for comparison assessment is shown in table 3. The two options are:

- Refurbished and new belt presses to produce slightly higher cake solids content at a reduced flow rate. Also, ventilation improvements are included and additional presses for future capacity increases. Two additional presses would be located in the existing dewatering building, where space has already been provided. One other belt press would be located in an expansion to the existing building west of the existing conveyor.
- An all-centrifuge dewatering option was defined for evaluation. Dewatering units would be located in the existing dewatering buildings, all on a raised deck. Digested sludge feed, polymer, ferric, centrate and foul air piping would be located below this raised deck.

Substantial data exist from other wastewater facilities with similar sludge characteristics to predict approximate performance for centrifuges at the RWPCF. However, pilot testing with controlled feed and careful data collection

should be undertaken prior to designing centrifuge additions at the RWPCF. Most centrifuge manufacturers have mobile units that can be used for pilot testing at little to no charge. Obtaining valid polymer dose and energy requirements would be a major purpose of pilot testing since polymer and electrical costs represent a large portion of expected total O&M costs for centrifuge dewatering.

Table 3 - Dewatering Criteria for Comparison Assessment[a]

Parameters	New and refurbished Belt presses	All centrifuge[d] System
No. of machines	4(2 existing) operating 1 spare	2 operating 1 spare
	5 total	3 total
Machines in existing dewatering bldg.	4 BFPs	3
Estimated typical power load, KW[b]	300	270
Estimated polymer use, dry lb/oper. Day[c]	540	900
Dry tons solids aver/day[c]	36	36
Wet tons cake per average operating day[c]	300	133

[a] For 50 mgd, midway between separate and co-thickening flowrates. Assumes 5 day/week, 16 hour per day operation, except in major peak or unusual situations. Assumes medium size centrifuge

[b] Including foul air ventilation/treatment.

[c] Assuming temperature phased digestion and 5 days dewatering per week.

d. Dewatering centrifuges assume 200 gpm capacity

Belt Press and Centrifuge System Layouts and Configuration

Two of the new belt presses will be located in space already provided in the existing dewatering building. One additional belt press would be located in an addition to the west side of the existing building. Figure 1 shows the conceptual layout of the building addition that would house the fifth belt press. In addition to the belt press equipment, a new odor control system would be located along the south west side of the existing building.

The three new centrifuges would also be located in an addition to the west side of the existing dewatering building. To allow the existing dewatering equipment to continue to operate while the new centrifuges are being installed and to avoid potential costly modification to the existing building, this building addition is recommended. Figure 2 shows a conceptual layout of this building addition that would house the four new centrifuges. Because odors can be contained in the centrifuges, a smaller odor control system would be needed. These odor control facilities could also be located along the west side of the existing building.

Figure 3 shows the site plan for these new facilities for both centrifuges and belt presses.

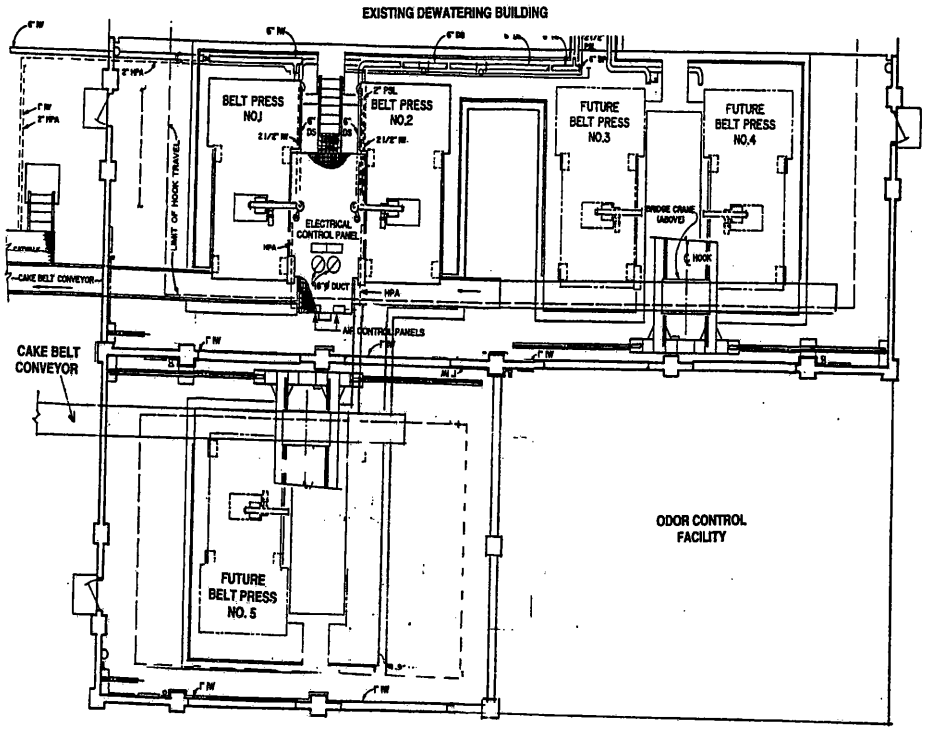


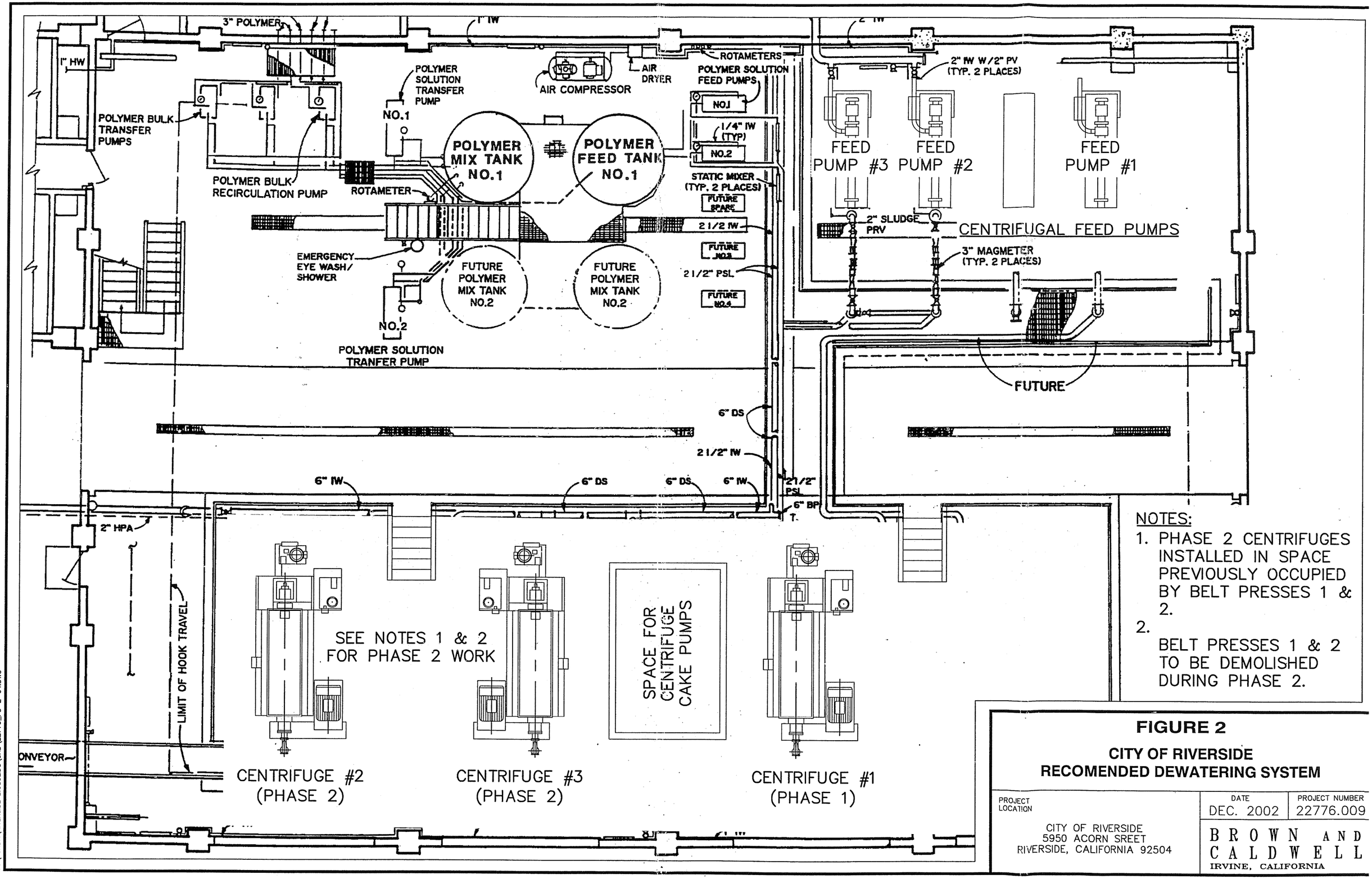
Figure 1 – Belt Press Dewatering Expansion

Dewatering Options Construction and Project Costs

Table 4 identifies construction and capital costs for these two dewatering options.

Table 4 - Estimated Costs for Dewatering Options ($1,000)

Cost element	Belt Press process	All centrifuge system
New dewatering units with installation Belt Presses (3), Centrifuges (3), labor, materials and appurtenances	3,700	4,500
Contingencies at 30%	1,100	1,300
Construction Cost	**4,800**	**5,800**
Project Costs at 25% (Engr., Admin. etc.)	1,200	1,400
Total capital cost	**6,000**	**7,200**



NOTES:

1. PHASE 2 CENTRIFUGES INSTALLED IN SPACE PREVIOUSLY OCCUPIED BY BELT PRESSES 1 & 2.
2. BELT PRESSES 1 & 2 TO BE DEMOLISHED DURING PHASE 2.

FIGURE 2

CITY OF RIVERSIDE RECOMENDED DEWATERING SYSTEM

PROJECT LOCATION	DATE	PROJECT NUMBER
CITY OF RIVERSIDE 5950 ACORN SREET RIVERSIDE, CALIFORNIA 92504	DEC. 2002	22776.009

BROWN AND CALDWELL
IRVINE, CALIFORNIA

P:\FONDA\RIVERSIDE BIOSOLIDS\CAD\22776_FG-2-04.DWG

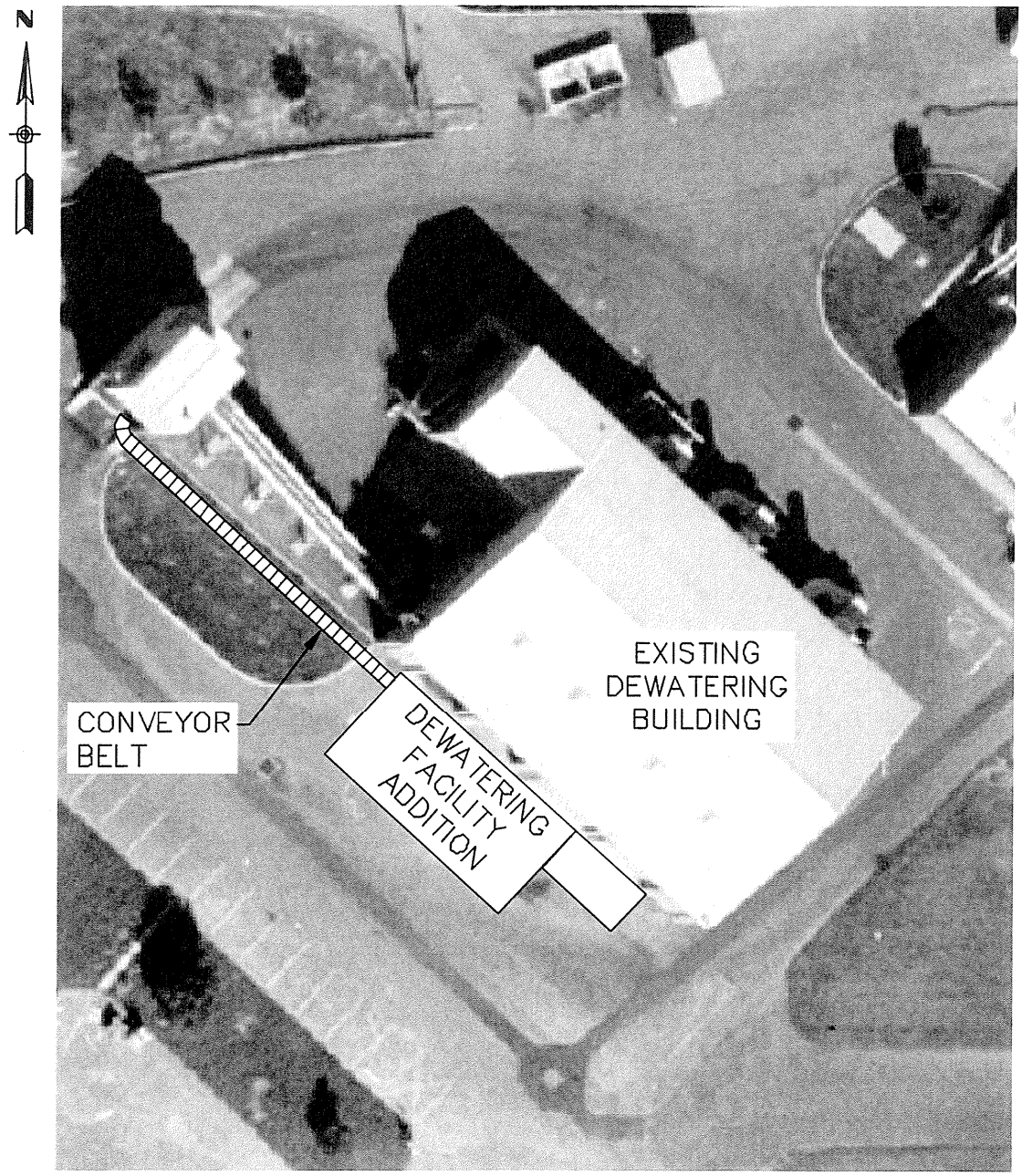
Odor from Dewatered Biosolids and Potential Air Drying

Concern for the odorous nature of digested, then centrifuged biosolids, is being expressed in various forms and locations in North America. Data are beginning to be collected, particularly for high-solids centrifuging (high G-force machines) which is indicating that high shear dewatering (and perhaps high-shear cake conveyance systems) are breaking apart biological floc particles and exposing protein to anaerobic degradation which is producing considerable odorous compounds including a variety of reduced sulfur compounds (Murthy et al, 2002). This is helping to explain the more odorous nature of centrifuged biosolids over belt pressed material. Also, there are scattered data on fecal coliform regrowth following such high-shear centrifuging. Fecal coliform regrowth may be caused by similar biological activity that is stimulated by exposing fresh organic food supply from high-shear processes. These problems are not occurring at belt filter press dewatering locations, evidently because of the low-shear type of processing involved with belt press operations.

When air drying digested centrifuged biosolids, the odor is expected to be considerably greater than air drying of belt press cake. The situation at the Riverside plant is already of concern in terms of long-term odor acceptability of air drying. Therefore, centrifuging followed by air drying is judged to be an incompatible process train for the Riverside plant. Digested centrifuged biosolids could be used directly in composting or heat drying facilities or might possibly be taken off-site immediately as a dewatered product for land application. However, these biosolids management practices have potential problems and/or relatively higher costs associated with them, so that they may not be particularly attractive in handling 100 percent of the Riverside plant dewatered biosolids production. We believe that air drying even a portion (say 25 percent) of the plant production of centrifuged biosolids would be an odor problem at the plant. At the project status and review meeting held on October 31, 2002, plant staff indicated a desire to phase out air drying over the next few years and that heat drying would be necessary to replace this air drying capacity. Therefore, centrifuges could be used for dewatering as long as centrifuge dewatered cake was sent to heat drying.

Recommendations

Based on both higher capital cost and non-economic comparison of the dewatering options, BC recommends upgrading the two existing belt presses and installing one centrifuge for 40 MGD. Two additional centrifuges would be installed for 50 MGD to replace the remaining two belt presses. Heat drying capacity would be provided for centrifuge dewatered cake.



DATE	PROJECT NUMBER	
09/12/02	22776.004	DEWATERING FACILITY EXPANSION

BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA

PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT, RIVERSIDE, CALIFORNIA

0 20 40
SCALE IN FEET

FIGURE 3

22776_FG-03-04

Air Drying Improvements

Covered Storage/Air Drying Area

There are various cover and containment technologies available to prevent precipitation from adversely affecting air drying or product storage areas at biosolids drying sites. However, cover/containment systems promoted by manufacturers are geared to relatively smaller POTWs with substantially less area than exists at the Riverside plant. These systems are expected to cost several to many million dollars to implement for the Riverside plant. The benefit of these systms is that contained air drying in winter is possible, but at a much reduced drying rate due to lower temperatures and variable weather patterns. This approach does not seem cost-effective for Riverside.

A more limited approach would be to provide a shed-type cover for a portion of the drying area (see Figure 4 for dried product storage site layout). Plant staff could use this covered area to store dewatered cake, partially air-dried biosolids, or even highly dried product during the wet weather months. Limited air drying operations might also be conducted under such a cover. If 0.75 acres (about 32,500 square feet) was covered with a structural steel shed-type system (no walls), with clear height of 30 feet under the cover, it would cost about $2.1 million. Such an area could contain the following materials:

- If 20 percent solids cake was stored to an average depth of two feet, this covered area could handle production for an estimated 3 to 4 weeks, assuming solids from a 40 mgd plant.
- If 35 percent solids material (partially air dried) was stored to an average depth of three feet, this area could store 3600 cubic yards. This would represent biosolids production for about 2 months (at 40 mgd plant flow).
- If 90 percent solids final product was stored to an average depth of three feet, this storage would represent about 6 months of plant production (at 40 mgd).

Conducting pile turning operations under this type of shed system would limit the amount of material that could be stored and may be difficult to implement without larger area being covered.

A simpler method of covering is to create a pile of dewatered and partially dried material (at about 25 percent solids) and cover it with plastic sheeting during the winter period when most precipitation and least evaporation are anticipated. This type of plastic cover system would reduce moisture addition from precipitation and minimize odor emissions from the pile. However, investigation would be needed to insure that pile temperatures did not rise significantly beneath such a cover.

DATE	PROJECT NUMBER
09/12/02	22776.004

BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA

DRIED PRODUCT STORAGE LAYOUT

PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT, RIVERSIDE, CALIFORNIA

0 30 60
SCALE IN FEET

FIGURE 4

22776_FC-01

Dried Product Monitoring for Class A Biosolids

Overview of Class A Alternatives and Monitoring Requirements

The 503 Part B regulations list six alternatives for obtaining Class A biosolids status. To achieve Class A status, biosolids must meet certain pathogen density requirements. These six alternatives are as follows:

Alternative 1: Thermally treated biosolids meeting specified time and temperature requirements.

Alternative 2: Biosolids treated in a High pH-High Temperature process meeting specified pH, temperature and air-drying requirements.

Alternative 3: Biosolids treated in other processes that can be demonstrated to reduce enteric viruses and viable helminth ova.

Alternative 4: Biosolids treated in many processes and then sampled to meet pathogen density requirements.

Alternative 5: Use of PFRP – biosolids treated in one of the listed processes to further reduce pathogens.

Alternative 6: Use of process equivalent to PFRP as determined by the permitting agency.

Of these six alternatives for achieving Class A, alternative 4 has been used to certify that Class A biosolids are produced. As stated in the regulations, this alternative requires monitoring of enteric viruses and viable helminth ova along with fecal coliform or galmonallac. The specific density limits are mentioned previously in this Technical Memo.

The other 5 Class A alternatives do not apply to the situation of air drying biosolids. For instance, air drying does not meet temperature or pH requirements of Alternatives 1 or 2. There is no PFRP or PFRP-equivalent process that has been approved for air drying (Alternatives 5 and 6). And, Alternative 3 is a difficult alternative to implement and is not recommended due to its regulatory complexity.

Alternative 4, involving final product pathogen analysis, can only be used where large batches of material are available – i.e., piles of dried product in this case. The City of San Jose has used this Alternative 4 for six years to sample its large annual pile of air-dried biosolids as Class A material. Goleta Sanitary District and a few other agencies in California have also used Alternative 4 to certify piles of product (typically air dried material) as Class A biosolids. To make it economical and workable, typically the pile would need to contain at least several months worth of biosolids production. "Representative samples" are required to be collected from the pile (both horizontally and vertically representative) and the number of samples needed is likely to be similar to the

number of months or production within the pile. For instance, San Jose usually collects 12 to 15 representative samples from its annual pile. These samples are then sent to a qualified laboratory for pathogen and indicator testing. Results take 5 to 6 weeks because of the lengthy helminth ova test protocol. If the analytical tests show that the pile contains less than required densities, then the sampled pile is declared to contain Class A biosolids.

However, records must be kept about each pile and the material within the pile, and the pile must be clearly identifiable and kept separate from other material during the sampling, certificatoin, and product disposition phases.

Improving the Reliability of Alternative 4

Since other agencies have sometimes not been able to produce Class A biosolids from the type of processing that Riverside is doing (air drying of digested biosolids to about 90 percent solids), there is some risk from using this approach. A question could be: Is the Riverside product far better than Class A requirements, or is the material on the verge of not passing the tests? And, there is always risk that analytical work will show inappropriately high densities of one of the pathogens or indicators. Based on available research and testing work, we believe Riverside is likely to be on the verge of not achieving Class A pathogen density requirements on some samples. If this is the case, then we should examine how the current solids processing system could be improved or adjusted to increase the likelihood that all samples will achieve Class A requirements. To conduct this assessment, some additional information about the solids system and pathogen testing work will be collected. Alternative methods to improve the reliability of achieving Class A product are listed here:

1. Increasing the temperature of at least one stage of the anaerobic digestion process to the thermophilic range (52 to 57 degrees C). Helminth ova are much more readily inactivated and virus kill is improved at these temperatures.
2. Drying biosolids to higher than 90 percent solids – although this may be difficult to achieve with the area available.
3. Conducting longer storage time for dewatered cake before it is actually air dried – i.e., storing cake in piles for a few months. This, also, is likely to be difficult to achieve due to site limitations.
4. Improving the stability of the biosolids that are sent to the drying area. Improved stability, as measured through volatile solids content or similar measurements, usually coincides with reduced pathogen density.

These options should be briefly evaluated to determine the most likely improvement that can be achieved in final product pathogen densities. This analysis needs to be balanced with the risk that is being encountered by the City – potential failure of a sample to achieve Class A status. If the air dried material can be used or disposed as Class B material (should samples fail the tests), then it may not be worth spending significant effort on improving the reliability of making all of the dried product a Class A product.

Odor Control from Air Drying Operations

In the long-term, odor control at the Riverside plant air drying area is of major concern. The objective must be to reduce odor emissions over time, even as sludge production rises. Odor emissions from air drying are primarily caused by the fact that significant organic material is still subject to degradation after mesophilic anaerobic digestion. Degradable organic material can be minimized by implementing advanced digestion processes, including temperature phased digestion (previously discussed in TM2) and acid/gas phased digestion. Aerobic digestion following anaerobic digestion has also proved to be a major benefit in reducing odor from subsequent air drying operations. This process (aerobic digestion following anaerobic digestion) is used at the 12 mgd Easterly WWTP at Vacaville, California. Aerobic decomposition in particular, if it includes nitrifying much of the ammonia, can be extremely beneficial in reducing air drying odor emissions. Further work on this approach is underway for other projects, and additional information will be presented when it becomes available.

Another method used at large area sites, is to install a solid fence or wall, especially on the downwind sides of the site (nearest toward sensitive receptors) to cause vertical atmospheric mixing of residual odors being emitted. The method has proved to be of major assistance at Sacramento, California in making the large facultative sludge lagoon complex an acceptable process for nearby residents. The twelve-foot high solid wall causes vertical mixing of 2 to 4 times the height of the wall, and the walls are very effective when inversion conditions exist which normally trap odors on the ground surface, and transport them downwind with limited vertical mixing.

Odor control is also enhanced for air drying operations by using the least-intrusive dewatering and cake conveyance processes and minimum polymer dose. Polymer provides additional organic material for decomposition reactions and odor production during drying. Reduced polymer is associated with belt press operations (versus centrifuge), and also frequently with highly stable sludge produced by advanced digestion processes.

CHAPTER 8 - TECHNICAL MEMORANDUM NO. 5, EVALUATION OF HEAT DRYING

City of Riverside Water Quality Control Plant Evaluation of Heat Drying Technical Memorandum 5

Prepared By: Brown and Caldwell
Date: Revised December 20, 2002

Introduction

Project Background

With increasing restriction of disposal of Class B biosolids, it is increasingly important that Riverside look into ways of meeting Class A biosolids requirements by considering different process options. On June 4, 2002, Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Water Quality Control Plant management and operations staff to further define the scope and design criteria for this heat drying options study. At the project status meeting held on October 31, 2002, RWQCP staff indicated that heat drying appeared to have substantial benefits

Objectives

As stated in the scope of work for this project and as discussed at the project kickoff meeting, the following objectives are addressed in this technical memorandum.

- Identify heat drying vendor systems, including systems that are lower-cost and may not produce commercial grade granules or pellets
- Summarize product beneficial use markets and likely changes in the future. Performing a market analysis is outside the scope of this project.
- Prepare schematics, equipment sizing and layouts as well as heat/energy requirements for drying. Identify heat source options and costs
- Define air emission and odor control limitations and provide necessary control equipment
- Determine condensate characteristics and recycle impacts
- Develop cost estimate for alternate capacity/size of thermal drying system to replace air drying. Drying capacity would be for the full plant sludge production and may operate up to 24 hr/day depending on the amount of operator attention the dewatering and drying process needs. As a minimum, 16 hr/day 5 day a week operation should be assumed.

Heat Drying Processes

Heat drying systems involve the application of heat to evaporate water from sludge. This becomes a major advantage in reducing the weight of final product and in creating a biosolids product that is free of pathogens (Class A). In addition, if the process creates hard, dry, and similar-sized particles (usually between 1 and 5 mm in size) that are safe and easy to handle (non-dusty material), the product can be marketable as a fertilizer material. If the sludge is not stabilized through a digestion process prior to heat drying, the final product can be odorous, especially if it becomes re-wetted. Such re-wetting can occur during storage, but most often occurs at the final use site, if land applied.

Vendor-Provided Systems

Heat or thermal drying systems are all essentially provided by vendors or manufacturers, and, therefore, each one is different due to its patented characteristics and the specific features and even the approach to drying taken by the vendor/manufacturer. Drying systems are often categorized according to whether they use a "direct' or "indirect" drying approach as defined here:

- Direct dryers. These are systems whereby hot drying gas (normally heated air) is in direct contact with the sludge material. A large amount of particulates are picked up in these gas streams and major particulate/gas handling and treatment systems are required. Many of these systems recycle the exhaust stream to improve thermal efficiency and provide some thermal destruction of odorous compounds. However, there is more experience in direct drying (than indirect drying) systems for sludge, and more experience in creating fertilizer products.
- Indirect dryers. In these systems, the heating source (steam or hot oil, typically) does not come into direct contact with the sludge. Instead, the heat is transferred to the sludge through paddles, mixers, or related devices. Therefore, the gas handling system is simpler for this approach, but there is somewhat different challenges in creating usable product and uniform particles with several of the processes available.

Some of the more common heat drying systems are described briefly below. These systems are all designed to provide a well-graded product with relatively uniform particle sizes. This approach maximizes the value of the product.

- **ESP Dryer.** The ESP process is a direct rotary drum process with once-through airflow. The dryer is a triple-pass, rotary dryer. A portion of the dried biosolids product exiting the dryer is recycled and blended with incoming dewatered biosolids to create the feedstock to the dryer. The gas/solids mixture entering the dryer is separated in cyclones and filters, and the dry product is classified by screens into oversize, market size, and fines. The oversize is crushed, mixed with fines, and recycled to mix with the incoming dewatered biosolids. The exhaust gases exiting the separation system are cooled and condensed in a wet scrubber, and the non-condensable fraction is heated in an afterburner to destroy odors.

- **Swiss-Combi.** The Swiss-Combi process is a direct-drying, rotary drum process with air circulation. The dryer is a single-pass, rotary dryer. A portion of the dried biosolids product exiting the dryer is recycled and blended with incoming dewatered biosolids to create the feedstock to the dryer. The gas/solids mixture exiting the dryer is separated in a cyclone and fabric filter, and the dry product is classified by screens into oversize, market size, and fines. The oversize is crushed, mixed with fines, and recycled to mix with the incoming dewatered biosolids. The exhaust gases exiting the separation system are divided into two streams. The first stream is recycled to the dryer. The second stream is condensed, and the non-condensable fraction is heated in an afterburner to destroy odors. The afterburner also provides heat recovery from its flue gas. Some plants report drying raw sludge with this dryer.

- **Andritz.** The Andritz process is a direct drying, rotary drum process with air recirculation. The evaporation process in the Andritz direct dryer takes place within a triple-pass, rotating drum. The high-speed air within the drum pulls the material through the drum until it is dry enough and, therefore, light enough to be lifted and pneumatically conveyed out of the drum. The Andritz dryer drum consists of three concentric arranged cylinders, so that the material to be dried flows through the innermost cylinder, back through the middle cylinder, and finally out through the outer cylinder. Flights on the inner walls of the cylinders lift the material and cascade it into the hot air stream. Andritz does not promote their system for raw primary sludge drying.

- **Seghers.** The Seghers process is an indirect, tray dryer process. The vessel is vertically oriented, and hot oil is passed through the trays while the solids fall from one tray to the tray beneath, similar to a multiple hearth furnace. Dewatered biosolids mixed with recycled dry biosolids are fed through a top inlet in the vertical, multi-stage dryer. The dryer has a central shaft with attached rotating arms that are supported by axial-radial bearings at the bottom of the dryer casing. The rotating arms move biosolids from one heated tray to another in rotating, zigzag motion until it exits at the bottom as a dried, pelletized product. The rotating arms are equipped with adjustable scrapers that move and tumble the solids in thin layers over heated, stationary trays. Round pellets are formed through a pearling process. The solids feed preparation technique, in combination with the rolling across the heat trays, causes the pellets to grow from inside out, the way pearls are formed.

- **VA Tech.** The VA Tech process is an indirect, fluidized bed process. Fluidization gases are distributed uniformly across the area of the dryer to keep the dry granules in an evenly floating motion. Inert gases are used for fluidization to provide a safe environment that requires minimal supervision. The heat exchanger is immersed in the fluidized layer to transfer all the energy necessary for evaporating the water from the wet sludge. Generally, steam or hot oil is used as the heat transfer media. The dryer hood collects the exhaust gases containing the evaporated

water and some dust. These gases are recirculated for energy recovery and air treatment. The process produces a uniform granulated product that is 90 to 95% dry solids in a single stage. This process has recently been added to the Schwing line and is constructed in a vertical arrangement, which can reduce the process footprint, but can become quite tall.

Most of the systems listed above are well suited for plants that are at least the size of the RWQCP. The final products are all pellets or granules of uniform size. However, the cost of one of these systems to handle the entire drying needs would be in the tens of millions of dollars range. Other dryer systems described below are more well suited to smaller plants and are reportedly less costly. The Fenton system had units sized to cover a range of production solids from 18 to 75 wet tons per day or 3.5 to 15 dry tons per day per dryer. The InnoDry system has units sized that are capable of handling a similar throughput up to 26 dry tons per day per dryer. The Komline Sanderson dryer come in unit sizes that could handle a portion of or up to the full daily production of the RWQCP. The product from these dryers is less uniform and has much larger variety of particle sizes. Consequently, the product has less "value" in the market place.,

- **Fenton.** The Fenton process is an indirect hollow plate dryer. Drying is done in a batch process to ensure compliance with EPA 503 regulations to produce a Class A product. The evaporator unit utilizes a patented sludge feeder with heated hollow discs using hot oil as an evaporating media. Programmed temperature control brings the dewatered cake to evaporation temperatures quickly then controls the temperature at optimum levels to produce a desired dryness. Exhaust air is scrubbed to remove particulates and minimize emissions. Standard size units can be provided for average daily production of 18 to 75 wet tons per day. Fenton also offers a product purchase option for terms of one to three years to provide product disposition.

- **INNOPLANA.** The INNOPLANA drying (InnoDry) process utilizes a two-step drying system that incorporates both indirect and direct drying. The first stage employs a thin film evaporator utilizing hot oil as an evaporating media. Dried solids leave the first stage at approximately 45 to 50% dry solids through an extrusion/chopping mechanism. This chopper shapes the product into spaghetti shaped strands of a selected size and length. The chopped material passes onto a belt dryer which passes the product through a hot air stream utilizing waste heat recovered from the first stage to produce a final dried product up to 90%+ dry solids. Process safety is enhanced because the drying process and dried product are largely dust free and temperatures in the plant are below ignition limits. This largely dust free operation provides vapor condensate and exhaust air with low emissions. Through use of an integral heat recovery system this second stage requires little additional energy to produce the desired dryness. This has been reported to represent approximately 30 to 40% energy savings over other drying systems. This process has been in operation for approximately four years in Europe. The plant in Merenschwand Germany has been in operation since 1996 and is available for pilot trials.

- **Komline-Sanderson.** The Komline Sanderson process is an indirect hollow paddle dryer using hot oil or steam as the heat transfer media. The dual counter-rotating shafts with intermeshing wedge-shaped paddles promote thorough mixing and convey the product through the drying process. No internal adjustments are needed on any of their moving parts. It's high torque mixing system enables it to take the dewatered cake through the plastic range without the need to recycle some of the dry product. The variable speed system conveyor system allows the unit to handle a wide range of solids loads and concentrations. These units are also equipped with an explosion relief system for added safety.

Process Operations Considerations

Dried Product Characteristics

The dried product is generally valued on its nitrogen content for use as a fertilizer amendment providing that it meets the required physical characteristics such as particle size, hardness, and density. To achieve the optimum or desired product, dryer systems may need ancillary equipment items such as screens, grinders, and even a pelletizer/compactor. Dryer systems also employ recycle of dried product to the feedstock at a variable rate to be determined for the specific feedstock and desired product characteristics. In some instances, additives may be mixed with the sludge material to achieve certain desired characteristics. These additives may include oils to assist in binding of product, nutrients to change fertilizer components, and chemical suppressants to minimize heating and potential combustion of product.

Anaerobically digested sludge, when heat dried, usually provides a good, usable product. Removal of hair and plastic debris is important for good product quality, and, therefore, sludge screening is a good approach when a high-quality marketable product is desired. When raw sludge is heat dried, the product can be more odorous than dried digested sludge because little stabilization of the organic material has occurred. The low moisture content in the product is the primary defense against biological activity. If any significant moisture accumulates in the product, then active biological activity is initiated and odor can become significant. For instance, when dried raw sludge is spread on a field, rainfall prior to soil incorporation of the material would likely create an odorous situation.

Product Auto-Heating and Safety

Hot or warm organic material that contains even small amounts of moisture and has an available oxygen supply can generate sufficient biological activity to produce increasing amounts of heat to the point that smoldering or even active combustion can occur. This is called auto-heating. Many such events have occurred with heat dried sludges in North America and overseas.

The control measures for this problem include the following:

- Reduce the temperature of the final product
- Minimize moisture content in the product
- Minimize oxygen content in the air/gas that is in contact with the heat-dried product. This is usually accomplished by containing the final product within a nitrogen gas atmosphere (nitrogen blanketing).

There have also been explosions caused by the organic dust associated with dried sludge. Dust control is, therefore, a major issue in any heat drying facility.

Heat Dryer Air Emissions Controls

All exhaust air stream organics from sludge heat dryers would need to be controlled to limit the concentrations of air contaminants. Some control is achieved within the initial heating process. For instance, temperature and excess oxygen control enables balancing nitrogen oxides (NOx) against carbon monoxide (CO). Whereas, the former increases at increasing temperatures, and the latter decreases at decreasing temperature. This is similar to what happens with automobile emissions. Typically a venturi scrubber installed just downstream of the sludge dryer will remove such mater-solid pollutants such as particulate matter and sulfur oxides to below reulatory limits. Engineered biological oxidizers, chemical oxidizers, or recycling of this air stream back to an existing process for reuse would then be designed to remove the remaining air pollutants to acceptable levels. Dryer systems have normally been able to meet necessary air emission regulations in the United States. The SCAQMD has an additional stipulation in that natural gas fired control devisces such as heat dryers must have a backup fuel system approved by the Executive officer of the air district.

The biggest risk in the context of air emissions would be the potential implementation of stricter regulations for control of dioxins, furans, and other trace toxic contaminants. Such regulation is currently proposed in the SCAQMD and is the subject of much debate. However, such regulatory changes are not expected to effect wastewater treatment plants in the near future.

The air emission that attracts the highest public awareness is invariably odor. Although the process air can be well oxidized and controlled through the use of the aforementioned systems, the ventilation air from buildings, storage tanks and truck loading is a much larger air flow and requires treatment before discharge. Essentially, all of the proposed systems require similar size buildings with consequently similar exhaust airflows to be treated. Bulk media biofiltration and/or activated carbon systems are often installed to insure adequate odor control at all times.

Development of Drying Option

The Fenton dryer, the Innodry and the Komline Sanderson dryers would work well to replace the existing air drying operations. A summary of these three systems are shown in Table 1. Figure 1 shows a schematic of how the dewatering and drying process would work together. Although both the Innodry and Komline-Sanderson dryers are continuous feed dryers a small surge bin is

also required to allow more flexibility in dewatering operation. Figure 2 shows a possible site layout for the heat drying facility. The footprint of this facility includes ancillary facilities such as odor control and dewatered cake surge bins, etc. Dewatered cake production quantities are shown in Table 2 for 32, 40 and 50 MGD plant flows. Future production quantities assume similar liquid process performance to current operation.

Table 1 – Heat Dryer Process summary

	FENTON RK 72E	**INNODRYER G4**	**KOMLINE-SANDERSON Model 11W-1200**
Method of operation	Batch	Continuous	Continuous
Dryer type	Indirect – hot oil	Indirect - hot oil, Direct – hot air	Indirect – hot oil or steam
Product type/quality	Ungraded/dusty	Granulated/low dust	Granulated/low dust
Capacity per unit[a]	13.7 cu yd/batch[b]	10 dtpd	10 dtpd
Heat Energy required	1600 Btu/lb water	1250 Btu/lb water	1,130
Dehydrated Solids	90%+	90%+	90%+
Minimum feed solids	16%	18%	18%
Cooling water	150 gpm	212 gpm	200 gpm

a. Assumes 24 hr/day operation
b. Batch size based on wet cake volume

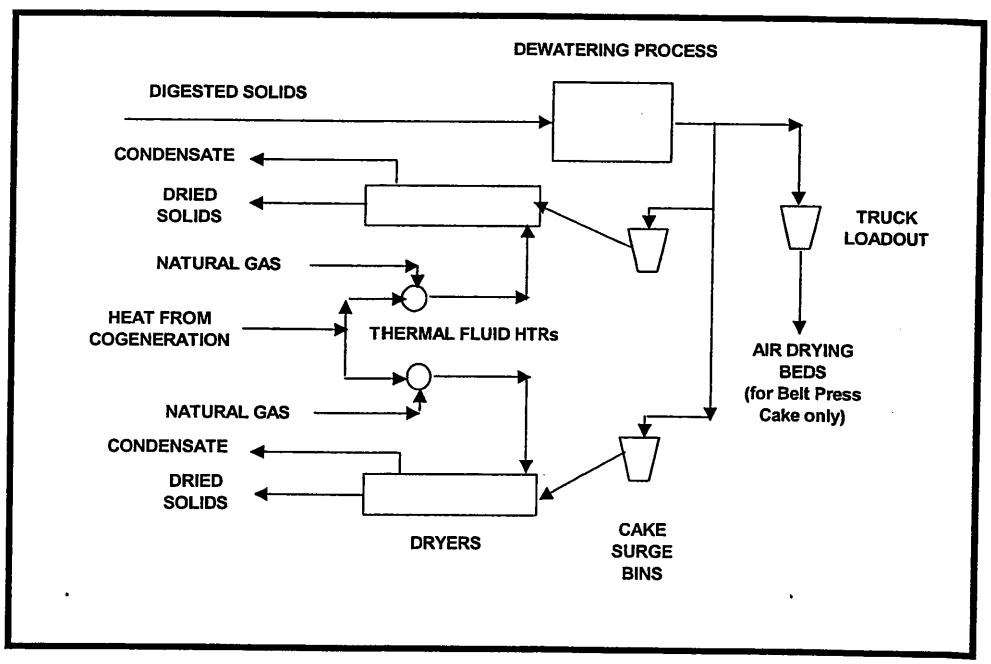


Figure 1 – Heat Drying Schematic

Table 2 – Dewatered Cake Production Quantities[a]

Parameter	Current 32 mgd	40 mgd	50 mgd
Digested solids			
Average, dtpd	19	29	36
Peak 2 week, dtpd	26	41	51
Dewatered cake, 27% solids[b]			
Average 7 day, wtpd	66	102	128
Average 5 day, wtpd	92	143	179
Peak 2 week 7day, wtpd	92	143	179
Peak 2 week 5 day, wtpd	129	200	250
Dewatered cake, 18% solids[b]			
Average 7 day, wtpd	99	153	191
Average 5 day, wtpd	138	214	268
Peak 2 week 7day, wtpd	138	214	268
Peak 2 week 5 day, wtpd	193	300	375

Notes:
a. Assumes 53% VSR in digesters
b. Assumes 95% capture in dewatering
27% from centrifuges (estimated)
18% from new belt presses (estimated)

Abbreviations:
Dtpd = dry tons per day
Wtpd = wet tons per day

Evaluation of Dryer Options

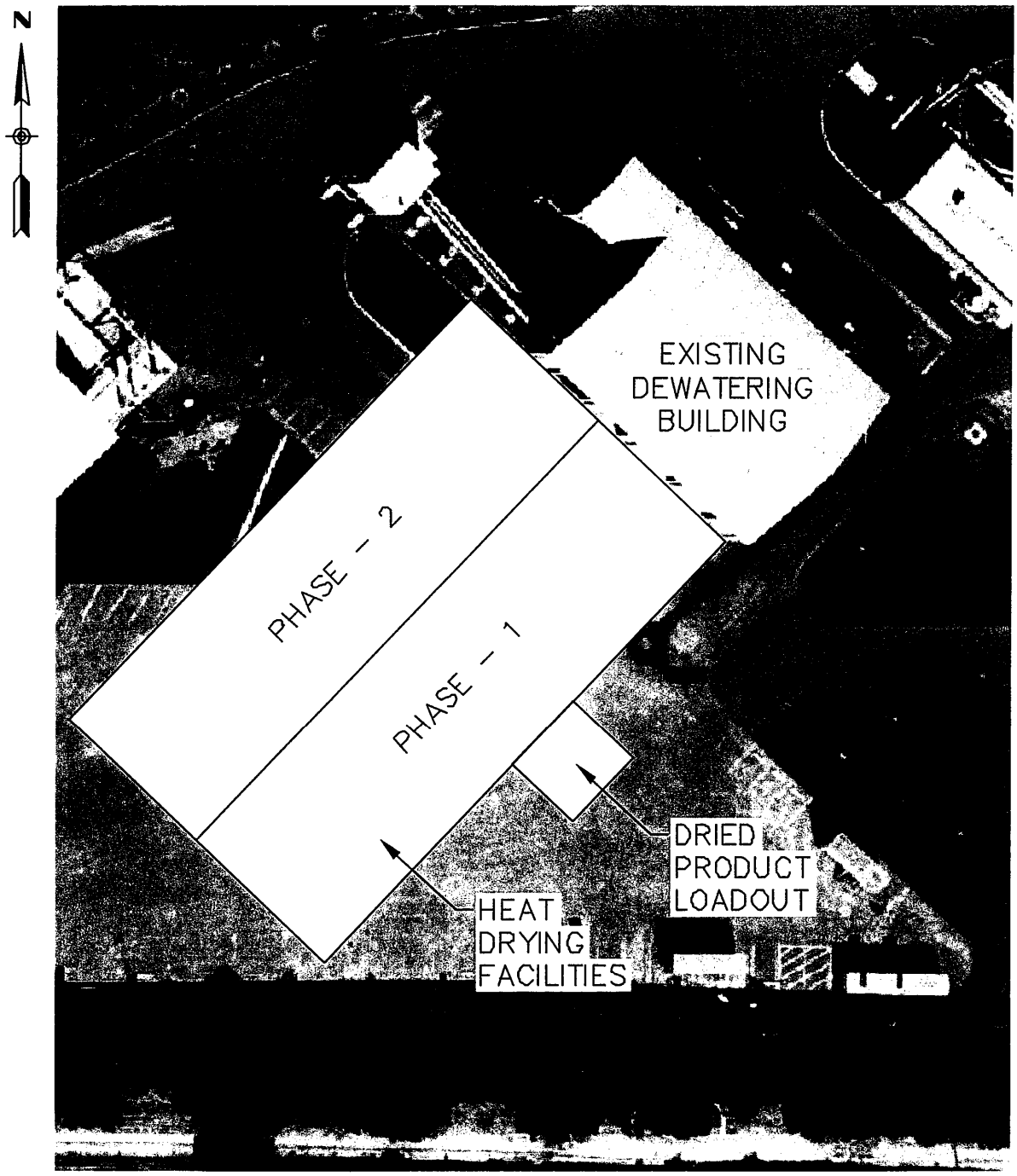
Energy usage and air emissions

Energy Use

Most sludge dryers use heat to evaporate the majority of the water in the sludge, and thus are very large energy consumers. This energy includes the fuel used to heat the sludge and evaporate the moisture, along with the electricity used to operate conveyors, pumps and fans. Typically the heat source is by far the largest energy, and this is usually provided by a natural gas fired burner. This burner flame is used to heat the hot oil thermal fluid.

Energy Consumption

The feed sludge entering a typical dryer is often 16 to 30 percent solids. Conversely the initial feed sludge is therefore 70 to 84 percent water. A sludge dryer that produces a 90 percent dry cake from an initial sludge at 20 percent solids thus removes about 1400 pounds of water per ton of feed sludge. Ideally it takes 970 British thermal units (Btu) to evaporate one pound of clean water. Thus, under laboratory or ideal conditions it takes about 970 Btu per pound, times 1400 pounds, or about 1.36 million Btu to dry one ton of wet sludge at 20 percent solids to a 90 percent dry product.



DATE	PROJECT NUMBER
11/07/02	22776.005

BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA

HEAT DRYING FACILITY
SITE PLAN

PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT, RIVERSIDE, CALIFORNIA

0 20 40
SCALE IN FEET

FIGURE 2

P:\PDNDA\RIV_...E BIOSOLIDS\CAD\22776_FG-2C

Sludge dryers do not operate under ideal or laboratory conditions, due to the nature of the product and the difficulty in uniformly applying heat without overheating a portion of the sludge, and thus realistically it takes about 1200 to 1700 Btu of heat energy per pound of water for sludge dryer to evaporate one pound of water. This value includes the combustion furnace or burner efficiency.

The different sludge dryer vendors quoted between 1100 and 1600 Btu per pound of water for their equipment on this application, depending on the specifics and efficiencies of their equipment. Based on this, it would take approximately 1.5 to 2.2 million Btu of heat to dry a wet ton of 20 percent solids sludge to a 90 percent dry product.

Cogeneration System Heat. Technical Memo No. 3 describes the cogeneration system and the possibility of available excess heat. If thermophelic digesters are not used, as per current plans, then the RWQCP would have approximately 2 to 4 million Btuh of excess heat from the cogeneration exhaust heat.

The three sludge dryers reviewed in this Technical Memo all use a hot oil or thermal fluid to indirectly heat the sludge. This hot oil is at a temperature of 340 to 420 degrees F, and is thus much hotter than the hot water heat recovery form the RWQCP cogeneration system. The cogeneration system heating water could be increased to about 200 degrees F with some simple modifications, but this is still too cool to use for heating the hot oil.

The existing engine heat recovery silencers could be replaced with heat recovery silencers that produce 150-psig 365 degree F steam, but this would be about as hot as the heat recovery system could be made. This would still be too cool to warm the hot oil. It could be used to warm the oil heater gas burner combustion air to reduce the amount of natural gas fuel being used.

The cost of this cogeneration system heat recovery system silencer replacement is not included here. For this study we assume that a portion of the cogeneration heat could be used to warm the oil heater burners' combustion air using the existing engine heat recovery system.

Dryer System Components

The principal sludge dryer process components are as follows:

1. **Hot oil thermal fluid heater unit, oil pump and piping.** This includes an oil bath, natural gas piping and gas train, gas burner(s) and oil temperature controls.

2. **Feed hopper/surge bin and sludge conveyance system.** The feed hopper/surge bin receives the wet sludge and serves as a pick-up reservoir for the inclined sludge conveyance system.

3. **Sludge dehydrator or dryer chamber**. This includes the hollow disk rotor (Fenton dryer), thin hollow plate (Innodry dryer) or hollow paddle (Komline-Sanderson dryer) in which the hot thermal fluid circulates, and the fluid circulation shell. The Innodry dryer also includes a belt conveyor drying section that utilizes recirculated hot air.

4. **Process controls and programming.** This includes the PLC controls and programming to control the dryer.

Sludge Dryer Auxiliary Systems

Three sludge drying systems were evaluated including the Fenton dryer, the Innodry dryer and the Komline-Sanderson dryer. These sludge dryer systems are generally similar but, individual components and arrangements differ. Thus their auxiliary systems are quite different for the three sludge dryer systems.

Fenton sludge dryer. The auxiliary systems are as follows:

1. **Exhaust vapor stream Venturi scrubber and condenser**: This condenser and scrubber are located on a stainless steel duct exiting the dryer chamber. Using a process water stream and sprays, the Venturi scrubber cools the water vapors and washes out airborne containments from the gas stream. This Venturi scrubber is fitted with a centrifugal exhaust fan and discharge stack. Each sludge dryer contains two chambers, and each chamber needs 210 gpm of 40-psig water, for a total of 420 gpm, per dryer.

2. **Bioway biologic treatment on the Venturi scrubber vapor exhaust stream**: The biological system is a compost type reactor in which the exhaust passes through a wetted biological media compost bed. One system will serve all of the sludge dryers, and the biological system needs a variable amount of water, up to 60 gpm. For redundancy, two biological systems should be provided.

3. **Water consumption**: The overall water consumption would be 3 times 420 gpm or 1260 gpm for the scrubbers, plus up to 60 gpm for the biological tower, for a total of up to 1320 gpm. This is a very significant plant water use rate. This final plant effluent must be strained to remove larger solids then strained thru a 300-micron filter to meet the dryer supplier requirements. An 8- or 10-inch diameter 3W plant water line, with strainers and filters will be required.

4. **Spent Venturi water and condensate drainage system**: The 1260 gpm of plant water from the Venturi scrubber, plus the condensed water that was evaporated by the sludge dryer is discharged back to the RWQCP head works, or to the primary sedimentation tanks. The total water evaporated is over 419,000 pounds per day, or about 53 gallons per minute. A 14- to 18-inch floor drain will be required for this drainage flow. This will be a significant drainage flow of almost 2 mgd when all the dryers are operating.

5. **Cogeneration system heat piping, pumps and heat exchangers:** If excess cogeneration system heat is used to reduce the oil heater natural gas consumption, heat transfer piping, pumps and heat exchangers will be required. This would likely be a 6-inch insulated steel line conveying

600 gpm of heating water, for a maximum 3 million Btuh system from the cogeneration heat recovery.

6. **Natural gas fuel system.** For a peak operation of 38 million Btu per hour, a 3-inch or 4-inch natural gas supply line will be required.

Innodryer sludge dryer. The Innodryer sludge dryers auxiliary systems are as follows:

1. **Sludge exhaust vapor condenser system:** This system will likely use plant water for condensing.

2. **Thermal fluid pumps and piping:** The dryer oil system includes the oil heater, a centrifugal oil pump, piping, an expansion tank, and temperature and safety controls. The thermal oil operates at a temperature of 340 to 430 degrees F. Innodryer suggests that the oil heaters be located in a separate room.

3. **Film evaporator and belt dryer air use system:** To minimize the exhaust air stream, the hot exhaust for the film evaporator is recycled and used to heat and further dry the final product pellets. This hot air is very moist and the piping contains drip traps and drains. This is a large air system with a total airflow rate of about 50,000 to 75,000 cfm.

4. **Film evaporator / belt dryer exhaust air system.** This includes the exhaust air ducting and fan. The reported exhaust air has a design flow rate of 1500 cfm.

5. **Exhaust air treatment ozone air purification system:** Details of this exhaust air treatment system are not available

6. **Condenser water system.** Each sludge dryer train contains two condensers. One condenser cools the air stream from the thin film dryer, and one condenser cools the belt dryer air stream.

7. **Spent condenser water and exhaust piping drainage system.**

8. **Dryer oil heater natural gas fuel system.** For a peak operation of 33 million Btu per hour, a 3-inch or 4-inch natural gas supply line will be required.

Komline-Sanderson. The K-S sludge dryers auxiliary systems are as follows:

1. **Dried sludge screw conveyor cooling water:** The 20-foot long inclined screw conveyor includes a water jacket for cooling the dried product to approximately 150 degrees F. Plant water might be used for conveyor cooling, and conveyor cooling water flows were not available.

2. **Thermal fluid pumps and piping:** The dryer oil system includes the oil heater, a 60 HP centrifugal oil pump, piping, an expansion tank, and safety devices and controls. The heated fluid is Paratherm HE thermal

oil. The thermal oil operates at a temperature of 355 to 380 degrees F with a design flow rate of 769 gpm per unit.

3. **Paddle dryer off-gas duct**. This ducting is stainless steel for the hot moist gases.

4. **Off-gas condenser/cooler**: This is a Venturi type counter flow gas scrubber. The condenser/cooler vessel bottom is a sump for the sprayed water pumps. Plant water may be required for make-up water.

5. **Stainless steel off-gas ducting**: Based on a quoted vapor off-gas flow of 4040 pound per hour, this could be a very significant duct form each sludge dryer. This warm off-gas stream is very moist and the piping contains drains and drip traps.

6. **Dryer oil heater natural gas fuel system**: A 3-inch or 4-inch natural gas supply line will be required for a peak operation of about 33 million Btu per hour.

Komline-Sanderson's proposed method of air treatment is described below. This system would not likely be acceptable for odor reasons and SCAQMD approval is doubtful. More conventional methods of air treatment would need to be substituted for the equipment listed below.

7. **Off-gas compressor**. Each sludge dryer includes a 30-horsepower liquid-ring type gas compressor. The compressor discharges the gases to the aeration basins. Air discharged to the aeration basins would reduce the amount of air supplied by the aeration blowers.

8. **Off-gas diffuser system**: A diffuser system would be mount in the existing aeration tanks.

Air Quality and Exhaust Emissions

The exhaust emissions include the natural gas combustion products from the oil or thermal fluid heater gas burners as well as the process vapors volatized from the drying sludge as the water is evaporated. Each of these two separate exhaust steams is treated separately in all of the sludge dryers.

Generally the sludge dryer discharge vapors are treated twice. First they are scrubbed and condensed in Venturi scrubbers. The three suppliers employ different types on secondary exhaust treatment, following the scrubbers.

For the Fenton sludge dryers the multiple dryer exhausts are combined and are treated through a single biological system tower. We understand that this type of biological treatment is accepted and possibly favored by the SCAQMD

The Innodryer offers an ozone treatment system for the exhaust off gas stream.

The Komline-Sanderson unit pipes the off-gases from the sludge dryers to the treatment plant aeration system. This would not be acceptable for odor reasons and SCAQMD approval is doubtful. An alternate system would be needed.

Safety Concerns

There are several safety concerns regarding equipment such as the proposed sludge dryers.

1. **Oil heater system**. The thermal fluid must be heated to approximate 340 to 420 degrees F. Oil is used as the thermal or heating fluid, rather than water, because oil can be heated to the required temperatures and will remain liquid at a much lower pressure than water.

2. **Hot oil circulation**. The thermal fluid circulates from the fluid heater to the sludge cake thin film evaporator and to the belt dryer air preheater system. The quantity of thermal oil that is actually circulated is not small.

3. **Conveyor safety**. The sludge conveyors and augers have many potential pinch points and similar safety hazards.

4. **Combustion systems**. The oil heaters have natural gas burners with their associated safety controls, accessories and devices.

5. **Electrical equipment safety**.

6. **Product dust**

Cost for Heat Drying Options

The RWQCP heat drying alternatives criteria and costs are shown in Table 3 along with a listing of cost categories. The primary capital cost categories are defined here:

- Demolition and site preparation – This includes demolition of paving and concrete on the west side of the existing dewatering facility and preparations of the site for a drying facility.

- Dryer Equipment Package – Several vendors have been contacted to discuss dryer equipment prices for a facility of this size. Fenton, INNOPLANA, and Komline-Sanderson were contacted to obtain equipment package pricing. For equal comparison, the systems are developed with one dryer as a backup unit. This allows a high degree of reliability in operation of the system. The Komline-Sanderson system is available in larger unit sizes than the Fenton and Innodry dryers allowing fewer units. However, this would reduce the overall redundancy.

- Building Cost – This is for a new building to house the drying facilities and equipment. The cost includes mechanical, electrical, instrumentation

and control, plumbing, lighting, and civil work associated with the building. The building would be on the west side of the existing dewatering building, and would be constructed to fit in architecturally with the plant.

- Dried Product storage – A dried product storage building as described in TM4 – Dewatering and Air Drying Options is assumed for this heat drying option. The cost for this building were developed as a part of TM4. The lower part of the sides of this building would be closed to prevent wind from blowing the dried product. The upper third of the walls would remain open for ventilation

- Ancillaries – this includes major power supply, piping, and major utilities services for this facility. This also includes sludge cake transfer conveyors to the heat drying building.

From these costs, a total construction cost estimate is shown, with 30 percent for construction contingencies. Another 25 percent is added to provide a capital cost estimate for Administration and Engineering. An evaluation of energy usage was calculated for each dryer system. Twenty year present worth energy costs are also shown in Table 3. A complete copy of the present worth energy analysis is included in Appendix A.

Project Phasing

As discussed at the project status meeting held on October 31, 2002, the City should plan to reduce the amount of biosolids being air dried at the RWQCB as soon as possible, and some capacity for heat drying could be logically used to reduce site air drying needs. Therefore, the initial heat drying facility would not need to be as large as the facilities shown on table 3. The number of units required for 7 day versus 5 day a week operation would also affect the number of units installed as well as the size of the building. Table 4 shows possible phasing scenarios. Phase 1 assumes a combination of belt press and centrifuge dewatering. For the 5 day per week scenario (current dewatering operation) one belt press would handle 100 gpm flow and one centrifuge would handle the remaining 200 gpm under peak flow conditions. For the 7 day per week scenario, one centrifuge could handle nearly the entire flow. This would allow maximum use of heat drying and phase out the drying beds much more quickly. Phase 2 assumes all centrifuge dewatering and complete phase out of the air drying beds. Depending on how quickly solids production increases, phase 2 may not occur for 10 or more years.

Conclusions

Three different indirect heat dryers have been evaluated as described above. Both the capital costs and life cycle energy cost for all three vendor technologies are very close. Because the evaluation for the 50 MGD facility was based on 10 dtpd size units, they could be easily phased in over several years to match plant solids production. To reduce initial capital costs, phasing these facilities in over a period of years would be recommended. Other benefits of the phased approach

would be realized by taking advantage of advances in technology. Heat drying would provide a reliable means of producing a Class A product that could be disposed of more readily. Full conversion to heat drying would eliminate the use of the air drying beds thus freeing up space for alternate uses.

Table 3 – Heat Drying Criteria and Capital Cost Estimate (50 mgd Facility)

	Fenton	Innodry	Komline-Sanderson
Process Design Criteria[a]			
Number of drying units required 7 day operation	5	3	3
Number of drying units required 5 day operation	6	4	4
Average evaporation capacity, lb/hr 7 day operation	6,157	6,157	6,157
Average evaporation capacity, lb/hr 5 day operation	8,620	8,620	8,620
Peak evaporation capacity, lb/hr 7day operation	7,697	7,697	7,697
Peak evaporation capacity, lb/hr 5 day operation	10,775	10,775	10,775
Capital Costs[b]			
Demolition/Site Preparation	200,000	200,000	200,000
Dryer Equipment Package	5,500,000	6,200,000	4,780,000
Building - 15,000 sf (including mechanical, plumbing, lighting, civil)	2,000,000	2,000,000	2,000,000
Dried Product Storage	1,500,000	1,500,000	1,500,000
Ancillaries	3,000,000	3,000,000	3,000,000
Base Construction	12,200,000	12,900,000	11,480,000
Plus 30% Construction Scope Contingencies	3,660,000	3,870,000	3,440,000
Construction Cost Estimate	15,860,000	16,770,000	14,920,000
Plus 25% Engr/Admin/Mgt, etc	4,000,000	4,200,000	3,730,000
Total Capital Cost	$19,860,000	$20,970,000	$18,650,000
Total 20 year LCC in 2002 dollars, rounded[c]	$20,770,000	$17,330,000	$15,510,000

a. Dryer criteria based on 27% dewatered cake concentration
b. Capital costs based on costs for similar sized projects in the Western United States and 5 day operation
c. Life Cycle Cost (LCC) assumes 4% interest rate (for energy usage only)

Table 4 – Phasing Options

	Fenton	Innodry	Komline-Sanderson
Phasing Criteria[a]			
Phase 1 - 40 mgd production, combined belt press and centrifuge dewatering –			
Number of drying units required 24 hr/day, 7 day operation[b]	4	2	2
Number of drying units required 16 hr/day, 5 day operation[c]	4	2	2
Phase 2 - 50 mgd production, 3 centrifuges (2 operating and 1 standby)			
Number of drying units required 24 hr/day, 7 day operation	4	3	3
Number of drying units required 16 hr/day, 5 day operation	5	4	4

a. Assume 53% VSR in digestion
b. One centrifuge would be capable of handling entire average solids production
c. Assumes one belt press and one centrifuge operating

ATTACHMENT - A
PRESENT WORTH ENERGY CALCULATIONS

Riverside WQCP Heat Drying: Energy and 20-Year LCC Cost

12/20/2002 15:27

Item	Fenton RK 72E	Innodryer G4	K-S Model 11W-1200	General Remarks
Dryer manufacturer	**Fenton**	**Schwing**	**Komline Sanderson**	
Sludge dryer capacity, each unit	3 wet tons/hour	10 dry tons/day	10 dry tons/day	Per vendor quote and data
	13.7 cu yrd/batch	1380 pounds per hour		Per vendor quote
Number of sludge dryers needed at 50 MGD (5 dy/wk)	**6**	**4**	**4**	
Dryer inlet sludge feed dryness, minimum	16% solids min	18% solids	18% solids	Per vendor quote
Dryer inlet sludge feed dryness used here	20% solids	20% solids	18% solids	
Dryed or the outlet sludge concentration	90% solids	90% solids	90% solids	Per vendor quote
Dryer exhaust vent flowrate, cfm per dryer	5200	1500		Per unit, exhaust treatment via biotower
Cooling water flowrate, gpm per dryer	420	211		Per unit, per vendor quote
Initial sludge dryer cost each, dollars	$920,000	$1,550,000	$1,195,000	Per unit, per vendor quote
Initial sludge dryer cost total for 50 MGD, dollars	$5,520,000	$6,200,000	$4,780,000	Approximate
Sludge dryer operating hours, per year	4160	4160	4160	for 5 days/week at 16 hrs/day
Dryer heat required, Btu per pound of water	1450	1250	1123	Per vendor quote
Feed sludge water content, pounds per wet ton	1640	1640	1640	For sludge at 18% solids
Wet sludge mass flowrate, tons per day	255	255	255	Basic design parameter
Water evaporation rate, pounds of water per day	418,200	418,200	418,200	Calculated from sludge data
Dryer heat needs, total, million Btu per day (16 hours)	606.4	522.8	469.6	Calculated from water evaporated per above
Dryer heat needs, total, million Btuh	37.9	32.7	29.4	Calculated from vendor data @ 16 hrs/day
Heat energy source used by sludge dryer	natural gas combustion	natural gas combustion	natural gas combustion	Primary heat energy source
Heat from RWQCP cogeneration system, million Btuh	3	3	3	Annual average, approximate
Added heat needed by dryer's burners, million Btuh	34.90	29.67	26.35	Calculated
Sludge dryer fuel use, annual, million Btuh	145,181	123,435	109,626	Calculated
Natural gas cost, per million Btuh	$5.00	$5.00	$5.00	For natural gas at $0.50 per therm
Natural gas total use, annual, million Btuh	145,181	123,435	109,626	Calculated from sludge and vendor data
Natural gas total cost, per year	$725,907	$617,175	$548,130	Calculated
Sludge dryer's operating electrical load, kW	109	80	105	Per vendor. Confirm InnoDryer value
Cooling water pump HP, approximate	10.5	5.3	***10***	Calculated from condenser water flow
Exhaust fan motor HP, approximate	15	5	included above	Estimated only. K-S unit disc to aeration basin
Sludge dryer's total operating electrical load, kW	128.0	87.7	112.5	Calculated
Annual electrical use, kWh per year, each dryer	532,684	364,745	467,821	Calculated
Total electricity use for all sludge dryers per year, kWh	3,196,105	1,458,979	1,871,284	Calculated
Electricity value, per kWhr	$0.10	$0.10	$0.10	Reasonable for a 20 year period
Value of dryer's consumed electricity, per year	$319,611	$145,898	$187,128	Calculated
Energy cost per year each dryer system, total	$1,045,518	$763,073	$735,259	Calculated
20-year LCC multiplier	14.590	14.590	14.590	For 20 years at a 4% annual rate
The 20-year energy cost, LCC in 2002 dollars, rounded	**$15,250,000**	**$11,130,000**	**$10,730,000**	At a 4% LCC annual rate
Total 20-year LCC, 2002 dollars, rounded	$20,770,000	$17,330,000	$15,510,000	Lower number is the better value

CHAPTER 9 - TECHNICAL MEMORANDUM NO. 6, COMPOSTING OPTIONS

City of Riverside Water Quality Control Plant Composting Options Technical Memorandum 6

Prepared By: Brown and Caldwell
Date: November 15, 2002

Introduction

Background

For centuries, farmers around the world have used composting as a process to convert organic wastes into beneficial soil amendments. The practice of adding biosolids to composting mixtures has been ongoing for more than 30 years. This process is now described in the EPA 40CFR, 503 Part B rule as one of the methods of achieving Class A status for biosolids, provided certain process parameters are achieved. Composting processes that generate temperatures of at least 55^0C are also recognized as acceptable methods for reduction of pathogens and vector attraction. Composting converts biosolids to an end product that is generally more acceptable to the public and may be a means of diversifying biosolids treatment and recycling options.

During a progress review meeting held on 31 October 2002, the City of Riverside (City) informed Brown and Caldwell that approximately 45,000 tons/year of green waste would be available for composting. Any process under consideration would have to provide enclosed facilities with adequate odor control. The City acknowledged that all composting options would present challenges.

Objectives

As stated in the scope of work for this project and as discussed at the project kickoff meeting held in June 2002, the following objectives are addressed in this technical memorandum:

- To define biosolids composting arrangements and their costs.
- To define green waste quantities and characteristics available for composting. Also, to identify biosolids characteristics for composting and process issues.
- To develop alternative composting arrangements, schematics and layouts, providing fully contained and controlled systems for odor control. The site for composting is assumed to be the RWQCP site.
- Provide construction and capital cost estimates for alternative composting systems. The compost product market is assumed to be viable; therefore no specific marketing studies are included.

This memorandum outlines the two most popular composting processes in use in North America, namely: Aerated Static Pile and In-Vessel composting.

Composting Process Overview

Composting may be described as a process by which organic waste materials are physically and chemically transformed by microbial action into a stable and beneficial end product. The primary objectives of most composting systems are as follows:

- Destruction of pathogenic organisms by promoting aerobic activity, which results in temperatures of at least 55^0C during the composting process.
- Stabilization of organic wastes by aerobic decomposition of organic compounds normally present in biosolids.
- Reduction of moisture to around 40-50% in the compost.
- Production of a stable, manageable and marketable end product.

Primary feedstocks to composting systems include dewatered biosolids and other materials, typically bulking agents or amendments. Amendments are added to the biosolids to the extent required to accomplish the following:

- Adjust the carbon to nitrogen ratio (C:N) of the initial mixture.
- To provide structure and porosity for air movement through the mixture.
- To increase surface area available for biological reactions to occur.

The ideal bulking agent (i.e. wood chips) provides solid particles that are around 1-2 inches in diameter. However, green waste can also be used, especially in agitated bed systems. For composting to occur, C:N ratios of initial mixtures need to be maintained between 25:1 and 35:1. Table 1 lists the intrinsic C:N ratios and other properties of certain types green wastes and biosolids.

Table 1. Characteristics of Compost Materials

Material	C:N Ratio	Water Content	Structure
Green Plant Waste	11:1 to 20:1	High	Low
Grass	12:1 to 25:1	High	Low
Garden Waste	20:1 to 60:1	Medium	Good
Wood Chips	100:1 to 150:1	Low	Good
Biosolids	6:1 to 10:1	High	Low

Process Alternatives

Aerated Static Pile Composting

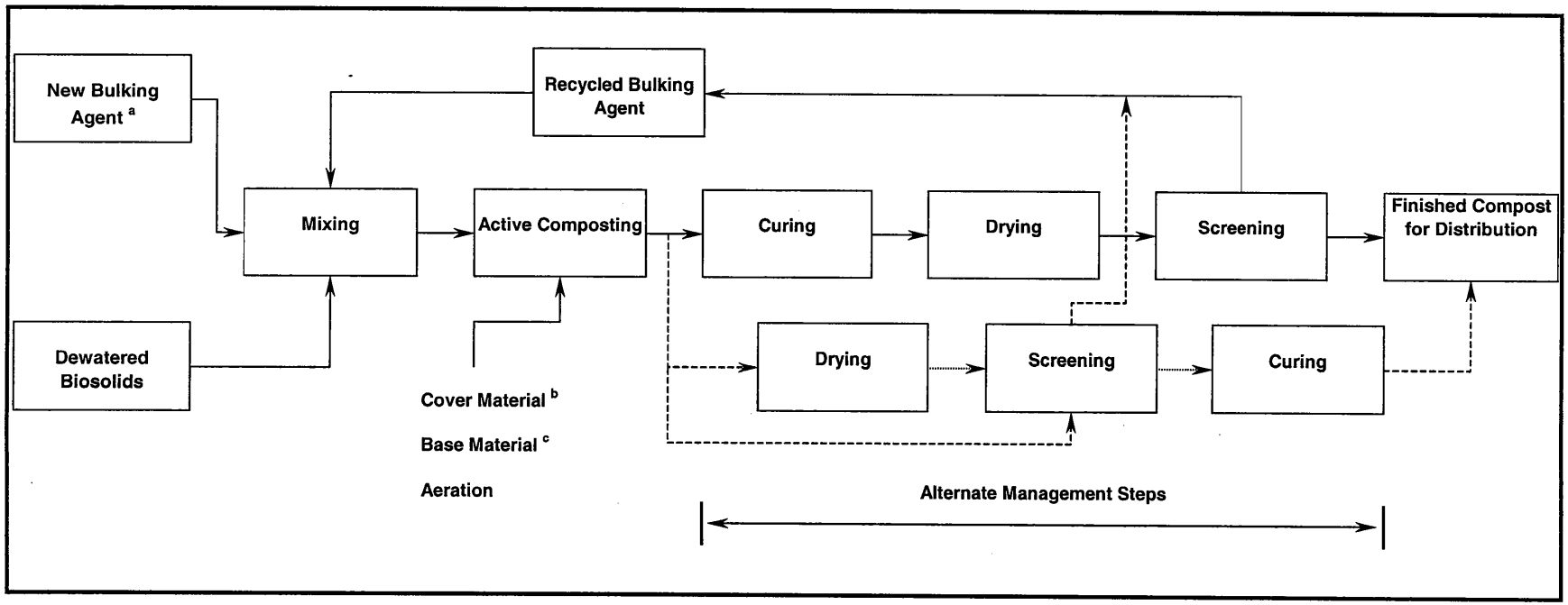
Aerated static pile composting is one of the most common methods of composting practiced in North America due to its relatively low capital cost, economic viability and ability to handle variations in process feedstocks. The primary disadvantage of this method is the relatively large area requirement. The process is started by mixing biosolids with bulking agents and amendments to achieve a composting mixture that has a good structure and a proper C:N ratio. The mixture is then placed over aeration trenches or plenums either in individual piles or extended piles up to 12-ft high. To keep the composting facility under negative pressure, a portion of the fresh air supplied to the building is drawn down through the piles. Blowers connected to the aeration plenums withdraw this air and send it to the foul air treatment system. The piles are normally not subjected to turning or mixing while the composting process is ongoing. However, some turning can be used to supplement aeration and promote biological growth. The EPA 503 rule recommends aerobic processing of biosolids at temperatures of 40^0C or greater for 14 days or more prior to land application of biosolids. Maintaining a temperature of at least 55^0C or more for 3 days during this 14-day period is required for Class A status pathogen reduction. Per industry standards, it is common practice to allow composting to occur for 21 days or more. After approximately 21 days have elapsed, the piles are torn down and the compost is screened for recovery of bulking agent if needed. The compost needs to be cured and partially dried before it is sent to storage or marketed. Figure 6-1 provides a schematic overview of the Aerated Static Pile Composting process.

In-Vessel Composting

Compared with aerated static pile composting, this method requires less floor space and provides better odor control. However, it is more labor intensive, has a higher capital cost and higher operating and maintenance costs. In-vessel systems have also had mechanical problems. This method is similar to the aerated static pile method, with the exception that most of the composting reactions occur in closed vessels or "Bioreactors". Biosolids are mixed with bulking agents in blenders or pug mills and routed to vertical or horizontal plug flow reactors by means of an automated conveyance system. The composting mixture may be agitated and mixed as in agitated bed systems, or allowed to progress unmixed through the reactor. The compost generated after approximately 21 days may be cured and partially dried either in the same reactor vessel or in separate vessels.

Recommended Process

As stated earlier, the City produces 45,000 tons/year or approximately 125 tons/day of green waste, which is available for composting. Biosolids available for composting amount to an average of approximately 20 dry tons/day or 80 wet tons/day. An operating capacity of 40 wet tons/day biosolids is feasible based on the amount of green waste available, and accounting for seasonal variations. This



a. Typically wood chips, wood waste, shredded yard wastes, shredded solid waste, or leaves
b. Typically screened or unscreened compost
c. New or recycled bulking agent

Figure 6-1. Flow Diagram of the Aerated Static Pile Composting Process (Adapted from Biosolids Composting, Water Environment Federation, pg. 121)

represents about 40% of RWQCP biosolids production assuming 35-40 mgd plant flow. Additional bulking agents such as sawdust or wood chips may be needed to produce an optimum feed mixture. Both composting processes discussed in the preceding sections are capable of handling such feed rates, and have their own advantages and disadvantages. Table 2 compares the two processes and applicability to the situation at hand.

Table 2. Comparison of Aerated Static Pile and In-Vessel Systems

Aerated Static Pile	In-Vessel	Comments for RWQCP
Capable of handling large quantities of feed, more than 100 dry ton/day	Few installations have been designed with a capacity of more than 100 dry ton/day	The anticipated feed rates based on the information at hand suggests both types of systems are suitable
Capable of handling a wide variety of bulking agents and incoming biosolids qualities	Bulking agents required to be amenable to flow and conveyance through mechanical systems, except for agitated bed systems	Due to their nature, green wastes may not be suitable for conveyance via mechanical means. This may result in possible operational issues
Is not as labor intensive as in-vessel systems	Requires significant labor for operation and maintenance	Aerated static pile systems are more suitable
May require lesser amount of bulking agent if final product is screened and bulking agent recovered	Bulking agent commonly used is sawdust, which usually becomes part of product	Regardless of the type of process chosen, green waste may need to be supplemented with other bulking agents
This method is not equipment intensive	In-vessel systems require installation of significant amounts of mechanical equipment and are susceptible to operational difficulties	Aerated static pile systems offer a lower capital cost and simpler operation.
Susceptible to odor and vector problems.	Offers better control over odors since feed mixtures are enclosed in a vessel and foul air is withdrawn for treatment	An enclosed facility for aerated static pile composting can limit odor problems. Foul air treatment for in-vessel systems will incur a slightly lower cost due to reduced air volumes
This method of composting is land intensive	Requires less floor space than aerated static pile systems	With full implementation of heat drying of biosolids, the space freed up from air drying can be used for a composting facility

For the situation at hand, the agitated bed system is recommended because of its proven track record and its adaptability to enclosed composting. Such units are designed, produced and installed by vendors such as U.S. Filter and Longwood Manufacturing Corporation.

The use of green waste as an amendment in compost production offers the best economics since sawdust or wood chips would otherwise need to be purchased. However, the use of green waste as an amendment is not without problems, some of which are listed below:

- High moisture content of green waste and lack of solids content may affect porosity, therefore hindering free movement of oxygen throughout the mixture.
- Seasonal variability of C:N ratio of green waste increases the difficulty of predicting the quantity of green waste required for mixing with biosolids.
- Storage of a supply of green waste may lead to odor problems and possibly introduces additional costs related to odor control.
- Green waste may need to be supplemented by other bulking agents in order to make the system viable.

Preliminary Design

Based on information gathered from conversations with technical staff at Longwood Manufacturing Corporation, a preliminary estimate of the floor space requirements for various components of the composting facility have been prepared. The facility sizing and capital costs associated with design and installation are presented in Tables 3 and 4 respectively. A conceptual site plan is shown in Figure 6-2. The site plan shown in Figure 6-2 assumes a portion of the air drying operations have been replaced by heat drying and additional biofilter area has not been provided to handle the entire building ventilation.

Table 3. Preliminary Facility Sizing

Facility Unit	Floor Space sq. ft
Facility Sizing	
Recommended process area	44,550
Recommended curing area	60,000
Recommended biofilter area [1]	20,000
Additional biofilter area [2]	90,000
Total area required	214,550 sq. ft. (4.9 acres)

1. Biofilter area for treatment of process air only, listed separately to aid visualization of costs associated with composting process only.
2. Additional biofilter area for treatment of air ventilated from composting facility.

DATE	PROJECT NUMBER
11/15/02	22776.006

BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA

COMPOSTING FACILITY
SITE PLAN

PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT, RIVERSIDE, CALIFORNIA

0 75 150
SCALE IN FEET

FIGURE 6-2

22776_FG-03

Table 4. Preliminary Facility Cost Estimate

Facility Unit	Cost $ Millions
Cost Estimate, Process Equipment	
Primary equipment (i.e. aeration blowers, compost turning system, bays, rails for turning system etc for composting 325 cubic yards/day of feed mixture),	2.19
Equipment for ventilation system for facilities only (Cost of composting aeration blowers and piping is included in cost of composting equipment). 400,000 scfm for 104,550 sq. ft.	1.00
Equipment for odor control and treatment of foul air from composting process only @ $50/sq. ft	1.00
Optional odor control facilities for treatment of foul air from ventilation system @ $50/sq. ft	4.50
Construction Cost Estimates	
Standard butler type buildings with 20-ft side walls and peak roof height of 22-ft. @ $120/sq. ft for process area plus foundation	5.53
Standard butler type buildings with 20-ft side walls and peak roof height of 22-ft. @ $120/sq. ft for curing area	7.20
Subtotal Construction Cost	21.42
Contingencies @ 30% of subtotal	6.43
Total Construction Cost	**27.85**
Administration and engineering @ 25%	6.96
Total Capital Cost (including odor control for entire building and compost ventilation)	**34.81**
Total Capital Cost (including odor control for compost ventilation only)	**27.50**

Estimated capital costs are based on vendor quotes, estimating guidelines and similar facilities in the western United States. The total capital cost calculated above is preliminary in nature and will be affected by several factors. The following assumptions were made for determining the costs:

- Green waste has a specific volume of 2.18 cu. yd./ton.
- Ventilation at the rate of 16 air changes will be provided, with 4 air changes for the composting process. The cost of the ventilation system includes heating only and not air conditioning.

- The process foul air treatment biofilter receives a volume equal to 4 air changes, with the remaining 12 air changes exhausted via stacks. While this arrangement has been provided for visualizing a conceptual system and costs associated with the composting process alone, it will most likely be unacceptable. Therefore, an additional line has been provided listing the cost for treating the remaining volume of foul air.
- The curing facility does not require odor control, only ventilation.

Cost estimates for a larger system were requested from another vendor as well. U.S. Filter estimated an overall cost of $ 17 million for a composting system operating 5 days a week with a biosolids feed rate of 200 wet tons/day @ 25% solids, and a green waste rate of 125 tons/day. The memo provided by U.S. Filter indicates that the cost of the composting equipment is $ 2.1 million. U.S. Filter recommends a process area of approximately 77,000 sq. ft, a curing area of 55,000 sq. ft, a 3-month product storage area of 140,000 sq. ft and a biofilter footprint of about 60,000 sq. ft. Additional space is also recommended by U.S. Filter for maintenance and operating rooms.

Conclusions

Based on the information available in the literature and from conversations with vendor technical staff, the following conclusions may be drawn:

- Composting is a possible solution for recycling both biosolids and green waste generated in the City of Riverside.
- The use of green waste as an amendment in the composting process will probably generate operational problems. Green waste may need to be supplemented by other bulking agents and amendments to achieve the optimum C:N ratio in the feed mixture.
- Agitated bed in-vessel systems are the best option for implementation due to their proven track record and their adaptability to enclosed composting.
- Due to the costs and labor involved in the composting process, this should only be considered to supplement other solids handling alternatives rather than be designed to handle the entire solids production at the RWQCP site. Due to space availability, composting is only considered feasible as the drying beds are phased out. Maximum buffer zone between any composting facility and neighbors would be required.

Bibliography

Kuter, J.H. *Chair, Task Force on Biosolids Composting.* (1995) Biosolids Composting. *Water Environment Federation*

Haug, R.T. (1993) The Practical Handbook of Compost Engineering. *Lewis Publishers, Boca Raton, Florida*

USEPA. (1999) Control of Pathogens and Vector Attraction in Sewage Sludge. *EPA/625/R-92/013*

CHAPTER 10 - TECHNICAL MEMORANDUM NO. 7, EVALUATION OF RECYCLE STREAM TREATMENT OPTIONS

City of Riverside Water Quality Control Plant Evaluation of Recycle Stream Treatment Options Technical Memorandum 7

Prepared By: Brown and Caldwell
Date:

Introduction

Project Background

The Riverside RWQCP is a tertiary wastewater treatment facility that is currently treating approximately 31 MGD. Raw solids are thickened, anaerobically digested and dewatered by two belt presses. Filtrate from the dewatering operation is combined with waste backwash water from the tertiary filters in an equalization basin prior to being returned to the primary sedimentation tanks. The secondary treatment system has been designed for partial denitrification to meet discharge limits of ammonia nitrogen of x mg/l. The plant reported that current nitrogen limits could become more stringent in the near future. Even though belt press filtrate is diluted by the waste backwash water, the ammonia load added to the existing aeration system can shock load the system which overloads the aeration blowers.

On June 4, 2002, Brown and Caldwell held a kickoff meeting with the City of Riverside Public Works Department Water Quality Control Plant management and operations staff to further define the scope and design criteria for this recycle stream treatment options study. Process objectives for this study would minimize sidestream recycle impacts on the other treatment processes to ensure compliance with discharge permit requirements, particularly for nitrogen loads. No specific treatment technologies were discussed during the meeting. Use of existing abandoned tanks that were a part of Plant 1 including circular clarifiers and a gravity thickener were indicated to be available for this process.

Objectives

As stated in the scope of work for this project and as discussed at the project kickoff meeting, the following objectives are addressed in this technical memorandum.

1. Review recycle stream treatment technology summarize the alternatives evaluated for sidestream treatment, and to provide preliminary sizing criteria for the selected alternative.

2. Develop process schematic, equipment needs maximizing use of the existing facilities at the RWQCP
3. Define the cost of the recycle treatment system.

Existing Available Tanks

Our scope requires identification of the most cost-effective means for reducing the ammonia loading to the main treatment process. Since capital cost is often the most significant component of a sidestream process, the ability to reuse some existing (currently unused) tanks on the RWQCP site would likely render any alternative considered the least costly alternative. However, if detailed investigation of these structures made during the design phase reveal significant deficiencies use of these structures may be rendered impractical and economically less desireable.

On the site are four (4) circular clarifiers 80 ft diameter by 10 ft sidewater depth and one (1) gravity thickener 45 ft diameter by 10 ft sidewater depth. All appear to be structurally sound, but the old mechanisms are rusted. The thickener is approximately 20 ft higher than the circular clarifiers. In considering the use of this tankage, all process evaluations were based on the future 50 mgd build out flow for the plant.

Process Alternatives

Steam Stripping. Steam stripping has been tested at demonstration scale in North America and Europe for ammonia removal from centrates and filtrates from dewatering of digested sludge. Stream stripping involves passing the filtrate through a stripper containing mass transfer media and in contact with steam. A steam plant supplies steam to the operation. In tests at New York City's 26th Ward WWTP, 85 percent removal was obtained. Economic comparisons showed it was less cost-effective than either separate biological treatment or treatment in the main WWTP. Also, considering that this technology would be unlikely to use any of the available facilities on the site, it would not be cost effective for use at the Riverside WWTP.

Activated Sludge Process. Here, a "small" conventional activated sludge plant is built which treats the sidestream flow. It is possible to get about 85 to 90 percent nitrification. The warm wastewater temperature means that a low SRT can be used (5 days was successful in demonstration trials in New York City). The waste is deficient in alkalinity, so caustic addition is required, along with pH control in the aeration tank to ensure the pH is maintained in an optimum range for nitrification (pH greater than 7.2 and less than 8.0). Because of the high ammonia levels in filtrate, very high oxygen demands are expressed in the aeration tank. It is also possible to incorporate denitrification, provided that additional reactor volume is provided for the denitrification zone. Since filtrate is relatively low in BOD, an external source of carbon is needed. Often methanol is used, or volatile acids created from the fermentation of raw sludge.

This is likely one of the lowest cost options available to Riverside, since there appears to be sufficient existing tanks that could be remodeled to accomplish both settling and nitrification.

Short SRT Process. The "Short SRT" Process is actually a conventional activated sludge process for sidestream treatment, but with an additional feature. As shown in Figure, the waste nitrifying sludge from the sidestream process is added to the effluent from the process and returned to the mainstream process. This waste sludge is high in nitrifier population and causes the nitrification in the mainstream process to be accelerated significantly, at least according to the developer's claims.

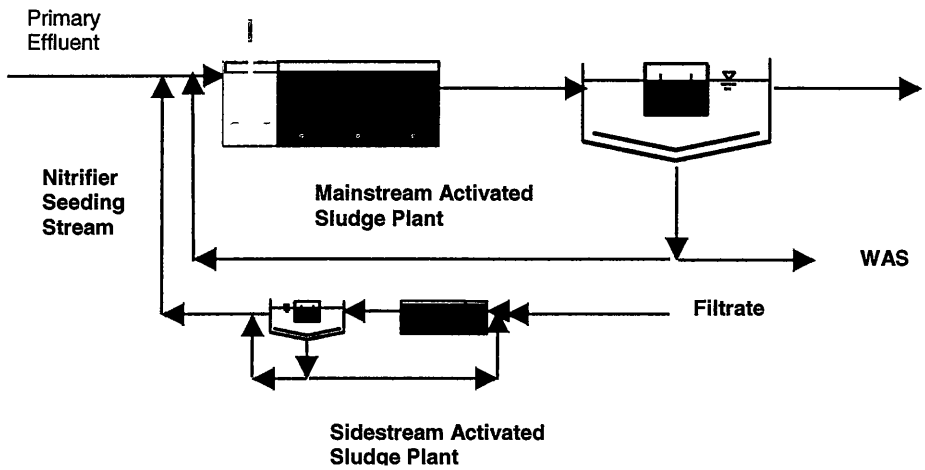


Figure 1. Short SRT Process with Seeding of Nitrifiers to the Mainstream Activated Sludge Plant

Heretofore, this process has not been demonstrated at other than bench scale. We present it here, because it is just a simple modification of the conventional process. Our modeling study for New York City showed that nitrification would be more complete at any given SRT as shown in Figure 2. Essentially, nitrification rates are higher and nitrification can be accomplished in a much smaller volume than would otherwise be the case.

It is a patented process, however, so the user would need to license the technology from Lotopro in order to place it into practice. It may be possible to conduct a trial with Lotopro's permission without cost, but this also would be subject to negotiation. We believe that the process warrants serious consideration by the City of Riverside.

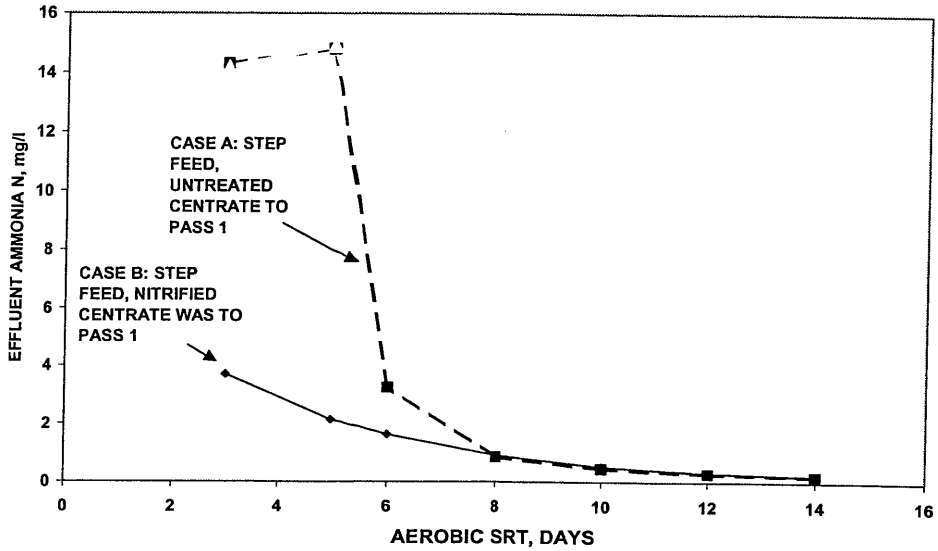


Figure 2. Comparison of Predicted Nitrification Performance for Means of Treating Centrate in New York City. Case A, All Centrate to First Pass. Case B, Short SRT Process with Treated Centrate and Waste Nitrified Sludge to First Pass

SBR Process. The SBR process is a variant of the activated sludge process. The main difference is that both aeration and settling are provided in a single tank (although multiple SBRs are normally provided). Owing to the need for the settling cycle, aeration volumes are similar to the total volumes required for aeration and settling in the conventional activated sludge process. Moreover, an equalization tank is usually provided to store effluent prior to equalize the slug discharges from the process.

The circular configuration of the available tanks make them poorly suited as SBR reactors. And given the available tankage, they would be no less expensive than the conventional process. These factors and their additional control complexity rules them out in favor of a conventional process, in our judgement.

SHARON™ Process. This process was recently introduced into Europe and has been implemented in two large plants there. Basically, it is an activated sludge process without a clarifier. At the elevated temperatures of digested sludge filtrate, simple aeration and caustic addition for pH control is sufficient to nearly nitrify the wastewater. No secondary clarifier is provided, so all of the solids formed pass on into the effluent. Because of this, the effluent must be returned to the mainstream process for further treatment. One stated advantage of the process is that less oxygen is needed, as nitrification stops at the formation of nitrite. This also means that less carbon is needed for denitrification when it is practiced in the mainstream process. The investigators found that there was no seeding benefit to the mainstream process, as all the nitrifiers were in a dispersed growth form and were quickly consumed by the protozoan predators in the activated sludge tank.

The typical design requires 48 hr of aeration. Between the four circular secondary clarifiers, there would be only 33 hours available, which is considered marginal. For this reason, we would consider the process marginal and therefore could not recommend it. The inventors believe the process may work at residence times as low as 24 hours, but have not demonstrated it. However, if a conventional activated sludge sidestream process were built, it would be possible to provide the SHARON™ process as an operating mode to test it out. Again, since this is a patented process, there would have to be negotiations with the patent holders for such a trial.

Trickling Filter. Trickling filters have been used for nitrification of sidestreams, most recently at the Inland Empire Utility Authority, where an existing rock trickling filter was employed. Nitrification on a trickling filter in this application requires a very high degree of solids removal from the sidestream, otherwise solids will coat the biofilm surface and displace the nitrifiers.

Owing to site-to-site variability in wastewater characteristics, employment of trickling filter technology would require a pilot study to determine design parameters for the application. This factor, along with the absence of trickling filters on the site, makes this alternative less attractive compared to other alternatives.

Process Recommendation

Table 1 below is a comparison of the various technologies available. From this table and the above discussion, the process that makes the best usage of the available tankage and is the best proven is the conventional activated sludge process. BC recommends that it be the basis of further evaluations of sidestream treatment and full-scale design if the City of Riverside chooses to provide sidestream treatment. BC would also recommend that the facility be provided the flexibility in design to operate in either the "Short SRT" or SHARON™ process modes. This would give the City the flexibility to optimize its mainstream BNR process (in the case of the Short SRT process) or to minimize the cost of aeration in the sidestream process (in the case of the SHARON™ process).

The sidestream treatment technology area has been evolving rapidly and providing a flexible facility now could pay dividends to the City over the long term.

Table 1. Comparison of Sidestream Treatment Technologies

Technology	Use of existing structures	Relative cost-effectiveness	Comment
Steam stripping	None except for equalization	Poor relative to activated sludge.	High energy requirements.
Activated sludge	Yes	Baseline for comparison to others; lowest cost.	Requires new blower building and caustic feed facility.
Short SRT process	Yes	Similar to activated sludge.	Same as activated sludge, but has mainstream nitrification seeding benefit. Benefit proven only a bench scale.
SBR	Doubtful	Poor relative to activated sludge.	Requires new blower building and caustic feed facility.
SHARON™ process	Yes	Requires construction of more tankage, so more expensive if implemented with full required residence time.	Requires new blower building and caustic feed facility. Has mainstream denitrification benefit, as less carbon is needed for nitrite produced.
Trickling filter	No	Poor relative to activated sludge as existing structures would have to be significantly modified for trickling filter application.	Requires a pilot study for application. Full-scale application requires new caustic feed facility.

Preliminary Development of the Activated Sludge Alternative

Calculations show that all of the available tankage will be necessary to accomplish nitrification in this potential sidestream treatment facility. There is no reactor volume available to accomplish denitrification as well, as the volume in the tanks is just sufficient to prevent excessive diffuser density and to provide the aerobic residence time needed for nitrification alone. Figure 3A shows the flow schematic and Figure 3B shows the possible layout of these facilites. The old gravity thickener is converted to a sedimentation tank to settle out any excess solids carried in the centrate flow. Transmission of excess solids to the sidestream treatment system would raise the mixed liquor level to the point that the aeration capacity would be exceeded. Alternatively, excessive solids loads could require the SRT to be dropped as nitrification could not be sustained.

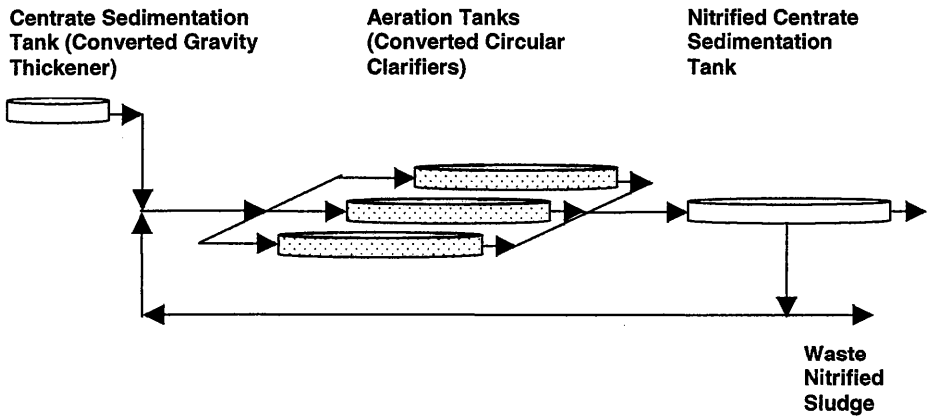
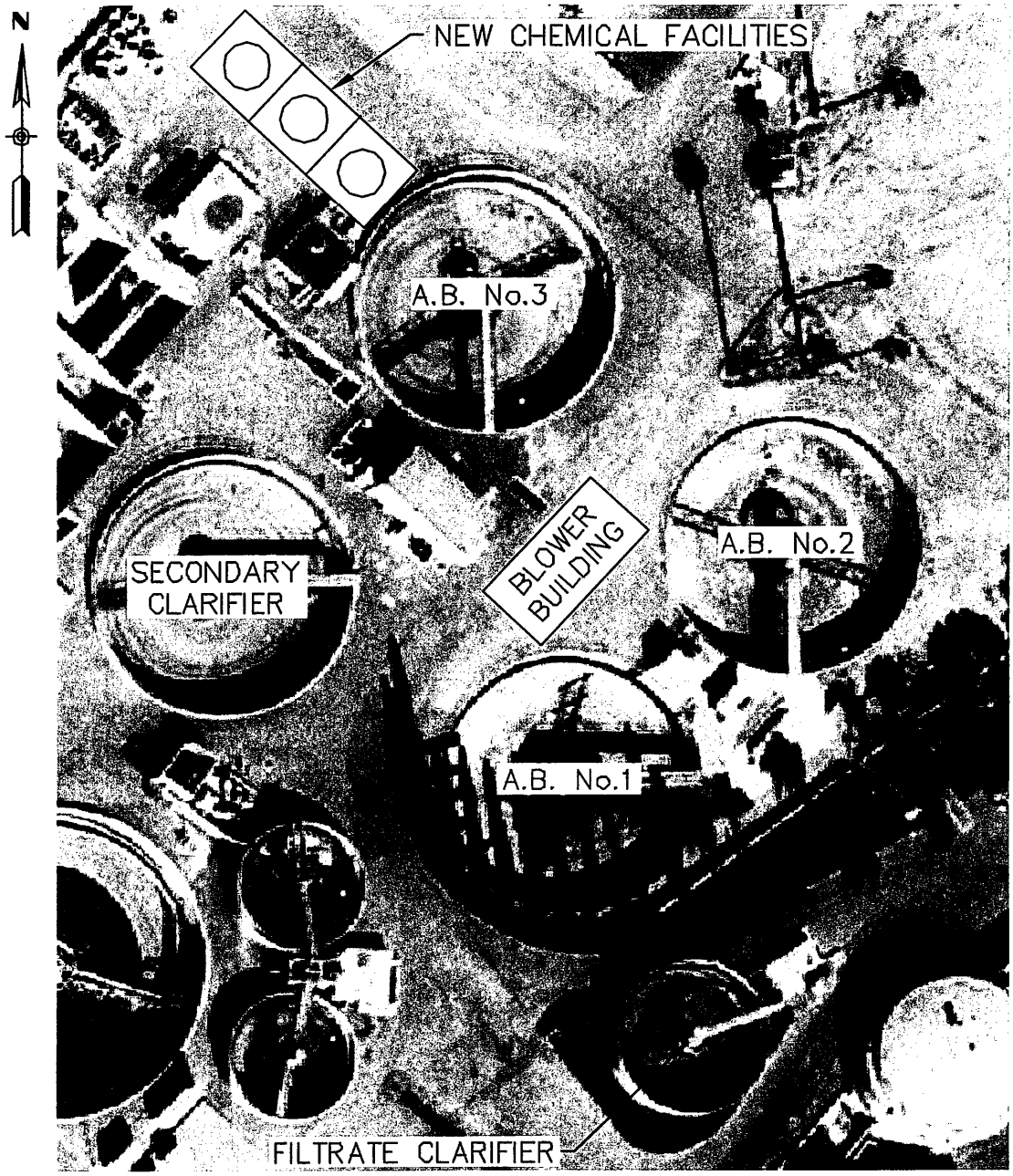


Figure 3A. Activated Sludge Process Flowsheet for Sidestream Nitrification Showing Use of Existing Facilities (New Aeration Blower Building and Caustic Storage and Feed Facilities Not Shown)

The assumption is made that the old secondary clarifiers have sufficient structural integrity to have their floors leveled to support the diffuser installation (this should be checked). BC has been able to do this at Colorado Springs (CO) and at Cobb County (GA), but were not able to do this recently in Hayward.

The modifications called for under this alternative are very similar to ones BC has done before. Figure 4 shows a secondary clarifier converted to aeration duty installed at the Colorado Springs Las Vegas St. Plant. The bottom had to be filled in to create a flat bottom, which was necessary to support the diffuser grid. The shallow sidewater depth (10 ft) required that the aeration efficiency be derated. However, the economics were still highly favorable since this was an existing tank. The water elevation was raised so that the flow would pass through this tank and then on to the existing secondary clarifiers which remained in service (all tanks originally had the same water depth as they were operated in parallel).



DATE	PROJECT NUMBER	SIDESTREAM RECYCLE TREATMENT PLAN	
09/12/02	22776.007		
BROWN AND CALDWELL SAN DIEGO, CALIFORNIA		PROJECT LOCATION: RIVERSIDE WATER QUALITY CONTROL PLANT RIVERSIDE, CALIFORNIA	0 25 50 SCALE IN FEET
			FIGURE 3B

22776_FG-01

One of the existing secondary clarifiers would be converted to it original duty with the addition of a new mechanism. The clarifier would also have to be modified to provide an essentially flat bottom and provided with suction sludge removal for rapid sludge removal in order to prevent floating sludge in the final clarifier due to denitrification.

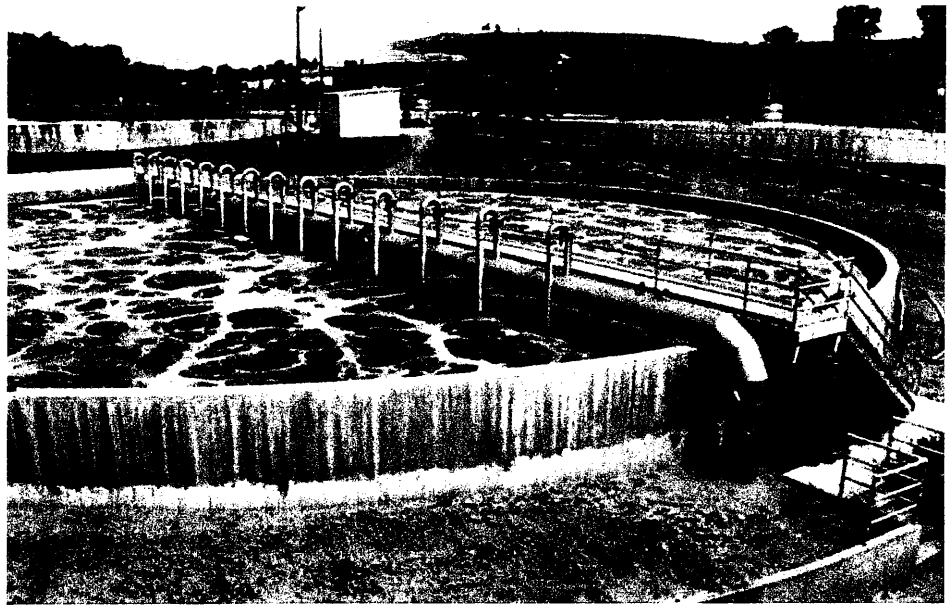


Figure 4. Secondary Clarifier Converted to Aeration Tank at the Las Vegas Street Plant in Colorado Springs

Table 2 provides a preliminary process design for the sidestream treatment facility. Note that both DO control for air modulation and pH control for pacing the caustic addition will be required. Also, to allow testing of the Short SRT process, waste nitrified sludge piping would be provided for both combinations with the main plants waste sludge but also for addition to the mainstream plant's influent. Similarly, to allow testing of the SHARON™ process, provisions for bypass of the secondary clarifier would be provided. This mode would also be used when the secondary clarifier needed to be taken out of service for maintenance.

Return sludge pumping should have variable speed capacity and be design for 100 percent of average flow for their maximum capacity. One pump and one standby are recommended.

Table 2. Preliminary Design Data for Centrate Treatment Facility

Item	Dimension
Average Future Centrate Loadings	
Flow, mgd	1.08
Ammonia nitrogen, mg/L	560
Assumed daily load peaking factor	1.5
Centrate clarifier	
Number	1
Diameter	40
Sidewater depth, ft	10
Average surface overflow rate, gpd/sf	680
Aeration tank volume	
Number	3
Volume, ea., mil gal	0.375
Sidewater depth, ft	10
Aerobic SRT, days	5
MLSS, mg/L	900 to 3,700
DO control, mg/L	2.0
Average air requirement, scfm	12,600
Peak air requirement[a], scfm	19,000
Number of blowers (variable speed)	3
pH control, units	7.2 to 8.0
Average caustic requirement gpd of 50 percent solution	4,400
Minimum storage requirement, based on 14 days, gal	62,000
Secondary clarifier	
Number	1
Diameter	80
Sidewater depth, ft	10
Average surface overflow rate, gpd/sf	210
Return sludge capacity, mgd	1
Number of service RAS pumps	1
Number of standby RAS pumps	1

[a]Peak air requirement approximated as 150 percent of average until peaking factor can be refined through more extensive sampling.

Only limited data were available to support this design, consisting of average monthly ammonia levels and belt filtrate flows for ten months of data. Missing are daily data on a variety of analyses that would be of interest in detailed design. Table 3 presents our recommendations for additional data collection, assuming the City of Riverside desires to proceed with a detailed design for the sidestream treatment facility.

Table 3. Recommended Sampling Schedule to Support Detailed Design

Location	Sample type	Sample analysis	Frequency[a]
Belt press influent	Composite	TS VS Flow	Once per week
Belt press filtrate and washwater	Composite	TS VS Flow Ammonia-N TKN Alkalinity TSS VSS COD sCOD[b] sBOD[b]	Once per week

[a]All samples to be taken on the same day for a six month period
[b]Soluble samples to be filtered through a Whatman GF/C or 934AH filter (not a Millepore filter)

Cost of Sidestream Recycle Treatment

As described above the cost of these facilities assumes that existing structures have sufficient structural integrity to support conversion to aeration basins and a flat bottom circular clarifier. Required chemical facilities for alkalinity addition could also vary significantly due to the lack of sufficient data note in Table 3. Chemical facility cost is based on assumed chemical usage as defined previously. Total capital cost for sidestream recycle treatment facilities including 30% contingencies and 25% for Engineering and Administration are estimated to be $6.4 M reusing the existing structures and $6.9 M to demolish the existing structures and build new facilities. Construction and equipment costs for these facilities are based on similar sized projects constructed in the Western United States. Capital costs for new facilities are also included for reference if existing structures are not suitable for conversion.

City of Riverside Water Quality Control Plant Evaluation of Options Technical Memorandum 8

Prepared By: Brown and Caldwell
Date: Revised March 2003

Introduction

Project Background

Seven Technical Memoranda (TMs) have been prepared to evaluate options for handling wastewater solids production from the RWQCP for an ultimate plant capacity of 50 MGD. These seven TMs included the following:

- Technical Memorandum 1 – Solids Projections and Thickening Evaluation
- Technical Memorandum 2 – Digestion Options
- Technical Memorandum 3 – Heat Energy Options
- Technical Memorandum 4 – Dewatering and Air Drying Options
- Technical Memorandum 5 – Heat Drying Options
- Technical Memorandum 6 – Composting Options
- Technical Memorandum 7 – Sidestream Treatment Options

Project status and review meetings were held with the City of Riverside Public Works Department Water Quality Control Plant management and staff in late 2002 and early 2003 to review TMs and the draft report that had been submitted. Comments and feedback received from these meetings were summarized in minutes of these meetings. Copies of these meeting minutes are included in Appendix A. Key points from these meetings which effect the evaluation of options included in this Technical Memorandum 8 are as follows:

- To reduce thickened sludge flow rate to the digesters, co-thickening should be considered to increase the thickened solids concentration. Benefits of co-thickening include:
    - Increased gas production from fresher primary sludge feed.
    - Increased capacity of the primary sedimentation tanks as a result of higher allowable overflow rates.
    - More homogenous feed to the digesters.

  The primary benefit would be increased capacity in the digesters.

- To reduce thickening system costs, the existing DAFT 3 located adjacent to the old digesters might be considered as a part of the system. Information received after the meeting indicates that this DAFT has

never been operated with sludge and the equipment is likely not workable. Complete replacement of equipment associated with this DAFT is assumed to be required to make this a viable approach.

- Due to odors coming from the air drying beds, the City should plan to phase out the air drying bed operation over time. It is recognized that air drying has provided for a low-cost solids dewatering and drying at the RWQCP and that replacement of this process will be more costly.

- Due to expected increased air drying odors when centrifuge dewatered cake is applied to the beds, centrifuge dewatering is best linked to heat drying equipment.

- Although heat drying is a reliable way to produce Class A biosolids, heat drying should be considered a supplement to air drying (initially) that could be phased in over a period of time to eventually replace air drying.

- Sidestream treatment will be addressed by improvements being made to the aeration basins being developed under a separate engineering contract.

- Project phasing should be done based on process needs rather than the 40 and 50 MGD phases previously defined.

This Technical Memorandum will evaluate the options presented in the other seven technical memoranda based on the feedback received at the most recent review meeting. Previous technical memoranda were not revised to reflect the key issues noted above.

Objectives

As stated in the scope of work for this project and as discussed with City staff at the kickoff meeting held on June 4, 2002 (see Appendix A for copies of meeting minutes), this technical memorandum evaluates options presented in previous technical memoranda and recommend facilities and improvements. Preliminary project costs, project phasing, and an implementation plan have also been developed. The following objectives are addressed:

1. Review and compare options presented in each Technical Memorandum.

2. Recommend facilities including immediate improvements needed to address capacity problems, as well as phasing options for facilities up to 40 MGD.

3. Develop costs for the recommended facilities and improvements.

Evaluation of Existing Solids Processes

Existing Facilities and Solids Production

The RWQCP is a tertiary treatment facility currently treating approximately 31 MGD (average dry weather flow) of influent wastewater flow. The solids handling processes that are a part of this plant include: primary sludge thickening within the primary sedimentation tanks, dissolved air flotation thickening (DAFT) for waste activated sludge (WAS), mesophilic anaerobic digestion, belt press dewatering and air drying. Heat used for anaerobic digestion is supplied from waste heat recovered from the cogeneration facility. The cogeneration facility burns a combination of natural gas, landfill gas, and digester gas. Boilers are provided to supplement cogeneration heat when needed. Air quality limits discussed in TM3 indicate that the cogeneration facility is nearing its NO_X emission limits that would need to be addressed if additional combustion equipment was proposed. Table 1 summarizes each of these unit processes and operating criteria. Table 2 summarizes current solids production quantities and flows based on influent flow stated above. Values shown in this table have been updated to reflect DAFT performance discussed at the draft report review meeting.

Table 1 – Summary of Solids Handling Processes[a]

Process Facility/Operating Criteria	Value
DAF Thickening	
Number of Units[b]	2
Gross Surface Area (sq. ft.), ea	1,018
Effective Surface Area (sq. ft.), ea	943
Total Surface Area (sq. ft.)	1886
Total Surface Area w/one unit out of service (sq. ft.)	943
Solids Loading (lb/sq. ft./day) WAS thickening (current approach) Co-thickening (future) Average Peak daily	 14.5 30.0 45.0
Hydraulic Loading (gpm/sq. ft.)	1.0 –2.0
Allowable Solids Loading, avg w/one unit out, (lb/day) WAS thickening (current approach) Co-thickening (future)	 13,700 28,300
Allowable solids loading, peak day w/all units, (lb/day) WAS thickening (current approach) Co-thickening (future)	 27,300 84,900
Allowable hydraulic loading, avg w/one unit out	943 gpm 1.36MGD

(table continues)

Table 1 (continued)

Process Facility/Operating Criteria	Value			
Allowable Hydraulic Loading, peak day w/all units	1886 gpm 2.71 MGD			
Air-to-Solids Ratio	.025-.04			
Capture rate, %	95			
Thickened solids concenteration, % WAS thickening (current approach) Co-thickening (future)	4.0 5.0 – 6.0			
Anaerobic Digesters				
Digester No.	1	2	3	4
Diameter, ft	90	90	75	88
Sidewater Depth, ft	32	32	32	38.5
Volume, million gal	1.64	1.64	1.06	1.8
Status	In service	In service	Digested Storage	Out of service
Total Current Digester Volume, million gal (excluding No. 3 and 4)	3.28			
Total Current Digester Volume, million gal (excluding No. 3)	5.08			
Allowable Average flow for min. 18 day solids retention time with one unit out, MGD	0.18			
Allowable Peak 2-week flow for min. 15 day solids retention time with all units in service, MGD	0.33			
Volatile Solids Reduction,%[c]	53			
Digester Gas Production, cu ft/lb Volatile Solids removed[c]	13			
Dewatering				
Number of belt filter presses	2			
Belt width, meters	2			
Unit capacity[d]				
Average, gpm	100			
Peak, gpm	150			
Dewatered cake solids concentration, %[d]	12			
Air Drying				
Number of drying beds	29			
Total drying area, acres	8			
Dried product solids concentration, %	90+			

a. Unless otherwise noted, all information stated in this table was obtained from the plant O&M manual.
b. Number of DAFTs includes only DAFTs 1 & 2. Thickened WAS concentration reported by the City.
c. VSR and gas production obtained from plant performance data.
d. Belt press performance based on plant data.

Table 2 – Summary of Current Solids Production at 31 MGD

Parameter	Values				
	TSS		VSS		Flow
	%	Lb/day	% of TSS	Lb/day	MGD
Thickened Primary Sludge					
Average daily	4.1	30,500	82	25,000	0.09
Peak daily	3.4	37,100	82	30,300	0.13
Unthickened WAS					
Average daily	0.53	27,400	79	21,600	0.61
Peak daily	0.54	38,300	80	30,700	0.85
Thickened WAS[a]					
Average daily	4.0	24,700	79	19,500	0.07
Peak 2-week	3.5	34,500	82	28,300	0.12
Combined Thickened Sludge					
Average daily	4.1	55,200	80.5	44,400	0.16
Peak 2-week	3.4	71,600	81.9	58,600	0.25
Digested Biosolids[b]					
Average	2.6	34,700	66	24,000	0.16
Peak 2-week	2.3	48,600	68	33,600	0.25
Dewatered Biosolids[c]					
Average daily feed	2.6	58,400	66	38,500	0.27
Peak 2-week feed	2.3	81,700	68	55,600	0.42
Average cake, ton per day (dry)	12	27.7			
Peak cake, ton per day (dry)	12	38.8			
Average cake, ton per day (wet)	12	231			
Peak cake, ton per day (wet)	12	323			

a. Assumes 90% capture by DAFT and stated float concentration.
b. Assumes 53% VSR in digestion, 7 days per week operation.
c. Assumes 95% capture by dewatering, 5 days per week, 16 hours per day operation.

Evaluation of Existing Capacity

This section evaluates the capacity of existing solids process facilities to identify immediate improvements needed to fill capacity shortfalls. Table 3 summarizes this evaluation of existing capacity and firm capacity needs. At the draft report review meeting, the City reported that DAFT 3 could be used to supplement current capacity. In the early 1990's an existing gravity thickener was converted to a DAFT to create DAFT 3. After the conversion, this DAFT was tested with water and never put into service. The condition of this equipment is poor and total equipment replacement is assumed necessary. Operation of this DAFT

would add to the complexity of the system because it is located approximately 500 feet away from the main digestion process and other DAFTs. Use as a redundant DAFT unit would be difficult and would require some modifications to plant piping and operating strategies.

Table 3 – Existing Capacity Needs

Process	Capacity			Comment
	Req'd	Available	Add'tl	
DAF Thickening				
Area (solids criteria) avg w/1 unit out, sq. ft.				Available surface area assumes only DAFTs 1 and 2
WAS thickening	1889	943	946	
Co-thickening[a]	2412	943	1470	
Area (solids criteria) peak daily, sq. ft.				
WAS thickening	2641	1886	755	
Co-thickening	2100	1886	208	
Area (hydraulic criteria) avg w/1 unit out, sq. ft.				
WAS thickening	423	943	None	
Co-thickening[a]	931	943	None	
Area (hydraulic criteria) peak daily, sq. ft.				
WAS thickening	590	1886	None	
Co-thickening	1208	1886	None	
Anaerobic Digestion[b]				
Detention time, avg w/Digester 1 and 2 in service, days				Detention times assume Digester 4 brought back into service.
WAS thickening (4%)	18	20.5	None	
Co-thickening (5%)	18	24.8	None	
Detention time w/Digester 1, 2 and 4 in service, peak 2-week, days				
WAS thickening (4%)	15	20.3	None	
Co-thickening (5%)	15	29.4	None	
Dewatering[c]				
Capacity, avg w/1 unit out, gpm	187	100	87	Additional capacity needed w/one belt press out of service.
Capacity, peak 2-week, all units in service, gpm	292	300	None	

a. Co-thickening DAFT loading includes 25% allowance for bottom sludge recycle. Hydraulic loading assumes primary sludge flow at 0.5 to 1.0% including 100 gpm bottom sludge recycle per DAFT.
b. Peak detention time shown includes volume of Digester 4 which is currently out of service.
c. Dewatering assumes continued 5 days per week, 16 hours per day operation.

Table 4 defines existing capacity in terms of equivalent plant influent flow. Equivalent plant influent flow is derived by dividing allowable loading for each process by current loading and multiplying by current plant influent flow of 31 MGD. By defining existing facilities according to their equivalent influent flow, planning for future expansion of individual processes may be accomplished more easily.

Table 4 – Existing Capacity (equivalent plant influent flow, MGD)

Process	Average w/one unit out	Peak w/all units
Thickening		
WAS thickening	15	22.1
Co-thickening	30.3	34.9
Digestion		
Current 4.1 % feed	35.3	41.9
(co-thickening 5%)[a]	43.0	59.8
(co-thickening 6%)[b]	51.6	71.8
Dewatering		
5 days per week,16 hours per day operation	16.6	31.8
7 days per week, 24 hours per day operation	27.9	53.4

a. Conservative concentration without polymer.
b. This concentration has been achieved at other plants in Southern California and Washington State on a consistent basis.

Review of Table 4 shows that expansion of existing thickening system without including DAFT 3 and dewatering system is needed immediately since the equivalent plant influent flow capacity is at or below existing influent flow. Some relief for dewatering capacity could be achieved by operating this process on a 7 days per week schedule. However, there still would be no redundancy available to allow a unit to be taken out of service for maintenance. Expansion of existing digestion facilities after Digester 4 is brought back on line may be delayed for several years depending on the concentration of the thickened sludge feed. The higher WAS thickened sludge concentrations have been shown to illustrate the effect of anticipated performance improvements. Expected plant influent flows could be handled by the existing digesters by converting the existing DAFT process to co-thicken primary sludge and WAS.

Comparison of Options

Parametric Analysis

When evaluating needed facilities it is important to understand the inter-relationship of individual processes. If a unit process is inadequately sized, it can

result in performance that is lower than design. This in turn would affect the performance of downstream processes. To illustrate the effects changes in upstream process performance parameters could have on downstream processes, a parametric or sensitivity analysis was conducted. For example, the digester volume required to achieve an 18-day detention time during average flow was calculated for three different thickened WAS solids concentrations: 4.0%, 4.5% and 5.0% (primary sludge concentration was held constant at 4.1%). A digestion process designed for a thickened WAS sludge concentration of 5.0% would require less volume than a thickened WAS sludge concentration of 4.0% to achieve the required detention times.

The calculations were performed for two different flows, 40 MGD and 50 MGD (avg. dry weather). Parameters such as the TSS and VSS content of the wastewater were assumed to remain unchanged and were simply scaled up from available data. Figures 1 and 2 below illustrate the variation of digester volume required based on different concentrations of the WAS thickened solids concentration (assuming primary sludge concentration held constant at 4.1%). The volatile solids reduction (VSR) in the digester was assumed to be constant at 53%.

The illustrations below show that the required digester volume displays a linear relationship with the concentration of solids in the thickened WAS. A higher solids concentration will result in reduced requirements of digester volume for a given influent flow rate. This statement is true for both average and peak flows as evident in these illustrations.

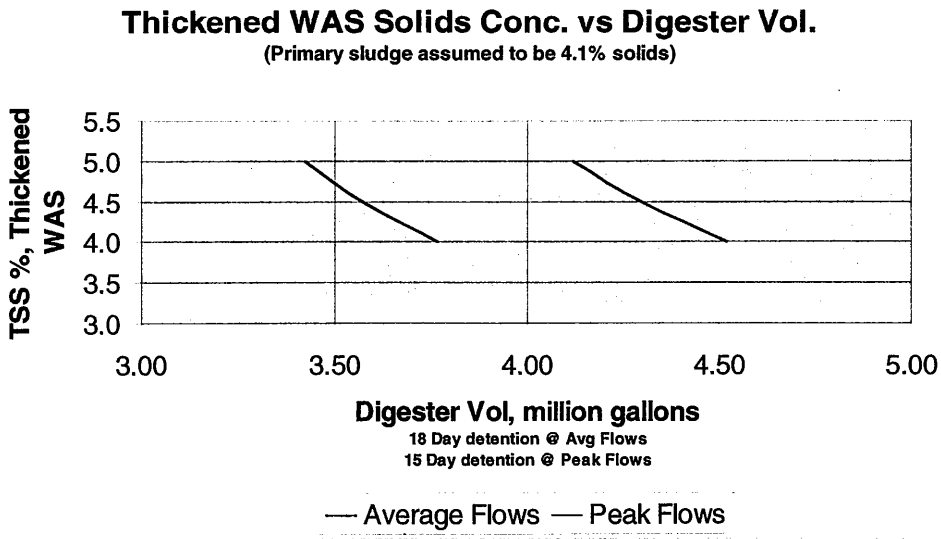


Figure 1. Variation of Thickened WAS Solids concentration with Digester Volume for a plant flow of 40 MGD (VSR of 53% in digester assumed)

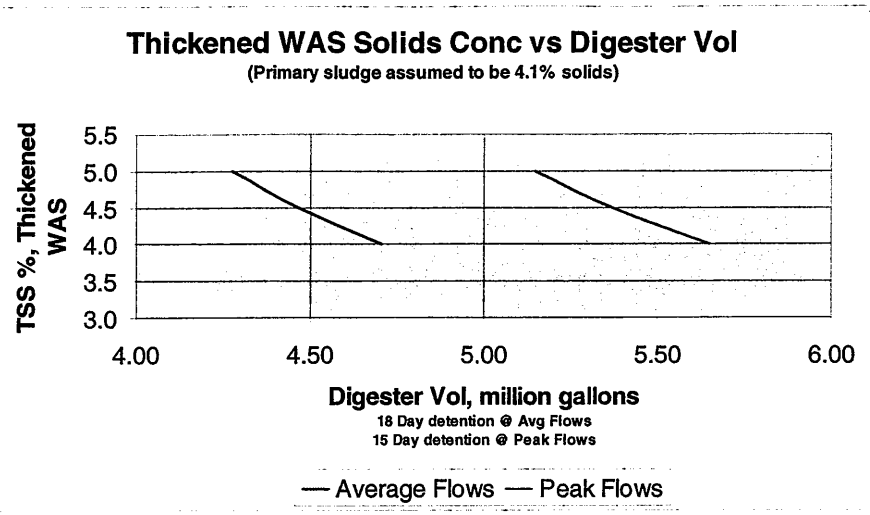


Figure 2. Variation of Thickened WAS Solids concentration with Digester Volume for a plant flow of 50 MGD (VSR of 53% in digester assumed)

Calculations were performed in a similar manner to determine the effect of VSR on cake production. The digester VSR was varied from 53% to 61% and the cake production was estimated. These VSR percentages were selected to correspond to expected performance of mesophilic and TPAD digestion options discussed in TM2. The WAS thickened solids concentration was assumed to remain constant at 5%.

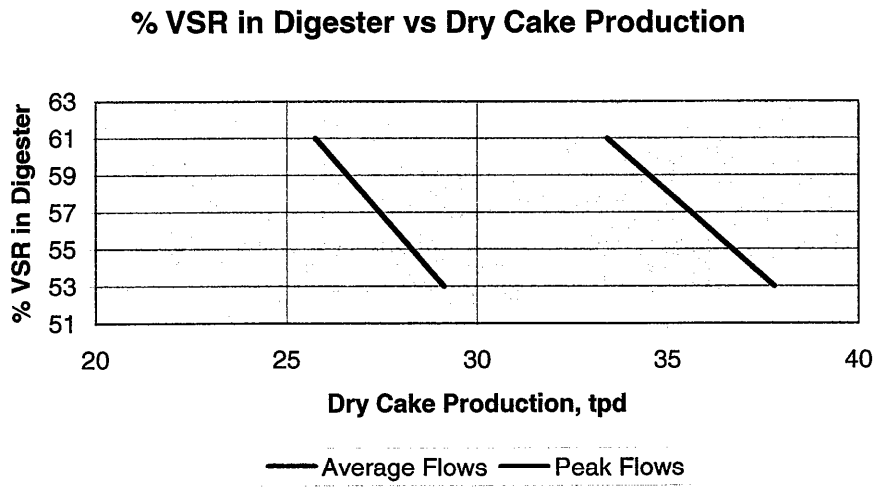


Figure 3. Variation of Dry Cake Production with % VSR in Digester for a plant flow of 40 MGD (Thickened WAS Solids concentration of 5% and Primary Sludge concentration of 4.1% assumed)

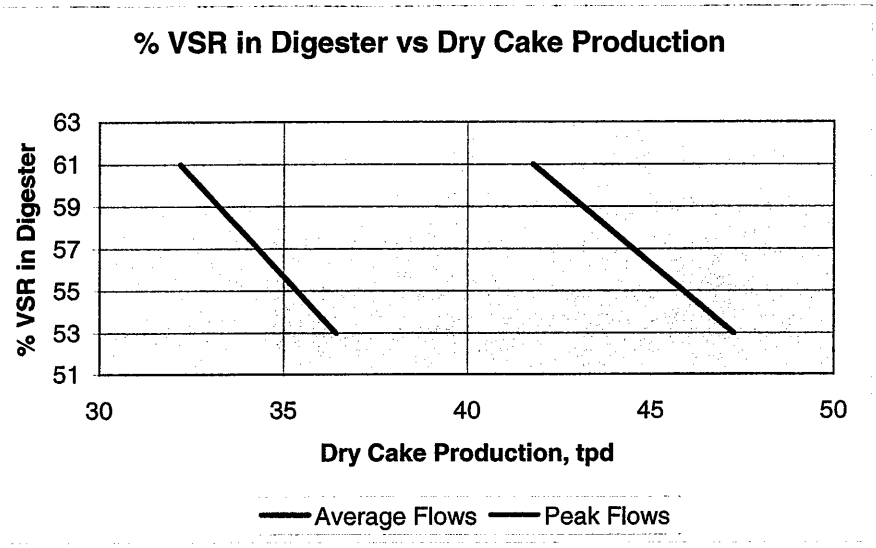


Figure 4. Variation of Dry Cake Production with % VSR in Digester for a plant flow of 50 MGD (Thickened WAS Solids concentration of 5% and Primary Sludge concentration of 4.1% assumed)

These calculations were performed for plant flows of 40 MGD and 50 MGD. Figures 3 and 4 above illustrate these comparisons. Dewatering performance for both at average and peak plant flows will be enhanced by increasing the VSR in the digester. This is also observed in the illustrations above.

Evaluation of Options Summary

As stated in the introduction, seven technical memoranda were prepared. The following section summarizes evaluations and recommendations made in each technical memorandum.

Technical Memorandum 1 – Solids Projections and Thickening Evaluation

Solids projections for 40 and 50 MGD were developed based on most recent data provided by RWQCP staff from the year 2001. This data indicated that the performance of the DAFTs was less than expected. Based on this information, a comparison of current separate thickening of primary and secondary sludge versus co-thickening was provided.

At the draft report review meeting held on February 14, 2003, the plant staff acknowledged that DAFT performance had not improved significantly since repairs and changes had been made to the DAFT equipment and that thickened solids concentration has increased only about 0.5%. As shown in Table 4 the available capacity is insufficient to provide for flows in the near future without having all units on line. As a possible way of reducing capital cost for expansion of the thickening system, the City suggested bringing DAFT 3 back into service. This DAFT, converted from a gravity thickener in the early 1990s, was tested with water and never used to handle sludge. Because it has never been proven to

handle sludge and it has been out of service for a prolonged period of time, complete equipment replacement is assumed necessary to make this a viable option. This DAFT is located approximately 500 feet from the other DAFTs and digesters currently in service. Operation of this DAFT as a part of the thickening system would likely require special attention and modification of control strategies. Therefore, bringing DAFT 3 back into service is not considered feasible.

Table 5 shows the additional capacity that would be provided by adding one DAFT for both separate thickening and co-thickening. As shown in Table 5, adding one DAFT under the co-thickening option, the DAFTs would be able to handle more solids because of the higher allowable solids loading rate. As noted in TM2, in addition to the benefit of producing a thicker sludge to feed to the digester, the following benefits could be realized.

- Increased digester detention time.
- More homogenous solids feed to the digesters that could improve digester performance.
- Increased primary sedimentation surface overflow rate.

Since additional DAFT capacity would need to be constructed and conversion to co-thickening would provide the benefits described above, we recommend that a new DAFT be constructed for co-thickening and the other DAFTs be retrofitted to be a part of the co-thickening system. Elements needed in the retrofitted DAFTs would include modifications to the compressor and pressurization system to provide the necessary air-to-solids ratio, modifications to the bottom sludge removal system, and float removal system, covers, and odor control. The new DAFT system would also include a new distribution box, as well as a 20,000 gallon thickened sludge blending tank and digester feed pumps. Provisions could also be made for future thickened bottom sludge degritting and blended sludge preheating.

Table 5 – Capacity Improvements

Criteria	WAS Thickening	Co-thickening
Number of units currently in service	2	2
Number of units added	1	1
Number of units total	3	3
Diameter[a] (ft) (new unit)	48	48
Net surface area (all units) (sq. ft.)	3356	3356
Net surface area w/1 unit out (sq. ft.)	2413	2413
Allowable solids loading (all units) (lb/day)		
Average	48,700	100,700
Peak	48,700	151,000

(table continues)

Table 5 (continued)

Criteria	WAS Thickening	Co-thickening
Allowable Solids Loading (one unit out) (lb/day)		
Average	35,000	72,400
Peak	35,000	108,600
Equivalent plant influent flow capacity (all units) (MGD)		
Average	55.1	53.9
Peak day	39.4	44.1
Equivalent avgerage plant influent flow capacity (one unit out) (MGD)		
Average	39.6	38.7
a. Diameter includes additional 5 ft for effluent launder and baffle.		

Technical Memorandum 2 – Digestion Options

Technical Memorandum 2 evaluated two digestion options including mesophilic digestion and temperature phased thermophilic/mesophilic digestion (TPAD). As noted in the presentation given at the October 31, 2002 review meeting, neither mesophilic nor TPAD would be able to achieve EPA Class A process requirements. However, it was also noted that TPAD produces Class B++ quality biosolids due to the higher VSR and reduced pathogens resulting from the high temperature phase. Only the addition of intermediate batch tanks between the thermophilic phase and the mesophilic phase would be able to ensure a Class A process. The primary benefits of TPAD noted in TM2 were increased volatile solids reduction (VSR) (approximately 61%), which in turn would yield increased digester gas production and reduced solids to dewatering. In addition, having the high temperature phase could also help to achieve Class A biosolids from air drying. TM2 also recommended that a thickened sludge blending tank be installed to simplify digester feed, provide a more homogeneous solids feed, and provide a place to preheat solids before feeding the digesters.

Technical Memorandum 3 evaluated available heat energy from existing cogeneration heat recovery (jacket water and exhaust heat recovery) and determined that for the 50 MGD facility, there would be a 5.4 MMBtu/hr shortfall in heat needed to operate TPAD. This shortfall could be filled either by sludge heat recovery between the temperature phases or by supplemental boilers. Since the present worth costs of the two digestion options were nearly equal, the City indicated their preference would be to continue the current mode of mesophilic anaerobic digestion. The added complexity of these heat recovery systems and operation of digesters at two different temperatures also make the TPAD a more challenging option. As shown in Table 4, current capacity, including Digester 4, would be capable of providing sufficient detention time for an equivalent plant influent flow of 35.4 MGD for WAS thickening, (assuming 4.0% thickened WAS concentration and 4.1% primary sludge concentration). Equivalent plant influent flow of 43 MGD for co-thickening, (assuming 5%

thickened sludge concentration) could be provided by the same number of units. Therefore, construction of a new digester may be delayed until some future date when plant influent flows are approaching these values. TPAD could be considered at a later date also.

Technical Memorandum 3 – Heat Energy Usage Options

Technical Memorandum 3 evaluated heat energy usage for future temperature phased anaerobic digestion as discussed above. Since TPAD is not recommended, there will be more than enough heat available to continue to operate the digesters in the mesophilic mode. At the ultimate 50 MGD plant capacity, there would be a shortfall of heat from the cogeneration heat recovery system of approximately 1.2 MMBtu/hr. This shortfall could be provided either by adding a new boiler or replacing the absorption chiller with an electric chiller. Technical Memorandum 5 – Heat Drying options indicated there would be approximately 2 to 4 MMBtu/hr surplus heat available from exhaust heat recovery if thermophilic digestion was not implemented. Because this heat energy would not be at the temperature needed to heat the hot oil used for drying, it could only be used to warm the oil before being brought up to necessary heat drying temperatures. Other uses of this surplus heat were not evaluated. Further evaluation of heat energy usage options could be done during detailed design.

Technical Memorandum 4 – Dewatering and Air Drying Options

Evaluation of Dewatering Options. Technical Memorandum 4 evaluated two different dewatering options: belt filter presses and centrifuges. This TM also evaluated current dewatering practices and identified current capacity deficiencies that need immediate attention. These deficiencies have been discussed above and summarized in Table 3. Since dewatered cake has been air dried, there has been no pressure to improve cake dryness. A potential problem associated with centrifuge dewatering is the potential for the dewatered cake to produce substantially more odors when placed on air drying beds. At the project status and review meeting held on October 31, 2002, the City indicated continued use of air drying is becoming less likely for two reasons: 1) odor problems associated with open air drying and 2) limited disposal options for Class B biosolids. Therefore, phasing out the air drying facility over time is recommended. A smaller air drying operation continuing to use belt presses achieving 90% solids may be satisfactory to produce Class A biosolids.

Dewatering options developed for the 50 MGD facility indicated that the two existing belt presses would be removed and replaced with 2 new belt presses for a total of 4 belt presses. Alternatively, if the facility were converted to all centrifuges, a total of 3 new high capacity (200 gpm) centrifuges (two duty and one standby) would be needed to provide sufficient capacity with adequate redundancy. Both options assumed no building expansion would be needed. Odor control should be included for either option.

Centrifuges could be placed on pedestals above the space already provided for the belt presses. To provide sufficient head space for removal of centrifuges on elevated platforms, raising the roof and existing bridge crane would be required. Minimal odor control would be needed for centrifuges because foul air is largely

contained within the centrifuges. As noted above, the current capacity deficiency could be filled either by using rental belt presses to supplement existing capacity until the permanent dewatering facility expansion is constructed, or by installing one or more centrifuges in the space provided for the two future belt presses. Use of centrifuges to provide needed capacity would only be considered feasible if the product was not air dried.

Table 6 shows recommended dewatering capacity improvements. As noted in this table, the current system, (assuming a 5 days per week/16 hours per day operation) would be capable of only handling solids from an equivalent plant influent flow of 17.2 MGD with one unit out of service or 34.1 MGD with both units in service operating at 150 gpm. As discussed earlier, operating at this peak hydraulic loading rate may be one of the reasons for the lower than expected cake concentration. With the addition of one 200 gpm centrifuge, the dewatering facility would be capable of handling solids from an equivalent influent flow of up to 45.9 MGD with one belt press out of service and 63.1 MGD with all units on line. One centrifuge alone would be capable of handling solids from an equivalent influent flow of approximately 40 MGD at 250 gpm. The capacity of both the existing system and the system with one centrifuge added could be increased by extending the hours of operation from a 5 days per week/16 hr per day schedule to a 7 days per week/24 hours per day schedule or somewhere in between. Centrifuges can run unattended or occasionally attended, so that additional staffing for extended operating hours may not be highly significant. Also, centrifuges operate better and use less energy when they are run continuously rather than starting and stopping. Operating under a 7 days per week schedule would also decrease the size of the heat drying system as well.

Air Drying Options. Technical Memorandum 4 also evaluated the ability of existing air drying beds to achieve Class A biosolids quality. As defined by EPA's Part 503 rule, Alternative 4 – Biosolids treated in many processes and then sampled to meet pathogen density requirements is the only alternative that would apply for certifying Class A Biosolids from air drying. To make it economically workable, the pile of dried biosolids would need to contain at least several months of production. Sampling, monitoring, and record keeping requirements to certify the air dried material as Class A could be done at a reasonable cost. As stated above, Class A biosolids may be achieved from a smaller air drying facility drying belt press cake to 90 to 95% solids concentration provided adequate monitoring is done. The reliability of producing a Class A material could be improved by having at least one high temperature stage of anaerobic digestion in the thermophilic range (52 to 57 degrees C), drying solids to higher than 90% or improving the stability of biosolids sent to air drying. Several methods to reduce odors from air drying were discussed in TM4 including using advanced digestion to reduce organic material, aerobic digestion after anaerobic digestion, and placing a solid wall on the down wind side of the site. Advanced digestion is not needed at this time. Aerobic digestion following anaerobic digestion is a relatively new process that has been tried in Vacaville, California that would require further testing before it could be utilized. Therefore, its value is less certain. Constructing a solid wall fence using plywood would be a relatively inexpensive way to test this method, and a semi-permanent wall could be installed to reduce odor from leaving the site while the City phases out the air drying beds.

Table 6 – Recommended Dewatering Capacity Improvements

Criteria	Phase One		Phase Two
	Belt Press (Existing Conditions)	Belt Presses & Centrifuge	Centrifuge
Number of units			
Belt Presses	2	2	
Centrifuge		1	2
Unit Capacity			
Belt Press, avg (gpm)	100	100	Removed
Belt Press, peak (gpm)	150	150	Removed
Centrifuge, avg (gpm)	NA	200	200
Centrifuge, peak (gpm)	NA	250	250
Capacity (w/one unit out)			
Belt Press, avg (gpm)	100	100	Removed
Belt Press, peak (gpm)	150	150	Removed
Centrifuge, avg (gpm)	NA	200	200
Centrifuge, peak (gpm)	NA	250	250
Total avg	100	300	200
Total peak	150	400	250
Capacity (all units)			
Belt Press, avg (gpm)	200	200	Removed
Belt Press, peak (gpm)	300	300	Removed
Centrifuge, avg (gpm)	NA	200	400
Centrifuge, peak (gpm)	NA	250	500
Total avg	200	400	400
Total peak	300	550	500
Equivalent Avg Influent Flow, 5 days per week – 16 hours per day operation			
With one unit (belt press) out	16.1	48.2	Removed
Average	17.2	45.9	Removed
Peak 2-week @ peak capacity with all units	34.1	63.1	57.4
Peak 2-week @ peak capacity centrifuge only			
Average	NA	32.1	64.2
Peak capacity		40.1	80.2

Technical Memorandum 5 – Heat Drying Options

Technical Memorandum 5 evaluated heat drying options to replace air drying. Three indirect drying systems were evaluated including the Fenton system, the INNOPLANA (InnoDry) system, and the Komline-Sanderson system. These systems were selected for evaluation based on their relatively low equipment cost, operating simplicity, and product quality. Each machine produces an ungraded product that could either be blended with other fertilizers or land applied by itself. At the draft report review meeting held on February 14, 2003,

the City suggested a way of reducing the cost of heat drying facilities may be by initially drying only centrifuge cake to approximately 80% dryness then placing this mostly dry product in the drying beds for continued drying. Vendors of the three systems evaluated have been contacted for a cost comparison of drying the product only 80% or 95%. A comparison of energy costs and equipment costs for drying the product beyond 80% does not appear significant. Therefore, to provide a Class A product we recommend the system be designed to achieve the 95% solids. None of the Vendors indicated there would be a significant change in odors from 80 to 95% solids.

Based on drying facilities needed for the ultimate 50 MGD plant capacity, the capital costs and present worth energy costs for these three systems were very close. Therefore, further evaluation of these three vendors would be considered during final design. Because the evaluation considered using smaller units (approximately 10 dry ton per day each), phasing in a heat drying system over several years could be easily done. To reduce initial capital costs a phased construction approach is recommended. Table 7 shows recommended heat drying facilities improvements

Table 7 – Mimimum Heat Drying Facility improvements

Phasing Criteria[a]	Fenton	InnoDry	Komline-Sanderson
Dewatered cake production, combined belt presses and centrifuge dewatering			
Current solids production, dry ton per hour			
Average 7 days per week/24 hours per day	0.79		
Average 5 days per week/16 hours per day	1.66		
Number of units[b]	2	2	1
Model Number	RK72E-Duplex	G4	17W-4000
Unit capacity dry tons/hr	0.75	0.78	1.85
System capacity dry tons/hr	1.50	1.56	1.85
Dryer heat required, Btu/lb water	1450	1250	1123
Electrical load, kW	256	175	298
Approximate building size[c]	100 x 60	125 x 90	100 x 60
Equivalent plant influent flow capacity			
Average 7 days per week/24 hours per day	61.2	61.2	72.5
Average 5 days per week/16 hours per day	28.0[d]	29.1	34.5

a. Assume 53% VSR in digestion.
b. Assumes no redundant units.
c. Building size includes drying equipment, ancillary equipment, and loading.
d. Effective operating hours may be extended because the last 2 hours of the batch can run unattended.

As shown in Table 7 above, each of the vendors would be capable of handling current and future production depending on the operations schedule used. As discussed in TM5, heat dryers work best when they are allowed to operate continuously because of the time required to reheat the units. Providing the units described above would allow the City to have the flexibility to dry all, or a portion, of their daily production and phase out the drying beds.

Technical Memorandum 6 – Composting Options

Technical Memorandum 6 reviewed available composting technologies that could be implemented at the RWQCP site including aerated static pile and in-vessel compositing. These two technologies were selected because they are the most commonly used in North America. Because of the amount of odors produced during the composting operation, both of these systems would require significant odor control. Composting is also a land intensive process. These two factors, plus the capital costs involved (estimated $35 million) to implement a system that could treat 20 dry tons per day, make this option economically and environmentally infeasible. No further consideration of this option is recommended.

Technical Memorandum 7 – Sidestream Recycle Treatment

Technical Memorandum 7 evaluated several technologies for treatment of sidestream recycle flows to reduce process impacts on the existing aeration basins. The process selected in TM7 was conventional activated sludge utilizing four existing sedimentation tanks and one gravity thickener for process tankage. Using this system to treat these sidestream flows would cost on the order of $7 million and would require substantial use of caustic for alkalinity control. At the project status and review meeting on October 31, 2002, the City indicated that improvements and additions to the existing aeration system were being designed to handle these recycle flows and separate recycle stream treatment would be unnecessary.

Recommended Facilities and Improvements

Recommended Facilities, Improvements and Costs

This section summarizes recommended solids handling process facilities for Phase One and Phase Two. Table 8 summarizes recommended facilities and costs for Phase One and Phase Two.

Phase One Facilities

Existing DAFT and Digester 4 Improvements

Existing DAFT Improvements

- Add high level switch, high level alarm, and solenoid valve to prevent the pressurization tank from becoming water logged.
- Automate existing manually operated valve with an air operated throttling valve with flow controller and flow meter.
- Optimize the polymer system to more closely match required polymer dosage.
- Modify bottom sludge removal system to improve efficiency.
- Convert DAFTs 1 and 2 to co-thickening.

Digester 4 Improvements

- To provide sufficient detention time at peak 2-week flow Digester 4 needs to be brought back into service. Bringing this digester back into service would require the following:
  - Automate thickened sludge feed valves.
  - Modify controls for thickened sludge feed and digested sludge withdrawal to a PLC based system coordinated with Digesters 1 and 2.
  - Digester gas piping should be evaluated before placing this unit back into service.
  - A new hot water boiler and possibly a new heat exchanger are required.
  - Automate mixing pump system valves and replace the mixing pumps.

New DAFT (Co-thickening)

- One – 48 ft diameter DAFT.
- Distribution box.
- Control building sized for ultimate needs.
- Pumps, piping, controls for one new DAFT and two converted DAFTs
- One 20,000 gallon thickened sludge blending tank.
- Digester feed pumps, piping, and controls to feed existing digesters and provide space for future thickened sludge preheating.

Addition of these facilities will increase thickened solids concentration to digestion allowing construction of additional digestion capacity to be deferred until the plant influent flow is near 43 MGD. Equivalent plant influent flow capacity for the thickening system will be approximately 39 MGD with one unit out of service.

Dewatering

Dewatering facilities assume 5 days per week, 16 hours per day operation.

- Refurbish existing belt filter presses.
- Supplement existing capacity with rental press or purchase used belt filter press for next several years service.

- One – 200 gpm high solids centrifuge installed in space provided for future belt press 3.
- Dewatering feed pump, polymer feed pump, piping, and controls.
- Dewatered cake conveyance to heat drying.

Combined capacity of centrifuge and belt press dewatering will provide plant influent flow capacity of approximately 45 MGD with one belt press out of service. One centrifuge alone would be capable of handling approximately 40 MGD plant influent average dry weather flow.

Heat Drying

Heat drying facilities assume 5 days per week, 16 hours per day operation. No redundant units are recommended. Critical spare parts will be kept on hand to repair unit that is down. Wet cake from belt presses may be sent to air drying during down time.

- 20 dry ton per day heat drying equipment.
- Two – 20 cubic yard dewatered cake surge bins[a].
- 125 ft x 90 ft building with provisions for expansion.
- Dried product conveyance and truck loading.
- Odor control facilities.
- Dried product storage for two weeks production.

Note:

a. Surge bin provided for variation in dewatered cake production.

Future Phase Two Facilities

Thickening (constructed before 38 MGD is reached)

- One – 48 ft diameter DAFT.
- Pumps, piping, and controls for one new DAFT,

Anaerobic Digestion (constructed before 43 MGD is reached)

- One – 90 ft diameter, 32 ft sidewater depth digester (to match Digesters 1 and 2).
- Pumps, piping, heat exchanger, backup boiler, controls, etc in new control building.

Dewatering (constructed before 40 MGD is reached)

Dewatering facilities assume 5 days per week, 16 hours per day operation.

- Remove existing belt presses.
- Two – 200 gpm high solids centrifuges (one duty and one standby).
- Dewatering feed pumps, polymer feed pumps, piping and controls.
- Dewatered cake conveyance to heat drying.

Heat Drying (constructed before 40 MGD if operating hours not extended)

Heat drying facilities assume 5 days per week, 16 hours per day operation. No redundant units are recommended. Critical spare parts will be kept on hand to repair unit that is down. Extended operating hours may be used to increase

system capacity when one unit is out of service to continue to produce Class A material.

- A second 20 dry ton per day of heat drying equipment (see note above for Phase One system if operating hours not revised).
- Expansion of Phase One building to house additional equipment provided for Phase Two.
- Two – 20 cubic yard dewatered cake surge bin(s).
- Dried product conveyance and loading.
- Expansion of odor control facilities for Phase Two.

Table 8 – Recommended Facilities and Costs

Phase One (40 MGD)				
Item/Process	**Costs ($1,000)[a]**			
	Construction	**Contingencies 30%**	**Admin/ Engr 25%**	**Total Capital**
DAFT and Digester 4 Improvements (allowance)[b]	600	200	200	1,000
DAFT Process	4,200	1,300	1,400	6,900
Dewatering Process	1,500	500	500	2,000
Heat Drying	10,100	3,000	3,300	16,400
Total Cost Phase One	16,400	5,000	5,400	26,800
Phase Two (50 MGD)				
Total Cost Phase Two	32,000			

a. All costs are shown in 2003 dollars.

b. No detailed costs have been developed for DAFT and Digester 4 Improvements. Detailed costs will be developed in final design.

APPENDIX A – MEETING MINUTES

Riverside Biosolids handling improvements - Kickoff meeting June 4, 2002

Subject: Riverside Biosolids handling improvements - Kickoff meeting June 4, 2002, 10 AM at the Riverside WWTP.

Attendees:

Name	Position	Organization	Phone #
John Claus	Operations Mgr	Riverside	909-351-6183
Jim Slider		Riverside	909-351-6181
Greg Stevens		Riverside	909-351-6097
Gerald Bossard	Operations Supervisor	Riverside	909-351-6139
Ben Urquiza		Riverside	909-826-5913
Rod Cruze		Riverside	909-351-6011
David Kush	Project Coordinator	Riverside	909-351-6188
Ken Fonda	Project Engineer	BC, San Diego	858-571-6749
Perry Schafer	Project Advisor	BC, Sacramento	916-853-5329
Azee Malik	Project Mgr	BC, Irvine	949-260-6117
Bob Finn	Senior PM	BC, Irvine	949-660-1070

Introduction:
Everyone present introduced themselves and described what their role in the project would be. Following introductions, Azee reviewed purpose of the meeting is to go over the SOW and brainstorm ideas. The project schedule would be discussed at the end of the meeting.

Before getting into the main discussion, the City asked if BC is helping other agencies with environmental insurance. Perry said this issue is an emerging issue for Agencies. Some are handling with insurance, but Riverside would be on the cutting edge of this issue. BC could help the City out if requested.

Review of Tasks:
Task 1 - Solids projections and thickening

- Process data can be obtained from Gerald. Base information is available electronically. The City will transmit this latter.
- Primary and secondary mix to the digesters is approx 50/50. Production is fairly stable with little peak variations. There was some discussion on increasing the percentage of primary solids by chemical addition. Other plants are seeing the benefits. This would impact the secondary system and reduce the loading. Increased primary production would also improve digestion. This should be coordinated with the study JCE is doing.
- Chemical addition to enhance settling could be considered. Ferric is being added now strictly for H2S control. Since ferric costs are going up an economic evaluation of the benefits should be done. Chemiron is the vendor for Ferric. Current delivery schedule is about 8 days for their 4k gal tank.

- To be consistent with other studies that have been done the study should set everything for 40 mgd, with an ultimate ultimate size of 50 mgd. The 40 mgd plant flow could be in 10-15 years.
- Work being done by JCE would be impacted more by our work. JCE isn't handling recycle flows.
- Thickening will be limited to assessing data on the existing system. DAF appear to be working okay. Co-thickening plant 1 sludge in the DAF could be an option since DAFs are generally not hydraulically limited. Adding primary solids could also improve thickening performance.
- Gas production is a side issue of thickening. Operations reported better gas quality when the primary sludge is fresher. Since the primaries in plant 1 are shallow, no thickening is done there. Spreading the load between plant 1 and 2.

Task 2 - Digestion options

- Reviewed process objectives as follows:
    1. Gas production is primary driver.
    2. Class A is not as much of a benefit since class A can be achieved by air drying.
    3. Odor reduction going to the drying beds is desirable.
- Perry reviewed various digester options.
    1. Thermophilic is generally more odorous and would probably not be desirable.
    2. Acid/gas can also be very odorous.
    3. Three phase digestion is being done in Inland empire. VS destruction has not increased significantly. Recycle impacts could also be significant and should not be considered as seriously unless there are some very positive impacts on gas and solids destruction.
    4. Performance data for VSS destruction appears to favor temperature phased digestion with thermophilic following.
- The City asked about impacts of metals concentrated when increased solids reduction happens. Impact on metals has not been significant on effluent. Metals get more concentrated in the solids. This should be checked to see how this could impact the liquid effluent. The City said they are not close to meeting the metals limit on their permit yet.
- Temperature phased digestion would be the one we look at most seriously. Thermo/Meso digestion would not meet class A because it would need to be continuous flow. Batch flow would be needed to meet class A.

Task 3 - Heat and energy options

- Jim Shettler will be the lead on this task. Jim will make a site visit latter to review the system.
- Heating and cooling load data would be needed from the City. TM digestion would increase heat loads. Heat drying would also increase the loads.
- Current cogen operation is about 75% for all three engines with allowance for down times.

- Data for cogen heat production and gas quantity and quality can be obtained from Gerry and Marshall.

Task 4 - Dewatering, drying and storage options

- Dewatering options would be looking at centrifuges to replace belt presses. Replacement or upgrading of existing dewatering would be the next phase immediately following this study. The study would include regulatory considerations.
- The study would look at ways of improving existing system, possibly by covering a portion of the beds. Covering would primarily be for wet months. Solar panels were mentioned as a possibility if beds are covered. Economics of solar panels may not pay off with the low electrical rates.
- Optimizing storage area is important for achieving class A. Belt press cake is typically 12-14% primarily for drainage at the beds. Combustion potential gets higher when it is over 50% dry. This gets to be a problem when beds are stacked higher than 4 ft.

Task 5 - Heat drying and product use

Two different technologies were reviewed - direct and indirect drying.

- Fenton dryer is indirect dryer using oil as a heating media. Fenton dryers are batch fed and relatively small capacity. BC has one Fenton drying facility in Oregon being built now and one other currently under design elsewhere.
- Most vendors produce a product that has a consistent size by screening which makes it more valuable.
- Disposal contract RFP is now being bid. Prices are being obtained for both class A and B.
- Fenton dryer would meet class A. Product would not be size graded.

Drying options were discussed

- Air drying could be supplemented by heat drying for wet months.
- One option could be to feed the sludge beds then feed out of the beds to the dryer when the beds are reaching capacity problems.
- Using exhaust heat from cogen could be a way to preheat the oil.

Air permit is now a title 5 facility because of cogen.

Task 6 - Composting/co-composting

- Would need to interface with Ben to get information on green waste quantities.
- Scope focuses on on-site options.
- All options would need to be enclosed.
- Traffic would need to be considered.
- Having a second party operating it would be a consideration.
- Sludge feed stock would need to be dewatered.
- Composting would only be a partial option based on quantity of green waste. Depending on moisture content of the sludge the mixture would be 50/50 or higher to bulk the wet material.
- Market study would be limited to a review of what others have done.

Task 7 - Recycle stream treatment

- Various technologies are available. Most plants just recycle back to the head of the plant. The plant said that adding high ammonia load to the existing aeration tanks places too much of a load on the air system. Operations would like to keep it separate to reduce impacts on the rest of the plant.
- Impacts of digestion, dewatering and drying options would be factored in. This would essentially be a separate activated sludge plant.
- Reuse of some existing facilites (old clarifier, etc). If existing tanks are used they may not meet requirements structurally.
- Current nitrogen discharge requirements are 13 and could go as low as 2 with 8 being more likely. Comparison of rehab existing tanks versus new should be considered.
- Fail-over should be to go back to plant 1 with flows distributed. Blending with the primaries would equalize the load and provide some benefit to odor control.

Task 8 and 9 - compare options, recommend and report.

Report would be structured as a collection of TMs with an introduction which summarizing the inter relationship of the TMs.

Schedule

- Final report would be okay if done by November - December.
- BC will prepare a draft schedule for TMs for review next week.
- Future meetings will be done on an as needed basis.

City of Riverside
RWQCP Solids Handling Improvements
Progress Review Meeting
October 31, 2002

MEETING MINUTES

Attendees:
Stephen Schultz, Wastewater Systems Manager
John Claus, Wastewater Operations Manager
Gerald Bossard, Wastewater Operations Supervisor
David Kush, Wastewater Projects Coordinator
Ben Urquiza, Wastewater Engineering
Bob Finn, Brown and Caldwell
Azee Malik, Brown and Caldwell
Perry Schafer, Brown and Caldwell
Ken Fonda, Brown and Caldwell

Meeting summary

Introductions:
Since Stephen Schultz was new to the project team, the Brown and Caldwell members of the team introduced themselves and explained their roles in the project.

Agenda and project status:
Azee briefly reviewed the agenda for the meeting and the project status. To date, five of the eight technical memos have been submitted. The purpose of the meeting was to review the high points of these TMs and get City feed back. The following changes to the original schedule were presented and accepted by the City:

TM 5 Heat Drying Options – November 8, 2002
TM 6 Composting Options – November 15, 2002
TM 8 Evaluate Options – November 22, 2002
Draft Report – December 20, 2002
City Review comments on Draft Report – January 6, 2003
Final Report – January 24, 2003

Azee explained that the TMs were written to take a broad brush approach on the issues with the focus being on developing direction for improvements needed for an ultimate plant capacity of 50MGD. Although the plant may not reach this capacity for some time, cost estimates were developed for this capacity for purposes of comparison.

The City indicated that TM 8 should focus on the near term projects needed in the next 8 to 10 years with the Final Report focusing on direction needed for the next 10 to 20 years.

TM 1 – Solids Projections and Thickening Options

Ken reviewed the solids projections and noted observations made on the solids process operations:

- Thickened sludge concentration appeared to be below expected performance
- This performance would have downstream performance impacts on digestion and dewatering.

The City noted that some maintenance had been deferred on the DAFs and Belt Presses that could also account for low performance. Recent modifications to the DAFs – bottom sludge rakes, dissolution air compressor, etc have helped improve performance and thickened sludge concentration is now between 4.5 and 5%

Thickening options comparison based on observations from plant performance were developed for separate thickening and co-thickening of WAS and Primary Sludge was developed. The major advantage noted for cothickening was that consistent 5-6% sludge concentration could be achieved. The capital cost for cothickening was significantly higher, but the present worth value based on separate thickened solids at 4% versus cothickened solids at 5.5 to 6% were $10 million less for cothickening. This difference will likely be reduced when the better WAS thickening performance is factored in.

The final report should look at possible modifications to the existing DAFs that were built in 1989 to improve their performance as well as any additional DAFs that may be needed. Present worth cost comparison should factor in the higher performance of the WAS thickening system.

TM 2 – Digester Options

Perry gave an overview of the TM beginning by stating that achieving a Class A product was not a major factor in this evaluation. Class A options were provided mainly for information purposes. Stephen was concerned that a digested dewatered product was a problem for users whether it was Class B or Class A. A sheet comparing performance of various digester options was included in the handouts. Perry pointed out that the new sludge blending tank ahead of digestion was suggested to ensure more homogenous feed to all the digesters. This would also serve as a place to recover heat for the thermophilic digestion phase of temperature phased digestion (TPAD). The benefits of TPAD were briefly discussed:

- Increased gas production
- Increased volatile solids destruction yielding less solids to dispose of
- Increased chance of achieving Class A with air drying

Ongoing debate by regulators on where samples are collected for Class A certification may also be an issue if the sample point is at the application site.

TM 3 – Heat and Energy Options

Ken reviewed information presented in the TM noting that air permitting limitations could effect any heat production option that required new combustion. The Heat Energy

usage evaluation focused on heat needed for the TPAD digestion option. The calculated heat energy shortfall was 5.4 MMBtu. The two heat production options presented were sludge heat recover and new boilers. Sludge heat recover was seen as being less costly to operate and more energy efficient. During summer months some waste heat would need to be rejected either by using effluent cooling or wasting it to the atmosphere through radiators.

The City asked if dumping hot water into the effluent would have an impact on their disharge permit limits. This had not been evaluated as a part of the TM, but would be addressed in the final report.

TM 4 – Dewatering and Air Drying Options

Perry discussed dewatering performance and noted that the cake solids concentration appeared to be low. This could be a result of low polymer usage and high feed rate. The City noted that the belt press performance improves significantly shortly after they are maintained. The City also acknowledged that the belt presses were being operated at the higher end of their hydraulic loading range. Currently there is no redundancy available in the system. The City acknowledged that this could be a major problem that could cause liquid sludge being sent to the drying beds. Increased capacity and redundancy are an important consideration that would be included in the final report. The City indicated that reduced operating hours limited to two shifts would be desireable and that cake storage for weekends and holidays may be required. Perry pointed out that higher odor risks associated with centrifuge dewatering would make centrifuges undesirable if the cake was still being air dried. The City stated that air drying may be phased out very quickly due to neighbor complaints and that this was a significant "risk" to the current biosolids system. Therefore, the dewatering options should consider their impact on heat drying. The City indicated a preference for centrifuge dewatering because is could be operated with less attention and achieve greater solids content. Centrifuges could be placed in the space provided for the future belt presses. Centrifuge design should consider noise levels produced.

Perry reviewed air drying options and Class A reliability improvements. Covered storage was seen as being too expensive and temporary tarps are a problem during windy conditions. Odor control improvements suggested included building a solid fence to force achieve increased vertical atmosphere mixing on the downwind side of the drying beds. This would improve odor dispersion and reduce odor levels.

TM 7 – Recycle Stream Treatment Options

Azee reviewed available recycle stream treatment technologies and noted that the recommended technology was the activated sludge process. The cost of modifying existing tanks for sidestream treatment was estimated to be $6.4 million and would require new chemical storage and blowers. The City said that aeration improvements that were being designed by others has made provisions for sidestream flows which would be less costly.

Upcoming technical memos

Upcoming technical memos include Heat Drying Options and Composting Options. Key considerations for heat drying would include:

- Drying capacity to replace air drying beds entirely.
- Critical failure equipment parts and redundancy requirements
- Heat dried product does not need to have uniform pellet or granule size
- Maximum use of available surplus heat

Composting was briefly discussed also. The City noted that existing green was handling site has been moved due to odor problems. Green waste quantities are estimated to be approximately 42,000 to 45,000 tons per year. Any composting operation would need to be totally enclosed. Off site composting with other agencies would be more likely. However, all composting options sounded challenging.

Other issues

Other issues discussed included:

- Final report should be in three ring binders with nice cover and spine lable
- Final report should briefly summarize regional biosolids management.
- Biosolids privatization was not considered a serious option because the City would loose control of its system with attendant cost impacts..

City of Riverside
RWQCP Solids Handling Improvements
Progress Review Meeting
October 31, 2002

MEETING MINUTES

Attendees:
Stephen Schultz, Wastewater Systems Manager
John Claus, Wastewater Operations Manager
Gerald Bossard, Wastewater Operations Supervisor
Rodney Cruze, Compliance and Monitoring Manager
Ben Urquiza, Wastewater Engineering
Bob Finn, Brown and Caldwell
Azee Malik, Brown and Caldwell
Perry Schafer, Brown and Caldwell
Ken Fonda, Brown and Caldwell

Meeting summary:
Introduction: Introductions were skipped because everyone knew each other.

Review project status: Azee reviewed the status of the project noting that since the last meeting TM 5 – Heat Drying Options, TM 6 – Composting Options, TM 8 – Evaluation of Options and the Draft Report have been submitted. Following this meeting BC intends on preparing the Final Report by revising TM 8 to incorporate comments received during the meeting and Chapters 1 – 3 of the Draft Report. An executive summary, approximately 3 pages in length will be included in the Final report.

Draft Report Review Presentation:

Introduction

Azee highlighted solids issues affecting the City of Riverside including:

- Limitation in Riverside county for Class B biosolids use.
- Long term odor issues from air drying beds
- Dewatering and digestion capacity to meet current needs
- Cogeneration system needs for additional digester gas to replace landfill gas as quantity decreases.
- Rising cost for disposal in Southern California
- Current program using air drying has significant risks.

The City commented that:

- The Class B ban in Riverside is limiting disposal options and that Class A disposal in Riverside County would be categorized by product odor. They felt that if they heat dried to less than 90% they might be able to use it as daily landfill cover mixed with dirt.
- Odor from drying beds needs to be reduced or eliminated. The solid fence idea may buy them some time, but they felt the fence would have to be taller than their existing fence.

- Although centrifuge cake may be more odorous, they suggested possibly drying the cake to 75% then placing it in the beds for further drying. The thought was that this would reduce odors from centrifuge cake and possibly reduce the capacity of the heat drying system.

Project Objectives:

Azee briefly review the original objects for the project and noted where these objectives had been addressed in the report.

Review of TM 8:

Since everyone was familiar with the TMs submitted up to TM 5, Ken briefly reviewed the TMs previously submitting as well as the new TMs noting the following:

Existing and future conditions

- Current Capacity deficiencies exist in the thickening, digestion and dewatering process.
    - Current DAF system has no redundancy
    - Digester 4 needs to be brought back into service do handle peak needs
    - An additional belt press is needed to provide redundancy for dewatering system and reduce loading on existing belt presses.
- DAF and Belt press dewatering performance were lower than expected. Operations noted that the City is saving money by using drying beds after dewatering, the wetter cake is not a significant problem, but should be noted for future improvements. Placing wetter cake on the drying beds prolongs the time for drying and increases the opportunity for odors.
- Because of the lower thickened sludge concentration, the digester system has marginal capacity to meet 503 regulations at peak flow conditions. The City said they were operating at higher than 35 degrees C and that the combined time and temperature met the 503 requirements. Perry questioned this and said he would need to verify this with EPA.
- Planning for future phases was based on 40 and 50 MGD capacities as noted in the kickoff meeting. Future solids flows were noted for these capacities.

Future Thickening Options

- At the previous meeting the City indicated that the DAF system was capable of achieving better performance and that cothickening to achieve higher digester feed concentration was not important. Using a higher thickened WAS concentration made separate thickening have a lower life cycle cost.
- The City commented that if a higher concentration could be achieved by cothickening to delay digester construction that cothickening could be more viable. The City asked that cothickening be reconsidered for this reason.

Digestion Options

- Digestion options were briefly reviewed. The decision made at the last meeting was to continue mesophilic digestion because the life cycle costs for TPAD were not significantly different.

Heat and Energy Options

- Heat energy needs were reviewed and noted that at 50 MGD there would be a shortfall of approximately 1.2 MMBtu/hr using only heat from cogeneration. Additional heat could be provided by either using new boilers or replacing the absorption chiller with an electric chiller.

Review of Dewatering and Drying Practices

- Current belt press dewatering process is operating below expected performance most likely due to hydraulic overloading and low polymer usage. As noted earlier, because dewatering is followed by air drying there isn't a great deal of importance in dewatering to a higher concentration.
- The system has no redundancy and the building has no odor control system.
- The City indicated they were in the process of getting a rental centrifuge to supplement existing dewatering capacity. Perry commented that centrifuge cake may be more odorous due to the higher G forces effecting the cell walls possibly causing continued digestion in the drying beds.
- BC recommended adding centrifuges for future phase as long as there was heat drying for centrifuge cake. Odor control from centrifuges would be less than belt presses because the odors are contained in the centrifuge.
- Adding centrifuges in the existing building may require raising the roof and the bridge crane. This explained why the initial phase dewatering appeared high.
- As a possible way or reducing odors from air drying a solid wall fence could be built on the down wind side. The City questioned how effective this would be because the drying beds were down lower. Perry suggested building a temporary wall with plywood to see how well that would work.

Heat Drying Options

- Drying technologies available are direct and indirect drying. Direct dryers are more difficult to permit because of the larger exhaust quantities.
- Indirect drying vendors evaluated included
    - Fenton – batch drying system that had been to the site for a demo in December. Largest size unit is 10 dtpd. Multiple units would be needed. Fenton is American made.
    - INNOPLANA – continuous drying system that combines an initial indirect dryer to remove 50% of the water then a direct dryer that uses recovered heat to bring the cake to over 90% dryness. Larger units are available to reduce space required. The INNOPLANA dryer is manufactured in Switzerland
    - Komeline-Sanderson – continuous drying system with highest heat transfer efficiency. Larger units are also available. This dryer is manufactured in Germany.

- Heat drying considerations include: product quality, air emissions and product auto heating.
- The City commented that product loading and storage would need to be considered in design with storage being kept to a minimum. A product that is dusty may be a problem for land application. This could be mitigated by coating the product with oil.
- The City liked the concept and favored a phased approach possibly not capable of drying all the cake. They would also like to see if drying to less than 90% would save them anything.

Composting Options

Composting options were briefly reviewed but considered unfeasible because of costs, odors and bulking material limitations. No further consideration of composting would be recommended.

Sidestream Recycle Treatment Options

The recommended treatment option that was presented at the last meeting was briefly reviewed. At that meeting the City had stated that the liquid treatment system would be designed to handle the recycle stream.

Recommended Project, Cost and Schedule

Perry briefly reviewed the recommended projects including immediate improvements and facilities needed for 40 MGD. Immediate improvements recommended were:

DAF thickening

- Pressurization pump throttling valve automation
- Pressurization tank level switches and high level alarm
- Bottom sludge removal
- Polymer system sizing to match required usage

Digestion

- Bring digester 4 back on line including:
    - Automated sludge feed valves
    - Coordination of feed and withdrawal with digesters 1 and 2
    - Verify gas piping capacity
    - Verify adequacy of mixing system

Dewatering

- Refurbish existing belt filter presses
- Supplement existing capacity with rental unit or purchase used unit. The City indicated they were looking into a rental centrifuge

Recommendations for 40 MGD included:

- One new DAF the same size as the others.
- One new digester in addition to bringing digester 4 back into service would be needed.
- One 200 gpm centrifuge with conveyance to heat drying
- 40 dtpd heat drying facility based on 5 day/16 hr/day operation with one redundant unit.

Estimated cost for the recommended 40 MGD facilities is $35 million

Discussion followed on ways to bring project costs down. Some suggestions were:

- Delay construction of new DAF by taking DAF 3 out of mothballs. The condition of DAF 3 would need to be reviewed during design.
- Delay construction of digesters could be done by:
  - Bringing digester 4 back in service. The City acknowledged that a thorough evaluation of work needed would be required
  - Increasing thickened solids feed concentration to digesters would reduce flow and increase detention time. The City acknowledged that current WAS thickening was not producing the 5% float they stated last time and that cothickening could be beneficial if it could delay construction of a digester. Cothickening may also have benefits on increased gas quantity and capacity improvements for primary sedimentation.
- Reduce the size of heat drying by:
  - Drying centrifuge cake to 80% and put on drying beds for the other 10% dryness.
  - Only dry centrifuge cake and put belt press cake on the drying beds

Other issues:

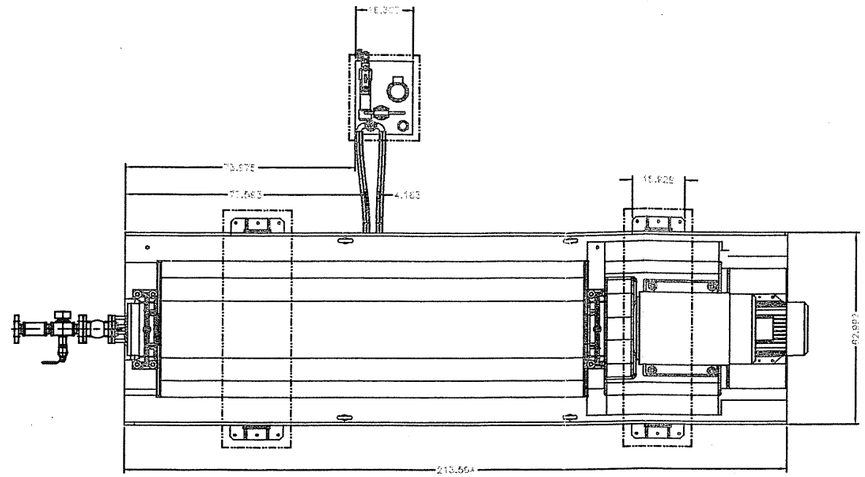
1. CIP budget for WW improvements including both liquid and solids is about 50 million. They are targeting 15 to 20 million for solids handling. If cothickening can delay or reduce primary sedimentation improvements, some of the liquid treatment budget could be moved for solids handling.
2. The City will be pilot testing "Sonix" to see if it improves dewatering and increases digester gas. Perry said there is a competing system called the "Dirk" system that may also be beneficial. Making provisions for this pilot test or future use of Sonix is outside the scope of this project.
3. Recommended project should focus on a system that is within the CIP budget and adds flexibility to drying and disposal. Capacity limitations for thickening, digestion and dewatering need to be handled. The recommended system needs to reduce or eliminate odors.
4. Developing phasing plans for less than 40 and 50 MGD would be a change in the scope as it was discussed at the kickoff meeting.

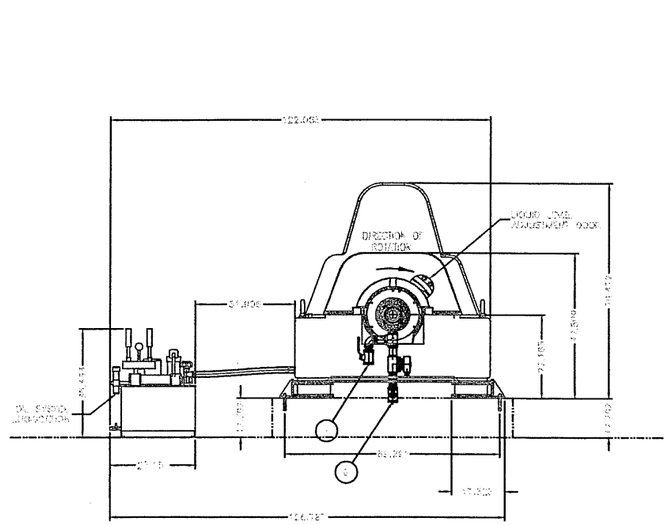
Actions planned:

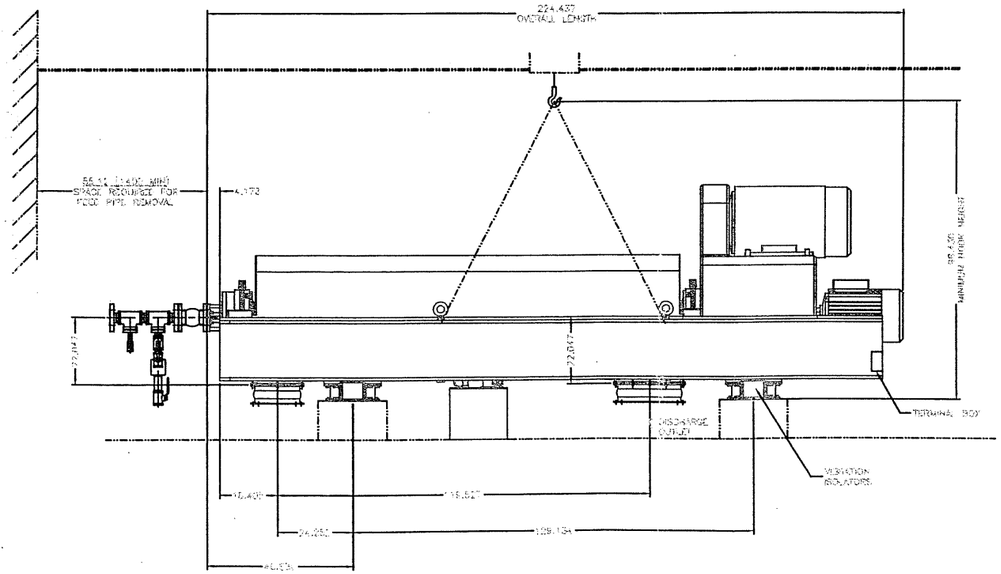
1. Re-evaluate thickening and digestion based on mesophilic digestion following cothickening using rehabbed digester 4 and DAF 3.
2. Get info from dryer vendors on ability to dry less than 90% and what are the product odors associated.
3. Get info from belt press vendors to find out if there are BPs that can be automated more.
4. Revise and resubmit the final report by the end of the month.

B

APPENDIX B – MANUFACTURER'S EQUIPMENT LAYOUTS







NOTES:

1. ALL PIPING TO AND FROM MACHINE TO BE COMPLETED WITH FLEXIBLE CONNECTIONS.
2. SEE FOUNDATION DRAWING DWF1365 FOR DESIGN LOADS AND CONNECTION DETAILS

REV	DR	REVISION	BY	APVD	DATE

ESTIMATED WEIGHT IN LBS.	DRAWN BY:	DATE
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CHECKED BY:	DATE
FABRICATION TOLERANCES .XX±0.030 ANGLE ±2° HOLES±.030	APPROVED BY:	DATE
MACHINING TOLERANCES .XX±0.005 ANG±2° HOLES±.030	THIRD ANGLE PROJECTION	
MILL FINISH ALL OVER		

ANDRITZ

ANDRITZ-RUTHNER, INC.
1010 COMMERCIAL BLVD. SOUTH
ARLINGTON, TEXAS 76001
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SCALE	FILE	SHEET OF

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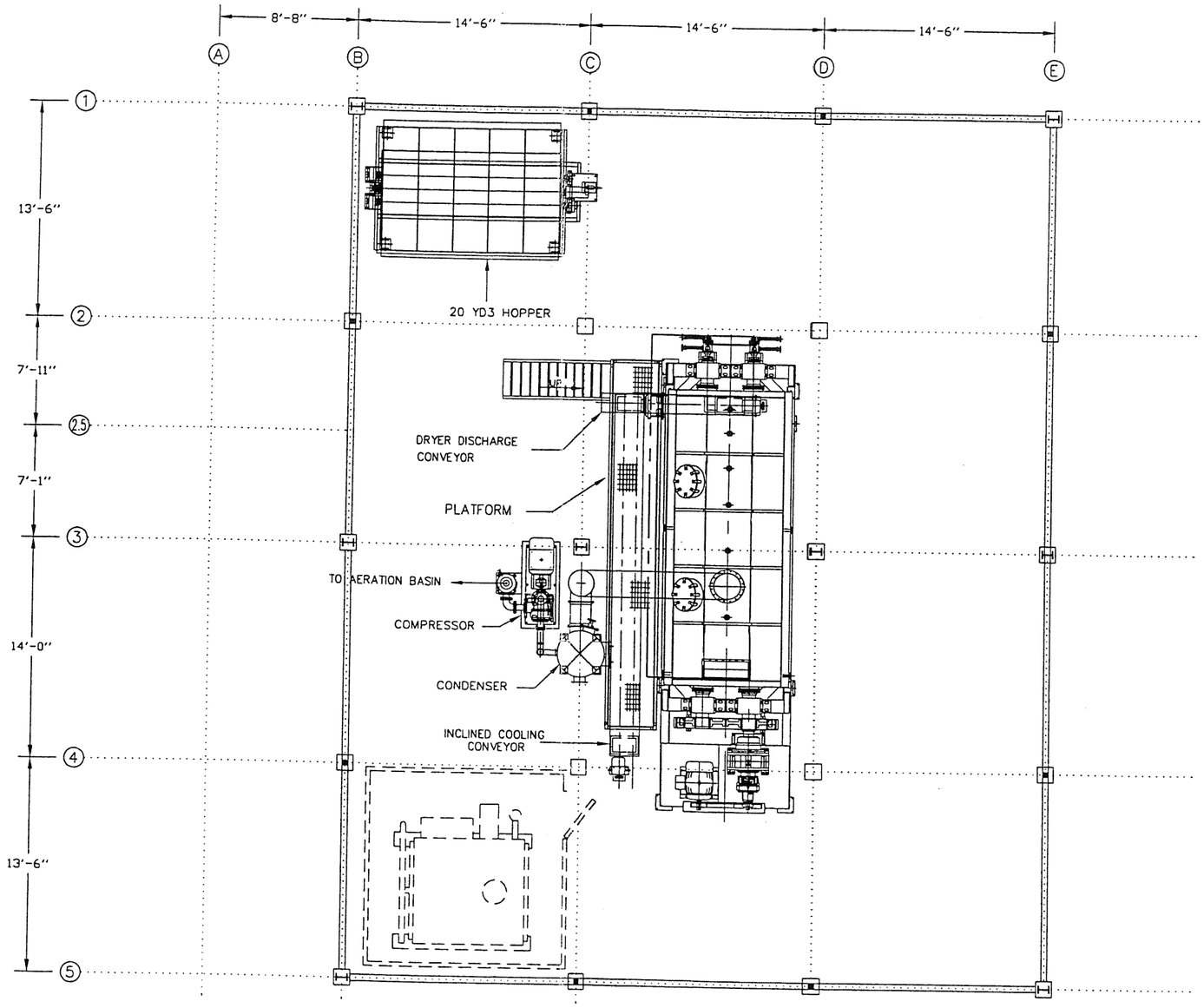

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GENERAL ARRANGEMENT SLUDGE DRYING SYSTEM PLAN VIEW

TPG 2369
BROWN & CALDWELL
RIVERSIDE, CA

DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY
CPS	CPS	-	-

DATE: 10-OCT-02
SCALE: 1/4"=1'

KOMLINE-SANDERSON
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PEAPACK, NJ 07977 USA

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SHT 1 OF 1

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01-JUL-02

ELO-907-126

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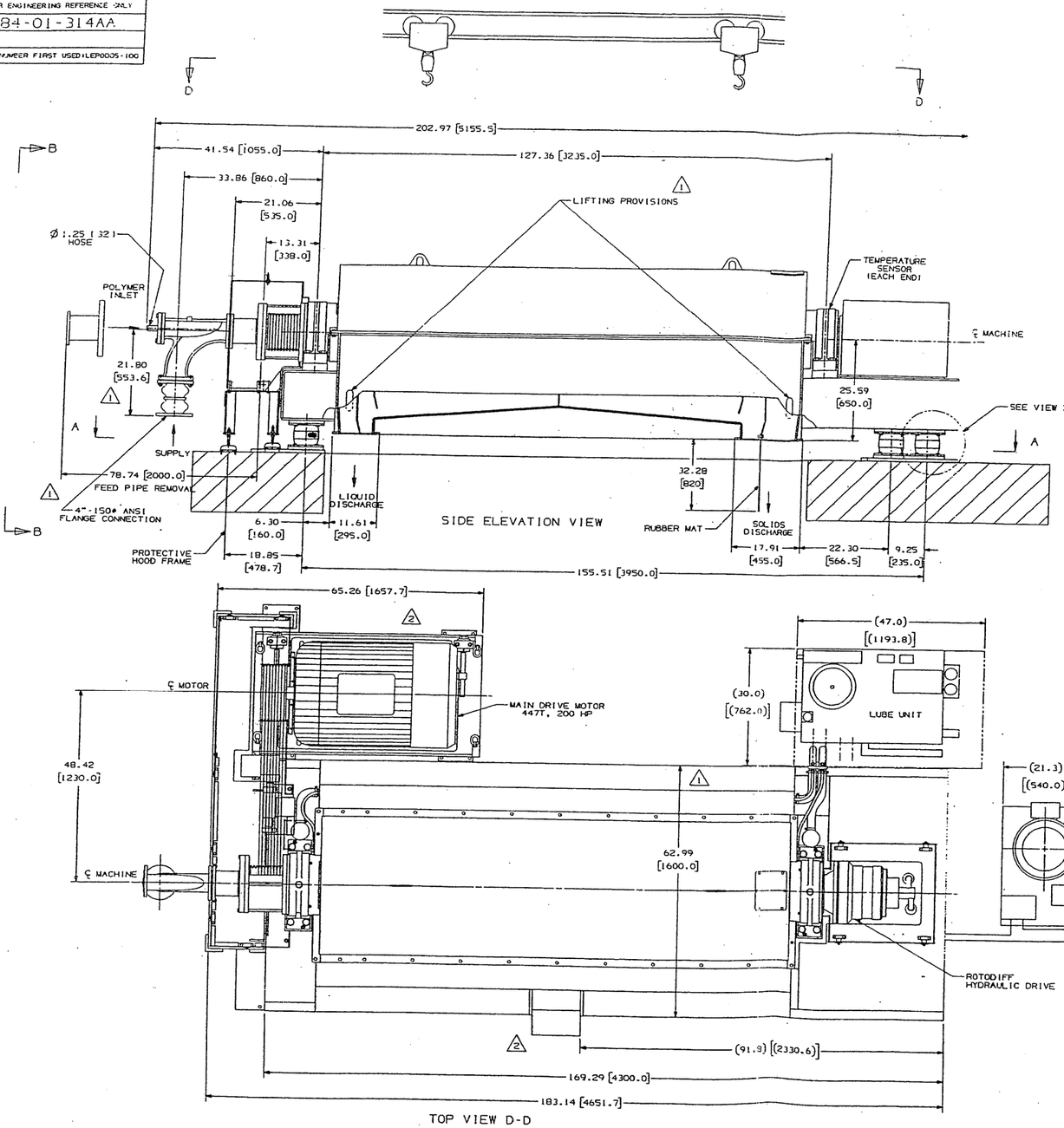
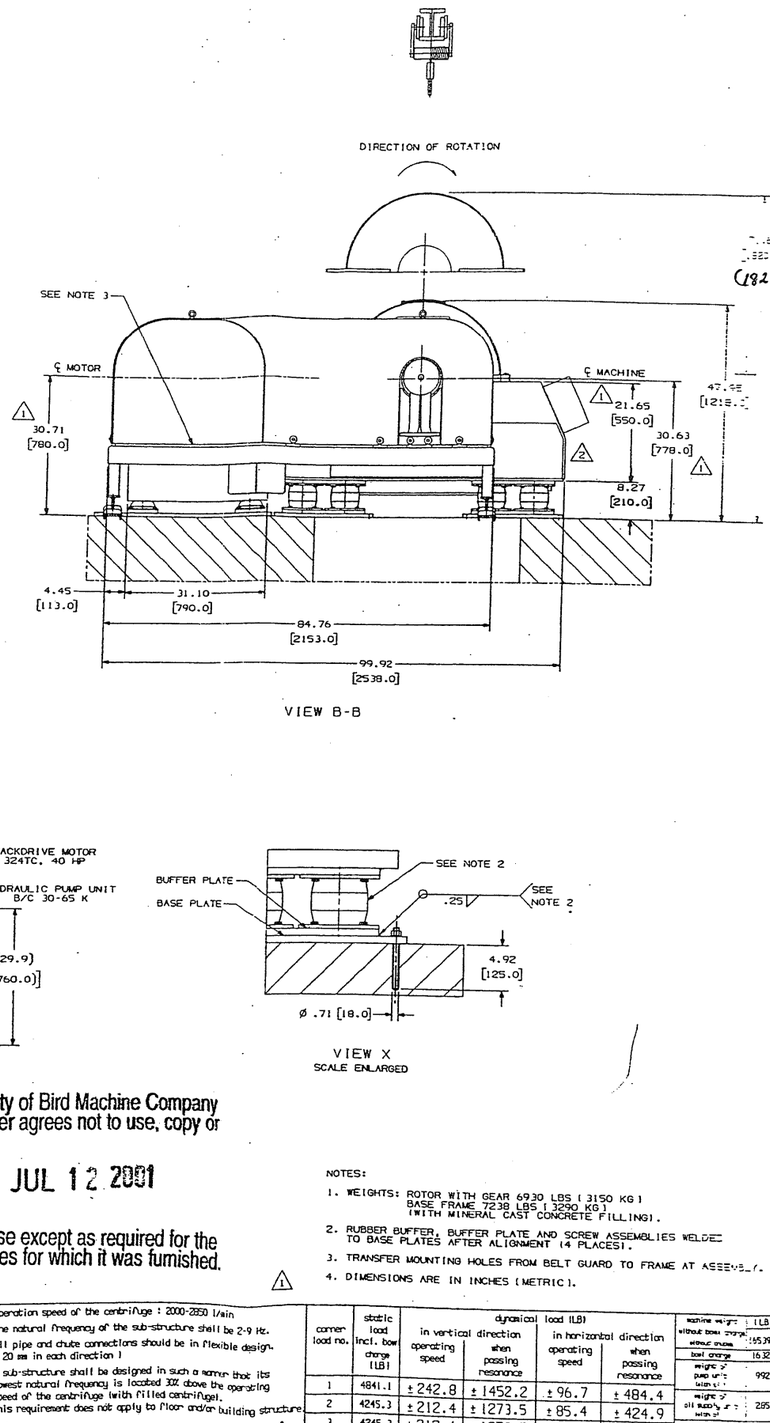
584-01-314AA

PART NUMBER FIRST USED: LEP0005-100



SIDE ELEVATION VIEW

TOP VIEW D-D



VIEW B-B

VIEW X
SCALE ENLARGED

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disclose except as required for the purposes for which it was furnished.

NOTES:

1. WEIGHTS: ROTOR WITH GEAR 6930 LBS [3150 KG]
   BASE FRAME 7238 LBS [3290 KG]
   (WITH MINERAL CAST CONCRETE FILLING).
2. RUBBER BUFFER, BUFFER PLATE AND SCREW ASSEMBLIES WELDED TO BASE PLATES AFTER ALIGNMENT (4 PLACES).
3. TRANSFER MOUNTING HOLES FROM BELT GUARD TO FRAME AT ASSEMBLY.
4. DIMENSIONS ARE IN INCHES (METRIC).

Betriebsdrehzahl der Zentrifuge : 2000-2950 l/min
Die unteren Eigenfrequenzen liegen im Bereich 2-9 Hz.
Alle Rohr- und Schurrenanschlüsse sind flexibel zu gestalten. (20mm in jeder Richtung wird.)
Ein Untergestell ist so abzustimmen, da dessen tiefste Eigenfrequenz 30% bei der Betriebsdrehzahl der Zentrifuge liegt. (Mit gefüllter Zentrifuge)
Dies gilt nicht für Decken- bzw. Gebäudekonstruktion.

Ecklast Nr.	statische Belastung incl. Füllgewicht [N]	Dynamische Belastung [N] in vertikaler Richtung: Betriebsdrehzahl	Durchfahren der Resonanz	in horizontaler Richtung: Betriebsdrehzahl	Durchfahren der Resonanz
1	21535	±1080	±6460	±430	±2155
2	18835	± 945	±5665	±380	±1890
3	18835	± 945	±5665	±380	±1890
4	21535	±1080	±6460	±430	±2155

Maschinengewicht ohne Füllgewicht ohne Schurrengewicht	7357SN
Füllgewicht	7260N
Gewicht des Pumpenaggregates bei II	4415N
Gewicht des Hydraulikaggregates bei II	1268N
Gewicht der Antriebseinheit	2264GN

operation speed of the centrifuge : 2000-2850 l/min
The natural frequency of the sub-structure shall be 2-9 Hz.
All pipe and chute connections should be in flexible design. (20 mm in each direction)
A sub-structure shall be designed in such a manner that its lowest natural frequency is located 30% above the operating speed of the centrifuge (with filled centrifuge). This requirement does not apply to floor- and/or building structure.

corner load no.	static load incl. bowl charge [LBS]	dynamical load [LBS] in vertical direction: operating speed	when passing resonance	in horizontal direction: operating speed	when passing resonance
1	4841.1	± 242.8	± 1452.2	± 96.7	± 484.4
2	4245.3	± 212.4	± 1273.5	± 85.4	± 424.9
3	4245.3	± 212.4	± 1273.5	± 85.4	± 424.9
4	4841.1	± 242.8	± 1452.2	± 96.7	± 484.4

machine weight without bowl charge	15539.7
bowl charge	1632.0
weight of pump unit (oil supply)	992.5
weight of oil supply unit	285.0
weight of drive unit	5529.5

STANDARD FABRICATION TOLERANCES	
DIMENSION	TOLERANCE
0" < 12" [0 < 300]	±.04 [1]
12" < 24" [300 < 600]	±.06 [1.5]
24" < 36" [600 < 900]	±.09 [2.2]
OVER 36" [900]	±.12 [3]

BAKER HUGHES — Baker Process

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1961	6/19/01	MACHINE DESIGNATION "HUMBOLDT CP3074 CF-2" WAS "HUMBOLDT CP3074 CF-2 ROTOR WITH CONCENTRIC BORE"	YCC	1
1891	4/4/01	ADD SHEET 2, DELETE JUNCTION BOX, DELETE VIBRATION SWITCH	CAH	2

CAD DRAWING: UG11 | SHEET 1 OF 3 | DRAWN BY: CAH | DATE: 8-4-00

TOLERANCES FOR MACHINED SURFACES

1.	1 1/25	±.04	(1.040)
1.0	1 1/25	±.02	(1.020)
1.00	1.125	±.01	(1.010)
1.000		±.005	

FOLLOW MANUFACTURING PRACTICES

CHECKED BY: SDH | DATE: 08/10/00
DESIGN ENG: YCC | DATE: 08/10/00
MFG ENG: N/A | DATE:

TITLE: OUTLINE AND FOUNDATION
MACHINE: HUMBOLDT CP3074 CF-2
DRAWING NUMBER: ELO-907-126

NOZZLE	QTY	SIZE/RATING/MAT'L	SERVICE
N1	1	TO BE DETERMINED	FEED INLET
N2	1	TO BE DETERMINED	VAPOR OUTLET
N3	1	10" x 12"	SIDE DISCHARGE
N4	1	10" x 34"	BOTTOM DISCHARGE
N5	4	1 1/2" 150# RF ANSI FLG	TROUGH JACKET STEAM INLET/LIQUID OUTLET
N6	4	2" 150# RF ANSI FLG	TROUGH JACKET CONDENSATE OUTLET/LIQUID INLET
N7	2	TO BE DETERMINED (BRAIDED HOSE/W FLANGED ENDS)	AGITATOR STEAM INLET/LIQUID OUTLET
N8	2	TO BE DETERMINED (BRAIDED HOSE/W FLANGED ENDS)	AGITATOR CONDENSATE OUTLET/LIQUID INLET
N9	2	24" DIA.	ACCESS OPENING
N10	2	6" DIA.	VIEW PORT W/ISOLATION GATE
N11	6	1"-150# RF ANSI FLG	WATER DELUGE/INSTRUMENTS
N12	4	1"-150# RF ANSI FLG	THERMOCOUPLES

NOTES

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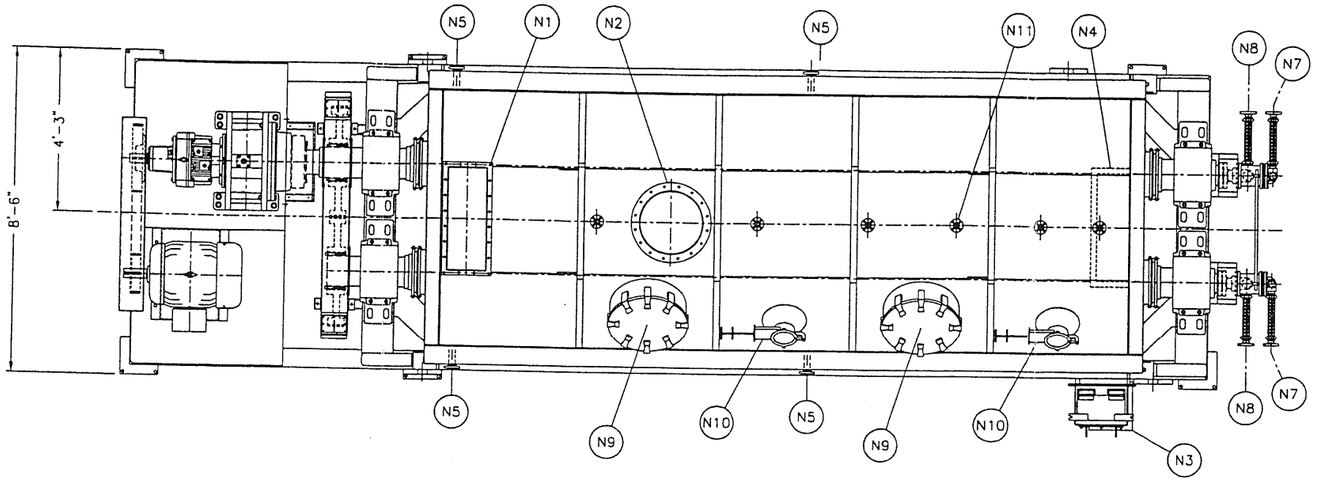
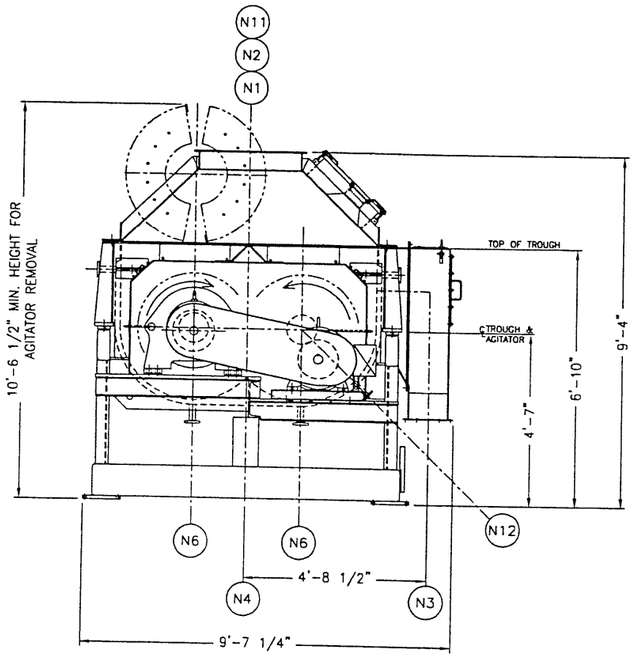
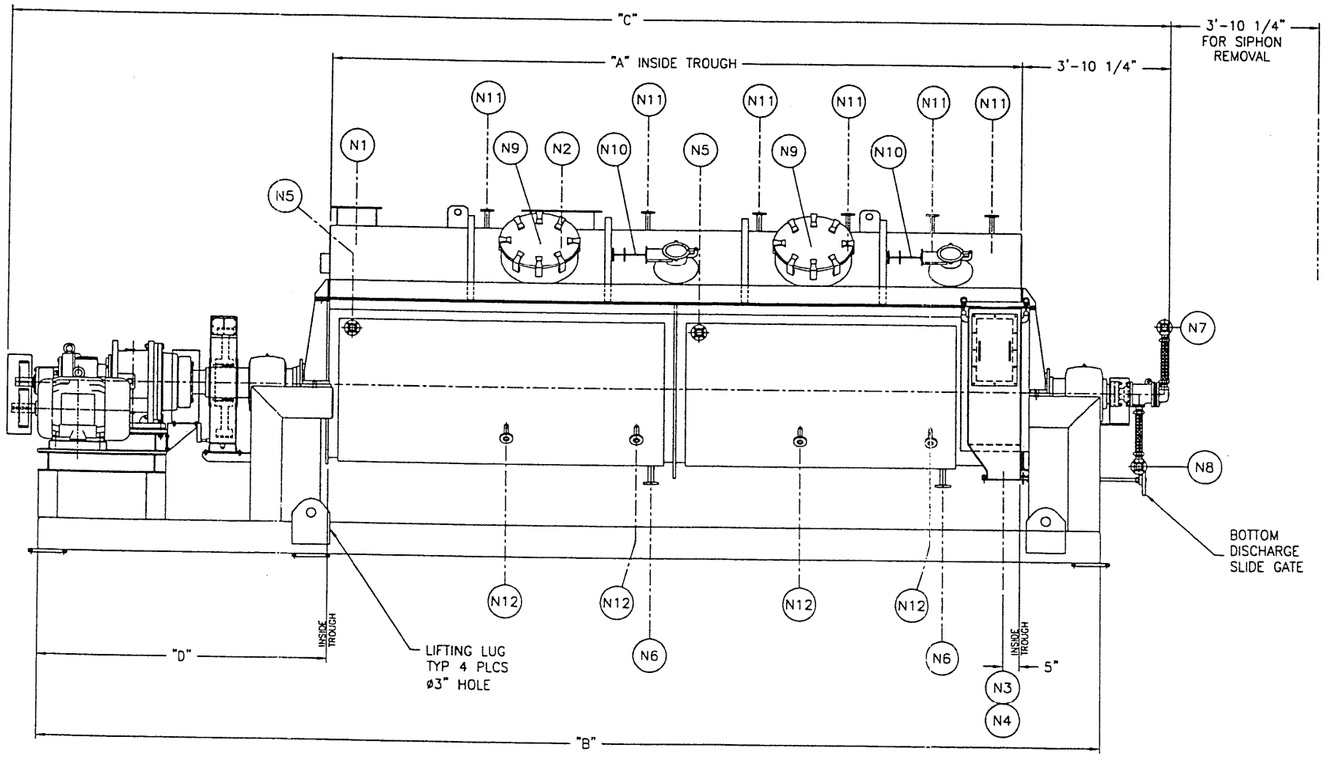
2. REFER TO KOMLINE-SANDERSON ENGINEERING CORPORATION PRELIMINARY SPECIFICATIONS FOR ADDITIONAL INFORMATION SUCH AS DRIVE DESCRIPTION, PRESSURE AND TEMPERATURE RATINGS, MATERIALS OF CONSTRUCTION, ETC.
3. CONNECTIONS ARE NOT DESIGNED TO ACCEPT EXTERNAL LOADS. CONNECTED PIPING AND DUCTS MUST BE INDEPENDENTLY SUPPORTED AND ARRANGED TO ALLOW FOR THERMAL EXPANSION. (HORIZONTAL MOVEMENT 1". VERTICAL MOVEMENT 1/4")
4. LIFTING LUGS ARE DESIGNED FOR VERTICAL LIFT ONLY. SPREADER BARS ARE NOT PROVIDED BY KOMLINE-SANDERSON.







MODEL	"A"	"B"	"C"	"D"	EMPTY WEIGHT	AGITATOR WEIGHT (EA)	PROCESS VOLUME
11W-1000	18'-0"	27'-7 1/2"	30'-3"	7'-7"	64,000 LBS	14,000 LBS	278 CU FT
11W-1200	21'-4"	31'-5"	34'-0"	8'-0"	70,000 LBS	16,000 LBS	330 CU FT

PRELIMINARY

REV. | DR. | CHK. | DATE | APPR

THIS DRAWING REPRESENTS THE DESIGN AND ENGINEERING EFFORTS OF THE KOMLINE-SANDERSON ENGINEERING CORPORATION. IT IS LOANED IN CONFIDENCE AND MUST BE RETURNED ON DEMAND. ANY USE DETRIMENTAL TO THE INTERESTS OF THE KOMLINE-SANDERSON ENGINEERING CORPORATION IS PROHIBITED. IT MUST NOT BE LOANED, COPIED OR REPRODUCED WITHOUT WRITTEN PERMISSION.

K-S NARA PADDLE DRYER/COOLER
MODEL 11W-1000.....1200
SIDE WEIR

DESIGNED	DRAWN	CHECKED	APPROVED
	DMP		

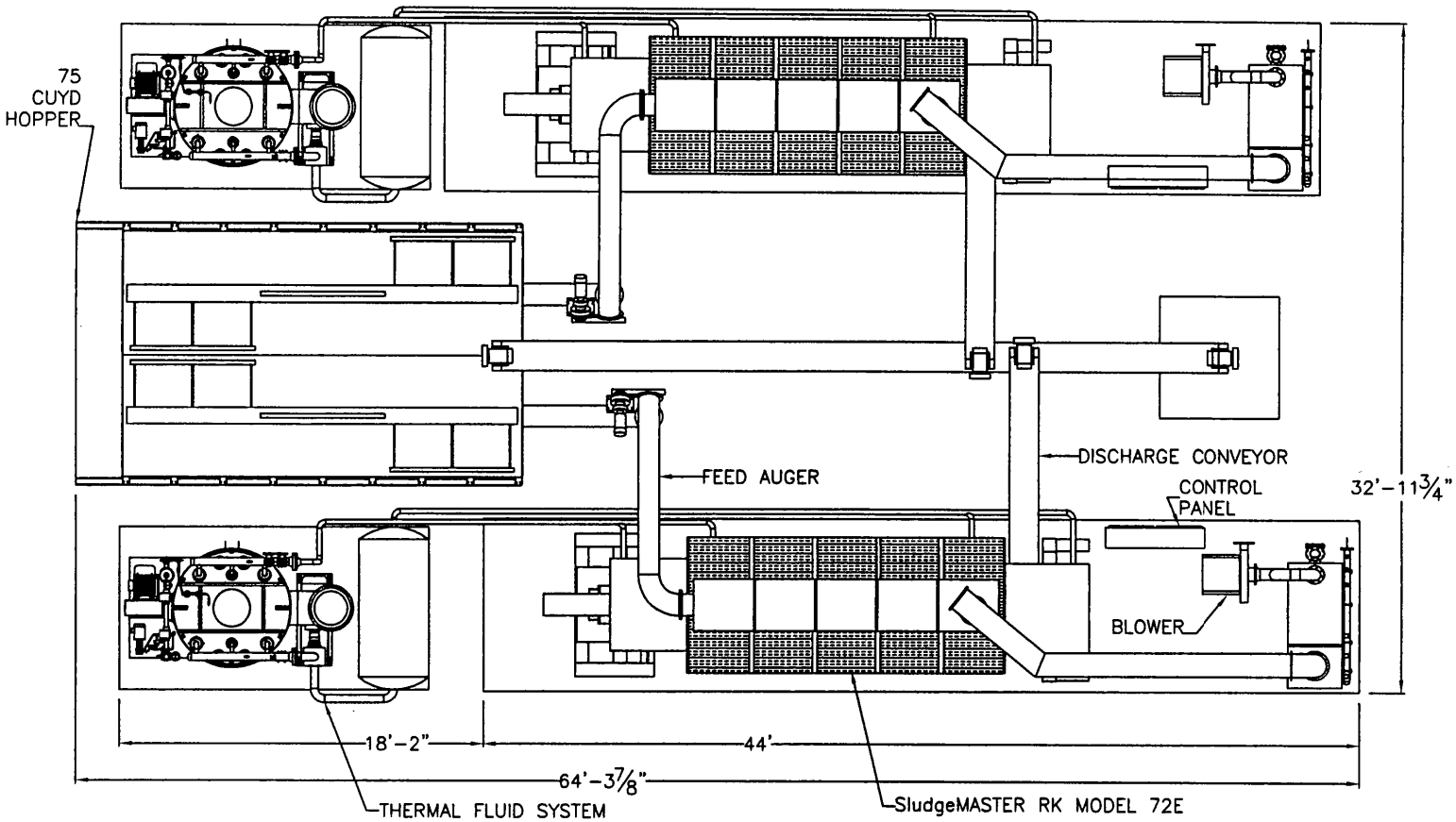
DATE	SCALE
8/21/01	1/2"=1'-0

KOMLINE-SANDERSON
ENGINEERING CORPORATION
PEAPACK, N.J.

REFERENCE
DWG. NO. CDP11-00001D

SHT. 1 OF 1

NOTE: THIS IS A GENERAL LAYOUT.
ALL DIMENSIONS AND INFORMATION ARE
SUBJECT TO CHANGE WITHOUT NOTICE.



RK 72E DUPLEX

FENTON ENVIRONMENTAL TECHNOLOGIES 4206 SOUTH HIGHWAY 377 BROWNWOOD, TX.		SIZE A	DRAWING NO. / REV
DESCRIPTION: DUAL RK 72E LAYOUT W/ 75 CU YD HOPPER		AUTOCAD RELEASE 12	
DRAWN BY:	DATE:	SCALE N.T.S	SHEET 1 OF 1

C

APPENDIX C – DETAILED COST ESTIMATES

40 mgd PROCESS PLANT UPGRADE OPTIONS

RIVERSIDE WATER QUALITY CONTROL PLANT

RIVERSIDE, CALIFORNIA

Project name	22776-011-40 mgd option
Estimator	B. Matthews
Labor rate table	San Diego - Labor
Equipment rate table	San Diego - Equipm't
Project	22776-011
Estimating Office:	Jax Fla
Estimate Issue No.	01
Revision No.:	07
Final Issue Date:	March 14,2003
BC Project Manager	K. Fonda
QA/QC Reviewer:	B. Matthews
Date Reviewed:	March 12,2003
Estimate Date:	March 14,2003
Design Percentage	Conceptual
Notes	PROCESS AREA LOCATIONS

1100 - CONTRACTOR GENERAL CONDITIONS
1101 - CIVIL/SITE WORK
1102 - DAFT PROCESS UNIT
1103 - CONVERT EXIST> DAF TO COTHICKENING DAF's
1104 - DEWATERING PROCESS UNIT
1105 - HEAT DRYING PROCESS UNIT

Brown and Caldwell
Estimating and Scheduling Department
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Jacksonville, Florida 32224
Phone No. 904-992-8804
Fax No. 904-379-0250

Description	Quantity	Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Equipment Amount	Other Amount	Total Amount
1100									
01100000 SUMMARY			2,822						2,822
01300000 ADMNSTRTV REQUIREMEN			234,730		6,312			20,150	261,192
01500000 TEMPORY FACILITS&CONTI			1,051		12,782		35,904	3,500	53,237
1100			***238,603***		***19,094***		***35,904***	***23,650***	***317,251***
8,620.00 Labor hours									
6,839.88 Equipment hours									
1101									
02500000 UTILITY SERVICES			20,760		105,000		5,500		131,260
1101			***20,760***		***105,000***		***5,500***		***131,260***
220.00 Labor hours									
220.000 Equipment hours									
1102									
11300000 WATER/WASTEWATER EQL			487,127		724,000		20,525		1,231,652
16010000 ELECTRICAL/INSTRUMENT/						110,000			110,000
17000000 INSTRUMENTATION						115,000			115,000
1102			***487,127***		***724,000***	***225,000***	***20,525***		***1,456,652***
1,231.00 Labor hours									
1,231.000 Equipment hours									
1103									
02200000 SITE PREPARATION			14,920				800		15,720
11300000 WATER/WASTEWATER EQL			117,683		1,103,728		30,609	375	1,252,395
15100000 BUILDING SERVICES PIPIN(			5,662		25,500		1,500		32,662
16010000 ELECTRICAL/INSTRUMENT/						325,500			325,500
17000000 INSTRUMENTATION						110,000			110,000
1103			***138,264***		***1,129,228***	***435,500***	***32,909***	***375***	***1,736,276***
545.75 Labor hours									
516.000 Equipment hours									
1104									
11300000 WATER/WASTEWATER EQL			131,342		691,500		19,750		842,592
16010000 ELECTRICAL/INSTRUMENT/						115,000			115,000
17000000 INSTRUMENTATION						95,000			95,000
1104			***131,342***		***691,500***	***210,000***	***19,750***		***1,052,592***
382.50 Labor hours									
370.00 Equipment hours									
1105									
02200000 SITE PREPARATION			157,486		3,500		45,600		206,586
11300000 WATER/WASTEWATER EQL			770,095		5,550,000		47,425		6,367,520
16010000 ELECTRICAL/INSTRUMENT/						750,000			750,000

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Description	Quantity	Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Equipment Amount	Other Amount	Total Amount
17000000 INSTRUMENTATION						250,000			250,000
1105			***927,582***		***5,553,500***	***1,000,000***	***93,025***		***7,574,107***
1,447.00 Labor hours									
1,447.00 Equipment hours									

Estimate Totals

Labor	1,943,678	1,943,678		12,446.250	ch	
Material	8,222,322	8,222,322				
Subcontract	1,870,500	1,870,500				
Equipment	207,613	207,613		10,623.880	ch	
Other	24,025	24,025				
	12,268,138	12,268,138	12,268,138			
Labor Mark-up	349,862			18.000 %		C
Material Mark-up	1,233,348			15.000 %		C
Subcontractor Mark-up	93,525			5.000 %		C
Equipment Mark-up	31,142			15.000 %		C
	1,707,877		13,976,015			
Sales tax (material)	678,342			8.250 %		C
Sales tax (equipment)	17,128			8.250 %		C
	695,470		14,671,485			
Performance Bond	146,715			1.000 %		T
Payment Bond	148,182			1.000 %		T
	294,897		14,966,382			
Material Shipping & Handling	123,335			1.500 %		C
	123,335		15,089,717			
Worker's Travel/Subsistence	1,944			0.100 %		C
	1,944		15,091,661			
Earthquake Insurance	15,092			0.100 %		T
	15,092		15,106,753			
Bldg Risk, Liability Auto Ins.	302,135			2.000 %		T
	302,135		15,408,888			
Start-up, training, O & M	308,178			2.000 %		T
	308,178		15,717,066			
Construction Contingency	4,715,119			30.000 %		T
	Total		***20,432,185***			

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Estimate Totals

Labor	2,901,375	2,901,375		27,636.634	ch	
Material	8,896,967	8,896,967				
Subcontract	3,072,750	3,072,750				
Equipment	424,091	424,091		20,578.094	ch	
Other	255,545	255,545				
	15,550,728	15,550,728	15,550,728			
Labor Mark-up	522,248			18.000	%	C
Material Mark-up	1,334,545			15.000	%	C
Subcontractor Mark-up	153,638			5.000	%	C
Equipment Mark-up	63,614			15.000	%	C
	2,074,045		17,624,773			
Sales tax (material)	734,000			8.250	%	C
Sales tax (equipment)	34,987			8.250	%	C
	768,987		18,393,760			
Performance Bond	183,938			1.000	%	T
Payment Bond	185,777			1.000	%	T
	369,715		18,763,475			
Material Shipping & Handling	133,455			1.500	%	C
	133,455		18,896,930			
Worker's Travel/Subsistence	2,901			0.100	%	C
	2,901		18,899,831			
Earthquake Insurance	18,900			0.100	%	T
	18,900		18,918,731			
Bldg Risk, Liability Auto Ins.	378,375			2.000	%	T
	378,375		19,297,106			
Start-up, training, O & M	385,942			2.000	%	T
	385,942		19,683,048			
Construction Contingency	5,904,914			30.000	%	T
	Total		***25,587,962***			

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40 mgd PROCESS PLANT UPGRADE OPTIONS

RIVERSIDE WATER QUALITY CONTROL PLANT

RIVERSIDE, CALIFORNIA

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Equipment rate table	San Diego - Equipm't
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Estimating Office:	Jax Fla
Estimate Issue No.	01
Revision No.:	07
Final Issue Date:	March 14,2003
BC Project Manager	K. Fonda
QA/QC Reviewer:	B. Matthews
Date Reviewed:	March 12,2003
Estimate Date:	March 14,2003
Design Percentage	Conceptual
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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1100												
01100000	**SUMMARY**											
01107700	*Surveying*											
1100	Surveying, crew for building layout, 2 person crew	4.00	day	705.61 /day	2,822	-	-	-		-	-	2,822
	Surveying				*2,822*							*2,822*
	32.00 Labor hours											
	SUMMARY				**2,822**		**0**	**0**		**0**	**0**	**2,822**
	32.00 Labor hours											
01300000	**ADMNSTRTV REQUIREMENTS**											
01310700	*Field personnel*											
0010	Field personnel clerk	52.00	week	480.00 /week	24,960	-	-	-		-	-	24,960
0140	Field personnel, field engineer	24.00	week	1,005.00 /week	24,120	-	-	-		-	-	24,120
0160	Field personnel, general purpose laborer	40.00	week	925.00 /week	37,000	-	-	-		-	-	37,000
0220	Field personnel, project manager	26.00	week	1,605.00 /week	41,730	-	-	-		-	-	41,730
0280	Field personnel, superintendent	52.00	week	1,510.00 /week	78,520	-	-	-		-	-	78,520
9001	Field personnel, health & safety manager	20.00	week	1,420.00 /week	28,400	-	-	-		-		28,400
	Field personnel				*234,730*							*234,730*
	8,560.00 Labor hours											
01320200	*Scheduling*											
0400	Scheduling, cost control, computer-update, micro, incl plots, maximum	12.00	ea	-	-	-	-	-		-	18,600	18,600
0800	As-built drawings, O & M Manuals	1.00	ea	-	-	-	-	-		-	1,550	1,550
	Scheduling										*20,150*	*20,150*
01321500	*Photographs*											
0010	Photographs 8" x 10", 4 shots, 2 prints ea, std mounting	24.00	set	-	-	263.00 /set	6,312	-		-	-	6,312
	Photographs						*6,312*					*6,312*
	ADMNSTRTV REQUIREMENTS				**234,730**		**6,312**	**0**		**0**	**20,150**	**261,192**
	8,560.00 Labor hours											
01500000	**TEMPORY FACILITS&CONTROLS**											
01510050	*Tm pw eq (pr-rtd per job)*											

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01510050	*Tm pw eq (pr-rtd per job)*											
0040	Temporary pwr equip (pro-rated per job), svce, ovhd feed, 3 use, 200 A	1.00	ea	375.82 /ea	376	710.00 /ea	710	-		-	-	1,086
	Tm pw eq (pr-rtd per job)				*376*		*710*					*1,086*
	8.00 Labor hours											
01520500	*Office*											
0550	Office trailer, furnished, no hookups, 50' x 12', rent per month	12.00	ea	-	-	345.00 /ea	4,140	-		-	-	4,140
0700	Office trailer, for air conditioning, rent per month, add	12.00	ea	-	-	35.50 /ea	426	-		-	-	426
0800	Office, trailer, furnished, for delivery, add per mile	100.00	mile	-	-	1.50 /mile	150	-		-	-	150
1350	Office, storage boxes, 28' x 10', rent per month	12.00	ea	-	-	103.00 /ea	1,236	-		-	-	1,236
	Office						*5,952*					*5,952*
01520550	*Field office expense*											
0100	Field office expense, office equipment rental	12.00	mo	-	-	136.00 /mo	1,632	-		-	-	1,632
0120	Field office expense, office supplies	12.00	mo	-	-	82.00 /mo	984	-		-	-	984
0140	Field office expense, telephone bill, avg bill/month incl long dist	12.00	mo	-	-	200.00 /mo	2,400	-		-	-	2,400
0160	Field office expense, field office lights & HVAC	12.00	mo	-	-	92.00 /mo	1,104	-		-	-	1,104
9001	Field subcontract, utility underground locating service	0.50	week	1,350.00 /week	675	-	-	-		-	-	675
9901	Field office expense, small tool allowance	1.00	ea	-	-	-	-	-		-	3,500	3,500
	Field office expense				*675*		*6,120*				*3,500*	*10,295*
	20.00 Labor hours											
01590400	*General equipment rental*											
0160	Rent aerial lift to 25'high 2000 lb cap scissor type	60.00	day	-	-	-	-	-		5,580	-	5,580
6410	Rent toilet portable chemical	12.00	mnth	-	-	-	-	-		900	-	900
6410	Rent toilet portable chemical	12.00	mnth	-	-	-	-	-		900	-	900
7200	Rent truck pickup 3/4 ton 4 wheel drive	12.00	mnth	-	-	-	-	-		15,000	-	15,000
	General equipment rental									*22,380*		*22,380*
	6,719.88 Equipment hours											
01590600	*Lifting and hoisting equi*											
2600	Rent crane truck mounted, hydraulic, 55 ton capacity	15.00	day	-	-	-	-	-		13,524	-	13,524

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	Lifting and hoisting equi								*13,524*		*13,524*
	120.00 Equipment hours										
	TEMPORY FACILITS&CONTROLS			**1,051**		**12,782**	**0**		**35,904**	**3,500**	**53,237**
	28.00 Labor hours										
	6,839.88 Equipment hours										
	1100			***238,603***		***19,094***	***0***		***35,904***	***23,650***	***317,251***
	8,620.00 Labor hours										
	6,839.88 Equipment hours										

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1101												
02500000	**UTILITY SERVICES**											
02510820	*Ppng,watr dstr,ductl iron*											
----	Yard Piping Allowance	1.00	ea	5,661.84 /ea	5,662	40,000.00 /ea	40,000	-		1,500	-	47,162
----	Site grading, drainage and landscaping allowance	1.00	ea	15,098.24 /ea	15,098	65,000.00 /ea	65,000	-		4,000	-	84,098
	Ppng,watr dstr,ductl iron				*20,760*		*105,000*			*5,500*		*131,260*
	220.00 Labor hours											
	220.000 Equipment hours											
	UTILITY SERVICES				**20,760**		**105,000**	**0**		**5,500**	**0**	**131,260**
	220.00 Labor hours											
	220.000 Equipment hours											
	1101				***20,760***		***105,000***	***0***		***5,500***	***0***	***131,260***
	220.00 Labor hours											
	220.000 Equipment hours											

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1102												
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
----	DAFT process control bldg, complete	2,100.00	sf	20.722 /sf	43,516	85.00 /sf	178,500	-		7,875	-	229,891
----	DAFT - process pumps, complete	3.00	ea	7,459.87 /ea	22,380	18,500.00 /ea	55,500	-		1,350	-	79,230
----	DAFT - manual and control valve allowance	1.00	ea	3,019.65 /ea	3,020	25,000.00 /ea	25,000	-		800	-	28,820
----	DAFT - Piping and fitting allowance	1.00	ea	3,774.56 /ea	3,775	15,000.00 /ea	15,000	-		3,000	-	21,775
----	Daft- 48 ft diameter, complete	1.00	ea	414,437.00 /ea	414,437	450,000.00 /ea	450,000	-		7,500	-	871,937
	Industrial W/W equipment				*487,127*		*724,000*			*20,525*		*1,231,652*
	1,231.00 Labor hours											
	1,231.000 Equipment hours											
	WATER/WASTEWATER EQUIPM'T				**487,127**		**724,000**	**0**		**20,525**	**0**	**1,231,652**
	1,231.00 Labor hours											
	1,231.000 Equipment hours											
16010000	**ELECTRICAL/INSTRUMENTATIO**											
16010100	*E & I Subcontractor*											
9001	Electrical and Instrumentation subcontractor	1.00	ls	-	-	-	-	110,000		-	-	110,000
	E & I Subcontractor							*110,000*				*110,000*
	ELECTRICAL/INSTRUMENTATIO				**0**		**0**	**110,000**		**0**	**0**	**110,000**
17000000	**INSTRUMENTATION**											
17000100	*INSTRUMENTATION CONTRACT*											
1001	Instrumentation subcontractor	1.00	ls	-	-	-	-	115,000		-	-	115,000
	INSTRUMENTATION CONTRACT							*115,000*				*115,000*
	INSTRUMENTATION				**0**		**0**	**115,000**		**0**	**0**	**115,000**
	1102				***487,127***		***724,000***	***225,000***		***20,525***	***0***	***1,456,652***
	1,231.00 Labor hours											
	1,231.000 Equipment hours											

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1103												
02200000	**SITE PREPARATION**											
02220880	*Equipment dismantling*											
9929	Equip. dml, air compressor unit, complete	1.00	ea	1,657.75 /ea	1,658	-	-	-			-	1,658
9981	Equip. dml, daf pressurization system, complete	1.00	ea	13,261.98 /ea	13,262	-	-	-		800	-	14,062
	Equipment dismantling				*14,920*					*800*		*15,720*
	36.00 Labor hours											
	36.00 Equipment hours											
	SITE PREPARATION				**14,920**		**0**	**0**		**800**	**0**	**15,720**
	36.00 Labor hours											
	36.00 Equipment hours											
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
9904	Pumps,mixed sludge recirculation pump	2.00	ea	460.25 /ea	921	8,372.00 /ea	16,744	-		-	150	17,815
9905	Pumps,digester feed pump	3.00	ea	523.013 /ea	1,569	21,328.00 /ea	63,984	-		-	225	65,778
----	Thickened sludge blending tk,20,000 gal.,st,comp. w/nozzles,manway	1.00	ea	3,347.28 /ea	3,347	27,500.00 /ea	27,500	-		6,000	-	36,847
	Industrial W/W equipment				*5,837*		*108,228*			*6,000*	*375*	*120,440*
	69.75 Labor hours											
	40.00 Equipment hours											
11390900	*Wastwtr treatment system*											
9940	DAF cover,steel,not incl insulation,coatings, flashing,38 ft dia	2.00	ea	26,912.40 /ea	53,825	100,000.00 /ea	200,000	-		17,809	-	271,634
----	DAF pressurization system	1.00	ea	41,443.70 /ea	41,444	650,000.00 /ea	650,000	-		5,000	-	696,444
----	DAF air system, complete	1.00	ea	16,577.48 /ea	16,577	145,500.00 /ea	145,500	-		1,800	-	163,877
	Wastwtr treatment system				*111,846*		*995,500*			*24,609*		*1,131,955*
	380.00 Labor hours											
	380.000 Equipment hours											
	WATER/WASTEWATER EQUIPM'T				**117,683**		**1,103,728**	**0**		**30,609**	**375**	**1,252,395**
	449.75 Labor hours											
	420.000 Equipment hours											
15100000	**BUILDING SERVICES PIPING**											
15106100	*Misc. Mechanical*											

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
15106100	*Misc. Mechanical*											
----	Misc. piping and valve allowance, daf pressurization system,complete	1.00	ea	5,661.84 /ea	5,662	25,500.00 /ea	25,500	-		1,500	-	32,662
	Misc. Mechanical				*5,662*		*25,500*			*1,500*		*32,662*
	60.00 Labor hours											
	60.00 Equipment hours											
	BUILDING SERVICES PIPING				**5,662**		**25,500**	**0**		**1,500**	**0**	**32,662**
	60.00 Labor hours											
	60.00 Equipment hours											
16010000	**ELECTRICAL/INSTRUMENTATIO**											
16010100	*E & I Subcontractor*											
9001	Electrical and Instrumentation subcontractor	1.00	ls	-	-	-	-	325,500		-	-	325,500
	E & I Subcontractor							*325,500*				*325,500*
	ELECTRICAL/INSTRUMENTATIO				**0**		**0**	**325,500**		**0**	**0**	**325,500**
17000000	**INSTRUMENTATION**											
17000100	*INSTRUMENTATION CONTRACT*											
1001	Instrumentation subcontractor	1.00	ls	-	-	-	-	110,000		-	-	110,000
	INSTRUMENTATION CONTRACT							*110,000*				*110,000*
	INSTRUMENTATION				**0**		**0**	**110,000**		**0**	**0**	**110,000**
	1103				***138,264***		***1,129,228***	***435,500***		***32,909***	***375***	***1,736,276***
	545.75 Labor hours											
	516.000 Equipment hours											

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1104												
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
9023	Possitive displacement piston pump, complete	2.00	ea	523.02 /ea	1,046	15,000.00 /ea	30,000	-		500	-	31,546
----	Centrifuge, complete incl. supports	1.00	ea	49,732.44 /ea	49,732	500,000.00 /ea	500,000	-		3,000	-	552,732
----	Polymer Feed pump, complete	1.00	ea	7,459.87 /ea	7,460	8,500.00 /ea	8,500	-		450	-	16,410
----	Manual and control valve allowance	1.00	ea	3,019.65 /ea	3,020	18,500.00 /ea	18,500	-		800	-	22,320
----	Piping and fitting allowance	1.00	ea	3,774.56 /ea	3,775	9,500.00 /ea	9,500	-		3,000	-	16,275
----	Dewatering Bldg. Raise roof, complete	1.00	ea	66,309.92 /ea	66,310	125,000.00 /ea	125,000	-		12,000	-	203,310
	Industrial W/W equipment				*131,342*		*691,500*			*19,750*		*842,592*
	382.50 Labor hours											
	370.00 Equipment hours											
	WATER/WASTEWATER EQUIPM'T				**131,342**		**691,500**	**0**		**19,750**	**0**	**842,592**
	382.50 Labor hours											
	370.00 Equipment hours											
16010000	**ELECTRICAL/INSTRUMENTATIO**											
16010100	*E & I Subcontractor*											
9001	Electrical and Instrumentation subcontractor	1.00	ls	-	-	-	-	115,000		-	-	115,000
	E & I Subcontractor							*115,000*				*115,000*
	ELECTRICAL/INSTRUMENTATIO				**0**		**0**	**115,000**		**0**	**0**	**115,000**
17000000	**INSTRUMENTATION**											
17000100	*INSTRUMENTATION CONTRACT*											
1001	Instrumentation subcontractor	1.00	ls	-	-	-	-	95,000		-	-	95,000
	INSTRUMENTATION CONTRACT							*95,000*				*95,000*
	INSTRUMENTATION				**0**		**0**	**95,000**		**0**	**0**	**95,000**
	1104				***131,342***		***691,500***	***210,000***		***19,750***	***0***	***1,052,592***
	382.50 Labor hours											
	370.00 Equipment hours											

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1105												
02200000	**SITE PREPARATION**											
02220875	*Site demolition*											
----	Site demolition, complete	1.00	ea	157,486.06 /ea	157,486	3,500.00 /ea	3,500	-		45,600	-	206,586
	Site demolition				*157,486*		*3,500*			*45,600*		*206,586*
	380.00 Labor hours											
	380.000 Equipment hours											
	SITE PREPARATION				**157,486**		**3,500**	**0**		**45,600**	**0**	**206,586**
	380.00 Labor hours											
	380.000 Equipment hours											
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
----	Heat Drying equipment package, complete	2.00	ea	187,500.00 /ea	375,000	1,500,000.00 /ea	3,000,000	-		7,500	-	3,382,500
----	Heat drying equipment bldg, complete	7,500.00	sf	20.722 /sf	155,414	110.00 /sf	825,000	-		28,125	-	1,008,539
----	Dried product storage facility	1.00	ea	82,887.40 /ea	82,887	750,000.00 /ea	750,000	-		5,000	-	837,887
----	Manual and control valve allowance	1.00	ea	3,019.65 /ea	3,020	15,000.00 /ea	15,000	-		800	-	18,820
----	Piping and fitting allowance	1.00	ea	3,774.56 /ea	3,775	10,000.00 /ea	10,000	-		3,000	-	16,775
----	Odor Control equipment package, complete	1.00	ea	150,000.00 /ea	150,000	950,000.00 /ea	950,000	-		3,000	-	1,103,000
	Industrial W/W equipment				*770,095*		*5,550,000*			*47,425*		*6,367,520*
	1,067.00 Labor hours											
	1,067.00 Equipment hours											
	WATER/WASTEWATER EQUIPM'T				**770,095**		**5,550,000**	**0**		**47,425**	**0**	**6,367,520**
	1,067.00 Labor hours											
	1,067.00 Equipment hours											
16010000	**ELECTRICAL/INSTRUMENTATIO**											
16010100	*E & I Subcontractor*											
9001	Electrical and Instrumentation subcontractor	1.00	ls	-	-	-	-	750,000		-	-	750,000
	E & I Subcontractor							*750,000*				*750,000*
	ELECTRICAL/INSTRUMENTATIO				**0**		**0**	**750,000**		**0**	**0**	**750,000**
17000000	**INSTRUMENTATION**											
17000100	*INSTRUMENTATION CONTRACT*											

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
17000100	*INSTRUMENTATION CONTRACT*											
1001	Instrumentation subcontractor	1.00	ls	-	-	-	-	250,000		-	-	250,000
	INSTRUMENTATION CONTRACT							*250,000*				*250,000*
	INSTRUMENTATION				**0**		**0**	**250,000**		**0**	**0**	**250,000**
	1105				***927,582***		***5,553,500***	***1,000,000***		***93,025***	***0***	***7,574,107***
	1,447.00 Labor hours											
	1,447.00 Equipment hours											

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Estimate Totals

Labor	1,943,678	1,943,678		12,446.250	ch	
Material	8,222,322	8,222,322				
Subcontract	1,870,500	1,870,500				
Equipment	207,613	207,613		10,623.880	ch	
Other	24,025	24,025				
	12,268,138	12,268,138	12,268,138			
Labor Mark-up	349,862			18.000	%	C
Material Mark-up	1,233,348			15.000	%	C
Subcontractor Mark-up	93,525			5.000	%	C
Equipment Mark-up	31,142			15.000	%	C
	1,707,877		13,976,015			
Sales tax (material)	678,342			8.250	%	C
Sales tax (equipment)	17,128			8.250	%	C
	695,470		14,671,485			
Performance Bond	146,715			1.000	%	T
Payment Bond	148,182			1.000	%	T
	294,897		14,966,382			
Material Shipping & Handling	123,335			1.500	%	C
	123,335		15,089,717			
Worker's Travel/Subsistence	1,944			0.100	%	C
	1,944		15,091,661			
Earthquake Insurance	15,092			0.100	%	T
	15,092		15,106,753			
Bldg Risk, Liability Auto Ins.	302,135			2.000	%	T
	302,135		15,408,888			
Start-up, training, O & M	308,178			2.000	%	T
	308,178		15,717,066			
Construction Contingency	4,715,119			30.000	%	T
	Total		***20,432,185***			

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50 mgd PROCESS PLANT UPGRADE OPTIONS

RIVERSIDE WATER QUALITY CONTROL PLANT

RIVERSIDE, CALIFORNIA

Project name	22776-011-50 mgd option
Estimator	B. Matthews
Labor rate table	San Diego - Labor
Equipment rate table	San Diego - Equipm't
Project	22776-011
Estimating Office:	Jax Fla
Estimate Issue No.	01
Revision No.:	07
Final Issue Date:	March 14,2003
BC Project Manager	K. Fonda
QA/QC Reviewer:	B. Matthews
Date Reviewed:	March 12,2003
Estimate Date:	March 14,2003
Design Percentage	Conceptual
Notes	PROCESS AREA LOCATIONS

1100 - CONTRACTOR GENERAL CONDITIONS
1101 - CIVIL/SITE WORK
1102 - DAFT PROCESS UNIT
1103 - ANEROBIC DIGESTION PROCESS UNIT
1104 - DEWATERING PROCESS UNIT
1105 - HEAT DRYING PROCESS UNIT

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Description	Quantity	Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Equipment Amount	Other Amount	Total Amount
1100									
01100000 SUMMARY			4,939						4,939
01300000 ADMNSTRTV REQUIREMEN			470,400		9,468			29,450	509,318
01500000 TEMPORY FACILITS&CONTI			1,051		24,854		80,498	3,500	109,903
1100			***476,390***		***34,322***		***80,498***	***32,950***	***624,160***
15,924.00 Labor hours									
13,631.76 Equipment hours									
1101									
02500000 UTILITY SERVICES			22,647		127,500		6,000		156,147
1101			***22,647***		***127,500***		***6,000***		***156,147***
240.00 Labor hours									
240.00 Equipment hours									
1102									
11300000 WATER/WASTEWATER EQL			487,127		724,000		20,525		1,231,652
16010000 ELECTRICAL/INSTRUMENT/						110,000			110,000
17000000 INSTRUMENTATION						115,000			115,000
1102			***487,127***		***724,000***	***225,000***	***20,525***		***1,456,652***
1,231.00 Labor hours									
1,231.000 Equipment hours									
1103									
01500000 TEMPORY FACILITS&CONTI			2,207		6,033				8,241
02300000 EARTHWORK			116,534		13,445		154,488		284,467
02450000 FNDTN&LOAD BEARNG ELE			58,758		81,081		31,846	84,000	255,684
03100000 CONCRETE FORMS&ACCES			143,891		48,935				192,826
03200000 CONCRETE REINFORCEME			99,429		94,548		7,675		201,652
03300000 CAST-IN-PLACE CONCRETE			205,684		247,816		20,892		474,392
04200000 MASONRY UNITS			185		138				323
05500000 METAL FABRICATIONS			1,068		2,280		66		3,414
07100000 DAMPPRFNG&WATERPROC			2,501		9,984	120,748	776		134,009
07200000 THERMAL PROTECTION			899		8,180				9,079
07600000 FLASHING & SHEET METAL			1,201		745				1,945
08100000 METAL DOORS & FRAMES			388		826		17		1,231
08300000 SPECIALTY DOORS			366		4,230				4,596
08900000 GLAZED CURTAIN WALL			2,186		7,425				9,611
09900000 PAINTS & COATINGS			3,186		2,990				6,176
11300000 WATER/WASTEWATER EQL			28,977		456,716		7,332	4,075	497,100
13800000 BUILDING AUTOMATN&CON			418		658				1,076
15050000 BASIC MATERIALS & METH(			5,668		1,700				7,368
15100000 BUILDING SERVICES PIPIN(			228,246		269,973		10,375	134,520	643,114
15200000 PROCESS PIPING			370		510				880
15600000 REFRIGERATION EQUIPMEI			4,557		30,000				34,557
15700000 HTNG/V/ CONDTNG EQUIPM			4,600		5,500				10,100

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Description	Quantity	Labor		Material		Subcontract	Equipment	Other	Total
		Unit Cost	Amount	Unit Cost	Amount	Amount	Amount	Amount	Amount
15800000 AIR DISTRIBUTION			518		882				1,400
16010000 ELECTRICAL/INSTRUMENT/						761,966			761,966
17000000 INSTRUMENTATION			2,684		11,550	375,036			389,270
1103			***914,520***		***1,306,145***	***1,257,750***	***233,467***	***222,595***	***3,934,478***
8,405.134 Labor hours									
3,651.334 Equipment hours									
1104									
02200000 SITE PREPARATION			82,887		17,000		15,000		114,887
11300000 WATER/WASTEWATER EQL			137,517		1,102,500		15,475		1,255,492
16010000 ELECTRICAL/INSTRUMENT/						275,000			275,000
17000000 INSTRUMENTATION						165,000			165,000
1104			***220,404***		***1,119,500***	***440,000***	***30,475***		***1,810,379***
661.50 Labor hours									
649.000 Equipment hours									
1105									
11300000 WATER/WASTEWATER EQL			780,287		5,585,500		53,125		6,418,912
16010000 ELECTRICAL/INSTRUMENT/						825,000			825,000
17000000 INSTRUMENTATION						325,000			325,000
1105			***780,287***		***5,585,500***	***1,150,000***	***53,125***		***7,568,912***
1,175.00 Labor hours									
1,175.00 Equipment hours									

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50 mgd PROCESS PLANT UPGRADE OPTIONS

RIVERSIDE WATER QUALITY CONTROL PLANT

RIVERSIDE, CALIFORNIA

Project name	22776-011-50 mgd option
Estimator	B. Matthews
Labor rate table	San Diego - Labor
Equipment rate table	San Diego - Equipm't
Project	22776-011
Estimating Office:	Jax Fla
Estimate Issue No.	01
Revision No.:	07
Final Issue Date:	March 14,2003
BC Project Manager	K. Fonda
QA/QC Reviewer:	B. Matthews
Date Reviewed:	March 12,2003
Estimate Date:	March 14,2003
Design Percentage	Conceptual
Notes	PROCESS AREA LOCATIONS

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1100												
01100000	**SUMMARY**											
01107700	*Surveying*											
1100	Surveying, crew for building layout, 2 person crew	7.00	day	705.61 /day	4,939	-	-	-		-	-	4,939
	Surveying				*4,939*							*4,939*
	56.00 Labor hours											
	SUMMARY				**4,939**		**0**	**0**		**0**	**0**	**4,939**
	56.00 Labor hours											
01300000	**ADMNSTRTV REQUIREMENTS**											
01310700	*Field personnel*											
0010	Field personnel clerk	76.00	week	480.00 /week	36,480	-	-	-		-	-	36,480
0140	Field personnel, field engineer	52.00	week	1,005.00 /week	52,260	-	-	-		-	-	52,260
0160	Field personnel, general purpose laborer	40.00	week	925.00 /week	37,000	-	-	-		-	-	37,000
0220	Field personnel, project manager	76.00	week	1,605.00 /week	121,980	-	-	-		-	-	121,980
0280	Field personnel, superintendent	76.00	week	1,510.00 /week	114,760	-	-	-		-	-	114,760
9001	Field personnel, health & safety manager	76.00	week	1,420.00 /week	107,920	-	-	-		-		107,920
	Field personnel				*470,400*							*470,400*
	15,840.00 Labor hours											
01320200	*Scheduling*											
0400	Scheduling, cost control, computer-update, micro, incl plots, maximum	18.00	ea	-	-	-	-	-		-	27,900	27,900
0800	As-built drawings, O & M Manuals	1.00	ea	-	-	-	-	-		-	1,550	1,550
	Scheduling										*29,450*	*29,450*
01321500	*Photographs*											
0010	Photographs 8" x 10", 4 shots, 2 prints ea, std mounting	36.00	set	-	-	263.00 /set	9,468	-		-	-	9,468
	Photographs						*9,468*					*9,468*
	ADMNSTRTV REQUIREMENTS				**470,400**		**9,468**	**0**		**0**	**29,450**	**509,318**
	15,840.00 Labor hours											
01500000	**TEMPORY FACILITS&CONTROLS**											
01510050	*Tm pw eq (pr-rtd per job)*											

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01510050	*Tm pw eq (pr-rtd per job)*											
0040	Temporary pwr equip (pro-rated per job), svce, ovhd feed, 3 use, 200 A	1.00	ea	375.82 /ea	376	710.00 /ea	710	-		-	-	1,086
	Tm pw eq (pr-rtd per job)				*376*		*710*					*1,086*
	8.00 Labor hours											
01520500	*Office*											
0550	Office trailer, furnished, no hookups, 50' x 12', rent per month	12.00	ea	-	-	345.00 /ea	4,140	-		-	-	4,140
0550	Office trailer, furnished, no hookups, 50' x 12', rent per month	12.00	ea	-	-	345.00 /ea	4,140	-		-	-	4,140
0700	Office trailer, for air conditioning, rent per month, add	12.00	ea	-	-	35.50 /ea	426	-		-	-	426
0700	Office trailer, for air conditioning, rent per month, add	12.00	ea	-	-	35.50 /ea	426	-		-	-	426
0800	Office, trailer, furnished, for delivery, add per mile	100.00	mile	-	-	1.50 /mile	150	-		-	-	150
0800	Office, trailer, furnished, for delivery, add per mile	100.00	mile	-	-	1.50 /mile	150	-		-	-	150
1350	Office, storage boxes, 28' x 10', rent per month	12.00	ea	-	-	103.00 /ea	1,236	-		-	-	1,236
1350	Office, storage boxes, 28' x 10', rent per month	12.00	ea	-	-	103.00 /ea	1,236	-		-	-	1,236
	Office						*11,904*					*11,904*
01520550	*Field office expense*											
0100	Field office expense, office equipment rental	12.00	mo	-	-	136.00 /mo	1,632	-		-	-	1,632
0100	Field office expense, office equipment rental	12.00	mo	-	-	136.00 /mo	1,632	-		-	-	1,632
0120	Field office expense, office supplies	12.00	mo	-	-	82.00 /mo	984	-		-	-	984
0120	Field office expense, office supplies	12.00	mo	-	-	82.00 /mo	984	-		-	-	984
0140	Field office expense, telephone bill, avg bill/month incl long dist	12.00	mo	-	-	200.00 /mo	2,400	-		-	-	2,400
0140	Field office expense, telephone bill, avg bill/month incl long dist	12.00	mo	-	-	200.00 /mo	2,400	-		-	-	2,400
0160	Field office expense, field office lights & HVAC	12.00	mo	-	-	92.00 /mo	1,104	-		-	-	1,104
0160	Field office expense, field office lights & HVAC	12.00	mo	-	-	92.00 /mo	1,104	-		-	-	1,104
9001	Field subcontract, utility underground locating service	0.50	week	1,350.00 /week	675	-	-	-		-	-	675
9901	Field office expense, small tool allowance	1.00	ea	-	-	-	-	-		-	3,500	3,500

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Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
	Field office expense				*675*		*12,240*				*3,500*	*16,415*
	20.00 Labor hours											
01590400	*General equipment rental*											
0160	Rent aerial lift to 25'high 2000 lb cap scissor type	120.00	day	-	-	-	-	-		11,160	-	11,160
6410	Rent toilet portable chemical	18.00	mnth	-	-	-	-	-		1,350	-	1,350
6410	Rent toilet portable chemical	18.00	mnth	-	-	-	-	-		1,350	-	1,350
7200	Rent truck pickup 3/4 ton 4 wheel drive	18.00	mnth	-	-	-	-	-		22,500	-	22,500
7200	Rent truck pickup 3/4 ton 4 wheel drive	18.00	mnth	-	-	-	-	-		22,500	-	22,500
	General equipment rental									*58,860*		*58,860*
	13,439.76 Equipment hours											
01590600	*Lifting and hoisting equi*											
2600	Rent crane truck mounted, hydraulic, 55 ton capacity	24.00	day	-	-	-	-	-		21,638	-	21,638
	Lifting and hoisting equi									*21,638*		*21,638*
	192.00 Equipment hours											
	TEMPORY FACILITS&CONTROLS				**1,051**		**24,854**	**0**		**80,498**	**3,500**	**109,903**
	28.00 Labor hours											
	13,631.76 Equipment hours											
	1100				***476,390***		***34,322***	***0***		***80,498***	***32,950***	***624,160***
	15,924.00 Labor hours											
	13,631.76 Equipment hours											

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Item	Description	Takeoff Qty	Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
1101											
02500000	**UTILITY SERVICES**										
02510820	*Ppng,watr dstr,ductl iron*										
----	Yard Piping Allowance	1.00 ea	7,549.12 /ea	7,549	52,500.00 /ea	52,500	-		2,000	-	62,049
----	Site grading, drainage and landscaping allowance	1.00 ea	15,098.24 /ea	15,098	75,000.00 /ea	75,000	-		4,000	-	94,098
	Ppng,watr dstr,ductl iron			*22,647*		*127,500*			*6,000*		*156,147*
	240.00 Labor hours										
	240.00 Equipment hours										
	UTILITY SERVICES			**22,647**		**127,500**	**0**		**6,000**	**0**	**156,147**
	240.00 Labor hours										
	240.00 Equipment hours										
	1101			***22,647***		***127,500***	***0***		***6,000***	***0***	***156,147***
	240.00 Labor hours										
	240.00 Equipment hours										

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1102												
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
----	DAFT - 48 ft diameter, complete	1.00	ea	414,437.00 /ea	414,437	450,000.00 /ea	450,000	-		7,500	-	871,937
----	DAFT process control bldg, complete	2,100.00	sf	20.722 /sf	43,516	85.00 /sf	178,500	-		7,875	-	229,891
----	DAFT - process pumps, complete	3.00	ea	7,459.87 /ea	22,380	18,500.00 /ea	55,500	-		1,350	-	79,230
----	DAFT - manual and control valve allowance	1.00	ea	3,019.65 /ea	3,020	25,000.00 /ea	25,000	-		800	-	28,820
----	DAFT - Piping and fitting allowance	1.00	ea	3,774.56 /ea	3,775	15,000.00 /ea	15,000	-		3,000	-	21,775
	Industrial W/W equipment				*487,127*		*724,000*			*20,525*		*1,231,652*
	1,231.00 Labor hours											
	1,231.000 Equipment hours											
	WATER/WASTEWATER EQUIPM'T				**487,127**		**724,000**	**0**		**20,525**	**0**	**1,231,652**
	1,231.00 Labor hours											
	1,231.000 Equipment hours											
16010000	**ELECTRICAL/INSTRUMENTATIO**											
16010100	*E & I Subcontractor*											
9001	Electrical and Instrumentation subcontractor	1.00	ls	-	-	-	-	110,000		-	-	110,000
	E & I Subcontractor							*110,000*				*110,000*
	ELECTRICAL/INSTRUMENTATIO				**0**		**0**	**110,000**		**0**	**0**	**110,000**
17000000	**INSTRUMENTATION**											
17000100	*INSTRUMENTATION CONTRACT*											
1001	Instrumentation subcontractor	1.00	ls	-	-	-	-	115,000		-	-	115,000
	INSTRUMENTATION CONTRACT							*115,000*				*115,000*
	INSTRUMENTATION				**0**		**0**	**115,000**		**0**	**0**	**115,000**
	1102				***487,127***		***724,000***	***225,000***		***20,525***	***0***	***1,456,652***
	1,231.00 Labor hours											
	1,231.000 Equipment hours											

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1103												
01500000	**TEMPORY FACILITS&CONTROLS**											
01540750	*Scaffolding*											
6600	Scaffold,h.d. shoring for suspended slab forms,fl area	63.51	csf	34.76 /csf	2,207	95.00 /csf	6,033	-		-	-	8,241
	Scaffolding				*2,207*		*6,033*					*8,241*
	28.23 Labor hours											
	TEMPORY FACILITS&CONTROLS				**2,207**		**6,033**	**0**		**0**	**0**	**8,241**
	28.23 Labor hours											
02300000	**EARTHWORK**											
02315120	*Backfill, structural*											
2220	Backfill, structural, 75 H.P., 150' haul, common earth	9,646.00	cy	1.17 /cy	11,278	-	-	-		7,013	-	18,291
	Backfill, structural				*11,278*					*7,013*		*18,291*
	157.52 Labor hours											
	157.52 Equipment hours											
02315130	*Bedding*											
0100	Bedding, crushed stone 3/4" to 1/2"	250.00	cy	5.44 /cy	1,359	19.552 /cy	4,888	-		323	-	6,570
	Bedding				*1,359*		*4,888*			*323*		*6,570*
	13.333 Labor hours											
	13.333 Equipment hours											
02315200	*Borrw,ldng and/or sprdng*											
2100	Borrow, crushed stone at pit, 3/4"-1-1/2"	605.00	cy	-	-	14.144 /cy	8,557	-		-	-	8,557
2500	Borrow, haul bank run sand 2 mi., spread w/200 HP dozer, bank measure	605.00	cy	2.05 /cy	1,240	-	-	-		2,296	-	3,535
3820	Borrow, delivery charge, min 12 CY, 1-1/2 hr round trip, add	605.00	cy	5.473 /cy	3,311	-	-	-		6,518	-	9,830
	Borrw,ldng and/or sprdng				*4,551*		*8,557*			*8,814*		*21,922*
	88.73 Labor hours											
	88.73 Equipment hours											
02315300	*Compaction*											
7040	Compaction, walk behind, vibrating plate 18" wide, 6" lifts, 4 passes	10,251.00	cy	2.24 /cy	22,939	-	-	-		6,353	-	29,292

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	Compaction				*22,939*					*6,353*		*29,292*
	585.742 Labor hours											
	585.742 Equipment hours											
02315400	*Excvtng,bulk bank measure*											
0250	Excavating, bulk bank measure, backhoe, hyd, 1-1/2 CY cap. = 100 CY/hr	15,416.00	cy	0.98 /cy	15,034	-	-	-		15,306	-	30,340
	Excvtng,bulk bank measure				*15,034*					*15,306*		*30,340*
	154.16 Labor hours											
	154.16 Equipment hours											
02315440	*Excavating, structural*											
0001	Excavating, structural, mach excav, com earth, hyd backhoe, 1-1/2 CY b	1,006.00	cy	4.33 /cy	4,356	-	-	-		4,435	-	8,790
	Excavating, structural				*4,356*					*4,435*		*8,790*
	55.894 Labor hours											
	55.893 Equipment hours											
02320200	*Hauling*											
0310	Hauling, LCY, no loading, 12 CY dump truck, 1/4 mile RT 3.7 lds/hr	15,416.00	cy	1.14 /cy	17,579	-	-	-		34,607	-	52,186
0550	Hauling, LCY, no loading, 12 c.y dump truck, 10 MI RT, 0.60 lds/hr	5,770.00	cy	5.662 /cy	32,668	-	-	-		64,312	-	96,981
0560	Hauling, LCY, no loading, 12 c.y dump truck, 20 MI RT, 0.4 lds/hr	1,006.00	cy	6.73 /cy	6,769	-	-	-		13,326	-	20,094
	Hauling				*57,016*					*112,245*		*169,261*
	1,430.473 Labor hours											
	1,430.473 Equipment hours											
	EARTHWORK				**116,534**		**13,445**	**0**		**154,488**	**0**	**284,467**
	2,485.851 Labor hours											
	2,485.850 Equipment hours											
02450000	**FNDTN&LOAD BEARNG ELEMNTS**											
02455220	*Piles, concrete*											
3400	Piles, conc, precast, prestressed, 40' long, 14" thick, square	7,425.00	vlf	5.35 /vlf	39,703	10.92 /vlf	81,081	-		26,953	-	147,737
4750	Piles, mobilization for 10,000 l.f pile job, add	7,425.00	vlf	0.971 /vlf	7,208	-	-	-		4,893	-	12,101
	Piles, concrete				*46,911*		*81,081*			*31,846*		*159,838*
	116.944 Labor hours											
	116.944 Equipment hours											
02455350	*Piling special costs*											
0500	Piling special costs, cutoffs, concrete piles	165.00	ea	71.80 /ea	11,847	-	-	-		-	-	11,847

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02455350	*Piling special costs*											
1150	Piling special costs, testing, 120 ton design load, 240 ton test	4.00	ea	-	-	-	-	-		-	84,000	84,000
	Piling special costs				*11,847*						*84,000*	*95,847*
	240.001 Labor hours											
	FNDTN&LOAD BEARNG ELEMNTS				**58,758**		**81,081**	**0**		**31,846**	**84,000**	**255,684**
	356.945 Labor hours											
	116.944 Equipment hours											
03100000	**CONCRETE FORMS&ACCESSORSS**											
03110420	*Fip,elevated slabs*											
1150	Forms in place, elev slab, flat plate plywd, to 15' high, 4 use	322.00	sf	4.18 /sf	1,345	0.89 /sf	286	-		-	-	1,631
2000	Forms in place, elev slab	6,350.96	sf	2.861 /sf	18,167	3.25 /sf	20,641	-		-	-	38,808
	Fip,elevated slabs				*19,513*		*20,926*					*40,439*
	163.38 Labor hours											
03110445	*Forms place, slab grade*											
2000	Forms in place, SOG, curb forms, wood, 6" - 12" high, 1 use	1,170.00	sfca	5.621 /sfca	6,577	1.942 /sfca	2,272	-		-	-	8,849
	Forms place, slab grade				*6,577*		*2,272*					*8,849*
	43.54 Labor hours											
03110455	*Forms in place, walls*											
2750	Forms in place, walls, job built plyform, over 16' high, 2 use	18,112.00	sfca	6.45 /sfca	116,757	1.35 /sfca	24,397	-		-	-	141,154
	Forms in place, walls				*116,757*		*24,397*					*141,154*
	499.71 Labor hours											
03150660	*Stair tread inserts*											
0550	Stair tread inserts, extruded aluminum safety tread, 4" wide	196.00	lf	5.33 /lf	1,045	6.84 /lf	1,340	-		-	-	2,385
	Stair tread inserts				*1,045*		*1,340*					*2,385*
	20.91 Labor hours											
	CONCRETE FORMS&ACCESSORSS				**143,891**		**48,935**	**0**		**0**	**0**	**192,826**
	727.53 Labor hours											
03200000	**CONCRETE REINFORCEMENT**											
03210600	*Reinforcing in place*											
0400	Reinforcing in place, A615 Gr 60, elevated slabs, #4 to #7	1.074	ton	464.53 /ton	499	590.26 /ton	634	-		-	-	1,133
0400	Reinforcing in place, A615 Gr 60, elevated slabs, #4 to #7	32.032	ton	242.383 /ton	7,764	590.27 /ton	18,907	-		-	-	26,671
0600	Reinforcing in place, A615 Gr 60, slab on grade, #3 to #7	36.10	ton	585.704 /ton	21,144	529.73 /ton	19,123	-		-	-	40,267

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03210600	*Reinforcing in place*											
0700	Reinforcing in place, A615 Gr 60, walls, #3 to #7	11.092	ton	449.041 /ton	4,981	529.73 /ton	5,876	-		-	-	10,856
0700	Reinforcing in place, A615 Gr 60, walls, #3 to #7	38.50	ton	478.443 /ton	18,420	529.73 /ton	20,394	-		-	-	38,814
0750	Reinforcing in place, A615 Gr 60, walls, #8 to #18	55.904	ton	336.78 /ton	18,827	529.73 /ton	29,614	-		-	-	48,441
2000	Reinforcing in place, unloading & sorting, add to above	101.30	ton	30.53 /ton	3,092	-	-	-		854	-	3,946
2000	Reinforcing in place, unloading & sorting, add to above	80.00	ton	24.40 /ton	1,952	-	-	-		539	-	2,491
2000	Reinforcing in place, unloading & sorting, add to above	32.032	ton	11.95 /ton	383	-	-	-		106	-	488
2210	Reinforcing in place, crane cost for handling, add to above	101.30	ton	33.184 /ton	3,361	-	-	-		928	-	4,290
2220	Reinforcing in place, crane cost for handling, add to above	233.50	ton	69.70 /ton	16,275	-	-	-		4,494	-	20,769
2220	Reinforcing in place, crane cost for handling, add to above	80.00	ton	34.133 /ton	2,731	-	-	-		754	-	3,485
	Reinforcing in place				*99,429*		*94,548*			*7,675*		*201,652*
	558.48 Labor hours											
	97.532 Equipment hours											
	CONCRETE REINFORCEMENT				**99,429**		**94,548**	**0**		**7,675**	**0**	**201,652**
	558.48 Labor hours											
	97.532 Equipment hours											
03300000	**CAST-IN-PLACE CONCRETE**											
03310220	*Concrete, ready mix*											
0300	Concrete, ready mix, regular weight, 4000 psi	1,448.00	cy	-	-	84.50 /cy	122,356	-		-	-	122,356
	Concrete, ready mix						*122,356*					*122,356*
03310240	*Concrete in place*											
2350	Conc in place, elev slab	400.71	cy	92.593 /cy	37,103	84.50 /cy	33,860	-		2,944	-	73,907
4300	Concrete in place, grade walls, 18" thick	513.200	cy	119.181 /cy	61,164	84.50 /cy	43,365	-		5,089	-	109,618
4701	Concrete in place, slab on grade, not including finish	480.60	cy	25.684 /cy	12,344	86.19 /cy	41,423	-		4,006	-	57,772
6800	Concrete in place, stairs, not incl safety treads, free stand, 3'-6" w	196.00	LFns	28.58 /LFns	5,602	5.472 /LFns	1,073	-		120	-	6,794
	Concrete in place				*116,212*		*119,721*			*12,160*		*248,092*
	198.86 Labor hours											
	198.86 Equipment hours											
03310700	*Placing concrete*											
1600	Placing conc, incl vib, elev slab, over 10" thick, pumped	12.00	cy	15.04 /cy	180	-	-	-		59	-	239

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03310700	*Placing concrete*											
4650	Placing conc, incl vib, slab on grade, slab over 6" thick, pumped	567.00	cy	14.63 /cy	8,295	-	-	-		2,692	-	10,987
5100	Placing conc, incl vib, walls, 10" thick, pumped	13.00	cy	24.61 /cy	320	-	-	-		104	-	424
5350	Placing conc, incl vib, walls, 15" & over thick, pumped	803.00	cy	22.56 /cy	18,113	-	-	-		5,878	-	23,991
	Placing concrete				*26,908*					*8,732*		*35,640*
	79.532 Labor hours											
	79.531 Equipment hours											
03350300	*Finishing floors*											
0005	Finishing slabs, break ties, forms & patch voids	1,170.00	sf	0.96 /sf	1,120	0.03 /sf	32	-		-	-	1,151
0005	Finishing slabs, break ties, forms & patch voids	6,350.96	sf	0.47 /sf	2,976	0.03 /sf	171	-		-	-	3,148
0150	Finishing floors, monolithic, screed, float & broom finish	6,730.00	sf	0.61 /sf	4,094	-	-	-		-	-	4,094
0150	Finishing floors, monolithic, screed, float & broom finish	6,350.96	sf	0.24 /sf	1,512	-	-	-		-	-	1,512
0200	Finishing floors, monolithic, screed, float, & hand trowel	322.00	sf	0.64 /sf	206	-	-	-		-	-	206
0250	Finishing floors, monolithic, machine trowel, for finish floor	6,361.00	sf	0.56 /sf	3,543	-	-	-		-	-	3,543
0950	Finishing floors, granolithic topping, 1:1:1-1/2 mix, 2" thick	6,350.96	sf	0.85 /sf	5,367	0.583 /sf	3,703	-		-	-	9,070
	Finishing floors				*18,818*		*3,906*					*22,724*
	552.612 Labor hours											
03350350	*Finishing walls*											
0010	Finishing walls, break ties & patch voids	18,112.00	sf	0.57 /sf	10,268	0.03 /sf	489	-		-	-	10,757
0150	Finishing walls, carborundum rub, wet rub	18,112.00	sf	1.75 /sf	31,692	0.03 /sf	489	-		-	-	32,181
	Finishing walls				*41,960*		*978*					*42,938*
	1,096.14 Labor hours											
03390200	*Curing*											
0300	Curing, sprayed membrane curing compound	270.87	csf	6.60 /csf	1,787	3.16 /csf	855	-		-	-	2,642
	Curing				*1,787*		*855*					*2,642*
	22.81 Labor hours											
	CAST-IN-PLACE CONCRETE				**205,684**		**247,816**	**0**		**20,892**	**0**	**474,392**
	1,949.952 Labor hours											
	278.390 Equipment hours											

04200000 MASONRY UNITS

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04270200	*Glass block*											
0150	Glass block, no scaf, 4" thk, plain, under 1,000 SF, 8" x 8"	16.00	sf	11.543 /sf	185	8.63 /sf	138	-		-	-	323
	Glass block				*185*		*138*					*323*
	0.80 Labor hours											
	MASONRY UNITS				**185**		**138**	**0**		**0**	**0**	**323**
	0.80 Labor hours											
05500000	**METAL FABRICATIONS**											
05520700	*Railing, pipe*											
0210	Railing, pipe, aluminum, 1-1/2" diameter, clear anodized	80.00	lf	13.35 /lf	1,068	28.50 /lf	2,280	-		66	-	3,414
	Railing, pipe				*1,068*		*2,280*			*66*		*3,414*
	4.671 Labor hours											
	4.671 Equipment hours											
	METAL FABRICATIONS				**1,068**		**2,280**	**0**		**66**	**0**	**3,414**
	4.671 Labor hours											
	4.671 Equipment hours											
07100000	**DAMPPRFNG&WATERPROOFING**											
07130500	*Membrane waterproofing*											
----	T-lock pvc liner, complete installation, subcontractor	7,318.08	sf	-	-	-	-	120,748		-	-	120,748
	Membrane waterproofing							*120,748*				*120,748*
07160150	*Cementits waterproofing*											
0020	Cementitious waterproofing, 1/8" application, sprayed on	6,350.96	sf	0.394 /sf	2,501	1.572 /sf	9,984	-		776	-	13,261
	Cementits waterproofing				*2,501*		*9,984*			*776*		*13,261*
	50.81 Labor hours											
	50.81 Equipment hours											
	DAMPPRFNG&WATERPROOFING				**2,501**		**9,984**	**120,748**		**776**	**0**	**134,009**
	50.81 Labor hours											
	50.81 Equipment hours											
07200000	**THERMAL PROTECTION**											
07220700	*Roof deck insulation*											
1964	Roof deck insul., extruded polystyrene, 60 PSI comp. strength, 3" thic	6,350.96	sf	0.142 /sf	899	1.29 /sf	8,180	-		-	-	9,079

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Fax No. 904-379-0250

Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
	Roof deck insulation				*899*		*8,180*					*9,079*
	52.141 Labor hours											
	THERMAL PROTECTION				**899**		**8,180**	**0**		**0**	**0**	**9,079**
	52.141 Labor hours											
07600000	**FLASHING & SHEET METAL**											
07650600	*Flashing*											
0060	Flashing, aluminum, mill finish, .019" thick	967.12	sf	1.241 /sf	1,201	0.77 /sf	745	-		-	-	1,945
	Flashing				*1,201*		*745*					*1,945*
	53.36 Labor hours											
	FLASHING & SHEET METAL				**1,201**		**745**	**0**		**0**	**0**	**1,945**
	53.36 Labor hours											
08100000	**METAL DOORS & FRAMES**											
08110200	*Commercial steel doors*											
0140	Commercial steel doors, flush, full panel, for narrow lite, add	2.00	ea	-	-	62.25 /ea	124	-		-	-	124
1760	Coml st doors, insulated, 1-3/4" thk, full pnl, 18 Ga., 3'-0" x 7'-0"	2.00	ea	53.29 /ea	107	242.06 /ea	484	-		-	-	591
	Commercial steel doors				*107*		*609*					*715*
	1.07 Labor hours											
08110250	*Door frames*											
0100	Door frs,st chans W/ahr&bar stops,6" chan @ 8.2#/LF,3'x7' dr,wt 150#	2.00	ea	140.70 /ea	281	108.68 /ea	217	-		17	-	516
	Door frames				*281*		*217*			*17*		*516*
	1.231 Labor hours											
	1.231 Equipment hours											
	METAL DOORS & FRAMES				**388**		**826**	**0**		**17**	**0**	**1,231**
	2.30 Labor hours											
	1.231 Equipment hours											
08300000	**SPECIALTY DOORS**											
08310350	*Floor, industrial*											
0351	Floor, industrial, steel 300 psf L.L., dbl leaf, 8' x 6' opg, 645#	1.00	opng	365.97 /opng	366	4,230.00 /opng	4,230	-		-	-	4,596
	Floor, industrial				*366*		*4,230*					*4,596*
	3.25 Labor hours											

Brown and Caldwell
Estimating and Scheduling Department
12959 South Chelsea Harbor Drive
Jacksonville, Florida 32224
Phone No. 904-992-8804
Fax No. 904-379-0250

Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
	SPECIALTY DOORS				**366**		**4,230**	**0**		**0**	**0**	**4,596**
	3.25 Labor hours											
08900000	**GLAZED CURTAIN WALL**											
08950100	*Skyroofs*											
0600	Skyroofs, continuous vaulted, semi-circular, to 20' wide, dbl glazed	165.00	hsf	13.25 /hsf	2,186	45.00 /hsf	7,425	-		-	-	9,611
	Skyroofs				*2,186*		*7,425*					*9,611*
	11.31 Labor hours											
	GLAZED CURTAIN WALL				**2,186**		**7,425**	**0**		**0**	**0**	**9,611**
	11.31 Labor hours											
09900000	**PAINTS & COATINGS**											
09910650	*Coatings & paints*											
6000	Coatings & paints, coatings, heavy duty, polyamide epoxy, finish	31.00	gal	-	-	34.37 /gal	1,065	-		-	-	1,065
6100	Coatings & paints, coatings, heavy duty, polyamide epoxy, primer	56.00	gal	-	-	34.37 /gal	1,925	-		-	-	1,925
----	Waterproofing & Moistureproofing Application, primer	89.600	csf	19.861 /csf	1,780	-	-	-		-	-	1,780
----	Waterproofing & Moistureproofing Application, 1 coat	89.600	csf	15.701 /csf	1,407	-	-	-		-	-	1,407
	Coatings & paints				*3,186*		*2,990*					*6,176*
	71.232 Labor hours											
	PAINTS & COATINGS				**3,186**		**2,990**	**0**		**0**	**0**	**6,176**
	71.232 Labor hours											
11300000	**WATER/WASTEWATER EQUIPM'T**											
11300500	*Industrial W/W equipment*											
9905	Pumps,digester sludge pump	2.00	ea	654.50 /ea	1,309	21,328.00 /ea	42,656	-		-	150	44,115
9906	Mixer, draft tube type, complete, equip # MIX12-103	1.00	ea	3,351.04 /ea	3,351	150,000.00 /ea	150,000	-		-	1,500	154,851
9907	PRV, digester pressure/vacuum assembly	2.00	ea	837.76 /ea	1,676	5,481.00 /ea	10,962	-		-	150	12,788
9908	Pumps,foam suppresion sludge recirculation pump	2.00	ea	759.22 /ea	1,518	8,372.00 /ea	16,744	-		-	150	18,412
9909	Pumps,sludge storage tank recirculation pump	2.00	ea	680.68 /ea	1,361	12,323.00 /ea	24,646	-		-	150	26,157
9911	Pumps,sludge heating recirculation pump	2.00	ea	612.61 /ea	1,225	8,372.00 /ea	16,744	-		-	150	18,119

Brown and Caldwell
Estimating and Scheduling Department
12569 South Chelsea Harbor Drive
Jacksonville, Florida 32224
Phone No. 904-992-8804
Fax No. 904-379-0250

Item	Description	Takeoff Qty		Labor Unit Cost	Labor Amount	Material Unit Cost	Material Amount	Subcontract Amount	Subcontract Name	Equipment Amount	Other Amount	Total Amount
11300500	*Industrial W/W equipment*											
9912	Waste gas burner sediment trap, complete	1.00	ea	261.80 /ea	262	3,081.00 /ea	3,081	-		-	75	3,418
9912	Waste gas burner sediment trap, complete	1.00	ea	261.80 /ea	262	3,081.00 /ea	3,081	-		-	75	3,418
9914	gas conditioning sediment trap, complete	1.00	ea	261.80 /ea	262	3,081.00 /ea	3,081	-		-	75	3,418
9915	gas conditioning drip trap, complete	1.00	ea	177.13 /ea	177	3,000.00 /ea	3,000	-		-	50	3,227
9916	Digester gas heat exchanger, complete	1.00	ea	3,403.82 /ea	3,404	9,708.00 /ea	9,708	-		-	250	13,362
9917	Digester gas moisture seperato	1.00	ea	177.13 /ea	177	2,000.00 /ea	2,000	-		-	50	2,227
9918	Digester gas booster blower unit, complete	2.00	ea	837.76 /ea	1,676	14,476.00 /ea	28,952	-		-	150	30,778
9919	Gas particulate filter, gas cond, digester	2.00	ea	177.13 /ea	354	1,500.00 /ea	3,000	-		-	100	3,454
----	Activated carbon filter	2.00	ea	3,351.04 /ea	6,702	60,000.00 /ea	120,000	-		-	1,000	127,702
----	Standpipe, digester, 12" diameter	1.00	ea	1,256.640 /ea	1,257			-		7,332	-	8,589
----	Emergency overflow, 6", glass pipe,fittings,complete	1.00	ea	3,778.82 /ea	3,779	15,000.00 /ea	15,000	-		-	-	18,779
	Industrial W/W equipment				*28,751*		*452,655*			*7,332*	*4,075*	*492,813*
	247.20 Labor hours											
11390900	*Wastwtr treatment system*											
9801	Arrestor, flame, digester	1.00	ea	225.15 /ea	225	4,061.00 /ea	4,061	-		-	-	4,286
	Wastwtr treatment system				*225*		*4,061*					*4,286*
	2.15 Labor hours											
	WATER/WASTEWATER EQUIPM'T				**28,977**		**456,716**	**0**		**7,332**	**4,075**	**497,100**
	249.35 Labor hours											
13800000	**BUILDING AUTOMATN&CONTROL**											
13838200	*Control components*											
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	2.00	ea	29.87 /ea	60	47.00 /ea	94	-		-	-	154
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	2.00	ea	29.87 /ea	60	47.00 /ea	94	-		-	-	154
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	2.00	ea	29.87 /ea	60	47.00 /ea	94	-		-	-	154
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	1.00	ea	29.87 /ea	30	47.00 /ea	47	-		-	-	77
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	1.00	ea	29.87 /ea	30	47.00 /ea	47	-		-	-	77
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	5.00	ea	29.87 /ea	149	47.00 /ea	235	-		-	-	384
3022	Pressure gauge, aluminum case, 0 - 300 PSI, 3.5" dia dial	1.00	ea	29.87 /ea	30	47.00 /ea	47	-		-	-	77

Brown and Caldwell
Estimating and Scheduling Department
12959 South Chelsea Harbor Drive
Jacksonville, Florida 32224
Phone No. 904-992-8804
Fax No. 904-379-0250

D

APPENDIX D – VENDOR QUOTES

APPENDIX D.1 – CENTRIFUGE EQUIPMENT

November 7, 2002

Brown and Caldwell
9665 Chesapeake Drive, Suite 201
San Diego, CA 92123

Ph: 858-571-6749
Fax: 858-514-8833

Attention: Ken Fonda

Reference: Riverside WWTP

Subject: Centrifuge Budget Sizing and Pricing

Dear Ken,

Per your request and based on our recent discussions, I am pleased to offer the following budget sizing and pricing. The sizing we are calling out is subject to change as more details of the Riverside project are determined.

Phase 1

Number of Refurbished BP's	2
Belt Press flow	150 gpm
BP Feed Solids	2.5%
Total BP Solids	3,753 lb/hr (total for both)
Quantity of Centrifuges	2 (1 standby)
Flow per Centrifuge	210 gpm
Feed Solids	2.5%
Total Discharge Solids	2,630 lb/hr (for 1 centrifuge)
Total Solids	6,383 lb/hr

Phase 2

Number of Centrifuges	4 (1 standby)
Flow per Centrifuge	170 gpm
Feed Solids	2.5%
Cent. Discharge Solids	6,383 lb/hr (2,128 lb/hr each)

Based on the above and assuming a 60/40 primary to secondary sludge blend, we would recommend our CP 3074 (26.5" x 105") for Phase 1 and Phase 2. It is conceivable that our CP 3054 (22" x 91")

could work, but the anticipated loss in performance (lower solids, higher poly, low centrate quality) deems this option as unacceptable in our opinion.

The CP 3074 at 210 gpm (phase 1) and 170 gpm (phase 2) will yield the highest cake solids, produce the better centrate, and consume lower polymer. Depending on the flow rate, you should expect 25-28% cake solids using 15-20 pounds per dry ton of polymer.

The Budget range for the CP 3074 is between $450K and $525K each, depending on the exact scope of supply and control package.

Our typical scope includes:

Flame sprayed tungsten carbide or STC Tiles
Carbon Steel or Duplex Stainless Steel Bowl and Scroll
Starter panels with wye/delta main drive
Hydraulic scroll drive
Flex connectors for feed, liquids and solids
Control panel with A/B PLC
Carbon steel panels
Standard 2 weeks of start up service (8 days on site) per unit
1 set of standard tools per order
Freight to site
Standard spare parts

I look forward to you review and further discussion relating to the centrifuges for Riverside. I would also be happy to provide additional information (drawings, specifications) if requested.

If you have any questions, feel free to contact me at 303-250-0055.

Best regards,
Bird/Humboldt Centripress

Scott Kelly
Western Regional Sales Manager

CC: Carl Petty – Pacific Process

CP 3054 vs. CP 3074 Comparison Chart

	CP 3054	CP 3074	Comparison Factor
Bowl Diameter inches	21.7	26.4	1.22
Bowl Length inches	91.3	105.5	1.16
RPM	3,140	2,850	0.91
Volume (gal)	87.0	141.0	1.62
G @ Bowl Wall	3,038	3,045	1.0
G-Volume (gal)	264,412	429,275	1.62

As you can see, the CP 3074 offers 1.62 greater G-Volume than the 3054, which in turn translates into:

- Higher cake solids.
- Lower polymer consumption.
- Better centrate quality
- More throughput for future possible plant expansion.
- More throughput for emergency catch-up situations
- Less wear and tear on the centrifuge throughout its life.

We feel that the upside with designing around a larger centrifuge far outweighs the cost savings realized with a smaller centrifuge.

Options

For your reference, the following specifiable options are available from Bird Humboldt for any centrifuge we produce:

Bowl/Scroll:	Duplex Stainless Steel or Carbon Steel
Flight Hardening:	Sintered Tungsten Carbide Tiles or Flame Sprayed Hardening
Back Drive:	Hydraulic or Electric VFD

We can offer any combination of the above as specified by the owner/engineer.

March 14, 2003

To: Mr. Ken Fonda
Brown And Caldwell

Alfa Laval
5400 International Trade Drive
Richmond, VA23231

Tel: +1 804-222- 5300
Fax: +1 804-236-1364
www.alfalaval.com

Subject: **City of Riverside WWTP**

Mr. Fonda:

We are pleased to provide you with our budget price for the above referenced project.

(1) Alfa Laval ALDEC 606 Decanter Centrifuge capable of dewatering sludge to 225 gpm. The units will be complete per the Alfa Laval scope of supply and dimension drawing and include the following:

- Centrifuge frame
- Upper casing constructed of Stainless Steel
- Pillow Block Bearings with forced oil lubrication system
- Centrifuge rotating assembly
- Conveyor drive gearbox
- Conveyor flight hardsurface protection; Sintered Tungsten Carbide (STC) tile assemblies; feed Nozzles shall be STC inserts. All STC to meet the ASTM G-65 Test Procedure A.
- 50 Hp AC/VFD Backdrive motor
- 150 Hp AC/VFD Main drive motor
- Nema 4X operator panel, floor-stand mounted
- Nema 12 free standing starter panel
- Decanter Logic Manager Plus (DLMP) for control of the centrifuge backdrice and dewatering system ancillary equipment.
- Vibration isolators & Vibration switch
- Belt guards
- Solids discharge flexible splash guard
- Feed, polymer, and centrate flexible connectors
- One (1) set required tools for maintenance
- One (1) year warranty against defects
- One (1) set required lubricants
- Eight (8) sets submittal drawings
- Eight (8) sets of Operation and Maintenance Manuals
- Freight to job-site

Subject: **City of Riverside WWTP**

- Alfa Laval shall provide for a total of fifteen (15) days of field service supervision for the purposes of checking the installation of the contractor, start-up and training. Additional days of field service may be purchased at published rates.

Not included in our pricing are the following:

- Field wiring and electrical flexible connections
- Piping & valves
- Anchor bolts
- Conveyors and diverter gates
- Polymer & polymer system
- Solid & Centrate discharge chutes
- Taxes
- Unloading at job-site
- Installation
- Bonds

BUDGET PRICE: **One (1) ALDEC 606 Centrifuge..... $440,000**

Pricing is valid for 60 days. After 60 days pricing may escalate based on the Euro/$ exchange rate in effect at the time of order.

TERMS OF PAYMENT: 25% upon submittals, net 30 days
70% upon delivery, net 30 days
5% upon acceptance, net 180 from delivery

DELIVERY: Decanter Centrifuge 26 - 30 weeks
Controls-12 weeks

DRAWING SCHEDULE: Drawings for Approval to be submitted within ten (10) weeks of acceptable purchase order.

WARRANTY STATEMENT

1. Warranty is for one (1) year after acceptance or eighteen (18) months after delivery, whichever occurs first. Our warranty is for replacement parts only. Labor for installation is the responsibility of the owner. Alfa Laval will provide supervision at its sole discretion for replacement of major parts (such as bearings) that fail under the warranty period.
2. Alfa Laval considers the equipment accepted and the warranty to begin:
   Upon beneficial use of the equipment, or
   Upon written acceptance of the equipment by the Owner, whichever comes first.

Subject: **City of Riverside WWTP**

We thank you for this opportunity to provide our budget price for this project. Please contact our representative, Mr. Rick Eismin of Coombs Hopkins Co. (760) 931-0555 if you have any questions.

Kind regards,

Michael Berry
Application Engineer

CC: Rick Eismin – Coombs Hopkins

March 14, 2003

To: Mr. Ken Fonda
Brown And Caldwell

Alfa Laval
5400 International Trade Drive
Richmond, VA23231

Tel: +1 804-222- 5300
Fax: +1 804-236-1364
www.alfalaval.com

Subject: **City of Riverside WWTP**

Mr. Fonda:

We are pleased to provide you with our budget price for the above referenced project.

(1) Alfa Laval ALDEC 706 Decanter Centrifuge capable of dewatering sludge between 200 – 350 gpm. The units will be complete per the Alfa Laval scope of supply and dimension drawing and include the following:

- Centrifuge frame
- Upper casing constructed of Stainless Steel
- Pillow Block Bearings with forced oil lubrication system
- Centrifuge rotating assembly
- Conveyor drive gearbox
- Conveyor flight hardsurface protection; Sintered Tungsten Carbide (STC) tile assemblies; feed Nozzles shall be STC inserts. All STC to meet the ASTM G-65 Test Procedure A.
- 50 Hp AC/VFD Backdrive motor
- 200 Hp AC/VFD Main drive motor
- Nema 4X operator panel, floor-stand mounted
- Nema 12 free standing starter panel
- Decanter Logic Manager Plus (DLMP) for control of the centrifuge backdrice and dewatering system ancillary equipment.
- Vibration isolators & Vibration switch
- Belt guards
- Solids discharge flexible splash guard
- Feed, polymer, and centrate flexible connectors
- One (1) set required tools for maintenance
- One (1) year warranty against defects
- One (1) set required lubricants
- Eight (8) sets submittal drawings
- Eight (8) sets of Operation and Maintenance Manuals
- Freight to job-site

Subject: **City of Riverside WWTP**

- Alfa Laval shall provide for a total of fifteen (15) days of field service supervision for the purposes of checking the installation of the contractor, start-up and training. Additional days of field service may be purchased at published rates.

Not included in our pricing are the following:

- Field wiring and electrical flexible connections
- Piping & valves
- Anchor bolts
- Conveyors and diverter gates
- Polymer & polymer system
- Solid & Centrate discharge chutes
- Taxes
- Unloading at job-site
- Installation
- Bonds

BUDGET PRICE: **One (1) ALDEC 706 Centrifuge..... $550,000**

Pricing is valid for 60 days. After 60 days pricing may escalate based on the Euro/$ exchange rate in effect at the time of order.

TERMS OF PAYMENT: 25% upon submittals, net 30 days
70% upon delivery, net 30 days
5% upon acceptance, net 180 from delivery

DELIVERY: Decanter Centrifuge 26 - 30 weeks
Controls-12 weeks

DRAWING SCHEDULE: Drawings for Approval to be submitted within ten (10) weeks of acceptable purchase order.

WARRANTY STATEMENT

1. Warranty is for one (1) year after acceptance or eighteen (18) months after delivery, whichever occurs first. Our warranty is for replacement parts only. Labor for installation is the responsibility of the owner. Alfa Laval will provide supervision at its sole discretion for replacement of major parts (such as bearings) that fail under the warranty period.
2. Alfa Laval considers the equipment accepted and the warranty to begin:
   Upon beneficial use of the equipment, or
   Upon written acceptance of the equipment by the Owner, whichever comes first.

Subject: **City of Riverside WWTP**

We thank you for this opportunity to provide our budget price for this project. Please contact our representative, Mr. Rick Eismin of Coombs Hopkins Co. (760) 931-0555 if you have any questions.

Kind regards,

Michael Berry
Application Engineer

CC: Rick Eismin – Coombs Hopkins

APPENDIX D.2 – HEAT DRYING EQUIPMENT

FENTON ENVIRONMENTAL TECHNOLOGIES

4306 Hwy. 377 South
Brownwood, TX 76801

SludgeMASTER / SludgeMIZER / SludgeMASTER IRC / SludgeMASTER RK
"SOLID SOLUTIONS FOR SLUDGE HANDLING PROBLEMS"

Telephone 800-777-1373
Fax 915-646-7027

02/27/03

Carl Petty
Pacific Process
14060 Honeysuckle Lane
Whittier, CA 90604

Subject: Riverside, CA
Brown & Caldwell Project # BC064-9

Dear Sir;

In accordance with our phone conversation with Ken Fonda of Brown & Caldwell I would like to submit the following for your consideration.

1. Current solids production is approximately 19 d.t./day @ 7 days/week.
2. Planned cake from a new centrifuge = 25% d.s.
3. Present plant operation = 16 hrs./day @ 5 days per week.
4. Future plant build out = 56.5 d.t./day @ 7days per week.
5. SludgeMASTER RK automatic batch cycle time = approximately 3 hrs.

Therefore:

19 d.t./day X 7 days/week div. by 5 days/week = 26.60 d.t./day.

26.6 d.t./day div. by .25 (%) = 106.4 wet tons/day @ 25% d.s.

106.4 wet tons/day div. by 18 hrs./day* = 5.91 wet tons/hr.

SludgeMASTER RK 72E – D = 3 wet tons per hr. X 2 dehydration chambers = 6 wet tons/hr.

*The dryer will be programmed to shut off automatically after the sixth (6th) batch is completed. This means that the unit will run unattended for only 2 hrs./day at the initial sludge feed rate.

Any multiple additional d-chambers may be planned for and added to the initial installation.The anticipated build out is approximately 56.5 d.t./day or 226 wet tons per day @ 25% d.s.

The 226 wet tons per day production rate would require one duplicate RK 72E-D be installed for slightly over an 18 hr. operating day @ 7 days per week.

Of course you may want a different operating scenario for the final build out.

Budget:

One (1) SludgeMASTER RK 72E-D complete with a 75 cu.yd. hopper.	$1,778,780
Additional burner capacity for utilizing digester gas.	$ 46,000
Four (4) BioMaster biofilters for odor control.	$ 80,000
Setup and reconnection of shipping splits.	$ 40,000
Freight	$ 18,000
Performance Bond	$ 48,700
Estimated Total Price	$2,011,480

As this project matures we will be pleased to work out the specific details on the necessary equipment package.

Meanwhile if you have any questions or we may be of help in any way please call on us.

Best Regards;

Neil M. Campbell
Sales Director
210 497 0508

SCHWING AMERICA INC.

98 Mill Plain Road
Suite 1A
Danbury, CT 06811

Phone: 203.744.2100
Fax: 203.744.2837
Subsidiary of: Schwing GmbH

February 25th, 2003

Brown & Caldwell
9665 Chesapeake Drive
Suite 201
San Diego, CA 92123

Attention: Mr. Ken Fonda

Subject: InnoDryer options

Dear Mr. Fonda,

Please find below a summary of InnoDryer machines per the various operating scenarios you have specified. Note that the dryers are sized for the capacity noted in the table. If you are considering multiple trains of dryers, you must multiply the number of machines by the increased capacity.

Example: Option 1 is sized for a weekly production of 50 dry tons operating 5 days a week, 16 hours per day. This requires (1) InnoDryer model G3.5. If you wish to process 100 dry tons while operating 5 days a week, 16 hours per day you will need (2) G3.5's.

If you have any questions regarding this information, please do not hesitate to contact me by phone at (651) 653-4231, fax (651) 653-5481, or via Email (cwanstrom@schwing.com).

SUMMARY

	Option 1	Option 2	Option 3	Option 4
Weekly Production	50 Dry Ton	50 Dry Ton	125 Dry Ton	125 Dry Ton
Weekly Operation	5 Days	7 Days	5 Days	7 Days
Daily Operation	16 Hours	24 Hours	16 Hours	24 Hours
Initial Solids Content	25%	25%	25%	25%
End Product Solids Content	80%	80%	80%	80%
Evaporation Rate	3,437 Lbs/hr	1,637 Lbs/hr	8,594 Lbs/hr	4,092 Lbs/hr
Model	G3.5	G2	G4	G4
Quantity	1	1	2	1
Dimension (LxWxH)	60'x36'x28	50'x30'x22'	66'x36'x28'	66'x36'x28'
Budget Price	$1,450,000	$1,100,000	$3,100,000	$1,550,000

	Option 1A	Option 2A	Option 3A	Option 4A
Initial Solids Content	25%	25%	25%	25%
End Product Solids Content	90% Class A	90% Class A	90% Class A	90% Class A
Evaporation Rate	3,611Lbs/hr	1,719 Lbs/hr	9,028 Lbs/hr	4,299 Lbs/hr
Model	G4	G2.5	G4-Qty 2	G4
Quantity	1	1	2	1
Dimension (LxWxH)	66'x36'x28'	52'x33'x26'	66'x36'x28'	66'x36'x28'
Budget Price	$1,550,000	$1,250,000	$3,100,000	$1,550,000

Yours very truly
Schwing America, Inc.

Chuck Wanstrom
Regional Manager
Material Handling Group

Cc: Bernie Pawlowski – Saddleback Environmental

Komline-Sanderson
12 Holland Av Peapack, NJ 07977-0257
908-234-1000 Fax: 908-234-9487
www.komline.com

February 25, 2003

Email: Kfonda@brwncald.com

Kenneth D. Fonda
Principal Environmental Engineer
Brown and Caldwell
9665 Chesapeake Drive, Suite 201
San Diego, CA 92123

Re: Komline-Sanderson Proposal TPG-2369 Rev. B

Dear Ken,

Per your request for additional pricing information for drying equipment to handle anaerobically digested belt filter press sludge cake, Komline-Sanderson is pleased to offer the following for your review and consideration.

In the interest of brevity, please refer to our previous quotation TPG-2369 Rev A for general equipment descriptions of the equipment being offered. Pertinent data regarding each of the four (4) cases and the equipment offered are tabulated below.

Process Conditions

	Case A	Case B	Case C	Case D
Dryer Feed Rate (Dry Tons)	20 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Dryer Operation	15 Hrs/Day	15 Hrs/Day	24 Hrs/Day	24 Hrs/Day
Wet (lbs/hr) per dryer	14,815	7,407	8,267	3,307
Solids (lbs/hr) per dryer	2,667	1,333	1,488	595
Evaporative Rate (lbs/hr)	12,000	6,000	6,700	2,680
Heat Load (MBTU/Hr) per Dryer	13.5	6.9	7.7	3.1

For all cases, Thermal Oil at 380°F was used as the heat transfer medium. An overall heat transfer rate of 26 Btu/(hr·ft²·°F) was used with a repletion rate of approximately 85%. The initial solids content was assumed to be 18%. Product exiting the dryer will be above 95% solids and at an approximate temperature of 240°F. Product exiting the product cooler will be below 120°F.

Equipment Offered

	Case A	Case B	Case C	Case D
Dryer Feed Rate (Dry Tons)	20 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Wet Cake Feed Silo	60 cyd	60 cyd	60 cyd	60 cyd
Amount of Storage at Design Rate	6.8 hrs	6.8 hrs	12.2 hrs	18.8 hrs
Number of Feed Pumps Supplied	Two (2)	Three (3)	Two (2)	Three (3)
Number of Pumps in Operation	One (1)	Two (2)	One (1)	Two (2)
Dryer Model Number	17W-4000	13W-2000	13W-2200	9W-840
Number of Dryers	One (1)	Two (2)	One (1)	Two (2)
Surface Area / Dryer	4000	2000	2200	840
Volumetric Capacity (cft)	1580	625	680	220
Dryer Empty Weight (tons)	133	53	56	29
Connected HP (per dryer)	400	200	200	75
Discharge Conveyor	One (1) 16"	Two (2) 12"	One (1) 12"	Two (2) 9"
Incline Cooling Conveyor	One (1) 16" double shaft	Two (2) 16" single shaft	One (1) 16" single shaft	Two (2) 12" single shaft
Product Delumper and Pneumatic Conveyor to Silo	One (1)	Two (2)	One (1)	Two (2)
Product Silo	One (1) 3,500 cft	One (1) 3,500 cft	One (1) 3,500 cft	One (1) 3,500 cft
Outlet Spray Duct, Condenser, Exhaust Compressor w/ Bubbler	One (1)	Two (2)	One (1)	Two (2)
Thermal Oil Heater	14 MBTUH	8.6 MBTU	8.6 MBTU	3.7 MBTUH
No. of Thermal Oil Heaters w/ Expansion Tank, I & C	One (1)	Two (2)	One (1)	Two (2)
Hot Oil Flow Rate per Dryer	1450 gpm	950 gpm	950 gpm	500 gpm
No. of Hot Oil Pumps	Two (2)	Two (2)	One (1)	Two (2)
Instrumentation and Control Package. MCC not included	One (1)	Two (2)	One (1)	Two (2)
Total Estimated Connected HP	638	765	398	395
Estimated HP Consumption	400	493	259	247
Tot. Gas Consumption (Therms/hr)	172.4	172.4	96.2	77.0
Utility Costs	$102.93/hr	$108.83/hr	$59.71/hr	$50.29/hr
Utility Cost $/Dry Ton	$13.90	$14.69	$14.44	$15.21

	Case A	Case B	Case C	Case D
Dryer Feed Rate (Dry Tons)	20 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Price	$2,547,000	$3,421,000	$1,897,000	$2,440,000

Prices are F.O.B Peapack, NJ. Prices quoted are exclusive of any local, State, or Federal sales or manufacture's taxes of any sort and such taxes and/or charges pertaining thereto are to be borne by the purchaser.

If you have any questions regarding the above information, or if additional information is required, please do not hesitate to contact us at your convenience.

Yours truly,

George M. Fraunfelder

Vice President

Komline-Sanderson
12 Holland Ave
Peapack, NJ 07977
TEL: (908) 234-1000
FAX: (908) 234-9487

KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 1**

Input Parameter

	20	Dry Tons per Day	15	Hour/Day Operation
Feed Rate	2667	Dry Lbs/Hr		
% Solids in Feed	18%	Feed Solids		
% Solids in Product	95%	Product Solids		
Solids Specific Heat	0.3	Btu/Lb·°F		
Liquid Specific Heat	1.0	Btu/Lb·°F		
Heat of Vaporization	970.3	Btu/Lb		
Liquid Boiling Point	212	°F		
Initial Temperature	70	°F		
Product Temperature	240	°F		
Oil Temp In	380	°F		
Oil Temp Out	341	°F		
Oil Flow Required	1,450	gpm (calculated on page 2)		

Material Balance

		Feed	Product	Off Gas
Solids	Lbs/Hr	2,667	2,667	-
Water	Lbs/Hr	12,148	140	12,008
Total	Lbs/Hr	14,815	2,807	12,008

Heat Load

Sensible Heat	1,838,637	Btu/Hr	13.6%	Percent of Heat Load
Latent Heat	11,651,166	Btu/Hr	86.2%	Percent of Heat Load
Final Heating Zone	26,330	Btu/Hr	0.2%	Percent of Heat Load
Total Heat Load	13,516,133	Btu/Hr - Process Load		
Dryer Efficiency 98%	13,791,972	Btu/Hr Heat to Dryer		

Logarithmic-Mean Temperature Difference

Sensible Heat Zone	215.3	°F	x	13.6%	=	29.3	°F
Latent Heat Zone	147.5	°F	x	86.2%	=	127.1	°F
Final Heating Zone	134.3	°F	x	0.2%	=	0.3	°F
						156.7	°F

Dryer Sizing

Repletion Rate	85%	
Overall Heat Transfer Rate	26	Btu/hr·ft²·°F
Area Required	3,904	Square Feet

KOMLINE-SANDERSON PADDLE DRYER
SIZING CALCULATIONS
w/ Thermal Oil

Komline-Sanderson
12 Holland Ave
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FAX: (908) 234-9487

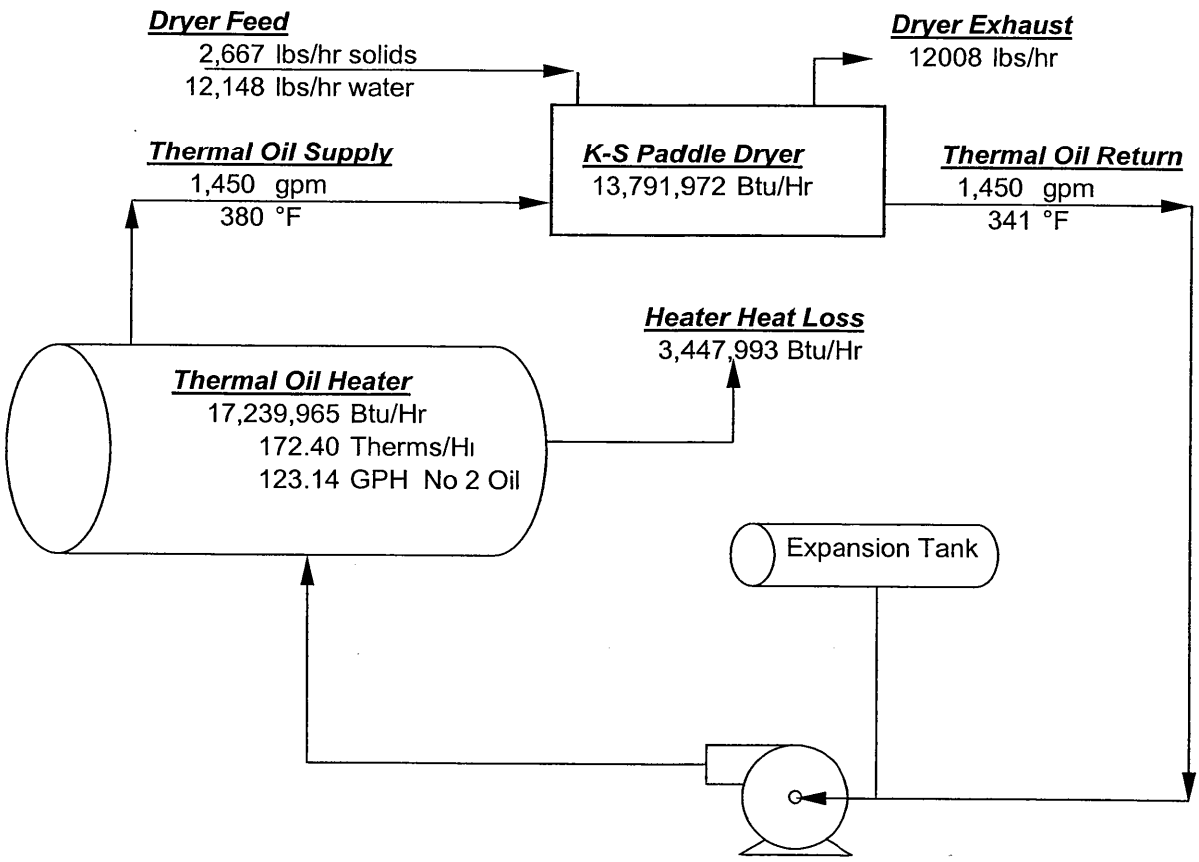
COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 1**

Thermal Oil Parameters

Thermal Oil Type	Paratherm HE or equal	
Oil Density @ Temp	6.2	Lbs/Gal
Oil Spefic Heat @ Temp	0.65	Btu/Lb-°F
Total Hot Oil Mass Flow	539,400	Lbs/Hr
Hot Oil Volume Flow	1,450	gpm

Thermal Oil Heater Requirements

Total Energy Required	13,791,972	BTU/Hr
Boiler Efficiency	80%	
Boiler Energy Needs	17,239,965	BTU/Hr
Therms Required	172.40	Therms/Hr
GPH No.2 Oil	123.14	GPH



	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	***Komline-Sanderson*** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 1**

Electric Costs

Electricity Costs	$ 0.085	per Kw	
System HP Required	400	HP	
kW Required	298.3	per hour	$ 25.35 per hour

Oil / Gas Costs for Hot Oil Heater / Boiler

Gas	$ 0.45	per Therm	
Gas Required	172.40	Therms/Hr	$ 77.58 per hour

Utility Costs

Dry Tons per Hour	1.33	Dry tons per Hour
Utilities Cost	$ 102.93	$ / Hr
Cost per Dry Ton	$ 77.20	per Dry Ton
Cost per Wet Ton	$ 13.90	per Wet Ton

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KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 2**

Input Parameter

	10	Dry Tons per Day	15	Hour/Day Operation
Feed Rate	1333	Dry Lbs/Hr		
% Solids in Feed	18%	Feed Solids		
% Solids in Product	95%	Product Solids		
Solids Specific Heat	0.3	Btu/Lb·°F		
Liquid Specific Heat	1.0	Btu/Lb·°F		
Heat of Vaporization	970.3	Btu/Lb		
Liquid Boiling Point	212	°F		
Initial Temperature	70	°F		
Product Temperature	240	°F		
Oil Temp In	380	°F		
Oil Temp Out	350	°F		
Oil Flow Required	950	gpm (calculated on page 2)		

Material Balance

		Feed	Product	Off Gas
Solids	Lbs/Hr	1,333	1,333	-
Water	Lbs/Hr	6,074	70	6,004
Total	Lbs/Hr	7,407	1,404	6,004

Heat Load

Sensible Heat	919,319	Btu/Hr	13.6%	Percent of Heat Load
Latent Heat	5,825,583	Btu/Hr	86.2%	Percent of Heat Load
Final Heating Zone	13,165	Btu/Hr	0.2%	Percent of Heat Load
Total Heat Load	6,758,066	Btu/Hr - Process Load		
Dryer Efficiency 98%	6,895,986	Btu/Hr Heat to Dryer		

Logarithmic-Mean Temperature Difference

Sensible Heat Zone	219.2	°F	x	13.6%	=	29.8	°F
Latent Heat Zone	152.5	°F	x	86.2%	=	131.5	°F
Final Heating Zone	139.0	°F	x	0.2%	=	0.3	°F
						161.6	°F

Dryer Sizing

Repletion Rate	85%	
Overall Heat Transfer Rate	26	Btu/hr·ft²·°F
Area Required	1,893	Square Feet

K-S	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	**Komline-Sanderson** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487

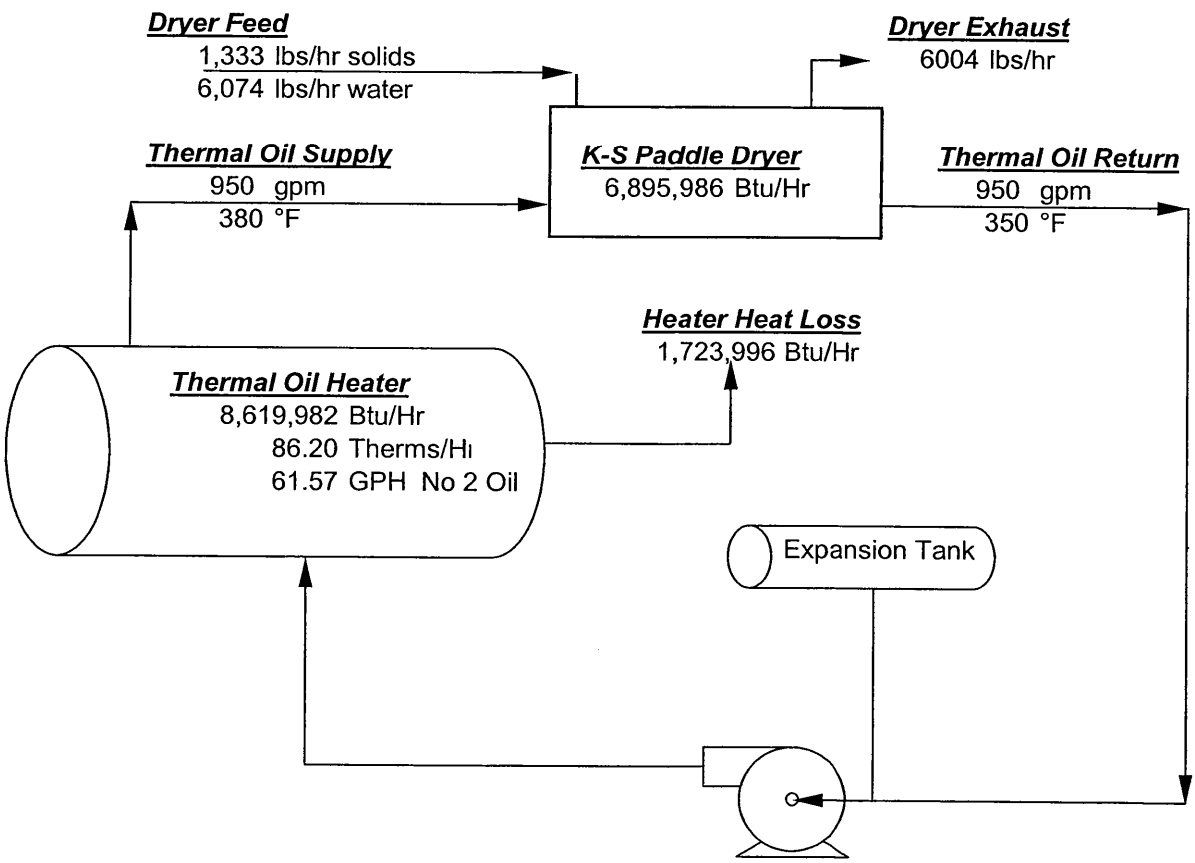
COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 2**

Thermal Oil Parameters

Thermal Oil Type	Paratherm HE or equal	
Oil Density @ Temp	6.2	Lbs/Gal
Oil Spefic Heat @ Temp	0.65	Btu/Lb-°F
Total Hot Oil Mass Flow	353,400	Lbs/Hr
Hot Oil Volume Flow	950	gpm

Thermal Oil Heater Requirements

Total Energy Required	6,895,986	BTU/Hr
Boiler Efficiency	80%	
Boiler Energy Needs	8,619,982	BTU/Hr
Therms Required	86.20	Therms/Hr
GPH No.2 Oil	61.57	GPH



	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	***Komline-Sanderson*** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 2**

Electric Costs

Electricity Costs	$ 0.085	per Kw	
System HP Required	493	HP	
kW Required	367.6	per hour	$ 31.25 per hour

Oil / Gas Costs for Hot Oil Heater / Boiler

Gas	$ 0.45	per Therm	
Gas Required	86.20	Therms/Hr	$ 38.79 per hour
Gas for Two Systems	172.40		$ 77.58

Utility Costs

Dry Tons per Hour	1.33	Dry tons per Hour (Two Systems)
Utilities Cost	$ 108.83	$ / Hr
Cost per Dry Ton	$ 81.62	per Dry Ton
Cost per Wet Ton	$ 14.69	per Wet Ton

K-S	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	***Komline-Sanderson*** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 3**

Input Parameter

	125	Dry Tons per Week	24 Hour/Day Operation
Feed Rate	1488	Dry Lbs/Hr	
% Solids in Feed	18%	Feed Solids	
% Solids in Product	95%	Product Solids	
Solids Specific Heat	0.3	Btu/Lb·°F	
Liquid Specific Heat	1.0	Btu/Lb·°F	
Heat of Vaporization	970.3	Btu/Lb	
Liquid Boiling Point	212	°F	
Initial Temperature	70	°F	
Product Temperature	240	°F	
Oil Temp In	380	°F	
Oil Temp Out	346	°F	
Oil Flow Required	950	gpm (calculated on page 2)	

Material Balance

		Feed	Product	Off Gas
Solids	Lbs/Hr	1,488	1,488	-
Water	Lbs/Hr	6,779	78	6,701
Total	Lbs/Hr	8,267	1,566	6,701

Heat Load

Sensible Heat	1,026,025	Btu/Hr	13.6%	Percent of Heat Load
Latent Heat	6,501,767	Btu/Hr	86.2%	Percent of Heat Load
Final Heating Zone	14,693	Btu/Hr	0.2%	Percent of Heat Load
Total Heat Load	7,542,485	Btu/Hr - Process Load		

Dryer Efficiency 98% 7,696,413 Btu/Hr Heat to Dryer

Logarithmic-Mean Temperature Difference

Sensible Heat Zone	217.8	°F	x	13.6%	=	29.6	°F
Latent Heat Zone	150.6	°F	x	86.2%	=	129.8	°F
Final Heating Zone	137.2	°F	x	0.2%	=	0.3	°F
						159.7	°F

Dryer Sizing

Repletion Rate	85%	
Overall Heat Transfer Rate	26	Btu/hr·ft²·°F
Area Required	2,137	Square Feet

Komline-Sanderson
12 Holland Ave
Peapack, NJ 07977
TEL: (908) 234-1000
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KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil

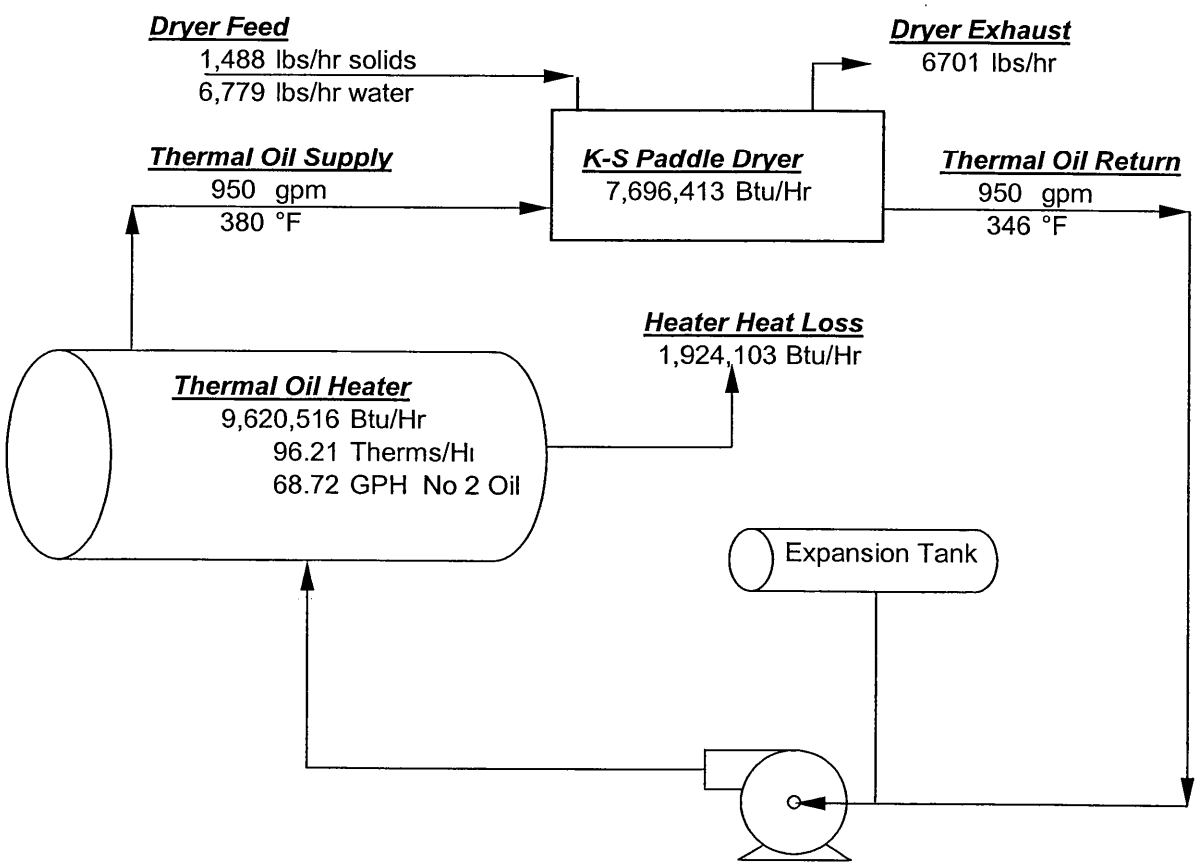
COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 3**

Thermal Oil Parameters

Thermal Oil Type	Paratherm HE or equal	
Oil Density @ Temp	6.2	Lbs/Gal
Oil Spefic Heat @ Temp	0.65	Btu/Lb-°F
Total Hot Oil Mass Flow	353,400	Lbs/Hr
Hot Oil Volume Flow	950	gpm

Thermal Oil Heater Requirements

Total Energy Required	7,696,413	BTU/Hr
Boiler Efficiency	80%	
Boiler Energy Needs	9,620,516	BTU/Hr
Therms Required	96.21	Therms/Hr
GPH No.2 Oil	68.72	GPH



	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	***Komline-Sanderson*** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 3**

Electric Costs

Electricity Costs	$ 0.085	per Kw	
System HP Required	259	HP	
kW Required	193.1	per hour	$ 16.42 per hour

Oil / Gas Costs for Hot Oil Heater / Boiler

Gas	$ 0.45	per Therm	
Gas Required	96.21	Therms/Hr	$ 43.29 per hour

Utility Costs

Dry Tons per Hour	0.74	Dry tons per Hour
Utilities Cost	$ 59.71	$ / Hr
Cost per Dry Ton	$ 80.25	per Dry Ton
Cost per Wet Ton	$ 14.44	per Wet Ton

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12 Holland Ave
Peapack, NJ 07977
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KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 4**

Input Parameter

	50	Dry Tons per Week	24	Hour/Day Operation
Feed Rate	595	Dry Lbs/Hr		
% Solids in Feed	18%	Feed Solids		
% Solids in Product	95%	Product Solids		
Solids Specific Heat	0.3	Btu/Lb·°F		
Liquid Specific Heat	1.0	Btu/Lb·°F		
Heat of Vaporization	970.3	Btu/Lb		
Liquid Boiling Point	212	°F		
Initial Temperature	70	°F		
Product Temperature	240	°F		
Oil Temp In	380	°F		
Oil Temp Out	355	°F		
Oil Flow Required	500	gpm (calculated on page 2)		

Material Balance

		Feed	Product	Off Gas
Solids	Lbs/Hr	595	595	-
Water	Lbs/Hr	2,712	31	2,680
Total	Lbs/Hr	3,307	627	2,680

Heat Load

Sensible Heat	410,410	Btu/Hr	13.6%	Percent of Heat Load
Latent Heat	2,600,707	Btu/Hr	86.2%	Percent of Heat Load
Final Heating Zone	5,877	Btu/Hr	0.2%	Percent of Heat Load
Total Heat Load	3,016,994	Btu/Hr - Process Load		
Dryer Efficiency 98%	3,078,565	Btu/Hr Heat to Dryer		

Logarithmic-Mean Temperature Difference

Sensible Heat Zone	221.2	°F	x	13.6%	=	30.1	°F
Latent Heat Zone	154.9	°F	x	86.2%	=	133.5	°F
Final Heating Zone	141.3	°F	x	0.2%	=	0.3	°F
						163.9	°F

Dryer Sizing

Repletion Rate	85%	
Overall Heat Transfer Rate	26	Btu/hr·ft²·°F
Area Required	833	Square Feet

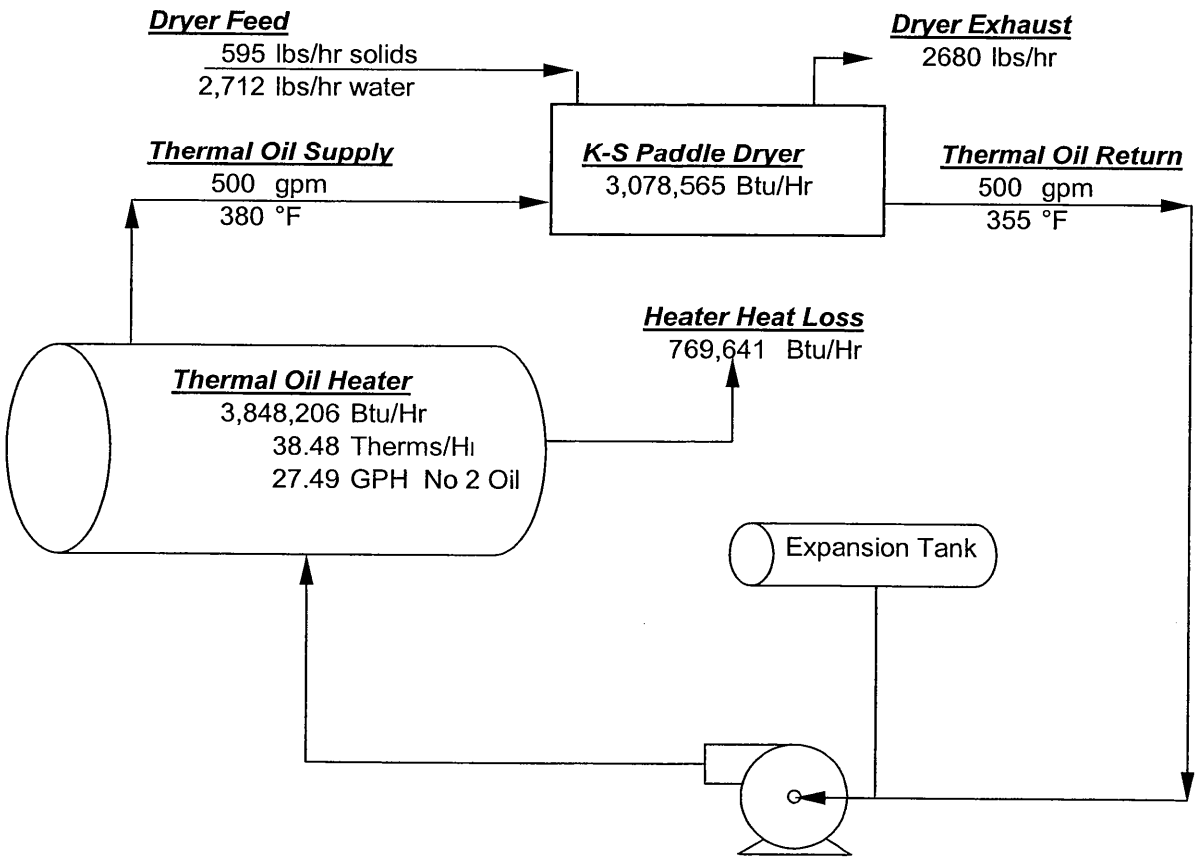
	KOMLINE-SANDERSON PADDLE DRYER SIZING CALCULATIONS w/ Thermal Oil	***Komline-Sanderson*** 12 Holland Ave Peapack, NJ 07977 TEL: (908) 234-1000 FAX: (908) 234-9487
COMPANY: Brown & Caldwell LOCATION: Riverside, CA	Proj # TPG-2369	February 25, 2003 **CASE 4**

Thermal Oil Parameters

Thermal Oil Type	Paratherm HE or equal	
Oil Density @ Temp	6.2	Lbs/Gal
Oil Spefic Heat @ Temp	0.65	Btu/Lb-°F
Total Hot Oil Mass Flow	186,000	Lbs/Hr
Hot Oil Volume Flow	500	gpm

Thermal Oil Heater Requirements

Total Energy Required	3,078,565	BTU/Hr
Boiler Efficiency	80%	
Boiler Energy Needs	3,848,206	BTU/Hr
Therms Required	38.48	Therms/Hr
GPH No.2 Oil	27.49	GPH



KOMLINE-SANDERSON PADDLE DRYER
SIZING CALCULATIONS
w/ Thermal Oil

Komline-Sanderson
12 Holland Ave
Peapack, NJ 07977
TEL: (908) 234-1000
FAX: (908) 234-9487

COMPANY: Brown & Caldwell Proj # TPG-2369 February 25, 2003
LOCATION: Riverside, CA **CASE 4**

Electric Costs

Electricity Costs	$ 0.085	per Kw	
System HP Required	247	HP	
kW Required	184.2	per hour	$ 15.66 per hour

Oil / Gas Costs for Hot Oil Heater / Boiler

Gas	$ 0.45	per Therm	
Gas Required	38.48	Therms/Hr	$ 17.32 per hour
	76.96	Therms for Two Units	$ 34.63 per hour

Utility Costs

Dry Tons per Hour	0.60	Dry tons per Hour (two Units)
Utilities Cost	$ 50.29	$ / Hr
Cost per Dry Ton	$ 84.49	per Dry Ton
Cost per Wet Ton	$ 15.21	per Wet Ton

Komline-Sanderson
12 Holland Av Peapack, NJ 07977-0257
908-234-1000 Fax: 908-234-9487
www.komline.com

March 17, 2003

Email: Kfonda@brwncald.com

Kenneth D. Fonda
Principal Environmental Engineer
Brown and Caldwell
9665 Chesapeake Drive, Suite 201
San Diego, CA 92123

Re: Komline-Sanderson Proposal TPG-2369 Rev. C

Dear Ken,

Per your request for additional pricing information for drying equipment to handle anaerobically digested belt filter press sludge cake, Komline-Sanderson is pleased to offer the following for your review and consideration.

Again, please refer to our previous quotation TPG-2369 Rev A for general equipment descriptions of the equipment being offered. Pertinent data regarding each of the four (4) cases and the equipment offered are tabulated below.

Process Conditions

	Case Rev C-1	Case Rev C-2	Case Rev C-3	Case Rev C-4
Dryer Feed Rate (Dry Tons)	25 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Dryer Operation	15 Hrs/Day	15 Hrs/Day	168 Hrs/wk	168 Hrs/wk
Wet (lbs/hr) per dryer	13,333	5,333	5,952	2,380
Solids (lbs/hr) per dryer	3,333	1,333	1,488	595
Evaporative Rate (lbs/hr)	9,825	3,390	4,390	1,750
Heat Load (MBTU/Hr) per Dryer	11.3	4.5	5.1	2.0

For all cases, Thermal Oil at 380°F was used as the heat transfer medium. An overall heat transfer rate of 24 Btu/(hr·ft²·°F) was used with a safety factor of approximately 85%. The initial solids content was assumed to be 25%. Product exiting the dryer will be above 95% solids and at an approximate temperature of 240°F. Product exiting the product cooler will be below 120°F.

Equipment Offered

	Case Rev C-1	Case Rev C-2	Case Rev C-3	Case Rev C-4
Dryer Feed Rate (Dry Tons)	25 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Wet Cake Feed Silo	60 cyd	60 cyd	60 cyd	60 cyd
Storage at Design Rate	7.2 hrs	9.4 hrs	16.9 hrs	21.1 hrs
Feed Pumps Supplied	Two (2)	Three (3)	Two (2)	Three (3)
Number of Pumps in Operation	One (1)	Two (2)	One (1)	Two (2)
Dryer Model Number	17W-3500	13W-1400	13W-1400	8W-585
Number of Dryers	One (1)	Two (2)	One (1)	Two (2)
Surface Area / Dryer	3500	1400	1400	585
Volumetric Capacity (cft)	1,390	440	440	148
Dryer Empty Weight (tons)	117	44	44	20
Connected HP (per dryer)	350	150	150	60
Discharge Conveyor	One (1) 16"	Two (2) 12"	One (1) 12"	Two (2) 9"
Incline Cooling Conveyor	One (1) 16" double shaft	Two (2) 16" single shaft	One (1) 16" single shaft	Two (2) 12" single shaft
Product Delumper and Pneumatic Conveyor to Silo	One (1)	Two (2)	One (1)	Two (2)
Product Silo	One (1) 3,500 cft	One (1) 3,500 cft	One (1) 3,500 cft	One (1) 3,500 cft
Outlet Spray Duct, Condenser, Exhaust Compressor w/ Bubbler	One (1)	Two (2)	One (1)	Two (2)
Thermal Oil Heater	14 MBTUH	6.6 MBTU	6.6 MBTU	2.5 MBTU
No. of Thermal Oil Heaters w/ Expansion Tank, I & C	One (1)	Two (2)	One (1)	Two (2)
Hot Oil Flow Rate per Dryer	1450 gpm	950 gpm	950 gpm	400 gpm
No. of Hot Oil Pumps	Two (2)	Two (2)	One (1)	Two (2)

	Case Rev C-1	Case Rev C-2	Case Rev C-3	Case Rev C-4
Dryer Feed Rate (Dry Tons)	25 DT/day	10 DT/day	125 DT/wk	50 DT/wk
No. of Drying Lines	One (1)	Two (2)	One (1)	Two (2)
Instrumentation and Control Package. MCC not included	One (1)	Two (2)	One (1)	Two (2)
Total Estimated Connected HP	675	636	341	352
Estimated HP Consumption	351	378	196	217
Tot. Gas Consumption (Therms/hr)	141.9	113.5	63.4	50.7
Utility Costs	$84.81/hr	$73.65/hr	$40.21/hr	$35.76/hr
Utility Cost $/Dry Ton	$12.72	$13.81	$13.51	$15.02
Price	$2,435,000	$2,875,000	$1,630,000	$2,000,000

The utility costs listed above are for dryer operation. For the 15 hour day operation, the feed to the dryer will be turned off at the end of daily operation. The thermal oil heater temperature is reduced and the dryer operation is put into a shut down mode. During the shut down mode, all feed equipment and product handling equipment is turned off. The dryer continues to rotate to prevent the sludge from baking onto the paddles. The condensing equipment and blower remain operational for odor control. The utility costs for these off-hour operations are not included in the above costs.

Prices are F.O.B Peapack, NJ. Prices quoted are exclusive of any local, State, or Federal sales or manufacture's taxes of any sort and such taxes and/or charges pertaining thereto are to be borne by the purchaser.

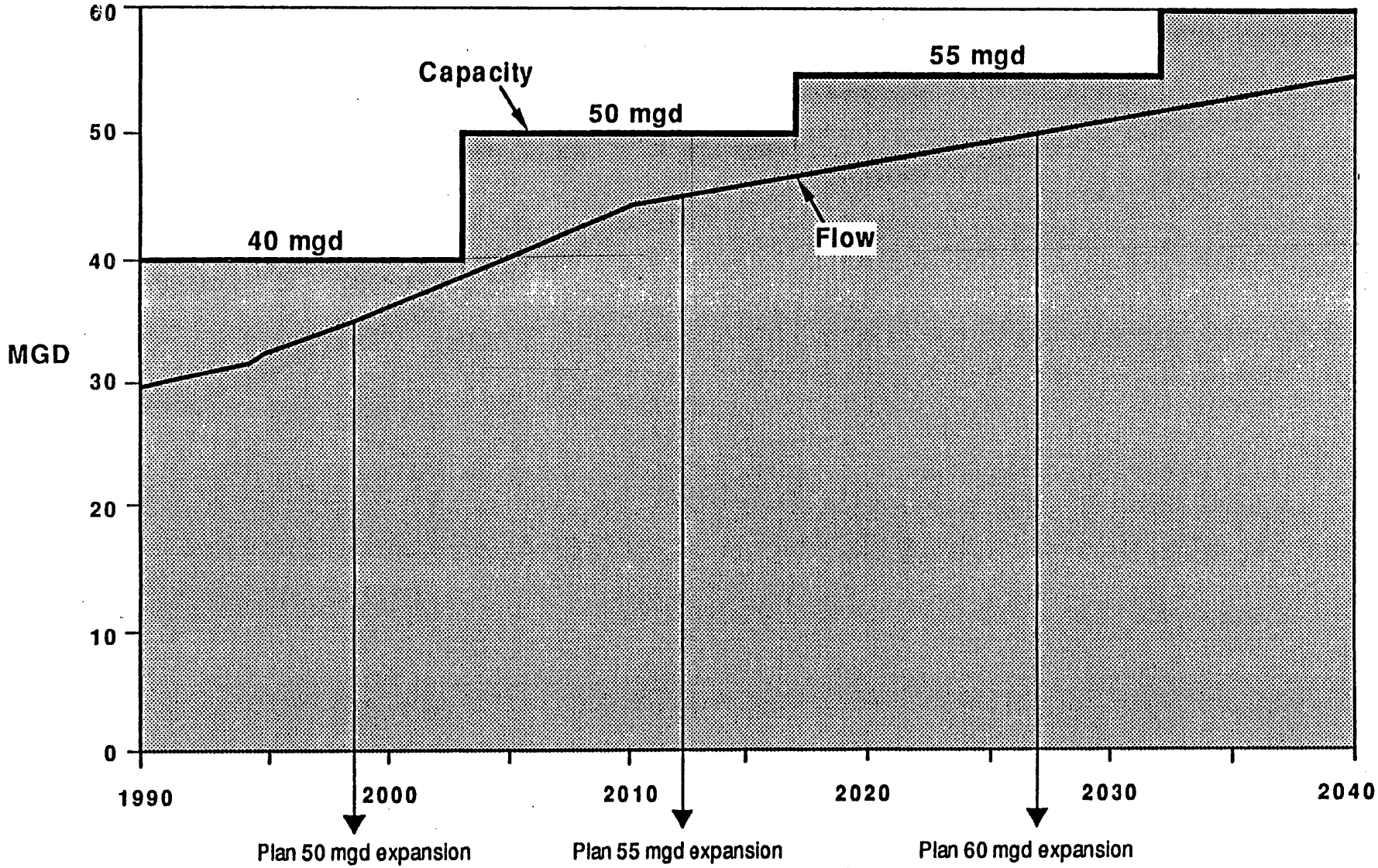
If you have any questions regarding the above information, or if additional information is required, please do not hesitate to contact us at your convenience.

Yours truly,

George M. Fraunfelder
Vice President

E

APPENDIX E – 1992 MASTER PLAN UPDATE FLOW PROJECTIONS



Assumptions: 5% industrial growth until 2010 - then 0.7%, 0.7% domestic growth after 2010, and 3% CSD growth until 2010 - then 0.7%

Riverside Water Quality Control Plant
Projected Flows
(1990 through 2040)
Figure 4-1

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 3: DESIGN CRITERIA

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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Chapter 3

DESIGN CRITERIA

3.1 PURPOSE

The purpose of this chapter is to summarize the design criteria for the solids handling facilities for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP). This chapter serves as a basis for the solids handling alternative evaluations.

3.2 EXISTING SOLIDS HANDLING FACILITIES

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd. Existing solids handling processes include: primary sludge thickening within primary sedimentation basins, Dissolved Air Flotation Thickening (DAFT) of Waste Activated Sludge (WAS), mesophilic anaerobic digestion, and belt-filter presses and centrifuges for dewatering.

3.3 SOLID HANDLING ALTERNATIVES

The following is a list of solids handling alternatives to be evaluated for this master plan. This list was approved by the City at the July 2006 kick-off meeting:

1. Primary Thickening:
    a. Gravity Thickeners.
    b. Gravity Belts.
    c. Rotary Drum Thickeners.
    d. Co-Thickening.
2. WAS Thickening:
    a. Centrifuges.
    b. Rotary Drum Thickeners.
    c. Gravity Belts.
    d. Co-Thickening.
3. Digestion:
    a. Mesophilic Anaerobic.
    b. Acid-Phase Anaerobic.
4. Dewatering:
    a. Belt Presses (existing).
    b. Centrifuges (selected previously for expansion).

The City has stated during the kick-off meeting that they do not want to continue the use of in-tank thickening for primary sludge, as the City wants to improve the primary solids content to lower the digester feed flow rate. In addition, the City would like to explore other alternatives besides DAFTs for the WAS thickening option.

3.4 SOLIDS PROJECTION

Solids projections were made for an average daily flow of 52 mgd. Table 3.1 summarizes the solids projections, which are based on current future levels of treatment.

Table 3.1 Solids Projections
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Primary Sludge	WAS
Solids, lbs/day	103,000	118,000
Feed Solids Concentration, %	1.5	0.6
Flow, mgd	0.82	2.36
VSS, %	81	85

3.5 DESIGN CRITERIA

3.5.1 Co-Thickening

The following information was used to develop the process design and unit sizing for the rest of the unit processes considered for the RWQCP expansion. Table 3.2 lists the primary sludge thickening design criteria, Table 3.3 lists the WAS thickening design criteria, and Table 3.4 lists the digestion design criteria.

Table 3.2 Design Criteria for Primary Sludge Thickening
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Values
Gravity Thickeners	
Mass Loading Rate, lbs/sf/day	20 to 40
Hydraulic Loading Rate, gpd/sf	380 to 760
Solids Retention Time, days	1 to 2
Side Water Depth, feet	15
Dilution Water Use	1:1
Gravity Belts	
Hydraulic Loading Rate, gpm/meter of belt width	150
Feed Solids Concentration, %	1 to 2

Table 3.2 Design Criteria for Primary Sludge Thickening Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Values**
Thickened Solids Concentration, %	5 to 7
Solids Capture Efficiency, %	90 to 98
Polymer Dose, active lbs/ton of dry solids	10 to 12
Minimum Flocculation Time, seconds	30
Rotary Drum	
Maximum Hydraulic Loading Rate, gpm	300
Feed Solids Concentration, %	1 to 2
Thickened Solids Concentration, %	5 to 7
Solids Capture Efficiency, %	93 to 98
Polymer Dose, active lbs/ton of dry solids	6 to 8

Table 3.3 Design Criteria for WAS Thickening Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Values**
Centrifuge	
Feed Rate, gpm	Up to 900
Dewatered Cake Solids Concentration, %	6 to 10
Solids Capture Efficiency, %	85 to 90
Operating Speed	2,000 to 3,000 rpm
Polymer Dose, active lbs/ton of dry solids	6 to 8
Gravity Belts	
Hydraulic Loading Rate, gpm/meter of belt width	150
Feed Solids Concentration, %	0.6 to 1.5
Thickened Solids Concentration, %	5 to 7
Solids Capture Efficiency, %	90 to 98
Polymer Dose, active lbs/ton of dry solids	10 to 12
Minimum Flocculation Time, seconds	30
Rotary Drum	
Maximum Hydraulic Loading Rate, gpm	300
Feed Solids Concentration, %	0.6 to 1.5

Table 3.3 Design Criteria for WAS Thickening Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Values**
Thickened Solids Concentration, %	4 to 8
Solids Capture Efficiency, %	90 to 95
Polymer Dose, active lbs/ton of dry solids	8 to 10

Table 3.4 Digestion Design Criteria Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Parameter	**Value**
Anaerobic Digestion	
Volatile Solids Loading (lbs/ft^3/day)	
All Units In Service	0.12
Largest Unit Out of Service	0.15
Detention Time (days)	
All Units In Service	20
Largest Unit Out of Service	15
Acid-Phase Anaerobic Digestion	
Acid Phase	
Volatile Solids Loading (lbs/ft^3/day)	
Largest Unit Out of Service	1 to 3
Detention Time (days)	
All Units In Service	2
Methane-Phase	
Volatile Solids Loading Rate	
Acid Phase In Service	N/A
Acid Phase Out of Service	0.15
Detention Time (days)	
All Units In Service	15
One Unit Out of Service	12
Acid Phase Out of Service	15

The design criteria for the solids dewatering facilities are listed in Table 3.5. These criteria were taken from the previous Biosolids Master Plan.

Table 3.5 Dewatering Design Criteria
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Belt Press[1]	High-Speed Centrifuge[2]	
		Existing Unit	Future Unit
Feed Rate, gpm			
Average	100	175	200
Peak	160	250	300
Cake Solids Content, %	16	25	25
Solids Capture, %	95	96	96
Estimated Polymer Dose (lb active/dry ton)	12	20	20
Typical Power Load per Machine, kW	20	90	110

Notes:
(1) Information given by the City Staff.
(2) Information taken from 2003 Biosolids Master Plan.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 4: SOLIDS PRODUCTION AND THICKENING OPTIONS

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Chapter 4

SOLIDS PRODUCTION AND THICKENING OPTIONS

4.1 PURPOSE

The purpose of this chapter is to evaluate thickening alternatives for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) expansion. Alternatives for primary thickening, Waste Activated Sludge (WAS) thickening and co-thickening are included in the evaluation. The detailed layout and specific equipment type would be determined during the preliminary and final design.

4.2 RECOMMENDATIONS AND CONCLUSIONS

- Based on the Dissolved Air Flotation Thickeners (DAFTs) design criteria, the DAFTs are operating near their rated capacity, assuming no polymer addition.
- For ease of Operation and Maintenance (O&M), the same type of thickening equipment is recommended for both primary and secondary thickening facilities
- Based on solids projections and design criteria for Gravity Belt Thickeners (GBTs) and Rotary Drum Thickeners (RDTs), it is estimated that 14 units of either type of thickening equipment will be required.
- The City has chosen to provide separate thickening facilities for primary solids and WAS, using GBTs for both types of solids.

4.3 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd. Existing thickening processes include in-tank thickening for the primary sludge, and DAFTs for thickening of WAS.

The following list of solids handling alternatives to be considered for this master plan was determined during the Kick-off meeting in July 2006:

1. Primary Thickening:
    a. Gravity Thickeners.
    b. GBTs.
    c. RDTs.
    d. Co-thickening with GBTs and RDTs.
2. WAS Thickening:
    a. Centrifuge.
    b. GBTs.

c. RDTs.
d. Co-thickening with GBTs and RDTs.

In-tank thickening for primary solids was not considered because the City does not want to continue the process. The City would like to use other alternatives that would provide a higher solids content to reduce the need for future digester expansions.

DAFTs were also not considered as one of the WAS alternatives because they have a high space requirement, and are a mechanically intensive process. They require numerous mechanical components such as compressors and a pressurized system to provide the dissolved air for floatation. In addition, they produce more dilute thickened sludge, which would significantly increase the required digester capacity.

4.4 SOLIDS PROJECTIONS

Table 3.1 summarizes the solids projections for the 52.2-mgd Annual Average Daily Flow (ADF) condition. The calibrated Biotran model was used to predict the future conditions.

Table 4.1 Solids Projections
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

52 mgd	Primary Sludge	Raw WAS
Solids, lbs/day	103,000	118,000
% Concentration	1.5	0.6
Max Month Flow, mgd	0.82	--
Peak Flow, mgd	1.34	2.36
VSS %	81	85

To ensure good performance by the mechanical thickeners, it is necessary to provide a continuous and consistent feed. With a continuous pumping operation, the primary sludge solids concentration is normally about 0.5 percent. However, this solids concentration would result in a very high primary sludge flow that would require many thickening units. In order to decrease the number of units required, a control system should be set up so that pumping would rotate among the primary sedimentation basins. This would allow the solids blanket to build up and provide continuous pumping of approximately 1.5 percent primary solids to the thickening facilities. Furthermore, in order to provide continuous pumping without storage, the primary thickening facilities would be based on the peak flow condition with a peaking factor of 1.8.

The WAS projection for the 52.2-mgd ADF condition was based on the historical data and the City's wasting record. The City could waste up to twice the average amount of WAS in order to adjust process control. The capacities for the secondary thickening facilities will allow the City to have this peak wasting flexibility.

4.5 EXISTING THICKENING FACILITIES CAPACITIES

As stated earlier, the existing thickening system includes in-tank primary sludge thickening. Primary sludge from Plant 1 is sent to the Plant 2 primary clarifiers where the sludge is thickened in-tank. From the Plant 2 primaries, the sludge is pumped to digestion.

WAS thickening is done using two DAFTs at the RWQCP. The design criteria for the DAFTs consist of a solids-loading rate of 18 lbs/day/sf (without polymer) and 24 lbs/day/sf (with polymer). It also requires a hydraulic loading rate of 0.5 gpm/sf. There are two 37-foot diameter DAFTs at the RWQCP, which have a combined effective surface area of 1,980 square feet. Based on the Biotran™ calibration, the plant is producing approximately 30,500 lbs/day of solids.

Based on the design criteria for the DAFTs and the current operating conditions, the capacity of the DAFTs (without polymer) with both units in service was estimated to be 36.3 mgd on an average daily flow basis (18.1 mgd with one unit out of service). Current plant average daily flow influent flow is approximately 33 mgd, so the DAFTs are operating near their rated capacity if the City does not add polymer to their DAFT operation. If polymer is added to the DAFTs, the City would have a capacity of 48.4 mgd with all units in service and about 24 mgd with one unit out of service.

4.6 THICKENING ALTERNATIVES

The new thickening facilities will be designed to include primary sludge and WAS thickening capabilities. For ease of O&M, it is preferred that the same type of thickening equipment be used for both primary sludge and WAS. It is assumed that the two existing DAFTs would be used to thicken scum once the new thickening facilities are installed.

As stated in Section 4.3, gravity thickening was considered as one of the alternatives for the primary thickening. Gravity thickening requires a high space requirement and can cause odors. Furthermore, gravity thickening is only suitable for primary sludge thickening. Since it is desirable to use the same type of equipment on both primary sludge and WAS, and the City staff did not have good experience with their gravity thickeners. This alternative was eliminated in the initial screening.

A centrifuge is an effective option for WAS thickening, whereas primary sludge is more suitable for gravity thickening because it contains abrasive material that can be detrimental to a centrifuge. Because of the desire to use the same equipment to thicken primary sludge and WAS, this option also was eliminated in the initial screening.

This leaves GBTs and RDTs as the two thickening options that would be evaluated for both separate and co-thickening for the master plan.

4.6.1 Design Criteria

Table 4.2 lists the design criteria for the GBTs and RDTs. The main design criterion that governs the design of GBTs and RDTs is the hydraulic loading rate. Manufacturers have claimed that GBTs can be operated at a hydraulic loading rate of up to 400 gpm per meter of belt width and 400 gpm per unit for RDTs. However, based on a series of phone surveys to existing installations, GBTs should not be designed at higher than 150 gpm per meter of belt width and 300 gpm per unit for RDTs. These criteria will be used for the RWQCP master plan.

Another criterion for GBTs is the solids loading rate, which is typically about 1,000 lbs/hr per meter of belt width. This criterion, however, is usually not the controlling parameter for GBTs.

Table 4.2 GBT and RDT Design Criteria(1)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	GBTs	RDTs
Hydraulic Loading Rate	150 gpm per meter	300 gpm per unit
Wash Water	60 gpm per meter	20 gpm per unit
Thickened Solids Concentration, %(2)	5 to 7	5 to 7
Solids Capture, %	90 to 95	90 to 95
Polymer Dose, Active lbs/dry ton	10 to 12	8 to 10

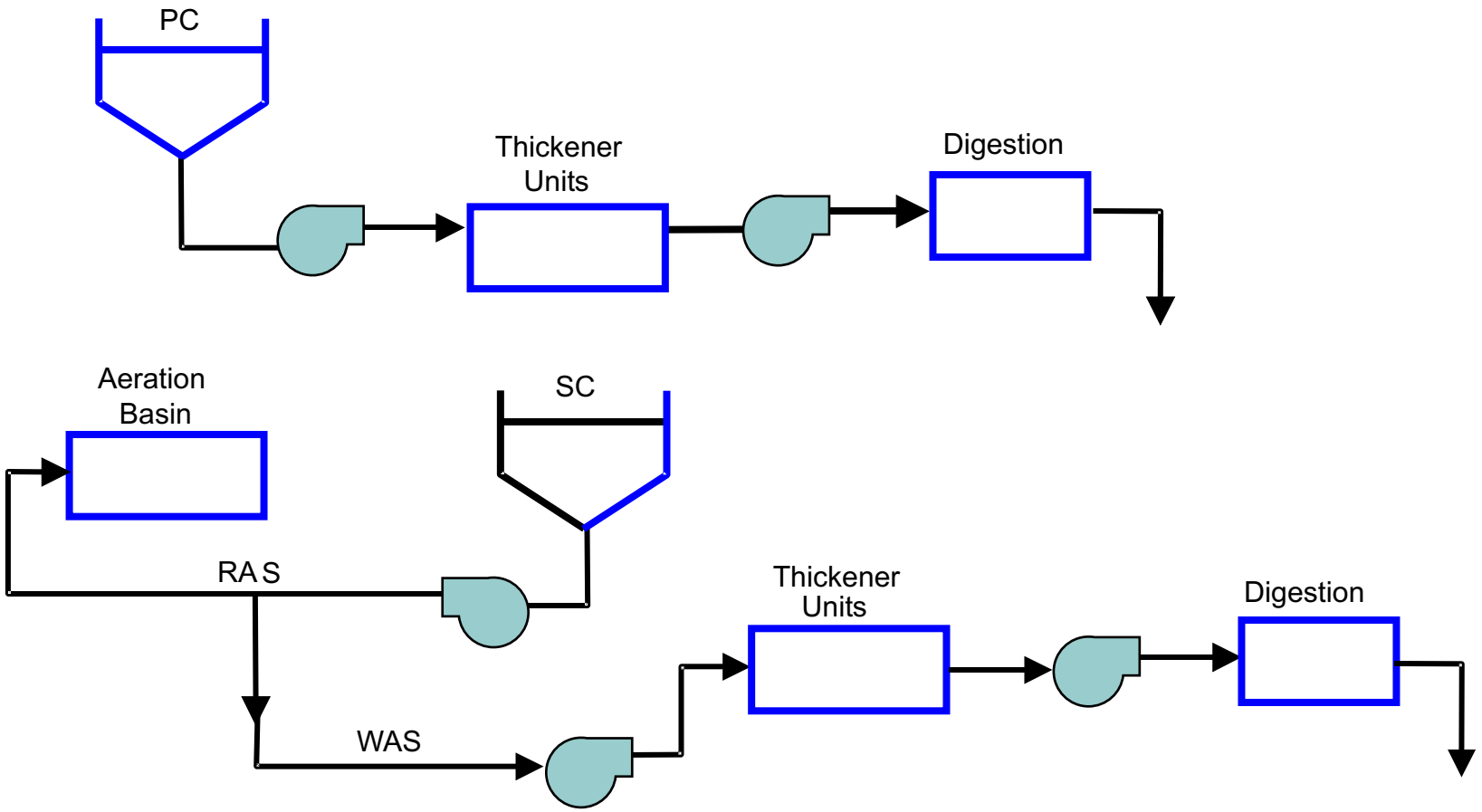
Notes:
(1) Assume same design criteria for separate thickening and co-thickening.
(2) Both GBTs and RDTs can thicken primary sludge to a much higher percentage, but are limited to this range for digestion purposes.

Furthermore, a 22-hour-per-day and 7-day-per-week operation schedule was assumed for the design.

4.6.2 Co-thickening versus Separate Thickening

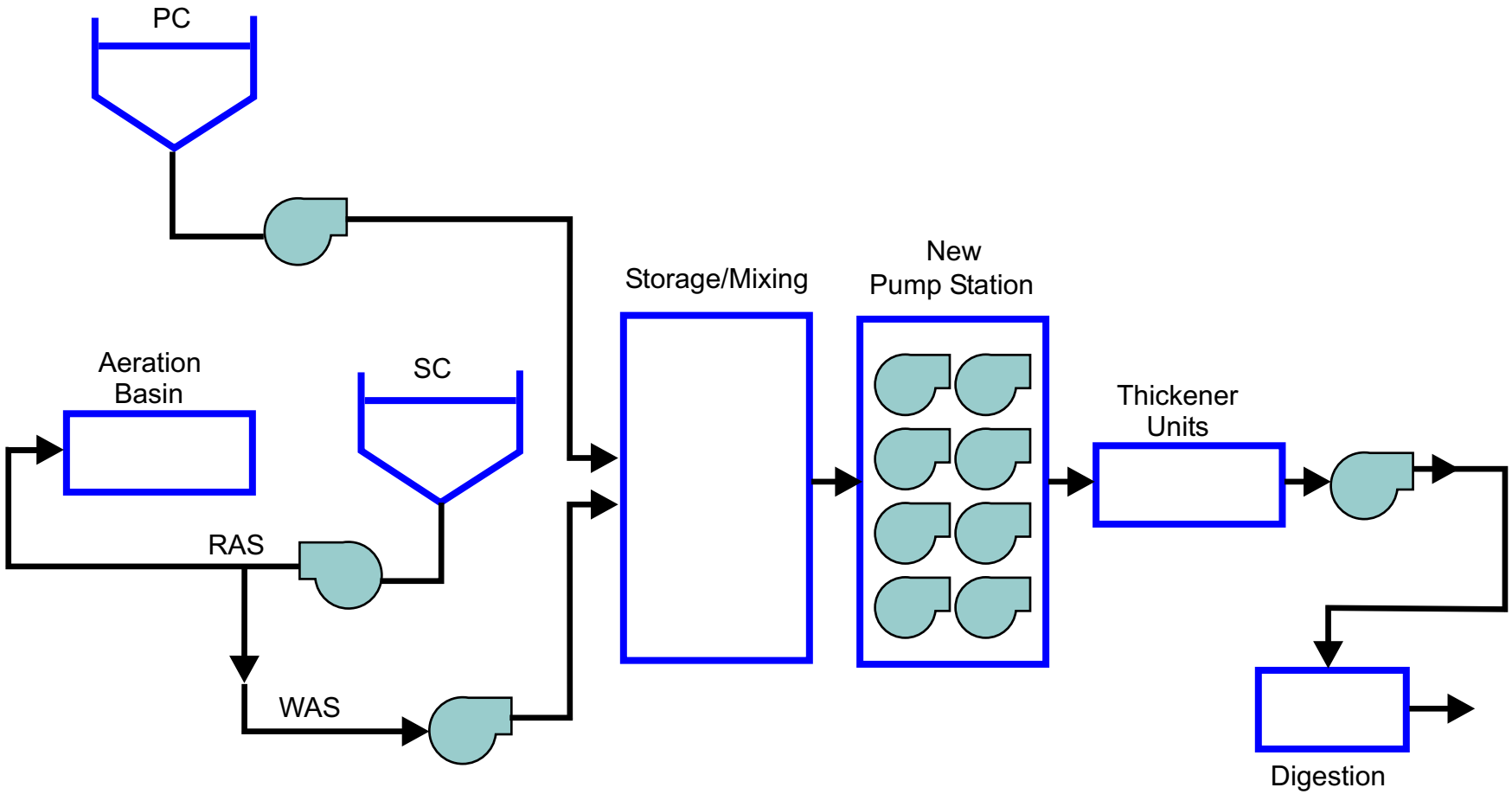
Figures 4.1 and 4.2 show flow schematics for separate thickening and co-thickening respectively. Co-thickening is mostly done in small facilities where they can reduce the number of mechanical equipment components. Since the design criteria are the same regardless of whether co-thickening or separate thickening is used, there are no savings in the number of thickening units for large facilities such as the RWQCP.

An advantage of co-thickening is that the addition of WAS to primary sludge would help to absorb some of the volatile fatty acids; which would help to reduce odor during the thickening process.



FLOW SCHEMATIC FOR SEPARATE THICKENING

FIGURE 4.1



FLOW SCHEMATIC FOR CO-THICKENING

FIGURE 4.2

A disadvantage of co-thickening is that the mechanical thickening components operate better with a consistent feed. Due to the variation in primary and WAS wasting, the primary sludge/WAS ratio varies a lot when blending the two types of sludge for thickening purposes. Also, primary sludge and WAS have very different characteristics and behave differently in thickening equipment. This makes it difficult to maintain the correct polymer dosage for the thickening process.

Furthermore, co-thickening would cost more than separate thickening because storage/mixing tanks are required to blend the primary sludge and WAS before it is sent to the thickening units. Odor control would also be required for the storage units. Additionally, an extra sludge transfer pump station would be needed to send the combined sludge to the thickening units. This would result in higher capital and O&M costs.

4.6.3 Alternative 1: Gravity Belt Thickener

GBTs operate similar to belt presses, but without the roller presses at the end. A GBT uses a slow-moving fabric belt to separate sludge solids from the liquid by gravity drainage and capillary suction forces, imparted by the fabric's interstitial voids. Usually, polymer is added to the solids in the feed pipe before the solids are fed into the inlet. The conditioned sludge is then fed down a gently sloped inlet ramp, with guide vanes and baffles, to uniformly disperse the solids across the width of the belt. Free water released from the solids drains through the fabric belt while the solids remain on top. The solids retained on the belt would first be scraped with doctor blades and deposited in a discharge hopper. The belt would then be cleaned by high-pressure water. For a 2-meter belt, it is estimated that the wash water requirement would be as high as 120 gpm per unit.

Using a 2-meter belt, and based on the solids hydraulic flow projection and the previously referenced design criteria, four GBT units are required for primary sludge thickening and seven GBT units are required for WAS thickening. Based on the moving mechanical reliability criteria, three standby units would also be required, which results in a total of 14 GBTs.

4.6.4 Alternative 2: Rotary Drum Thickener

An RDT works similar to a GBT, in which free water drains through a moving porous media while flocculated solids are retained on the media. However, an RDT uses a rotating screen instead of a belt. An RDT is different from a centrifuge in that a centrifuge does not have a filter media and operates at a much higher speed than an RDT. An RDT is internally fed with dilute sludge from a head-box after conditioning with polymer. The suspension is distributed onto the internal surface of the rotating screening cylinder and physically strained for the separation of free water. The RDT has a built-in spray backwashing system, controlled with programmable timers that can be optimized for each application. For RDTs, about 20 gpm per unit of wash water is required for continuous cleaning of the drum.

Similar to GBTs, four RDT units are required for primary sludge thickening, and seven RDT units are required for WAS thickening. Three standby units will also be required to meet the reliability criteria. A total of 14 RDTs would be required for the expansion project.

The same numbers (14 units GBT or RDT) of thickening equipment would also be required under the co-thickening option.

Table 4.3 summarizes the new thickening facilities requirement.

Table 4.3 New Thickening Facilities Capacity
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	GBT[(1)]	RDT[(1)]
Number of Units[(2)]	11 + 3 (standby)	11 + 3
Wash Water Requirement	120 gpm per unit	20 gpm per unit
Polymer Dosage, active lbs/dry ton	10 to 12	8 to 10

Notes:
(1) GBT is based on a 2-meter belt at 300 gpm per unit. RDT is based on 300 gpm per unit.
(2) Based on a peak primary sludge and WAS hydraulic loading rate, and 22 hour-per-day, 7-day-per-week operation.

4.7 ALTERNATIVE COMPARISON

A comparison of non-economic factors for the two thickening alternatives is presented in Table 4.4. In general, both GBTs and RDTs are gaining popularity because of their efficient space requirements, low power usage, and moderate capital costs compared to other thickening processes. The performance of both alternatives is highly dependent on the solids characteristics and effective polymer dosing and mixing. The main difference is that GBTs have been used for thickening applications for over 25 years, while RDTs are relatively new pieces of equipment and have no installations for primary sludge thickening. In addition, RDTs may require sole-source procurement. RDTs, however, can be enclosed to control odors. Historically, GBTs were not usually enclosed, and therefore had odor issues and were not spill-proof. Ashbrook's GBT; however, can be enclosed and therefore odors can be contained and the cover can also provide improved "spill-free" operation. Another difference is that one RDT uses much less wash water (20 gpm versus 120 gpm of wash water required for a 2-meter GBT), which translates to higher recycle stream treatment costs.

Table 4.4 Comparison of Gravity Belt and Rotary Drum Thickeners Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
	Alternative 1: Gravity Belt Thickener	**Alternative 2: Rotary Drum Thickener**
Space Requirement	+	+
Long-Term Equipment Reliability	+	–
Sole Source Procurement	+	–
Polymer Addition Requirement	0	0
Backwash Downtime	+	+
Recycle Stream Treatment	–	+
Maintenance Requirement	+	+
Odor Control	+	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

4.8 LIFE CYCLE COST ANALYSIS

A cost comparison of GBTs and RDTs for both separate thickening and co-thickening is presented in Table 4.5. Costs associated with recycle stream treatment make up about 70 to 75 percent of the (O&M) costs. The O&M costs for GBTs are higher than the RDTs due to the higher amount of wash water, which requires additional treatment. At the project meeting on January 24, 2007, the City decided to use GBTs because GBTs have been used for more than 25 years and their operation is similar to the belt filter presses. The City might still consider co-thickening in the future, but for this master plan, separate thickening is the chosen option.

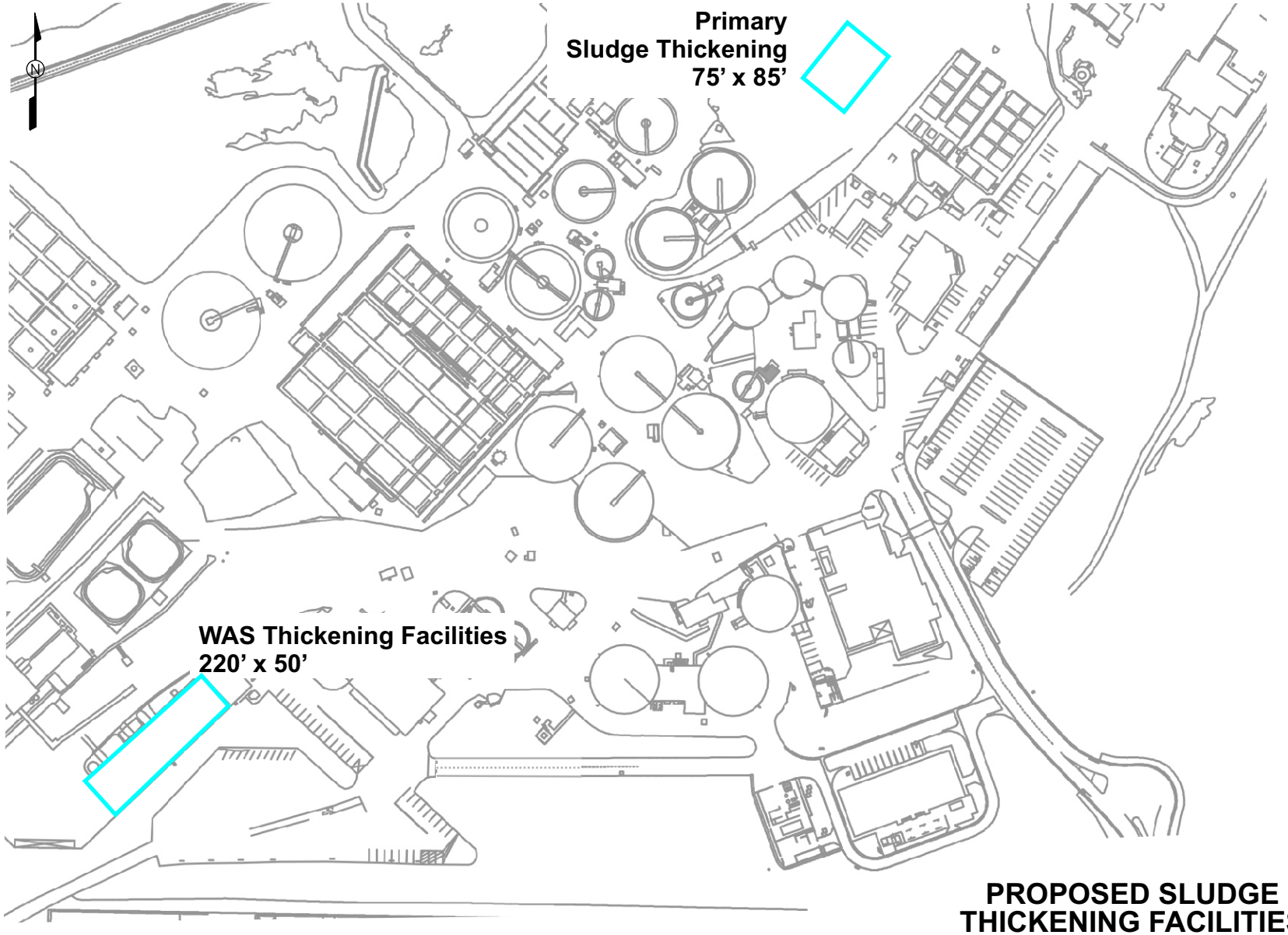
Table 4.5 Life-Cycle Cost of Gravity Belts and Rotary Drum Thickeners Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	Separate Thickening		**Co-thickening**[2]	
	GBT	**RDT**	**GBT**	**RDT**
Total Capital Cost[1]	$20,800,000	$24,200,000	$25,900,000	$29,300,000
Total Project Cost	$27,000,000	$31,400,000	$33,700,000	$38,000,000

Table 4.5 Life-Cycle Cost of Gravity Belts and Rotary Drum Thickeners Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	Separate Thickening		Co-thickening[2]	
	GBT	RDT	GBT	RDT
Annual O&M Cost[3]	$4,700,000	$3,700,000	$4,800,000	$3,800,000
Life-Cycle Cost[4]	$103,200,000	$90,700,000	$111,400,000	98,900,000

Notes:
(1) Total costs for thickener equipment, polymer blending unit, mechanical piping and valves, booster pump, filtrate pump station, building (metal), primary sludge pipe.
(2) Extra items added to co-thickening include: Retrofitting costs for DAFTs, covers for DAFTs, mixing system, sludge pump station.
(3) Includes the electrical cost, polymer cost, recycle treatment cost, and maintenance cost.
(4) As present value, assuming a life-cycle period of 19 years, a discount rate of 6 percent, and an escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

4.9 PROPOSED SLUDGE THICKENING FACILITIES

Figure 4.3 shows a proposed layout of the thickening facilities using separate thickening facilities for primary sludge and WAS. The City plans to put the primary sludge thickening facilities near the Plant 1 primary clarifiers, while retrofitting the existing chemical building to house the nine WAS thickening units. The existing chemical building is currently not big enough to house all the necessary WAS thickening. Figure 4.3 shows a proposed layout of the new WAS thickening facility. As a result of the expansion of the building, the hypochlorite tanks will need to be moved from their current location. It is assumed that both thickening alternatives would require a similar amount of space. The area allocated is big enough to house all thickening units, polymer blending units, booster pumps and all other ancillary equipment.



PROPOSED SLUDGE THICKENING FACILITIES

FIGURE 4.3

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 5: SOLIDS PROCESSING

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 5: SOLIDS PROCESSING

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Chapter 5

SOLIDS PROCESSING

5.1 PURPOSE

The purpose of this chapter is to evaluate biosolids digestion alternatives for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) expansion. Acid-Phased Anaerobic Digestion (APAD) is compared with the existing conventional anaerobic digestion. Final decisions about a detailed layout and specific equipment type would be determined during the preliminary and final design.

5.2 CONCLUSIONS AND RECOMMENDATIONS

- The City could reduce digestion construction to a minimum of one 90-foot digester and possibly not have to build any additional digestion during the master plan planning period by using APAD versus conventional anaerobic digestion.
- The City has selected the APAD system with a new multi-compartment acid-phase digester for their digestion facilities.
- It is recommended that the City use Digester No. 3 for downstream digester sludge storage, as this would provide the City with 3 days of storage versus 2 days, if the City were to use Digester No. 5 instead.

5.3 SOLIDS PROJECTION

The calibrated Biotran™ model was used to estimate the thickened solids production for an Average Daily Flow (ADF) of 52.2 mgd. The projections were based on the thickening discussions in Chapter 4 in which Gravity Belt Thickeners (GBTs) selected to thicken both primary sludge and Waste Activated Sludge (WAS). The GBTs were assumed to have a solids capture rate of 95 percent and able to thicken both the primary sludge and WAS solids to 5 to 7 percent. However, for master planning level purposes, 6-percent solids concentration was used because it maybe difficult to get continuous 7-percent solids from the thickeners. Furthermore, for conventional anaerobic digestion, 6 percent is the upper feed solids concentration to avoid digester process control problems. Table 5.1 summarizes the thickened solids projections for the 52.2-mgd annual ADF condition.

Table 5.1 Thickened Solids Projections
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

52 mgd	Primary Sludge	WAS
% Thickened Solids Concentration	6	6
Total Solids, lbs/day	91,000	65,500

Table 5.1 Thickened Solids Projections Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
52 mgd	**Primary Sludge**	**WAS**
Volatile Solids, %	81	85
Volatile Solids, lbs/day	73,800	55,700
Maximum Month Flow, mgd	0.182	0.131
Peak Flow, mgd	1.34	2.36
Organic N, total lb/d	3,820	4,525

5.4 EXISTING DIGESTION FACILITIES

As stated in Volume 8, Chapter 1 - Existing Facilities, the City currently has five digesters with the smallest unit being out of service. Table 5.2 summarizes the descriptions of each of the digesters. The RWQCP currently operates with only the two 90-foot diameter tanks as active digesters. These are labeled as Digester Nos. 1 and 2. Digester No. 3 is being retrofitted and will be put back in service. After digestion, the stabilized solids are transferred into Digester No. 4, which serves as a holding tank for the dewatering process.

Table 5.2 Existing Digestion Facilities Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	Description			
Digester No.	**Diameter, ft**	**Side water Depth, ft**	**Digester Volume, MG**	**Notes**
1, 2	90	32	1.64	
3	75	32	1.06	
4	88	38.5	1.8	Digested Sludge Storage
5	60	28.5	.63	Out of Service
	Current Active Volume		4.34	Digester Nos. 1-3
	Current Storage Volume		1.8	Digester No. 4

The RWQCP has been running a project since April 2005 in which restaurant grease is added directly to Digester No. 2 to increase gas production. The project results have shown that solids destruction in the digester is also increased.

5.5 DIGESTION ALTERNATIVES

The two digestion alternatives evaluated for the master plan are variations of mesophilic anaerobic digestion:

1. Conventional anaerobic digestion.
2. APAD.

As mentioned earlier, the City is adding grease to one of the digesters. This alternative evaluation assumes this procedure will continue. The City's plan for their grease study is to expand it and begin adding heated grease along with thickened sludge into Digester No. 3, using it for upstream storage. For this plan, Digester Nos. 1, 2, and 4 would be active digesters and Digester No. 5 would be downstream storage. Effectively, if the City upgrades the heating capability of Digester No. 3, they would have an APAD system. Heating Digester No. 3 is recommended because if the heated grease is added to relatively cold sludge (estimated at 70 degrees Fahrenheit), a grease layer may form. Hence, poor mixing within the reactor would occur, and the City would also experience problems with pumping. More importantly, if Digester No. 3 is not heated the digester would perform similarly as an acid-phase digester, but it would not work optimally since it is not heated. The digester would then move in and out of the acid-phase digester operating range, and the City would have process control issues with the remaining digesters.

5.5.1 Design Criteria

Table 5.3 lists the design criteria for the two anaerobic digestion processes. In most cases, the Volatile Solids Loading Rate (VSLR) is the controlling parameter.

Table 5.3 Anaerobic Digestion Design Criteria
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Value
Conventional Anaerobic Digestion	
Volatile Solids Loading (lbs/ft^3/day)	
All Units in Service	0.12
Largest Unit Out of Service	0.15
Detention Time (days)	
All Units in Service	20
One Unit Out of Service	15
Acid-Phase Anaerobic Digestion	
Acid Phase	
Volatile Solids Loading (lbs/ft^3/day)	1 to 3

Table 5.3 Anaerobic Digestion Design Criteria Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
	Value
Detention Time (days)	
All Units in Service	1 to 3
Methane Phase	
Detention Time (days)	
All Units in Service	15
One Unit Out of Service	12
Acid Phase Out of Service	15
Volatile Solids Loading (lbs/ft^3/day)	
Acid Phase in Service	N/A
Acid Phase Out of Service	0.15

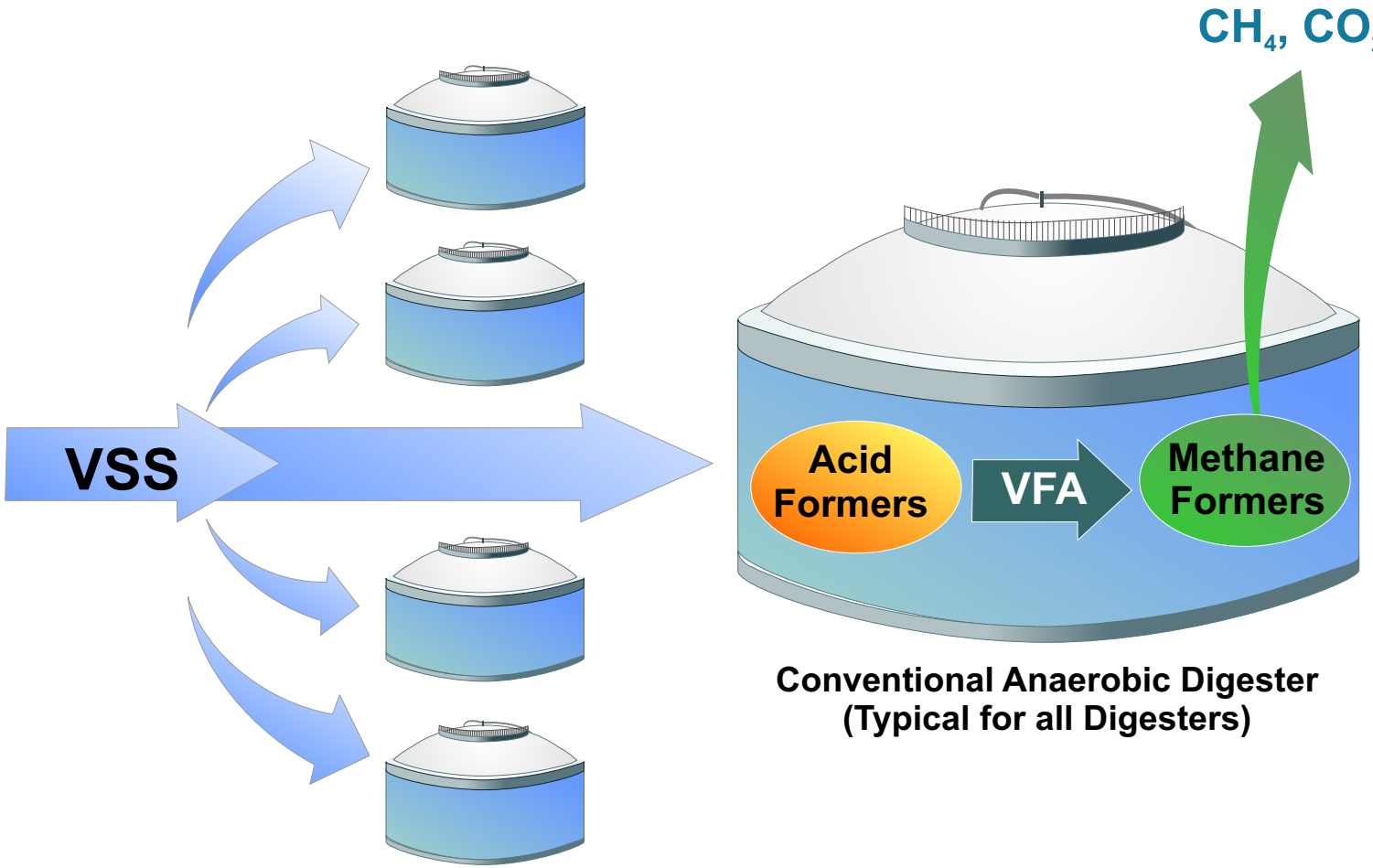
The controlling parameter for the methane-phase digester when the acid-phase digester is out of service (assuming there is only one acid-phase digester) in the APAD system is also the VSLR. During this time, the methane-phase digesters would operate as conventional anaerobic digesters and, therefore, the VSLR criteria (0.15 lbs/ft^3/day) for the conventional anaerobic digestion process is applied.

Since the start of the City's grease-to-gas project, the City has experienced an increase in Volatile Suspended Solids (VSS) destruction. However, the City does not have any information on the VSLR at this time. As the City runs this grease-to-gas project longer and is able to collect information on the VSLR, the City might be able to increase this parameter for design in the future, which could decrease the requirement for additional digestion.

5.5.2 Alternative 1: Conventional Anaerobic Digestion

Figure 5.1 shows a schematic representation of the conventional digestion process. In general, an anaerobic digestion process is divided into three stages: hydrolysis, formation of soluble organic compounds (short-chained organic acids), and methane formation. In the first stage, the complex organic matter is converted into a soluble form through hydrolysis. In the second stage, the acetogenic organisms convert these soluble organics into Volatile Fatty Acids (VFAs), and finally in the third stage, the methanogenic bacteria convert the VFAs to methane and carbon dioxide gases.

In conventional anaerobic digestion, all three reactions take place in one tank, hence, both acetogenic and methanogenic organisms must co-exist in the same tank. The acetogenic



Conventional Anaerobic Digester
(Typical for all Digesters)

CONVENTIONAL ANAEROBIC DIGESTION PROCESS

FIGURE 5.1

organisms are fast-growing bacteria while the methanogenic organisms are slow growing bacteria, and the VFAs that the acid formers produce are toxic to the methane formers. In order to have the acetogenic and methanogenic organisms co-exist in the same environment, it is necessary to starve the acetogenic organisms by artificially limiting the VSS in the feed to create a balance between the acid formers and the methane formers. The advantages and disadvantages of conventional anaerobic digestion are as follows:

5.5.2.1 Advantages

- Produces methane gas, which can be used to produce heat and electricity.
- Stable process.
- Relatively low operating costs.

5.5.2.2 Disadvantages

- Methane-producing bacteria are slow growing, and therefore, larger tankage and longer detention time is required for process completion.
- High capital costs.

5.5.2.3 Conventional Anaerobic Digestion Facilities

Based on the design criteria for conventional anaerobic digestion and the thickened solids projections, Table 5.4 summarizes the digestion facilities required for this alternative.

Table 5.4 Conventional Anaerobic Digestion Facilities Design
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	All Units in Service	One Unit Out of Service
Facilities Requirement Based on HRT		
Total Required Digester Volume (MG)	6.26	4.7
Additional Required Volume (MG)	0.63	0.81
Facilities Requirement Based on VSS Loading		
Total Required Digester Volume (MG)	6.45	8.1
Additional Required Volume (MG)	2.58	2.44

This is based on the assumption of using Digester No. 3 as downstream storage, which would provide the City with approximately 3 days of storage. As Table 5.4 shows, the VSLR is the controlling parameter, and the City would need to install two new 90-foot digesters to meet the additional digestion volume requirement.

5.5.3 Alternative 2: Acid-Phased Anaerobic Digestion

Figure 5.2 shows a schematic representation of the APAD concept. The acid-phased digestion, unlike conventional anaerobic digestion, makes use of the different growth conditions of the anaerobic organisms. In APAD, the organisms are separated into an acid-phase digester and a methane-phase digester. The first two stages of the anaerobic digestion process take place in the acid-phase digester, where the complex organics are hydrolyzed and converted into VFAs. Once the acids are formed, the sludge is sent to the methane-phase digester where the methanogenic organisms break down the VFAs further into methane and carbon dioxide. Due to the conditions present in the acid-phase digester, the solubility of the complex organic matter is increased. Because of the improved hydrolysis, the volatile solids destruction is increased, and the amount of solids resulting from the digestion process is reduced.

The gas from the acid-phase digester, which accounts for about 5 to 10 percent of the methane produced, has relatively high H_2S and low methane concentrations. This poor-quality gas cannot be used as a fuel source and, therefore, needs to be flared off. The methane digester gas, however, has a higher methane concentration due to a higher pH in this digester. It also has a lower H_2S concentration compared to gas produced in the conventional digesters. Furthermore, higher VSS destruction results in higher methane gas volumes.

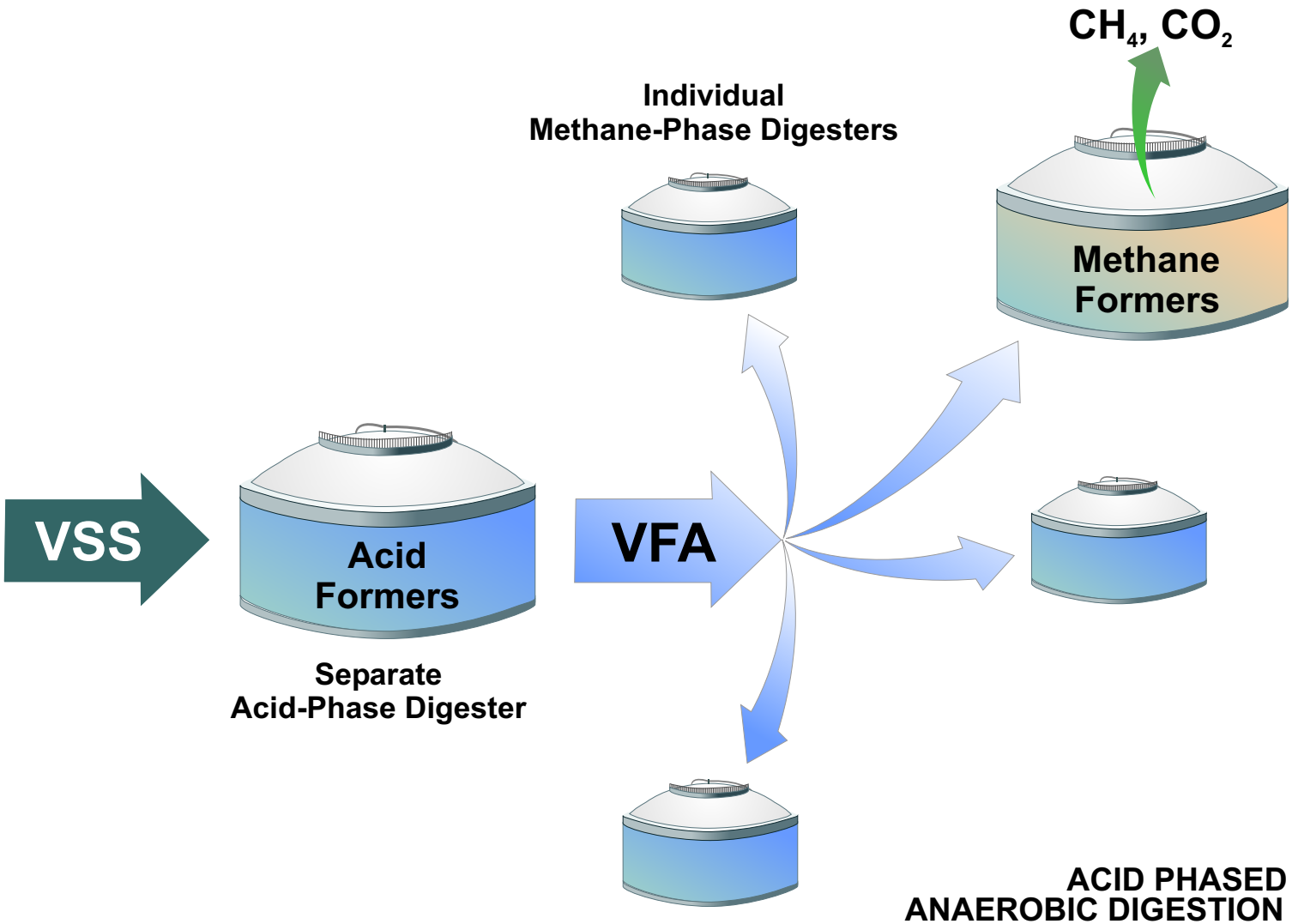
The following summarizes the advantages and disadvantages of the APAD system.

5.5.3.1 Advantages

- Higher reaction rates, hence smaller digester volumes.
- Decreased solids to disposal.
- Equalized feed to the methane-phase digester, which equalizes gas production.
- Higher methane gas production.
- Improved quality of methane-phase digester gas.
- Decreased foaming and improved dewatering characteristics.
- Improved solids dewater ability.

5.5.3.2 Disadvantages

- Higher recycle costs due to higher ammonia concentration in the recycle stream.
- Poor quality of acid-phase gas.



ACID PHASED
ANAEROBIC DIGESTION PROCESS

FIGURE 5.2

5.5.3.3 Acid-Phased Anaerobic Digestion Facilities Design

Based on the design criteria for conventional anaerobic digestion and the thickened solids projection, Tables 5.5 and 5.6 summarize the digestion facilities required for this alternative.

Table 5.5 APAD Facilities Design - Acid-Phase Digester
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Value
Acid-Phase Digester Requirement Based on HRT	
Total Required Digester Volume (MG)	0.31 to 0.94
Digester 5 Volume (MG)	0.6
Digester 3 Volume (MG)	1.06
Additional Required Volume (MG)	None
Acid-Phase Digester Requirement Based on VSS Loading	
Total Required Digester Volume (MG)	0.32 to 0.97
Digester 5 Volume (MG)	0.6
Digester 3 Volume (MG)	1.06
Additional Required Volume (MG)	None

Table 5.5 shows that there would be no requirement for any additional acid-phase digesters using either Digesters Nos. 3 or 5 as the acid-phase digester.

Table 5.6 APAD Facilities Design - Methane-Phase Digester
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	All Units in Service	One Unit Out of Service
Methane-Phase Digester Requirement Based on HRT		
Total Required Digester Volume (MG)	4.7	3.76
Additional Required Volume (MG)	None	0.48
	Acid-Phase Digester Out of Service	
Facilities Requirement Based on VSS Loading		
Total Required Digester Volume (MG)	6.46	
Additional Required Volume (MG)	1.43	

Table 5.6 shows that the VSLR is the controlling parameter for the methane-phase digester when the acid-phase digester is out of service (assuming there is only one acid-phase digester). This would require the City to add one 90-foot diameter digester. As a reminder, this is based on the 0.15 lbs/ft^3/day VSLR for a conventional anaerobic digester. If the City's APAD project proves that it is possible to get a VSLR up to 0.19 lbs/ft^3/day or higher, the

City would have enough methane-phase digester volume and would not require an additional digester for the 52.2-mgd flow condition. Therefore, using the APAD design, the City can save, at a minimum, the cost of one digester and possibly up to two digesters.

In the case that the City does require extra digester volume, another alternative is to build a new multi-compartment acid-phase digester. The multi-compartment tank is more expensive than a circular digester; however, this type of tank is configured specifically to work as an acid-phase digester and to provide process reliability. It reduces the likelihood for sludge short-circuiting and, therefore, works more effectively. The multi-compartment tank provides a plug flow condition, which would enhance the hydrolysis performance. It would also give the City the flexibility to isolate any of its compartments for maintenance, without adversely impacting digester operation.

5.6 ALTERNATIVE COMPARISON

A comparison of the two anaerobic digestion alternatives is presented in Table 5.7. In summary, APAD would provide an extra ammonia load in the recycle stream. However, it would require less space, achieve higher VSS destruction, and hence, produce less solids for disposal. The amount of good-quality methane gas is also increased by using the APAD system.

Table 5.7 Comparison of Conventional and Acid-Phased Anaerobic Digestion Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Alternative 1: Conventional Anaerobic Digestion	Alternative 2: Acid Phased Anaerobic Digestion
Space Requirement	–	+
Recycle Treatment	+	–
Operation/Maintenance Requirement	+	0
Methane Gas Production	0	+
Dewatering Polymer Usage	0	+
Total Solids Production/Solids Disposal	–	+
Acid-Phase Gas Quality	N/A	–
Methane Gas Quality	0	+

Ratings:
+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

5.7 LIFE-CYCLE COST ANALYSIS

The life cycle cost analysis included the following capital costs and O&M costs:

Capital Costs:

- Digestion facility.
- Support facilities:
  - New sludge transfer pump station.
  - Retrofitting existing transfer pump station.
  - New flare for APAD.
  - Heat exchanger for acid-phase digester.

O&M Costs:

- Operation (labor).
- Recycle treatment.
- Dewatering polymer.
- Maintenance.
- Solids disposal.
- Credit from gas production.

A cost comparison of conventional anaerobic digestion and APAD are presented in Table 5.8. There are three options for Alternative 2. Option 1 is to add one extra circular digester, Option 2 is to add a new multi-compartment acid-phase digester, and Option 3 is not adding any new digesters (assuming the City will be able to achieve a VSLR of 0.19 lbs/ft^3/day). The higher annual O&M costs for conventional anaerobic digestion are because less credit was given to this alternative for gas production, while APAD options were able to produce more gas and therefore, receive a higher credit for the gas produced, hence reducing the O&M costs.

Table 5.8 Life-Cycle Cost of Anaerobic Digestion Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

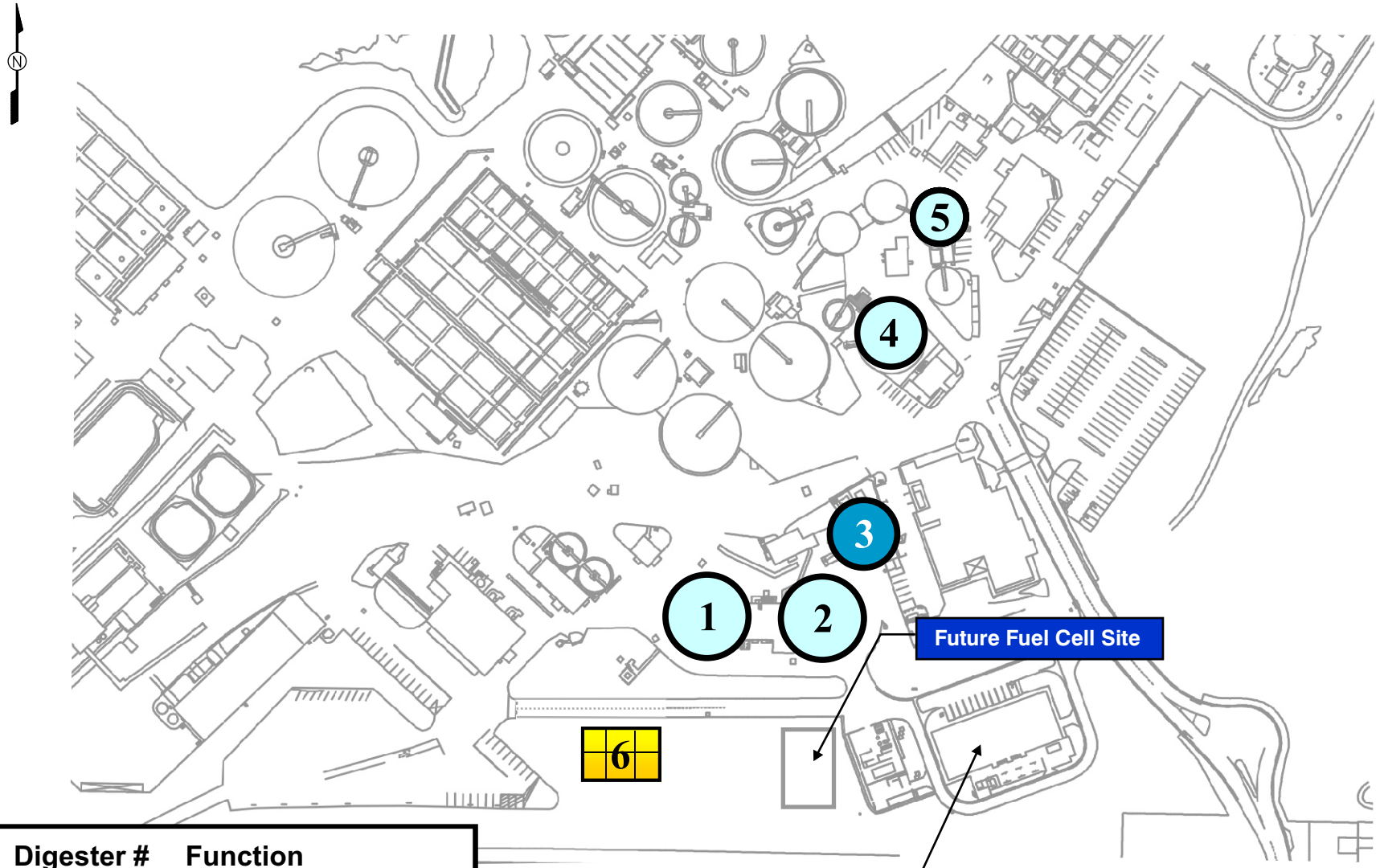
		Alternative 2: APAD		
	Alternative 1: Conventional Anaerobic Digestion	**Option 1: With Circular Digester**	**Option 2: With Multi-Compartment Acid-Phase Digester**	**Option 3: Without Extra Digester**
Digestion Facility Project Costs	$8,500,000	$4,300,000	$7,700,000	$0

Table 5.8 Life-Cycle Cost of Anaerobic Digestion Facilities Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
		Alternative 2: APAD		
	Alternative 1: Conventional Anaerobic Digestion	Option 1: With Circular Digester	Option 2: With Multi-Compartment Acid-Phase Digester	Option 3: Without Extra Digester
Support Facilities Project Costs	$3,600,000	$5,100,000	$5,100,000	$4,000,000
Total Project Cost	$12,100,000	$9,400,000	$12,800,000	$4,000,000
Annual O&M Cost	$2,900,000	$800,000	$820,000	$770,000
Life-Cycle Cost	$58,500,000	$22,300,000	$26,100,000	$16,000,000

At the project meeting on February 21, 2007, the City selected APAD for the master plan. The decision was made because conventional anaerobic digestion is not economical when compared to APAD. In addition, APAD will increase the gas production, which will allow the City to better utilize their cogeneration facilities. The addition of grease to an APAD will further increase the gas production. For the master plan, the City chose the multi-compartment acid-phase digester option. An alternative treatment scenario for the Master Plan Manager™ (MPM™) will include Option 3 (without addition of a new digester), for the possibility that the City can increase the VSLR to 0.19 lbs/ft^3/day.

5.8 DIGESTION FACILITY LAYOUT

Figure 5.3 shows a proposed layout of the digestion facilities with the multi-compartment acid-phase digester. The City said in the March meeting that it is planning to place fuel cells in the open area to the west of the co-generation facility. The City staff estimated that the fuel cells facilities will take up about 1/3 of that area. This would leave the western portion of this open area for the new digester facilities.



Digester #	Function
# 6	Acid-Phase Digester
#1, 2, 4, 5	Methane-Phase
#3	Storage

ALTERNATIVE LAYOUT FOR APAD SYSTEM

FIGURE 5.3

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 6: SOLIDS DEWATERING

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Chapter 6

SOLIDS DEWATERING

6.1 PURPOSE

The purpose of this chapter is to provide a summary of the dewatering options that were recommended to the City of Riverside (City) in the City's Regional Water Quality Control Plant (RWQCP) 2003 Bio-Solids Handling Improvement Report that was completed by Brown and Caldwell. The Capital Improvement Plan (CIP) relating to dewatering from the 2003 Report will be used as input into the Master Plan Manager™ (MPM™) and Financial Planning Tool™ (FPT™). A copy of the report is included as Appendix A to this Volume of the Integrated Master Plan.

6.2 BACKGROUND

In 2002, the City hired Brown and Caldwell to study its solids handling facilities operation and to develop options for a two-phase expansion from 40- and 50-mgd average dry weather influent flows basis. The recommended plan was intended to phase in new facilities over several years rather than completing them all at one time. Part of the study included an evaluation of the City's dewatering facilities. The City plans to continue with the dewatering implementation plan based on the recommendations from the 2003 Report. The focus of this chapter is, therefore, a review and a summary of the dewatering options presented in the 2003 Report. No additional evaluations on dewatering facilities were completed.

6.3 SUMMARY OF 2003 BIOSOLIDS HANDLING IMPROVEMENT REPORT

At the time of the study, the City's dewatering facilities consisted of two 2.2-meter Andritz SMX belt presses with an average capacity of 100 gpm each and a peak capacity of 200 gpm each. Both machines operated together without a redundant unit at an average feed rate of 150 gpm and produced a 12-percent cake solids. The study concluded that the two belt presses had reached their capacity limit and additional dewatering capacity was needed immediately.

The evaluated dewatering options included belt presses and centrifuges. The analysis concluded that the performance of the belt presses could be improved (achieving 15-percent cake solids) by lowering the feed flows. It further concluded that 18-percent cake solids could be obtained from new belt presses. The centrifuges that were evaluated for the master plan were high-speed units that could produce dewatered solids with percent solids in the range of 25 to 28 percent.

Table 6.1 lists the estimated dewatering performance of the belt presses and centrifuges. The information was taken from Table 2 of Chapter 7 of the 2003 Report.

A cost and non-cost assessment for the two dewatering options was conducted for the master plan.

Table 6.1 Performance Data of Dewatering Equipment[(1)]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Belt Press	High-Speed Centrifuge
Feed Rate, gpm		
Average	100	200
Peak	160	300
Cake Solids Content, %	16	25
Solids Capture, %	95	96
Estimated Polymer Dose (lb active/dry ton)	12	20
Typical Power Load per Machine, kW	20	110

Notes:
(1) Information taken from 2003 Biosolids Handling Improvement Report.

6.3.1 Recommendations for the 40-mgd Flow Condition

Based on the digested sludge flow rates and characteristics for dewatering, the 2003 Report recommended that the City refurbish their two belt presses and add one 200-gpm centrifuge for the Phase 1 project. This was based on dewatering facilities operating at 16 hours per day, 5 days a week.

Since the completion of the study, the City has implemented this recommendation. However, the City installed a 120-gpm high-speed centrifuge instead of a 200-gpm centrifuge. The combined capacity of the smaller centrifuge and the two belt presses do, however, provide the current plant influent flow capacity of 40 mgd with one belt press out of service.

6.3.2 Recommendations for the 50-mgd Flow Condition

For the Phase 2 project, the 2003 Report recommended removal of all belt presses and installation of two additional 200-gpm high-solids centrifuges (a total of three centrifuges; two duty and one standby). The City has begun to implement this phase of the project by installing a second centrifuge, which has a hydraulic capacity of 275 gpm.

6.4 DEWATERING REQUIREMENT VERSUS CAPACITY FOR THE 52.2-MGD FLOW CONDITION

The Biotran model projected that the RWQCP will need to dewater approximately 0.40 mgd of solids for the 52.2-mgd (annual average flow) condition. This is based on the assumptions that Gravity Belt Thickeners (GBTs) will be used to thicken the primary sludge to 6-percent solids; the WAS is thickened by the Dissolved Air Flotation Thickeners (DAFTs) to 3.5 percent and the Acid-Phased Anaerobic Digestion (APAD) will be used to stabilize the solids.

Based on the above projection, with a combined dewatering capacity of 0.57 mgd, the two centrifuges (120 gpm and 275 gpm) will provide enough dewatering capacity for the RWQCP. Therefore, there is no requirement for installation of any additional centrifuges for the master planning period.

The two belt presses will be used for standby purposes when one of the centrifuges is out of service. Since the City has just refurbished these belt presses, it is assumed that these belt presses will have useful lives for the duration of the master planning period.

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CHAPTER 7: SOLIDS DISPOSAL

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Chapter 7

SOLIDS DISPOSAL

7.1 PURPOSE

The purpose of this chapter is to provide a brief summary of the City of Riverside's (City) solids (biosolids) disposal plan for the next 20 years. The schedule and cost information provided from the City will be used for input into the Capital Improvement Plan (CIP), Master Plan Manager™ (MPM™) and Financial Planning Tool™ (FPT™).

7.2 BACKGROUND

The City began evaluating alternative methods for biosolids disposal in April 2002. The 2003 Bio-Solids Handling Improvement Report by Brown and Caldwell recommended $60 million in capital expenditures and an additional $1 million/year in operating costs to convert the City's current Class B biosolids treatment facility to a Class A facility, in accordance with industry and regulatory trends. Since then, the Public Works Department has been working to reduce and postpone the need for these improvements through operating modifications and by improving process efficiencies.

7.3 CURRENT DISPOSAL METHOD

As mentioned above, the City of Riverside Regional Water Quality Control Plant (RWQCP) currently produces Class B sludge. To minimize odors, the RWQCP limits on-site solids storage of dewatered solids to the existing sludge storage hopper. Fleet transportation services sends trucks to the RWQCP daily to pick up the dewatered solids and delivers it to alfalfa and cotton farms in Arizona, where it is used as a soil amendment.

Currently the RWQCP generates and requires disposal of 140 Wet Tons Per Day (WTPD) of dewatered solids. According to the City, the 2006 to 2007 disposal cost is about $3 million (all-inclusive costs, $57.53/wet ton (wt)). The cost varies based on the price of diesel fuel. This price is expected to increase more than 10 percent as all Southern California counties either have banned the land application of Class B biosolids or do not have acreage that has a permit that allows land application.

7.4 CITY'S FUTURE SOLIDS DISPOSAL PLAN

The City has entered into an agreement with EnerTech Environmental California, LLC (EnerTech) to participate in the Rialto Regional Biosolids Project as a component of the City's long-term biosolids management strategy. The decision was made after a discussion with industry experts from the University of California Riverside Center for Environmental Research and Technology (UCR CE-CERT) that the Rialto project's technology is sound

and pricing is advantageous. Furthermore, experts from UCR CE-CERT said that emerging technology such as converting biomass into vehicle fuel is only in the development stage and would not be available to the City for quite some time.

The Rialto project is an outcome from the Orange County Sanitation Districts (OCSD) December 2003 Long-Range Biosolids Management Plan (LRBMP). The study evaluated four technology areas: composting, heat drying, energy recovery, and organo-mineral fertilizer manufacturing. Among the eight proposals received, the EnerTech proposal ranked the highest, based on a set of comprehensive criteria.

According to the City analysis, participation in this project would result in a net present value savings of more than $27 million to the City over the 20-year life of the Rialto project, when compared to making improvements to improve the City's Class B biosolids to Class A. The following describes the EnerTech SlurryCarb™ process.

7.4.1 Enertech SlurryCarb™ Process

Biosolids at up to 20-percent solids content are brought to a central manufacturing facility where they are processed as a pumpable slurry. The biosolids slurry is continuously pumped and pressurized above its saturated steam pressure to maintain a liquid state throughout processing. By avoiding evaporation, thermal energy inputs for the evaporation of water are minimized. According to Enertech, the SlurryCarb™ process requires approximately two-thirds less energy than traditional drying methods.

Upon reaching the desired reaction pressure and temperature, the biosolids undergo a molecular reconfiguration. The cellular structure of the biosolids ruptures and carbon dioxide gas splits off, a step called "carbonization." According to the company, this reaction significantly reduces the size and improves the uniformity of the biosolids molecules. The reacted product becomes extremely hydrophobic and can be mechanically dewatered to greater than 50-percent solids. This dewatered, reacted product is concentrated in carbon, and over 80 percent of the original water present in the biosolids is removed without evaporation.

The reacted, dewatered product is dried to form a fuel that has a heating value of approximately 6,500 Btu/lb. This fuel, called E-Fuel, is exported to a customer and utilized as a renewable fuel. The filtrate from dewatering is pretreated to the standards of the local wastewater treatment plant.

7.4.2 City's Agreement with EnerTech

The following lists the highlights of the City's agreement with Enertech:

1. Agreement term is for 20 years.

2. The City's participation is capped at the solids production level of 150 WTPD, allowing the City to employ other technologies for expected increases in biosolids production.

3. The project commencement date is March 30, 2008, with a tipping fee of $54.15/wt, exclusive of transportation which is expected to be approximately $3/wt for a total cost of $57.15/wt.

4. The agreement guarantees that the City's tipping fee would be 10 percent below the tipping fee charged to other project participants.

7.5 OTHER SOLIDS DISPOSAL OPTIONS

Because it is possible that the Enertech facility will not be able to process all of the RWQCP biosolids for the 20-year planning period, the City is exploring an option using biosolids to produce biodiesel. UCR CE-CERT is currently performing a study to test the feasibility of using RWQCP biosolids for biodiesel production. The final report will be available in April 2007.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 8: SOLIDS TREATMENT AND HANDLING
CHAPTER 8: IMPLEMENTATION SCHEDULE AND COST

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IMPLEMENTATION SCHEDULE AND COST

8.1 PURPOSE

The purpose of this chapter is to present the costs and schedules of the projects for the solids stream for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) Integrated Master Plan. This chapter is closely tied to Volume 4, Chapter 14 - Implementation Schedule and Cost, for the liquid stream projects.

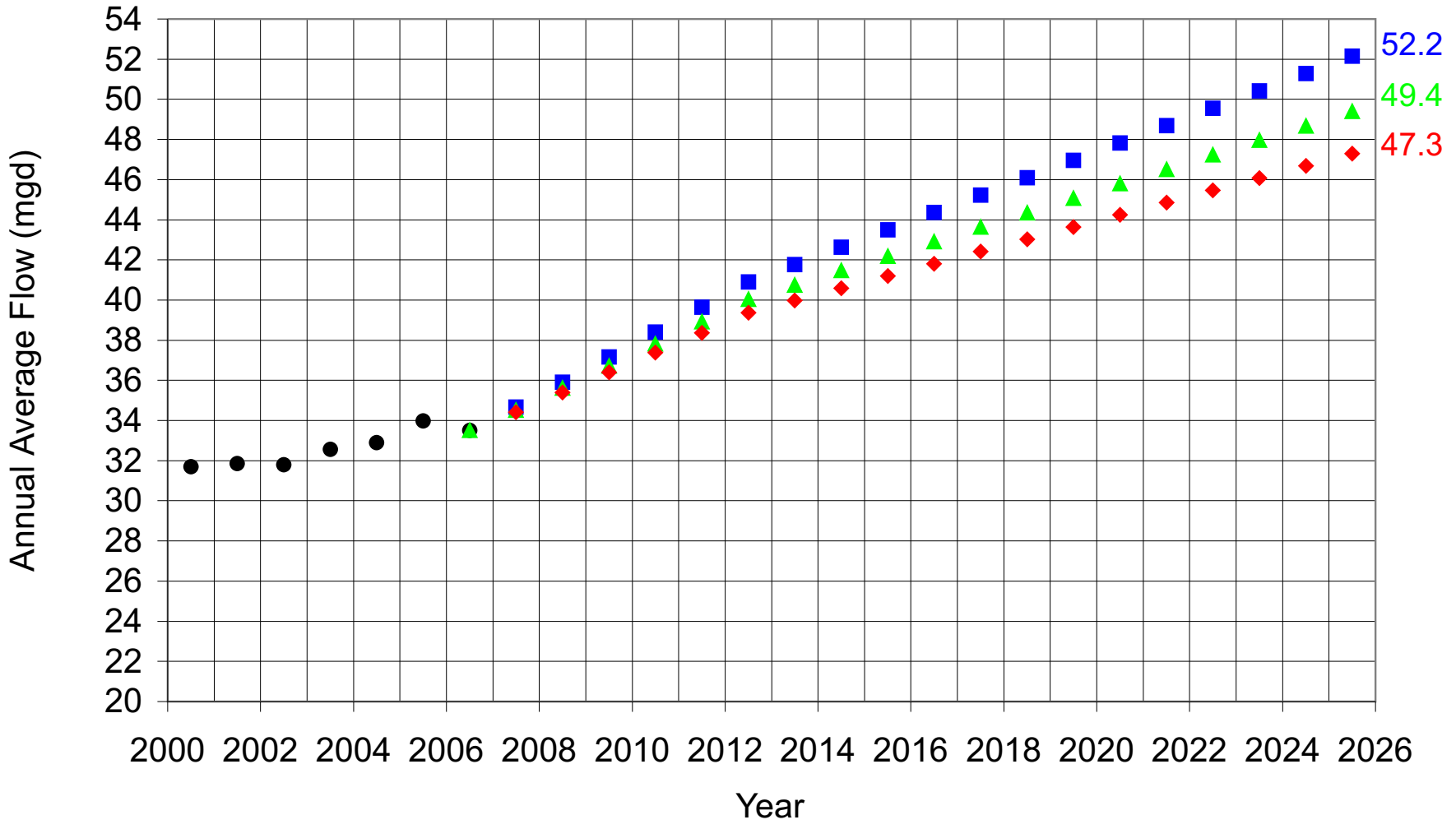
8.2 CONCLUSIONS AND RECOMMENDATIONS

- Primary Sludge Thickeners will be included in the Plant 1 Primary Expansion project.
- A Multi-Compartment Acid-Phase Digester will be combined into one project with the Plant 1 Primary Expansion and the Membrane Bioreactor (MBR) projects.
- Waste Activated Sludge (WAS) thickeners will be constructed in the later phase (project to begin in July 2023).

8.3 BACKGROUND

In Volume 2, Chapter 3 - Population and Flow Projections, the projected average daily flow for the RWQCP is 49.4 mgd. This is based on increasing the flow at the same rate as the projected population growth, which is 1.09 percent for the City. Because population and flow projections may be different than the actual values, a 90-percent confidence interval was applied to the data. This results in a high-growth scenario at 1.50 percent and low-growth scenario at 0.75 percent. Figure 8.1 shows the projected annual average influent flows for the RWQCP, along with projections using the high- and low-growth scenarios. Based on the existing capacity and future flow requirements, implementation schedules for both high-growth and low-growth scenarios were developed for the solids stream process projects, which are listed below:

- Solids Thickeners - Gravity Belt Thickeners (GBTs):
  - Five GBTs for primary sludge thickening.
  - Nine GBTs for WAS thickening.
- Anaerobic Digestion:
  - A new multi-compartment acid-phase digester.
- Solids Dewatering:
  - The City will have enough dewatering capacity with their existing centrifuges and belt presses. There is no requirement for installation of any additional centrifuges.



- Actual Flow Data
- Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)
- Master Plan Flow Projections (1.09% Annual Increase)
- Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)

RWQCP FLOW PROJECTIONS

FIGURE 8.1

- Solids Disposal:
  - The City has an agreement with Enertech to handle their solids disposal for up to 150 wet tons per day.

As mentioned in Volume 2, the City's original decision (August 2006) was to base all alternative analyses on the high-growth scenario. Subsequently (August 2007), after all analyses were completed, the City noticed a slowdown in the population/housing growth, and decided the low-growth scenario would be more appropriate for scheduling projects. Based on the August 2006 decision, the alternative analyses of this Master Plan are based on a 2025 flow of 52.2 mgd. However, as a result of the August 2007 decision, the capital costs, Operations and Maintenance (O&M) costs, Capital Improvement Plan (CIP), and schedule for the projects have been revised to reflect the low-growth scenario (2025 flow of 47.3 mgd).

8.4 COST AND SCHEDULE CRITERIA

The implementation schedule for each project consists of a planning/design period and a construction/start-up period. A 2-year duration for the planning and design period is used for each project to include a conservative schedule at the master plan level. Because the projects for solids stream treatment are relatively small, if completed as separate projects, 1.5 years may be used for the construction and start-up period. The construction and start-up period is based on the contractor being able to perform approximately $2 million per month worth of construction. When final implementation schedules are established, adjustments to this schedule should be made based on experience, looking at factors such as project sequencing and equipment procurement times. For some of the projects, it may be possible to shorten the planning/design and construction/start-up schedules. However, for the master plan, the schedules will be presented based on the criteria described above.

The costs for these projects are based on the information presented in the previous chapters for Volume 8 - Solids Treatment and Handling. They are based on costs in August 2006 dollars. These costs will be adjusted to their midpoint of construction before placement in the CIP, which is presented in Volume 10 - CIP and Overall Implementation Schedule.

8.5 SOLIDS STREAM TREATMENT FACILITIES SCHEDULE

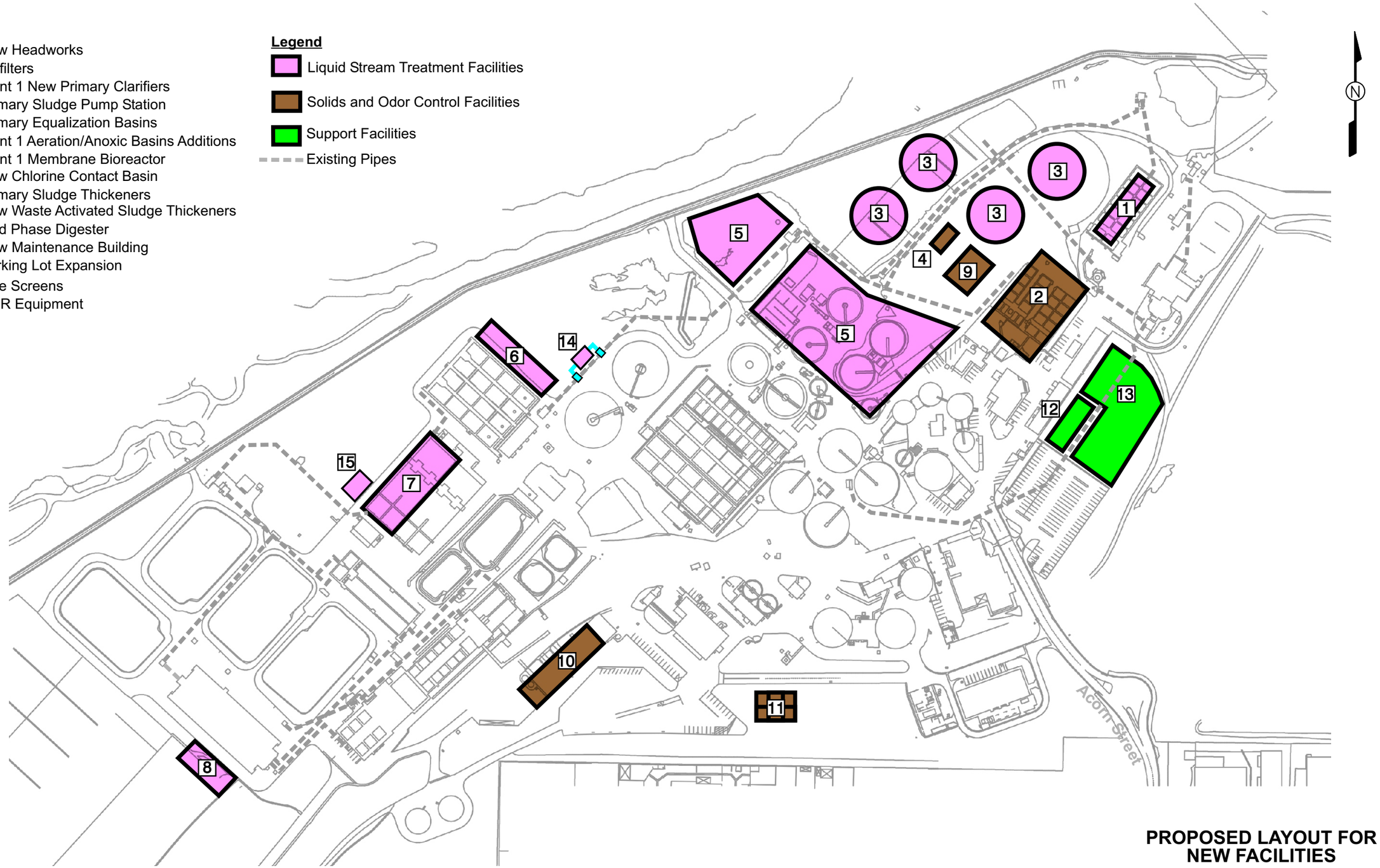
Figure 8.2 shows the proposed layout of the new solids stream treatment facilities. It also includes the liquid treatment facilities proposed in Volume 4 - Wastewater Treatment System. The schedules for the solids stream treatment facilities are discussed as follows.

Key

1. New Headworks
2. Biofilters
3. Plant 1 New Primary Clarifiers
4. Primary Sludge Pump Station
5. Primary Equalization Basins
6. Plant 1 Aeration/Anoxic Basins Additions
7. Plant 1 Membrane Bioreactor
8. New Chlorine Contact Basin
9. Primary Sludge Thickeners
10. New Waste Activated Sludge Thickeners
11. Acid Phase Digester
12. New Maintenance Building
13. Parking Lot Expansion
14. Fine Screens
15. MBR Equipment

Legend

- Liquid Stream Treatment Facilities
- Solids and Odor Control Facilities
- Support Facilities
- Existing Pipes



PROPOSED LAYOUT FOR NEW FACILITIES

FIGURE 8.2

8.5.1 Primary Sludge Thickening

As described in Volume 8, Chapter 4 - Solids Production and Thickening Options, primary sludge thickening facilities using GBTs will be added as part of the RWQCP expansion to 52.2 mgd (annual averaged basis). As further described in Volume 4, Chapter 14, the thickeners will be included in the Plant 1 primary expansion project. Figure 8.3 shows the schedule of the Plant 1 Primary Expansion Project. Based on the schedule, assuming the low-growth scenario, the primary sludge thickeners will need to be completed by July 2013. Based on a 2-year planning/design period and a 2.5-year construction/start-up period as mentioned in Volume 4, Chapter 14 - Implementation Schedule and Cost, this project would need to begin at the beginning of 2008.

8.5.2 WAS Thickening

The existing capacity of the two Dissolved Air Flotation Thickeners (DAFTs), with polymer addition, is estimated to be 48.4 mgd. As shown on Figure 8.4, the WAS thickening project does not need to start until July of 2023, in order to meet the January 2027 completion schedule assuming the low-growth scenario. This is based on a 2-year planning/design period and 1.5-year construction/start-up period.

8.5.3 Multi-Compartment Acid-Phase Digester

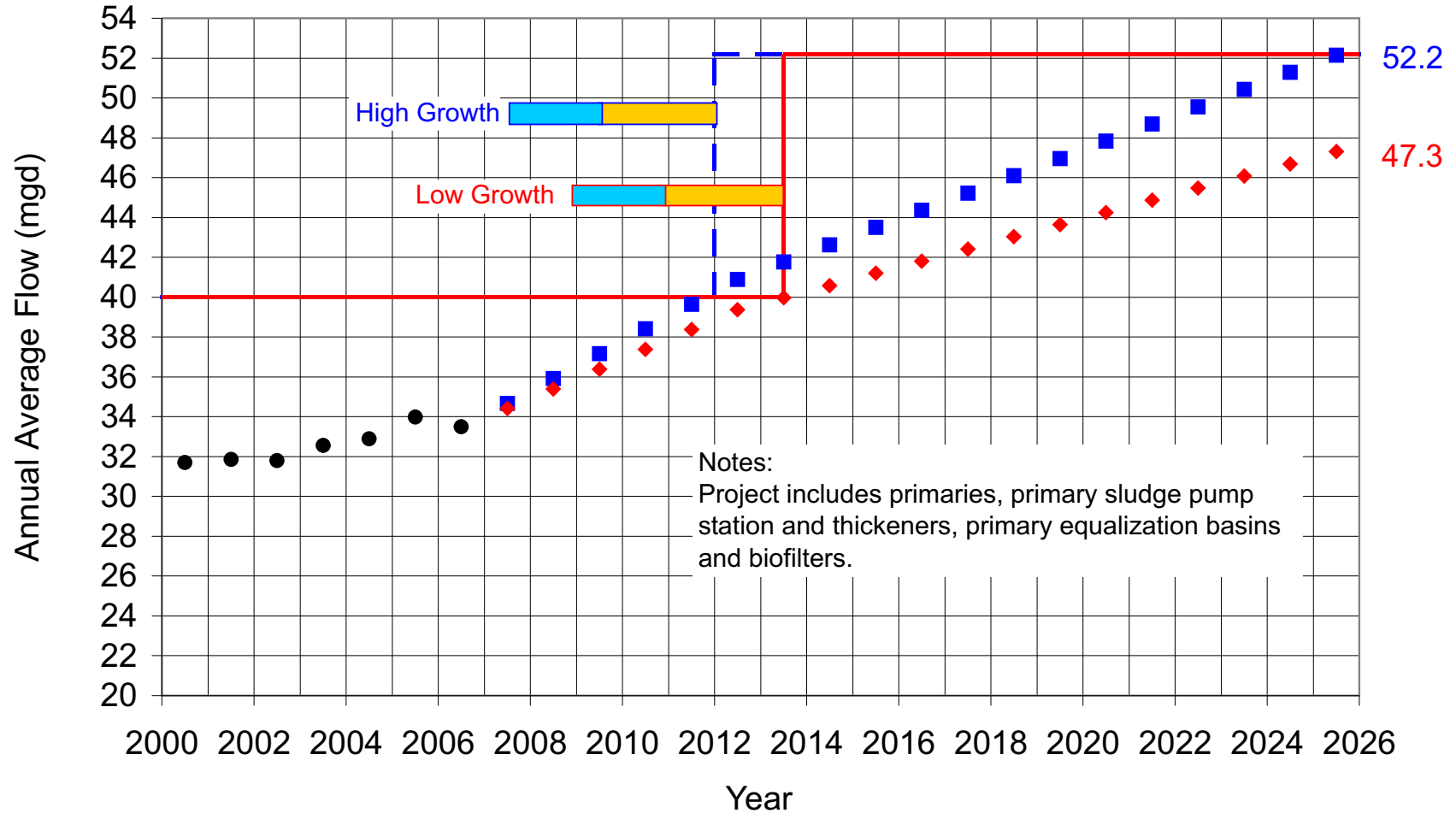
The calculations on anaerobic digestion in Volume 8, Chapter 5 - Solids Processing are based on the assumption that both primary sludge and WAS thickeners (GBTs) would be in use at the same time, resulting in a 6-percent solids sludge being fed to the digesters.

Based on the implementation schedule for WAS thickening presented above, the WAS would not be thickened to 6 percent, but to only 3.5 percent by the DAFTs. The capacity of the anaerobic digesters based on the 6-percent thickened primary sludge and 3.5-percent thickened WAS is estimated to be 39.7 mgd. As shown on Figure 8.5, assuming the low-growth scenario, the Multi-Compartment Acid-Phase Digester project will need to begin by the end of 2008 in order to meet the June 2012 completion schedule. This is based on a 2-year planning/design period and 1.5-year construction/start-up period.

8.5.4 Combination of Projects

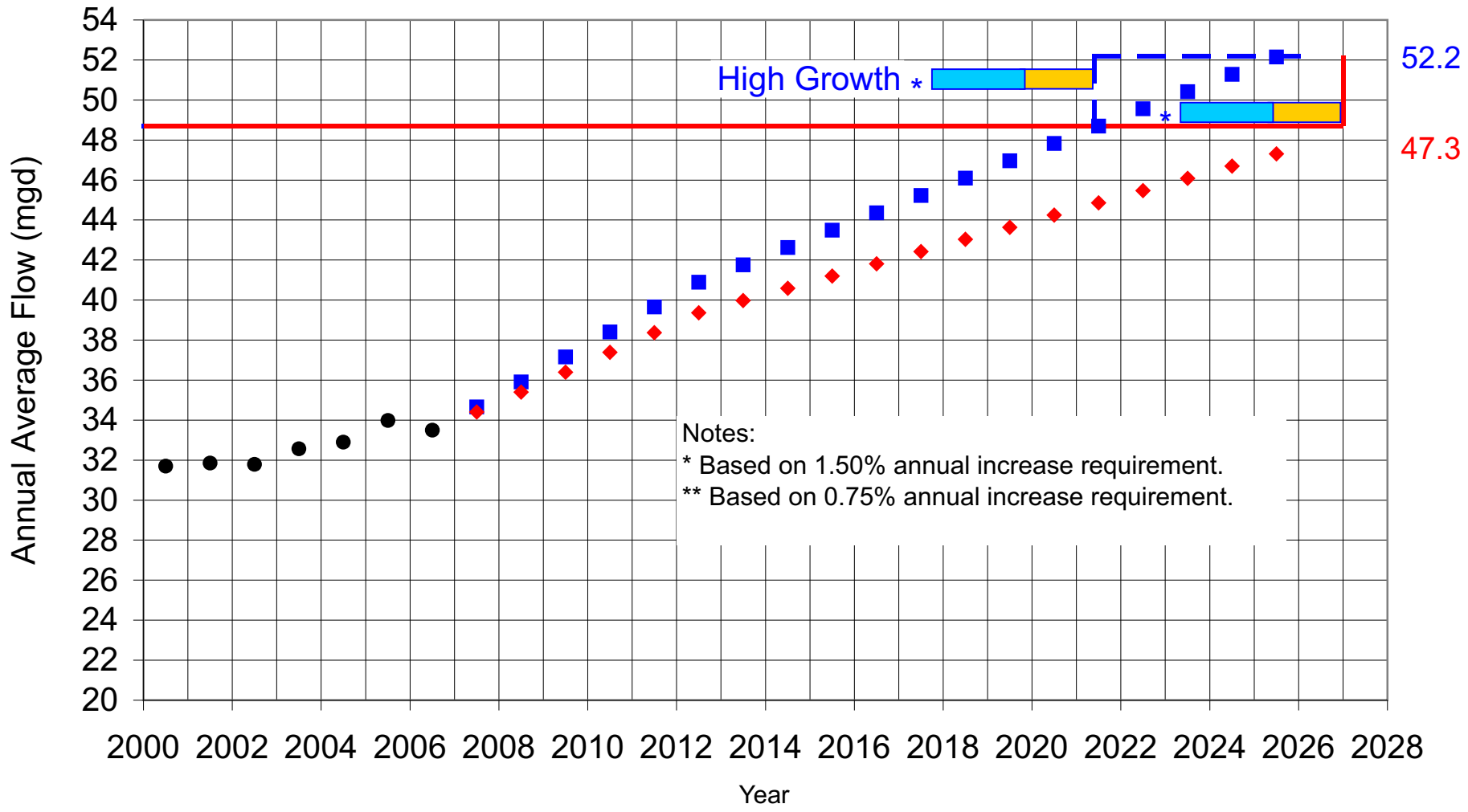
As described in Volume 4, Chapter 14 - Implementation Schedule and Cost, the Plant 1 Primary Expansion, MBR Facilities, and Acid-Phase Digester can be combined into one project, the 2008 Expansion Project. There are advantages and disadvantages of doing separate projects versus combined projects. These advantages and disadvantages are described in Volume 4, Chapter 14.

These advantages and disadvantages were presented to the City at a project meeting on March 21, 2007. Based on the discussion in the meeting, it was decided that a combined



PLANT 1
PRIMARY EXPANSION SCHEDULE

FIGURE 8.3



WAS Thickening (1.50% Annual Increase – High-Growth Scenario)

WAS Thickening (0.75% Annual Increase – Low-Growth Scenario)

Master Plan Flow Projections (1.50% Annual Increase – High-Growth Scenario)

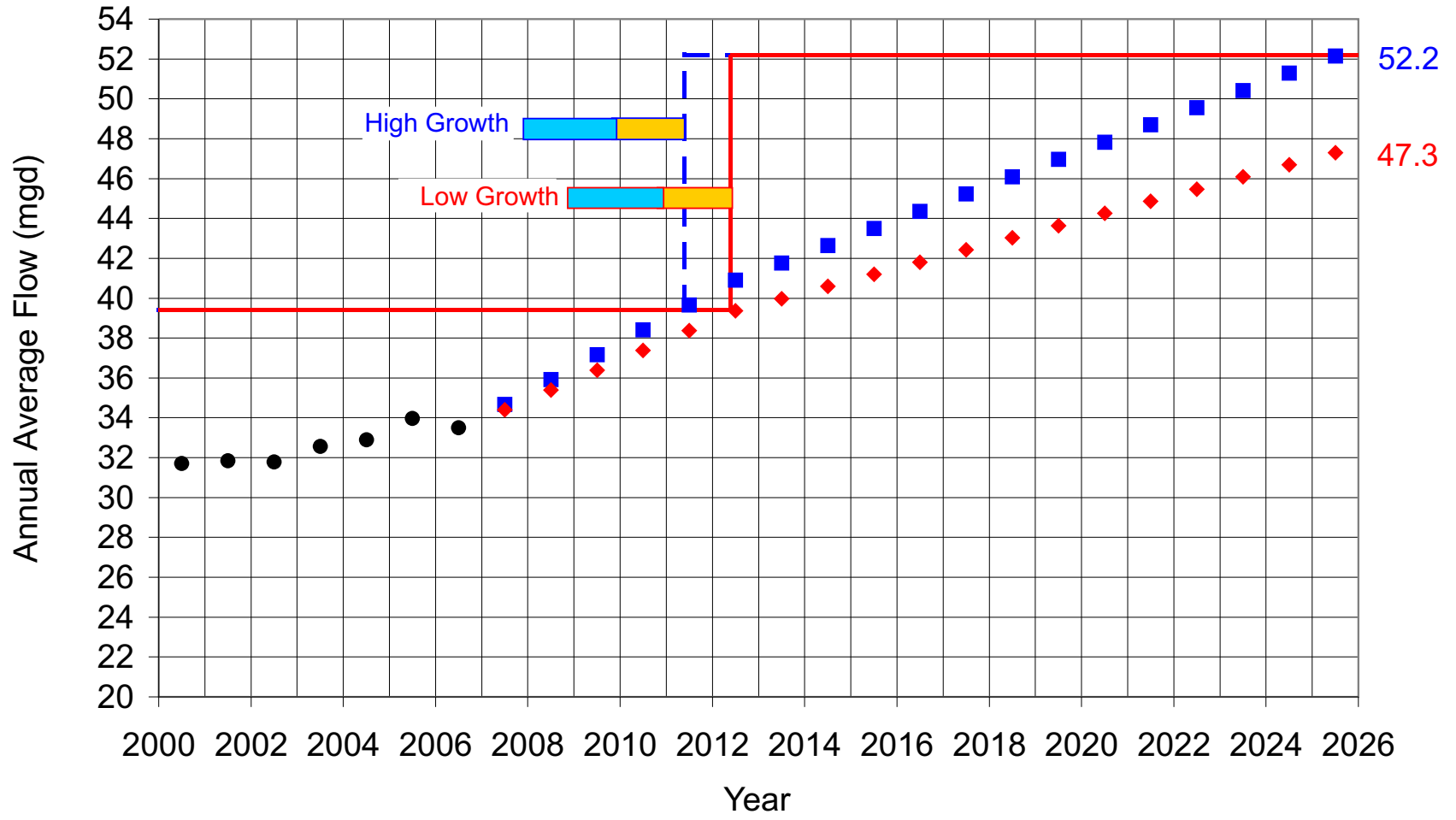
Master Plan Flow Projections (0.75% Annual Increase – Low-Growth Scenario)

Planning/Design

Construction/Startup

WAS THICKENER SCHEDULE

FIGURE 8.4



MULTI-COMPONENT ACID PHASE DIGESTER SCHEDULE

FIGURE 8.5

project consisting of the Plant 1 Primary Expansion, MBR Facilities, and Acid-Phase Digester would be completed, instead of completing the projects separately.

At the meeting, it was also decided that the WAS thickeners will be constructed as a separate project. Assuming the low-growth scenario, the combined project needs to begin in January of 2008, based on a 2-year planning/design period and a 3.5-year construction/start-up period (Figure 8.6). Figure 8.7 shows the schedule of the combined project with the high-growth scenario.

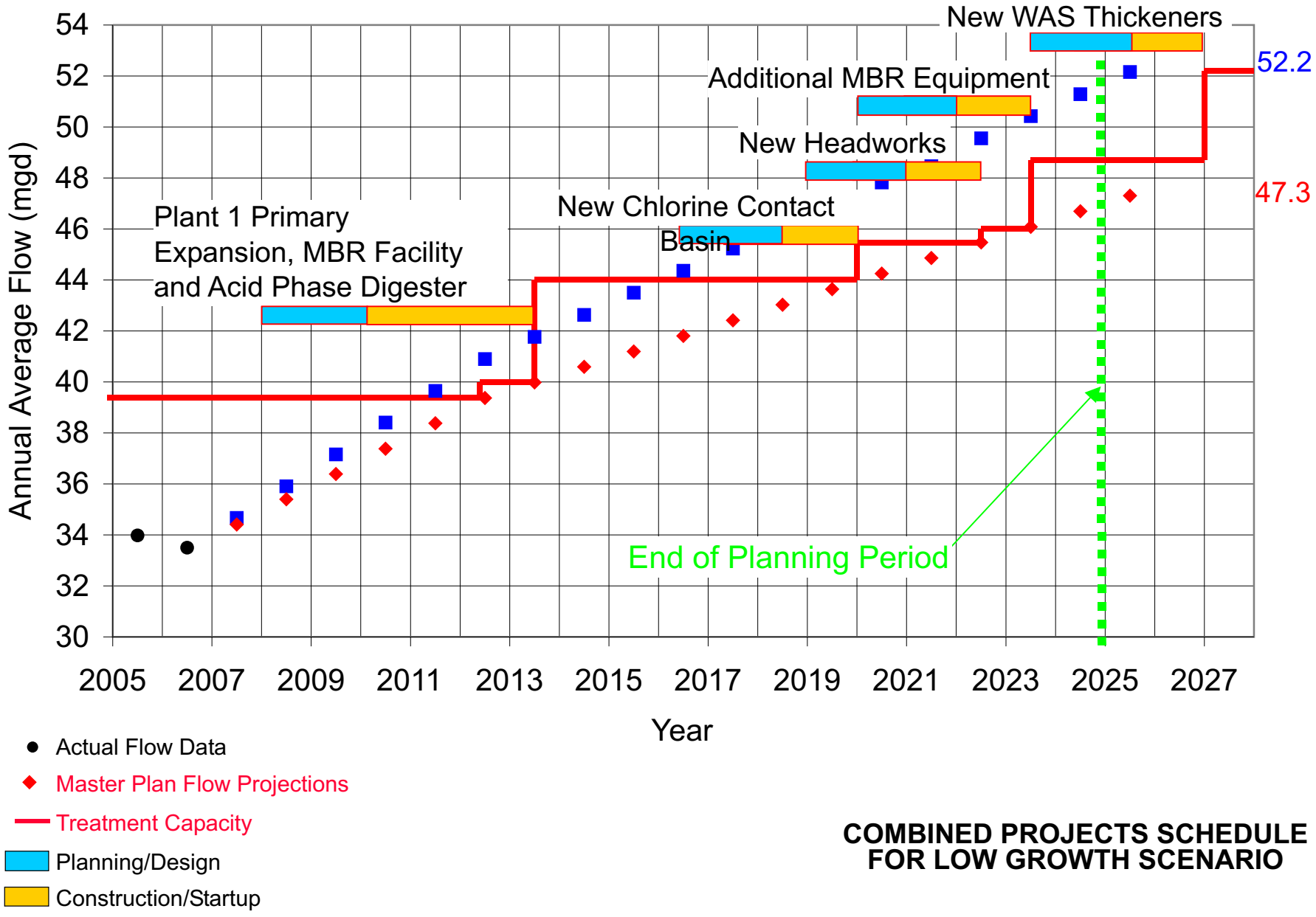
8.6 IMPLEMENTATION COST

The total project costs of the new liquid and solids stream facilities are summarized in Table 8.1. This is also presented in Volume 4, Chapter 14 - Implementation Schedule and Cost. The costs are based on an Engineering News-Record (ENR) value of 8,570 (Los Angeles, August 2006). The midpoint construction costs, adjusted for the phasing and schedule, are presented in Volume 10 - CIP and Overall Implementation Schedule.

Table 8.1 Total Project Cost for Proposed Expansion - Liquid and Solids Stream Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

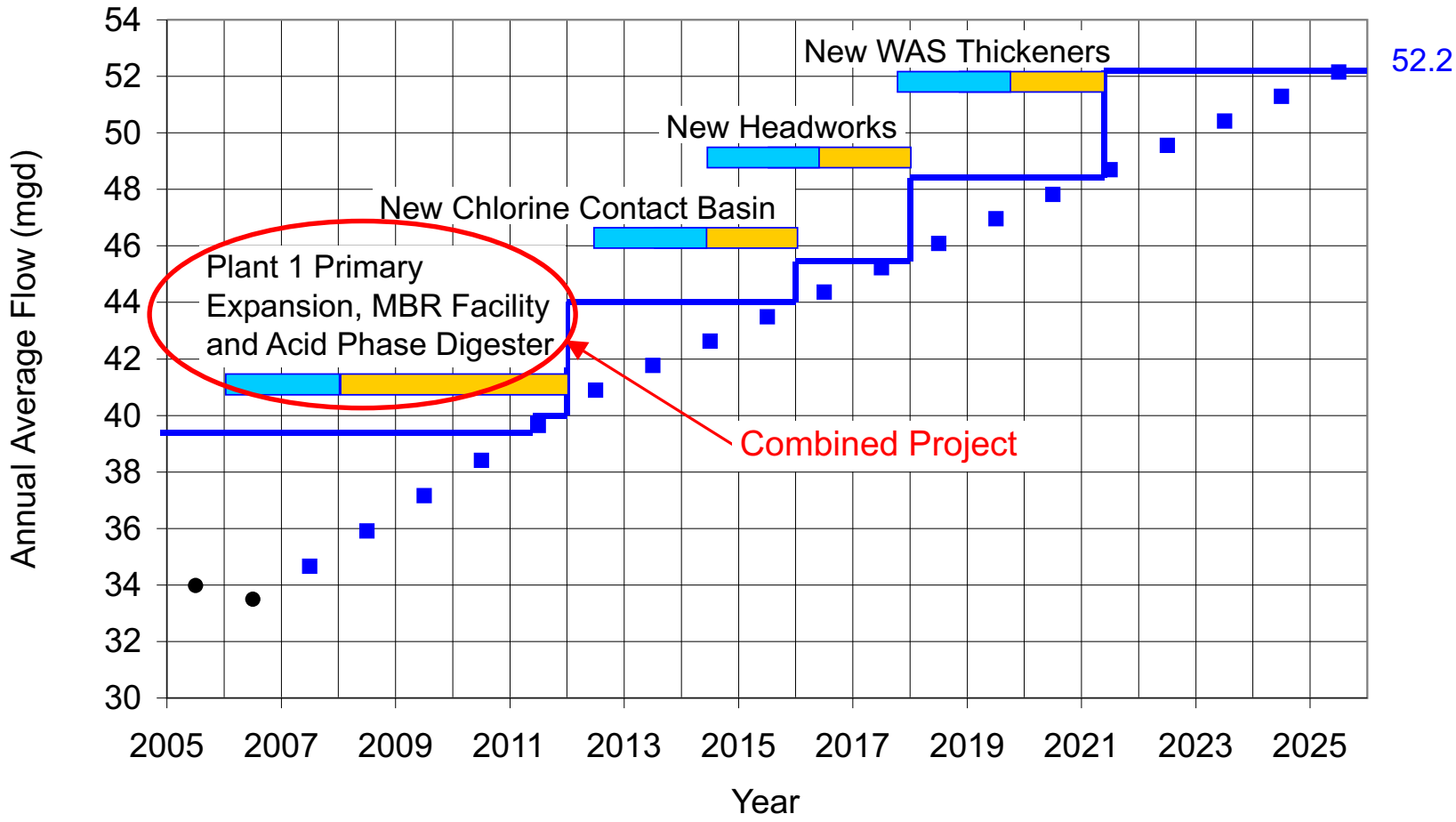
Separate Projects	Project Cost[(1)]	Combined Projects	Project Cost[(1)]
Plant 1 Primary Expansion	$64 M	Primary, MBR, and Digester	$185 M
Primary Clarifiers		Primary Clarifiers	
Primary Sludge Pump Station		Primary Sludge Pump Station	
Primary Sludge Thickening Facility[(2)]		Primary Sludge Thickening Facility[(2)]	
Primary Effluent Equalization Basins		Primary Effluent Equalization Basins	
Biofilters		Biofilters	
MBR Facility	$108 M	MBR Facility	
Acid-Phase Digester[(2)]	$13 M	Acid-Phase Digester[(2)]	
New Chlorine Contact Basin	$4 M	New Chlorine Contact Basin	$4 M
New Headworks	$10 M	New Headworks	$10 M
Additional MBR Equipment	$12 M	Additional MBR Equipment	$12 M
WAS Thickening Facility[(2)]	$17 M	WAS Thickening Facility[(2)]	$17 M
Total Cost	**$228 M**	**Total Cost**	**$228 M**

Notes:
(1) As present value (ENR value of 8,570 for Los Angeles in August 2006).
(2) Details discussed in Volume 8 - Solids Treatment and Handling.



COMBINED PROJECTS SCHEDULE FOR LOW GROWTH SCENARIO

FIGURE 8.6



COMBINED PROJECTS SCHEDULE FOR HIGH GROWTH SCENARIO

FIGURE 8.7

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT
CHAPTER 1: EXISTING ENERGY SYSTEMS

FINAL
February 2008

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT
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Chapter 1

EXISTING ENERGY SYSTEMS

1.1 PURPOSE

The purpose of this chapter is to summarize the existing energy systems at the City of Riverside (City) Regional Water Quality Control Plant (RWQCP).

1.2 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd on an average annual (AA) basis. The RWQCP has a rated capacity of approximately 40-mgd AA. The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs for up to the year 2025. Energy systems are an integral part of the RWQCP operation. With proper planning and appropriate implementation of energy system improvements, the RWQCP will reduce the need for outside sources of energy (power and natural gas) and be able to cost effectively treat and dispose of wastewater solids.

1.3 EXISTING ENERGY SYSTEMS

The energy systems of the plant consist of an electrical power system, a natural gas system, a digester heating system, and a digester gas system.

1.3.1 Existing Power System

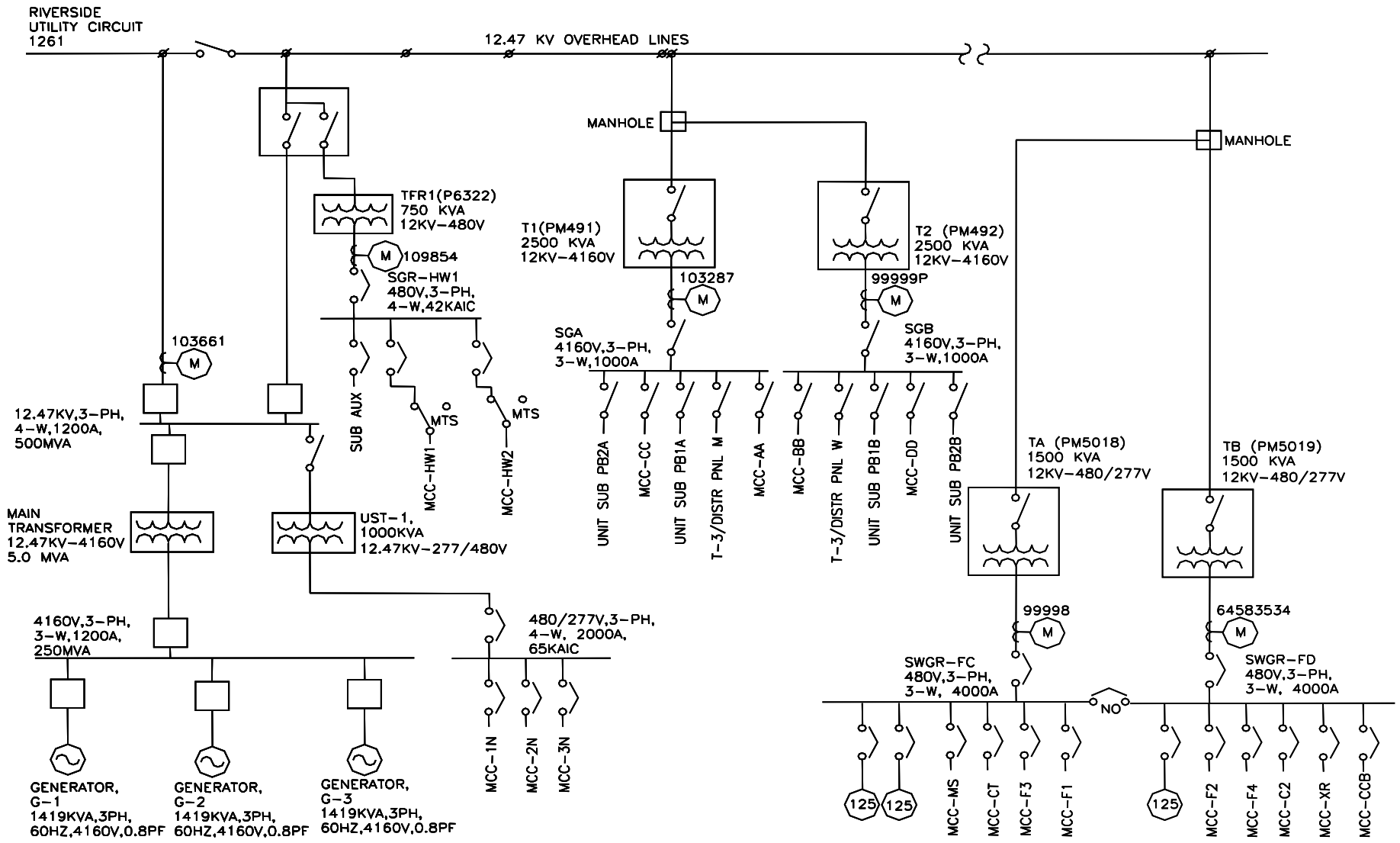
The RWQCP receives normal power from the Riverside Public Utility electrical grid and in-plant cogeneration system. The existing RWQCP electrical configuration and distribution plan are shown on Figures 1.1 and 1.2, respectively.

The Riverside Public Utility provides two feeds into the plant's single 12-kV overhead line. These two feeds originate from the same utility substation and only the feed coming into the plant entrance on Acorn Street is in service. The other feed is disconnected and is used as a backup when the Acorn feed is out of service for maintenance.

In normal operation, the plant cogeneration system provides half of the plant current total load of approximately 3,000 kW, with the balance provided by the Riverside Public Utility.

1.3.1.1 Electrical Distribution System

The plant power sources (utility and cogeneration system) distribute power to the RWQCP's substations through a single common 12-kV overhead line. The substations step down the voltage to 4.16 kV or 480 volts, depending on the system. Except for the headworks facility, the existing in-plant substations are designed in a double-ended configuration and feed



EXISTING RWQCP ELECTRICAL CONFIGURATION

FIGURE 1.1

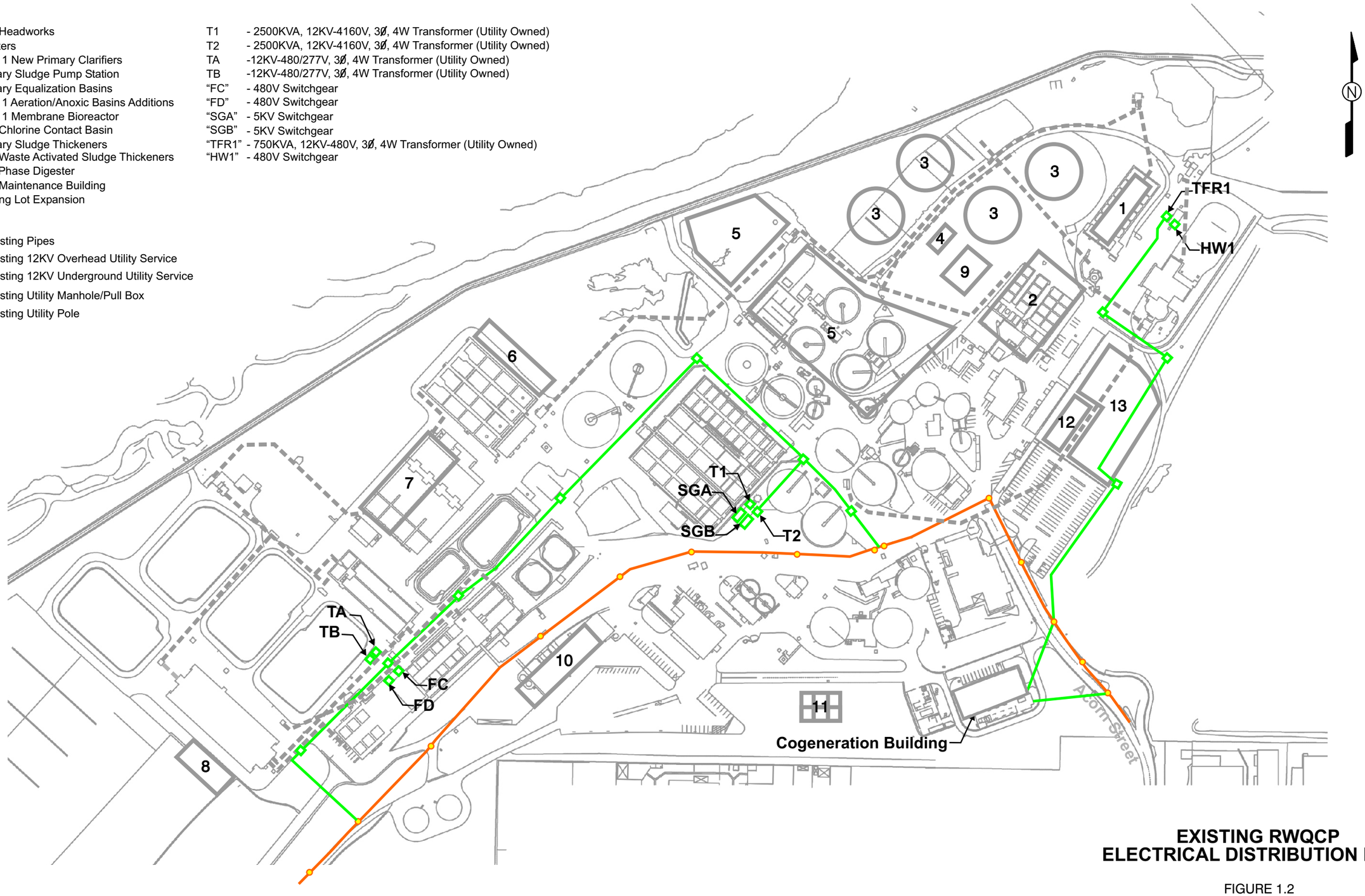
Key

1. New Headworks
2. Biofilters
3. Plant 1 New Primary Clarifiers
4. Primary Sludge Pump Station
5. Primary Equalization Basins
6. Plant 1 Aeration/Anoxic Basins Additions
7. Plant 1 Membrane Bioreactor
8. New Chlorine Contact Basin
9. Primary Sludge Thickeners
10. New Waste Activated Sludge Thickeners
11. Acid Phase Digester
12. New Maintenance Building
13. Parking Lot Expansion

T1	- 2500KVA, 12KV-4160V, 3Ø, 4W Transformer (Utility Owned)
T2	- 2500KVA, 12KV-4160V, 3Ø, 4W Transformer (Utility Owned)
TA	-12KV-480/277V, 3Ø, 4W Transformer (Utility Owned)
TB	-12KV-480/277V, 3Ø, 4W Transformer (Utility Owned)
"FC"	- 480V Switchgear
"FD"	- 480V Switchgear
"SGA"	- 5KV Switchgear
"SGB"	- 5KV Switchgear
"TFR1"	- 750KVA, 12KV-480V, 3Ø, 4W Transformer (Utility Owned)
"HW1"	- 480V Switchgear

Legend

- Existing Pipes
- Existing 12KV Overhead Utility Service
- Existing 12KV Underground Utility Service
- Existing Utility Manhole/Pull Box
- Existing Utility Pole



EXISTING RWQCP ELECTRICAL DISTRIBUTION PLAN

FIGURE 1.2

different Motor Control Centers (MCC) or Switchboards (SWBD) in their respective areas. The existing headworks facility is currently fed from a single substation, but has the provision for a future second substation, which if installed, would provide a double-ended configuration.

1.3.1.2 Standby Power System

The existing RWQCP cogeneration facility was designed to provide cogeneration and backup standby power through the controls in the plant Supervisory Control and Data Acquisition (SCADA) system. However, the backup standby power controls were not implemented in the plant SCADA system.

Currently, when the utility power fails, the cogeneration will shut down and the plant will not have any power except for the headwork facilities, which is provided with portable standby generator hook-ups.

1.3.1.3 Cogeneration System

The RWQCP cogeneration system consists of three Caterpillar gas-fired lean-burn reciprocating engine generators. These engines are fueled by a combination of digester gas and natural gas, with digester gas being the primary fuel source and natural gas being used only when digester gas is not available.

The RWQCP is within the jurisdiction of the South Coast Air Quality Management District (SCAQMD). The cogeneration engines are subject to current emissions limits as shown in Table 1.1.

Table 1.1 Emission Limits for Existing Cogeneration Engines(1)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Air Contaminant	Emission Limit, lbs/hour each
Reactive Hydrocarbons	2.1
Nitrogen Oxide, as NO_x	2.3
Sulfur Dioxide	0.4
Carbon Monoxide	8.0
PM10 Particulate Matter	1.0

Notes:
(1) Information extracted from Table 6 of the 2003 Bio-Solids Handling Improvements Report; refer to Volume 8, Chapter 2 - Summary of Planning Studies.

The engines are equipped with a continuous emission-monitoring system to ensure compliance with the NO_x emissions limit.

SCAQMD is revising the emission regulations associated with engine generators. The revised Rule 1110.2 requirements significantly lower NOx, Volatile Organic Compound (VOC), and Carbon Monoxide (CO) emission requirements. Although the rule is not final yet, the proposed limits are listed in Table 1.2. The revised rule requires all existing engines to either be retrofitted to meet these requirements or shut down, by 2012. Retrofitting to meet the revised requirement will require the addition of a Selective Catalytic Reduction (SCR) system and a CO oxidation catalyst. In order for these to work, with digester gas, a gas conditioning system will be required to remove all siloxane and sulfur compounds.

Table 1.2 SCAQMD Propose Rule 1110.2 Emission Limits for Existing Engines Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Air Contaminant	Emission Limit, ppm
NO_x	11
VOC	30
CO (fueled with natural gas)	70
CO (fueled with 90% or more digester/landfill gas)	250

Notes:
(1) From SCAQMD Rule 1110.2 (proposed) January 23, 2007.

The RWQCP has indicated that the existing cogeneration engines will be retrofitted to be fueled exclusively by natural gas. They will then be used as standby generators for the RWQCP.

To replace the cogeneration capacity that will be lost by converting the cogeneration engines to a standby power source, the RWQCP is currently installing a 1,000-kW fuel cell installation, using digester gas as the fuel source. The RWQCP staff has also indicated that an additional 1,200-kW fuel cell installation is planned to be added following successful operation of the first fuel cell system. The addition fuel cells would be added before the cogeneration engines are retrofitted in 2012.

1.3.2 Existing Natural Gas System

A summary of the existing natural gas system at the RWQCP was included in Volume 4, Chapter 11 - Plant Utilities and Support Facilities.

Natural gas is currently used as supplemental fuel for the cogeneration engines as well as for miscellaneous uses throughout the plant for space and domestic water heating and uses within the laboratory. 2006 natural gas usage data, as well as information provided by RWQCP staff, indicate that on average 9,500 therms/month are used by the cogeneration engines. This value typically ranges from 7,000 to 12,000 therms/month. The other non-cogeneration uses account for an average of 535 therms/month.

Current 2006 average natural gas costs averaged $0.90/therm for cogeneration usage and $1.03/therm for non-cogeneration uses.

1.3.3 Existing Digester Heating System

A summary of the existing digester heating system at the RWQCP was included in the 2003 Bio-Solids Handling Improvements Report. Refer to Volume 8, Chapter 2 - Summary of Planning Studies. In general, the cogeneration system supplies the heat for the digesters. Standby boilers are used when the cogeneration system is not operation.

Current average digester heating requirements are estimated at 3,255,000 Btu/hr with peak heat demand of 5,077,000 Btu/hr. The RWQCP currently accepts Fats, Oils, and Grease (FOG) in order to augment digester gas production. 2006 testing in one of the active methane digesters shows that approximately 25,000 gallons/day per digester of FOG can be added to supplement gas production. As such, the RWQCP plans to accept FOG to digest in the two active methane digesters. The amount of FOG for the two digesters was estimated at approximately 50,000-gallons/day total based on the results of the recent testing. The final amount of FOG will be dependent on availability and on how much can be added to the digester process without negatively impacting digester operation. The added FOG entering the digesters will increase the heat demand of the digestion system by an average of 80,000 Btu/hr, with peak additional heat needed of 1,000,000 Btu/hr. The plant expects to start accepting this additional FOG waste immediately. This will increase the projected current heat demands to 4,055,000 Btu/hr, average and 6,077,000 Btu/hr, peak.

1.3.4 Existing Digester Gas System

A summary of the existing digester gas system at the RWQCP was included in the 2003 Bio-Solids Handling Improvements Report. Refer to Volume 8, Chapter 2 - Summary of Planning Studies.

Current average digester gas production was measured at approximately 325,000 standard cubic feet per day (scfd), with a peak heat demand of approximately 455,000 scfd during periods with no grease addition to the digesters. As noted previously, the RWQCP currently accepts FOG in order to augment digester gas production. 2006 testing has indicated the ability to use 25,000 gallons/day of FOG within the active methane digester. The testing indicated that the addition of FOG resulted in approximately 7.4 scfd per gallon/day of FOG. Also, as noted previously, the RWQCP plans to accept approximately 50,000-gallons/day total of FOG to digest in the two active methane digesters. This additional 50,000 gallons/day of FOG entering the digesters will increase digester gas production by an average of 370,000 scfd, with peak additional production of 480,000 scfd. The plant expects to start accepting this additional FOG immediately. This will increase the projected digester gas production to 695,000 scfd, average and 936,000 scfd, peak. RWQCP staff have indicated that the target gas production level is 1,000,000 scfd. To reach this target as average digester gas production, it is estimated that approximately 100,000 gallons/day of FOG would be required.

Table 1.3 presents the anticipated average and peak digester gas production, both with and without grease addition, through 2025. The gas production values were calculated by ratioing current 2006 values, noted above, to projected plant flows. The RWQCP plant flow estimate is from Volume 2, Chapter 3 - Population and Flow Projections.

Table 1.3 Estimated RWQCP Digester Gas Production
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Year	Flow, mgd	No Grease: Average Gas Production, scfd	No Grease: Peak Gas Production, scfd	Grease Addition: Average Gas Production, scfd	Grease Addition: Peak Gas Production, scfd
2006	33.5	325,000	455,000	695,000	936,000
2007	34.4	334,000	467,000	704,000	948,000
2008	35.4	343,000	481,000	713,000	961,000
2009	36.4	353,000	494,000	723,000	975,000
2010	37.4	363,000	508,000	733,000	988,000
2011	38.4	373,000	522,000	743,000	1,002,000
2012	39.4	382,000	535,000	752,000	1,016,000
2013	40.0	388,000	543,000	758,000	1,024,000
2014	40.6	394,000	551,000	764,000	1,032,000
2015	41.2	400,000	560,000	770,000	1,040,000
2016	41.8	406,000	568,000	776,000	1,048,000
2017	42.4	411,000	576,000	781,000	1,056,000
2018	43.0	417,000	584,000	787,000	1,065,000
2019	43.6	423,000	592,000	793,000	1,073,000
2020	44.3	430,000	602,000	800,000	1,082,000
2021	44.9	436,000	610,000	806,000	1,090,000
2022	45.5	441,000	618,000	811,000	1,099,000
2023	46.1	447,000	626,000	817,000	1,107,000
2024	46.7	453,000	634,000	823,000	1,115,000
2025	47.3	459,000	642,000	829,000	1,123,000

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SUMMARY OF PLANNING STUDIES

2.1 PURPOSE

The purpose of this chapter is to summarize the planning studies, related to energy management, for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP).

2.2 PLANNING STUDIES REVIEWED

Summaries of the various planning studies conducted for the City RWQCP are shown in Volume 4, Chapter 2 - Summary of Planning Studies, and Volume 8, Chapter 2 - Summary of Planning Studies.

The planning studies presented, which have impacts on Energy Management, are:

1. Volume 4, Chapter 2:
    a. 1992 Master Plan.
    b. Regional WQCP Biosolids Handling Improvements.
1. Volume 8, Chapter 2:
    a. 2003 Bio-Solids Handling Improvements Report (2003 Report).

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Chapter 3

EXISTING AND FUTURE ENERGY USES

3.1 PURPOSE

The purpose of this chapter is to summarize the existing energy uses at the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) and provide projections for future uses.

3.2 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd annual average flow. The RWQCP has a rated capacity of approximately 40-mgd annual average flow. The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs for up to the year 2025. Energy systems are an integral part of the RWQCP operation. With proper planning and appropriate implementation of energy system improvements, the RWQCP will reduce the need for outside sources of energy (power and natural gas) and be able to cost effectively treat and dispose of wastewater solids.

3.3 EXISTING ENERGY USES

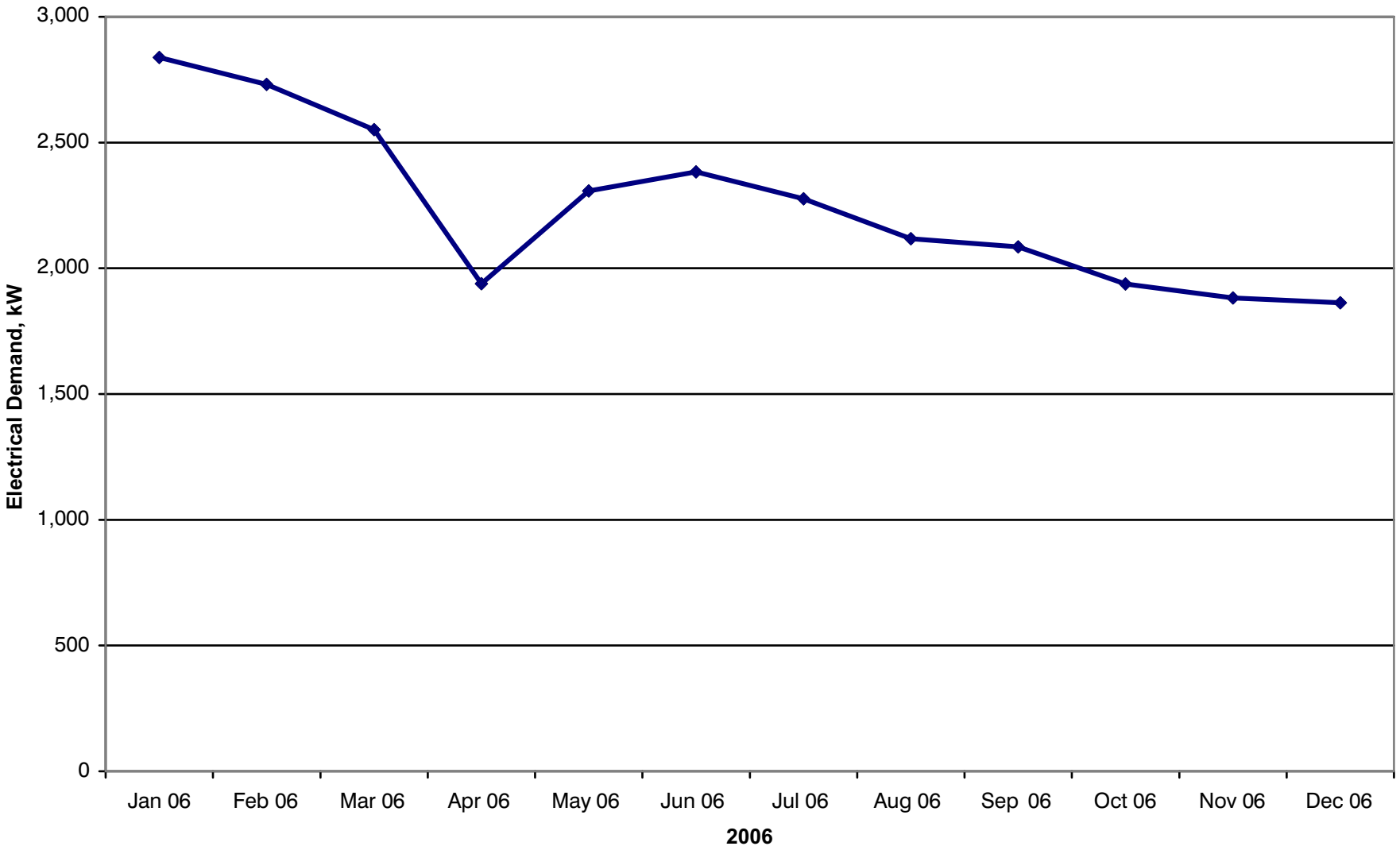
The existing energy systems of the plant consist of an electrical power system, natural gas system, digester heating system, and digester gas system.

3.3.1 Existing Power Uses

Historical data for electrical power demand and consumption at the RWQCP were obtained for the period of January 2006 to December 2006. A summary from the 2006 utility data is as follows:

Average Demand	2,456 kW
Peak Demand	
Off Peak	3,179 kW
Mid Peak	3,179 kW
On Peak	3,096 kW
Average Power Cost	$0.0919/kWh

Figure 3.1 shows the monthly average electricity demand at the RWQCP for the year 2006.



RWQCP 2006
MONTHLY AVERAGE
ELECTRICITY DEMAND

FIGURE 3.1

3.3.2 Existing Heat Uses

Hot water is utilized within the plant for building and process uses as described below. The primary heat use is for process heating of the digesters. Volume 9, Chapter 1 - Existing Energy Systems, presents information on the existing digester heating system. In addition, existing heat uses include using hot water to provide space heating and cooling for the Administration Building. These uses are further presented in Volume 8, Chapter 2 - Summary of Planning Studies.

3.4 FUTURE ENERGY USES

The future energy systems of the plant will continue to consist of an electrical power system, natural gas system, digester heating system, and digester gas system.

3.4.1 Future Power Uses

Based on the master plan, the anticipated future loads for the RWQCP are as follows:

Headworks	Additional 186 kW in year 2023
Primary Clarifier, Primary EQ, MBR and Sludge Thickening	Additional 1955 kW in year 2013; increase to 3047 in year 2025
Acid Digester	Additional 186 kW in year 2013
Disinfection	Additional 8 kW in year 2020
UV/Ozone	Possible addition of 583 kW in year 2020
WAS Thickeners	Additional 34 kW in year 2027

Figure 3.2 shows the anticipated electrical demand at the RWQCP for the next 20 years.

3.4.2 Future Heat Uses

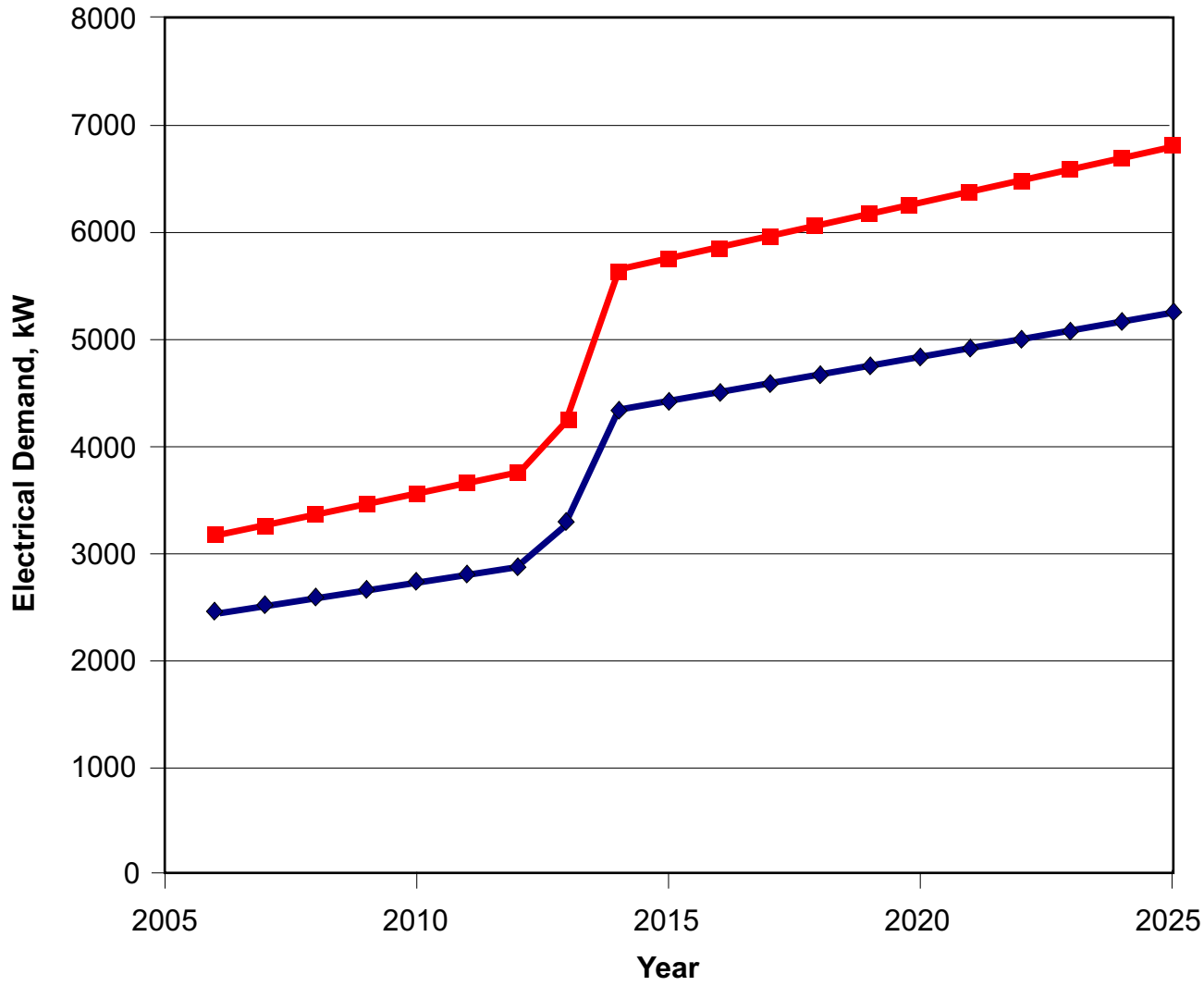
Future heat uses will include additional heat needed to provide additional digester heating required as a result of increased plant loading and flow. Projections of future digester heating through 2025 are presented in Table 3.1. The basis for future projections is presented in Volume 9, Chapter 1 - Existing Energy Systems.

Table 3.1 Estimated RWQCP Digester Heat Demand
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Year	Flow, mgd	No Grease: Average Heat Demand, Btu/hr	No Grease: Peak Heat Demand, Btu/hr	Grease Addition: Average Heat Demand, Btu/hr	Grease Addition: Peak Heat Demand, Btu/hr
2006	33.5	3,255,000	5,077,000	4,055,000	6,077,000
2007	34.7	3,374,000	5,263,000	4,174,000	6,263,000

Table 3.1 Estimated RWQCP Digester Heat Demand Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
Year	Flow, mgd	No Grease: Average Heat Demand, Btu/hr	No Grease: Peak Heat Demand, Btu/hr	Grease Addition: Average Heat Demand, Btu/hr	Grease Addition: Peak Heat Demand, Btu/hr
2008	36.0	3,493,000	5,448,000	4,293,000	6,448,000
2009	37.2	3,255,000	5,077,000	4,055,000	6,077,000
2010	38.4	3,342,000	5,213,000	4,142,000	6,213,000
2011	39.4	3,440,000	5,365,000	4,240,000	6,365,000
2012	40.4	3,537,000	5,517,000	4,337,000	6,517,000
2013	41.5	3,634,000	5,668,000	4,434,000	6,668,000
2014	42.5	3,731,000	5,820,000	4,531,000	6,820,000
2015	43.5	3,828,000	5,971,000	4,628,000	6,971,000
2016	44.4	3,887,000	6,062,000	4,687,000	7,062,000
2017	45.2	3,945,000	6,153,000	4,745,000	7,153,000
2018	46.1	4,003,000	6,244,000	4,803,000	7,244,000
2019	46.9	4,061,000	6,335,000	4,861,000	7,335,000
2020	47.8	4,120,000	6,426,000	4,920,000	7,426,000
2021	48.7	4,178,000	6,517,000	4,978,000	7,517,000
2022	49.6	4,236,000	6,608,000	5,036,000	7,608,000
2023	50.4	4,304,000	6,714,000	5,104,000	7,714,000
2024	51.3	4,363,000	6,805,000	5,163,000	7,805,000
2025	52.2	4,421,000	6,896,000	5,221,000	7,896,000

Table 3.1 presents the anticipated average and peak digester heating demand both with and without grease addition through 2025. The heat demands were calculated by ratioing the values, noted above, to projected RWQCP flows. The RWQCP flow estimate is from Volume 2, Chapter 3 - Population and Flow Projections.



PROJECTED FUTURE ELECTRICAL DEMAND AT RWQCP

FIGURE 3.2

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Chapter 4

ENERGY SAVING OPTIONS

4.1 PURPOSE

The purpose of this chapter is to identify and discuss various energy saving options that can be implemented for the Regional Water Quality Control Plant (RWQCP) expansions. The chapter also presents some of the energy saving measures, which are already in place at the RWQCP and can be expanded in the future expansion projects.

4.2 CONCLUSIONS AND RECOMMENDATIONS

- Major energy saving measures such as Variable Frequency Drive (VFD) applications, efficient blowers and diffusers, cogeneration, premium efficiency motors, medium voltage motors and distribution system, natural lighting, and energy efficient lighting and controls are already in place at the RWQCP. These measures are recommended to be included as design criteria for any future expansion projects.
- Currently, the RWQCP is installing a 1,000-kW fuel cell cogeneration system by the end of year 2007 as part of its energy saving program. The City of Riverside (City) also plans to install an additional 1,200-kW fuel cell system by the year 2012.
- Recommendations:
  - Upgrade the existing plant Supervisory Control and Data Acquisition (SCADA) system to include a Computerized Load Management System (CLMS) to continuously monitor the plant power usage and provide energy management in terms of demand and supply. The CLMS can also provide a load-shedding and load-adding sequence. It will also help with peak-shaving, off-peak power use, and generator optimization.
  - Retrofit existing eddy-current drives with VFDs for the three 250-hp filter influent pumps and two 100-hp waste backwash pumps. Replace the pump motors with premium efficiency motors.
  - Use Title 24, Part 6, of the California Code of Regulations: “California’s Energy Efficiency Standards for Residential and Nonresidential Buildings” as a design guideline for new facility construction.

4.3 BACKGROUND

As discussed in Volume 9, Chapter 3 - Existing and Future Energy Uses, electrical power demand and energy consumption at the RWQCP will increase as the plant flow increases. For the year 2006, the RWQCP paid nearly $1.7 million for the Plant 1 and Plant 2 electric energy bill (average demand about 2,456 kW at an average rate of $0.09/kWh). It is anticipated that power demand and energy usage at the RWQCP will almost double by the

year 2012. In the future, electricity rates are likely to continue increasing, prompting the RWQCP to take measures to implement energy saving projects.

4.4 IMPLEMENTED ENERGY SAVING MEASURES

The major existing energy consumption process for the RWQCP plant is the aeration process, which consumes about 50 percent of the total running load. Other substantial loads of the plant are Return Activated Sludge (RAS) pumps, Waste Activated Sludge (WAS) pumps, mixed liquor pumps, filter influent pumps, backwash pumps, and waste backwash pumps.

The following are energy saving measures, which are already incorporated at the RWQCP plant:

- Efficient blowers and diffusers.
- VFD application for all pumps except for three of the filter influent pumps and two of the waste backwash pumps.
- Premium efficiency motors.
- Gas engine cogeneration.
- Fuel cell cogeneration.
- Natural lighting.
- Energy efficient lighting and controls.
- Medium voltage motors.
- Medium voltage distribution system.

It is recommended that future RWQCP expansions continue to include these energy saving measures (except gas engine cogeneration).

4.5 ENERGY SAVING OPTIONS

The energy saving options that could be implemented at the RWQCP are described in this section.

4.5.1 Computerized Load Management System

As part of the electrical system upgrades and conversion of the cogeneration gas engine generators to backup standby power for the RWQCP expansion (Volume 9, Chapter 6 - Standby Power), a CLMS could be used to learn how and when each piece of equipment uses energy. The rate at which energy is used will vary throughout the day, depending upon factors such as influent flows and biological oxygen demand. A CLMS could plot daily electrical load as a function of time for different plant loading conditions and identify which

large equipment can be operated off-peak. It could also examine all available rate schedules to determine which can provide the lowest cost in conjunction with appropriate operational changes by reducing peak demand or shifting loads to off-peak.

The CLMS would include, but not be limited to, the following functions:

- Power monitoring.
- Energy management.
- Load management and scheduler.
- Generator priority sequence and optimization.
- Circuit breaker control and monitoring.
- Load-shedding sequence.
- Load-adding sequence.
- Advanced power quality analysis.
- Reports, event records, trending, and historical data.
- Graphical user interface.
- Graphical plant electrical system.
- Password protected for different level access authority.

4.5.2 Retrofit Existing Eddy-Current Drives with VFDs

There are three 250-hp Filter Influent Pumps (Nos. 1 through 3) that use eddy-current drives and three other 125-hp Filter Influent Pumps (Nos. 4 through 6) that use VFDs. There are also two 100-hp Waste Backwash Pumps that currently use eddy-current drives. These loads constitute about 20 percent of the plant load when these pumps are running at full load.

A well-engineered and maintained eddy-current drive application can save energy by allowing motors to operate at reduced speed. However, in this case, the RWQCP plant flows have increased to the point that these eddy-current drives are operating at 100-percent speed the majority of the time. It is recommended that the eddy-current drives be replaced with VFDs to provide greater operating flexibility. In conjunction with the new VFDs, replace the pump motor with a VFD-rated and premium efficiency motor. This retrofit will yield energy and maintenance savings due to greater pumping system efficiency and less frequent maintenance when compared to eddy-current drives.

4.5.3 Implement Title 24 Design Guidelines

Part 6 of Title 24 of the California Code of Regulations contains standards for energy efficiency for buildings. The standards were established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods.

The wastewater facility is not required to comply with this standard, but it is recommended that this standard act as a design guideline for new RWQCP facility construction.

4.5.4 Implement Leadership in Energy and Environmental Design Standard

The Leadership in Energy and Environmental Design (LEED) is the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings. LEED encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria.

The City has adopted a “Green Municipal Building Policy,” for new City buildings in excess of 5,000 square feet, to meet the LEED standard. All buildings proposed as part of the Master Plan will be designed and constructed to meet the LEED standard.

4.5.5 Other Energy Saving Ideas

- Maintenance: A program of regular cleaning, replacement, and maintenance of lamps and luminaries can significantly save energy. A typical lamp, as it reaches 80 percent of its useful life, produces 15 to 35 percent less light due to lamp degradation. Dust, dirt, and other materials on lamps, reflectors, and lenses can decrease lighting output by 30 percent or more. Photocells used to activate outdoor lights should also be cleaned regularly.
- General Operation and Maintenance: For older space conditioning systems, replacing the heating pilot light with an electronic intermittent ignition device will eliminate unnecessary energy use. To prevent energy losses caused by dirt, maintenance routines should include regular cleaning of the cooling condenser, evaporator coils, and intake louvers. Regular cleaning of air filters alone can lower energy use as much as 20 percent and extend equipment life. Outside air economizers should be cleaned regularly and checked to ensure that they are functioning properly.
- Lighting Controls: Simple controls can eliminate unnecessary lighting in the many facility areas that do not require continuous lighting. Occupancy sensors detect the presence of personnel within an area and turn lights on and off accordingly. Time switches that turn lighting systems on and off are useful for outdoor signs, security lighting, and corridors. Dimming systems take advantage of daylight to further reduce

energy use and costs. Photocell controls provide easy, effective on/off switching of outdoor lighting. In addition, photocells can be combined with time switch controls for areas that do not require lighting all night.

- Power Factor Correction: A low power factor is frequently caused by motors that run less than fully loaded. This also wastes energy because motor efficiency drops off below 75-percent load. Examine motor systems to determine if the motor should be resized or if a smaller motor can be added to handle lower loads. Perform a plant-wide power factor study to determine which of the plant busses require power factor correction. A power factor can also be corrected by installing a capacitor in parallel with equipment that is run at less than full load.
- Reduction in Harmonics: As more and more applications of non-linear equipment such as VFDs, Uninterruptible Power Supplies (UPS), fluorescent lamps, computers, etc., are used in the plant, more harmonics are being introduced to the electrical system. Besides causing unwanted tripping to relaying, telephone interference, misoperation to electronic equipment, and resonance, harmonics also generate heat losses in transformers, cables, switchgear, motors, and generators. Measures such as harmonic filters and 18-pulse technology for VFDs rated 100 hp and above, can be used to mitigate the harmonics.
- Energy Efficient NEMA TP-1 Dry-Type Low-Voltage Distribution Transformers: The goal of NEMA TP-1 efficiency levels for 600-volt class distribution transformer is to reduce energy consumption when the transformer is lightly loaded. At low load levels, no load losses account for most of the losses of a transformer. A NEMA TP-1 transformer is the most efficient transformer and the most economical choice for applications where the anticipated daily loading of a distribution transformer is around 40 percent or less of the full capacity of the transformer.

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Chapter 5

POWER SUPPLY ALTERNATIVES

5.1 PURPOSE

The purpose of this chapter is to present alternatives for future power supply for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP).

5.2 CONCLUSIONS AND RECOMMENDATIONS

- Due to more stringent emission requirements for cogeneration engines, the City has decided to convert their existing cogeneration engines to standby generators, which do not require the same ultra-low emissions.
- The City has decided to install a new 1,000-kW fuel cell cogeneration system and follow with another 1,200-kW fuel cell system once the first project is installed and proven.
- At the project meeting on April 16, 2007, the City decided to install a low-pressure gasholder because of the higher capital and maintenance costs associated with high-pressure digester gas systems.

5.3 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd. The RWQCP has a rated capacity of approximately 40 mgd. The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs for up to the year 2025. Energy systems are an integral part of the RWQCP operation. With proper planning and appropriate implementation of energy system improvements, the RWQCP will be able to cost effectively treat and dispose of wastewater solids.

5.4 POWER SUPPLY ALTERNATIVES

Various electrical power supply alternatives are available at the RWQCP. These include the following:

1. Utility Power (Dual Feeds).
2. Continued Use of Existing Cogeneration System.
3. Use of New Fuel Cells (currently being installed).
4. Planned Fuel Cell Expansion.

The above alternatives are discussed in more detail as follows.

5.4.1 Utility Power (Dual Feeds)

The plant receives utility power from the Riverside Public Utilities at a 12-kV voltage level. The Riverside Public Utilities provides dual feeds, which originate from the same utility substation into the plant distribution system. Only the feed coming into the plant entrance on Acorn Street is in service, while the other feed is disconnected and is used as a backup when the Acorn feed is out of service for maintenance.

At present, it is not known if there is a plan for the Riverside Public Utilities to provide a separate utility substation for the other feed. Because it is a single feed, the existing utility configuration does not provide power reliability to the plant. The plant will lose power when the utility substation requires maintenance or when the substation experiences an electrical disturbance/fault. The existing plant generation system is not currently able to operate as a standby power source.

Standby power alternatives are discussed in Volume 9, Chapter 6 - Standby Power.

5.4.2 Existing Cogeneration System

The plant currently has three 1,100-kW lean-burn engine generators installed that are used to generate heat and power for the RWQCP. The engines were installed in approximately 1999. The engines are fueled with a mixture of digester gas and natural gas. Typically, one or two engines are operated depending on gas availability and the economics of the operating units. During periods of high electric utility cost (on peak periods) two engines are operated as much as possible to minimize the purchase of high-priced power. The RWQCP generates enough digester gas when the digesters are not augmented with Fats, Oils, and Grease (FOG) to generate approximately 900 kW of electric power on average. Operation of one engine at full load and/or operation of the second engine requires either digester gas augmentation with FOG addition or natural gas usage.

The engines have heat recovery systems installed which recover heat from the engine jacket water-cooling system as well as from the engine exhaust. Heat is recovered as hot water into the RWQCP's hot water heating system. Heat provided by the operating engine(s) is sufficient to provide plant heating needs during all but the most extreme cold weather conditions.

Recent proposed changes by South Coast Air Quality Management District (SCAQMD) will impact the existing cogeneration engine generators.

5.4.2.1 SCAQMD Regulations

SCAQMD has recently proposed new regulations for both new and existing engine generators operating within the SCAQMD air basin. The new emission rule, while not final and approved, is expected to be implemented in 2008. The proposed rule is SCAQMD Rule 1110.2. The rule will require new and existing engine generators to meet ultra-low NOx, CO, and VOC emission requirements, as well as require installation of Continuous

Emissions Monitoring (CEMS) equipment. The rule mandates that existing non-standby engine generators be modified to meet the new ultra-low emission requirements or be shut down. There is a sliding schedule for implementation of the new standard that will affect the existing engines. Engines fueled with natural gas must be retrofitted or shut down prior to 2010, while engines fueled with digester and/or landfill gas must be retrofitted or shut down prior to 2012. The existing engine generators likely would fall into the 2010 scheduling window.

The existing engine generators currently have CEMS equipment installed. In order to meet the ultra-low emissions requirements, the existing engine generators would need to be modified to include both Selective Catalytic Reduction (SCR) and CO oxidation catalyst equipment. In order to assure that this equipment will be operational with digester gas, fuel treatment equipment designed to remove all H_2S and siloxane compounds from the digester and landfill gas would also be required.

Cost estimates for installing systems are included in Appendix A and are summarized in Table 5.1.

Table 5.1 Estimated Construction Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Estimated Construction Costs
Fuel Conditioning System	$2,479,000
SCR Equipment	$1,125,000
CO Oxidation Catalyst Equipment	$471,000
Total Project Costs	$5,297,000

These systems will also significantly increase operations and maintenance costs of the existing engine generator systems.

The City has made a decision, based on the expected costs, to convert the existing engines to natural gas only operation for use as standby generators. Emission rules for standby generators do not require the ultra-low emissions noted above, thus the modifications noted above would not be required.

5.4.3 New Cogeneration System

As part of the conversion of the existing engine generator systems to standby engines, the City has decided to install a new cogeneration system. The City is currently installing a new 1,000-kW fuel cell project and plans to follow this with another 1,200-kW fuel cell project once the first project is installed and proven.

5.4.3.1 Existing Fuel Cell Project

The City has contracted with Alliance Power to install a new 1,000-kW fuel cell cogeneration system at the RWQCP. The project is currently under design with installation expected to be complete in early 2008. The existing fuel cell project consists of installing a Fuel Cell Energy FCE1500 fuel cell system complete with hot water heat recovery equipment, fuel treatment, and all ancillary equipment required to install and operate the new fuel cell system at the RWQCP. The City will receive a grant from the State of California Self Generation Incentive Program (SGIP). The SGIP will provide $4,500,000 to the City once the project is operational.

5.4.3.2 Planned Fuel Cell Expansion

The City plans to install a similar 1,200-kW fuel cell system following installation of the existing fuel cell project. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.2.

Table 5.2 1,200-kW Fuel Cell Installation
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Estimated Construction Costs
Estimated Construction Costs	$10,139,000
Total Project Costs	$13,181,000

The City has indicated that they expect to receive grant funding for a portion of the project cost from the SGIP. As currently written, the SGIP only allows funding to be received up to a total of $4,500,000 for fuel cell installations. In order for the City to realize additional funding from the SGIP, program changes must first be made by the program administrators. The possibility of receiving additional funding cannot be assured at this time.

5.4.4 Existing Digester Gas System

The existing digester gas system is comprised of a piping network that collects digester gas from all active digesters. The digester gas is conveyed either via numerous gas boosters to existing boilers or via compressors to the existing cogeneration system. Digester gas not used by the above boilers or existing cogeneration equipment is automatically flared in the RWQCP emergency flare. The digester gas system collects digester gas at pressures that range from 7 to 14 inches of water column. The City has expressed concern regarding operation of the existing digester gas system. Control of blower, compressors, and the flare are very difficult due to lack of adequate volume within the digester gas system. When devices start/stop or change load, the pressure within the digester gas system changes. These abrupt changes impact the control schemes of the operating equipment causing operational issues with the digester gas utilizing equipment. The City has requested that digester gas storage be included within the digester gas system to alleviate the pressure

control problems. Two types of storage are utilized within digester gas systems, low-pressure digester gasholders or high-pressure digester gasholders.

5.4.4.1 Low-Pressure Digester Gasholders

Low-pressure digester gasholders consist of an expandable storage vessel capable of holding approximately 10,000 cubic feet (can be larger or smaller). As digester gas production increases or digester gas usage decreases, excess digester gas expands the gasholder, similarly as digester gas production decreases or digester gas usage increases, digester gas is drawn from the gasholder. As long as the gasholder is not completely full or empty the pressure within the digester gas system remains constant during these changes. Thus operation of digester gas equipment would no longer be impacted by pressure fluctuations. A key advantage offered by this type of system is the ability to utilize level (or volume) measurements within the gasholder as control signals for the operating digester gas equipment. Because of the large volumes stored in the gasholder, control is greatly simplified.

The costs to install a 10,000 cubic foot gasholder into the existing low-pressure digester gas system has been estimated. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.3.

Table 5.3 10,000-Cubic Foot Gasholder Installation
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Estimated Construction Costs
Estimated Construction Costs	$1,046,000
Total Project Costs	$1,360,000

5.4.4.2 High-Pressure Digester Gasholders

High-pressure digester gasholders appropriate for the RWQCP would consist of a high-pressure storage sphere capable of holding approximately 250,000 cubic feet of digester gas. The sphere would have a design pressure of approximately 75 psig. One or two high-pressure compressors would be part of the system. The compressors would compress low-pressure digester gas for storage into the high-pressure gasholder. Typically, high-pressure storage spheres are used to allow storage of digester gas for later use. A common use is to allow for multiple engines to be run during peak power periods. Using a high-pressure gasholder for pressure control in a low-pressure digester gas system is not typically done, although it is possible. Unlike the low-pressure gasholder previously described, installation of a high-pressure gasholder will not allow the low-pressure gas system to operate at constant pressure. Operation of the gas storage system is typically done by pressure control, such that as pressure increases above a preset value, the lead compressor operates to store gas, as gas pressure falls below a preset value a pressure-reducing valve opens to admit high-pressure digester gas into the low-pressure

system. Without significant design attention, such a system may not address the issue of pressure fluctuation control desired by the City.

The costs to install a 250,000-cubic foot high-pressure gasholder into the existing low-pressure digester gas system have been estimated. Estimated construction and project costs associated with this project are included in Appendix A and are summarized in Table 5.4.

Table 5.4 250,000-Cubic Foot High-Pressure Gasholder Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Estimated Construction Costs
Estimated Construction Costs	$4,076,000
Total Project Costs	$5,299,000

In addition, high-pressure digester gasholders require significant operating and maintenance expenses. The digester gas compression equipment will include an approximately 150-hp compressor. The compression equipment is very maintenance-intensive and requires electricity to operate. In addition, annual inspections of the ASME-stamped storage vessel are required. Annual operating costs for a high-pressure storage system could be $25,000 to $75,000 per year.

Appendix A

COST ESTIMATES

carollo engineers

PROJECT : Cogen Preliminary Design
Riverside RWQCP
JOB # : 7472A.00
SUBJECT: Fuel Treatment System

DATE : 15-Jun-07
BY : TGM
CHECKED :
DATE : 15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	None	0	SF	$0	1.00	$0
11	**EQUIPMENT**					
	Fuel Treatment System	1	LS	$1,000,000	1.25	$1,250,000
15	**MECHANICAL**					
	Misc. piping	1	LS	$15,000	1.00	$15,000
	SUBTOTAL					$1,265,000
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$190,000	1.00	$190,000
	SUBTOTAL					$1,455,000
	CONTINGENCY - 30%					$437,000
	SUBTOTAL					$1,892,000
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$189,000
	General Overhead & Profit - 15%					$284,000
	Sales Tax - 7.75% on material					$73,000
	SUBTOTAL					$546,000
	Bid Market Allowance - 15%					$41,000
	TOTAL CONSTRUCTION COST					$2,479,000
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$744,000	1.00	$744,000
	SUBTOTAL					$744,000
	Total Project Cost					$3,223,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

carollo engineers

PROJECT :	Cogen Preliminary Design Riverside RWQCP	**DATE :**	15-Jun-07
		BY :	TGM
JOB # :	7472A.00	**CHECKED :**	
SUBJECT:	SCR System Installation	**DATE :**	15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	None	0	SF	$0	1.00	$0
11	**EQUIPMENT**					
	SCR System	3	LS	$145,000	1.25	$543,750
15	**MECHANICAL**					
	Misc. piping	3	LS	$10,000	1.00	$30,000
	SUBTOTAL					$573,750
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$86,000	1.00	$86,000
	SUBTOTAL					$659,750
	CONTINGENCY - 30%					$198,000
	SUBTOTAL					$857,750
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$86,000
	General Overhead & Profit - 15%					$129,000
	Sales Tax - 7.75% on material					$33,000
	SUBTOTAL					$248,000
	Bid Market Allowance - 15%					$19,000
	TOTAL CONSTRUCTION COST					$1,124,750
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$337,000	1.00	$337,000
	SUBTOTAL					$337,000
	Total Project Cost					$1,461,750

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

carollo engineers

PROJECT :	Cogen Preliminary Design Riverside RWQCP	**DATE :**	15-Jun-07
		BY :	TGM
JOB # :	7472A.00	**CHECKED :**	
SUBJECT:	CO Catalyst Installation	**DATE :**	15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	None	0	SF	$0	1.00	$0
11	**EQUIPMENT**					
	CO Catalysts	3	LS	$60,000	1.25	$225,000
15	**MECHANICAL**					
	Misc. piping	3	LS	$5,000	1.00	$15,000
	SUBTOTAL					$240,000
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$36,000	1.00	$36,000
	SUBTOTAL					$276,000
	CONTINGENCY - 30%					$83,000
	SUBTOTAL					$359,000
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$36,000
	General Overhead & Profit - 15%					$54,000
	Sales Tax - 7.75% on material					$14,000
	SUBTOTAL					$104,000
	Bid Market Allowance - 15%					$8,000
	TOTAL CONSTRUCTION COST					$471,000
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$141,000	1.00	$141,000
	SUBTOTAL					$141,000
	Total Project Cost					$612,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

carollo engineers

PROJECT :	Cogen Preliminary Design	**DATE :**	15-Jun-07
	Riverside RWQCP	**BY :**	TGM
JOB # :	7472A.00	**CHECKED :**	
SUBJECT:	Low Pressure Digester Gas Storage	**DATE :**	15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	Pad	2000	SF	$25	1.00	$50,000
11	**EQUIPMENT**					
	10,000 cu. Ft. Low pressure storage holder	1	LS	$500,000	1.00	$500,000
15	**MECHANICAL**					
	Misc. piping	1	LS	$20,000	1.68	$33,600
	SUBTOTAL					$533,600
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$80,000	1.00	$80,000
	SUBTOTAL					$613,600
	CONTINGENCY - 30%					$184,000
	SUBTOTAL					$797,600
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$80,000
	General Overhead & Profit - 15%					$120,000
	Sales Tax - 7.75% on material					$31,000
	SUBTOTAL					$231,000
	Bid Market Allowance - 15%					$17,000
	TOTAL CONSTRUCTION COST					$1,045,600
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$314,000	1.00	$314,000
	SUBTOTAL					$314,000
	Total Project Cost					$1,359,600

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

carollo engineers

PROJECT :	Cogen Preliminary Design Riverside RWQCP	**DATE :**	15-Jun-07
		BY :	TGM
JOB # :	7472A.00	**CHECKED :**	
SUBJECT:	High Pressure Digester Gas Storage	**DATE :**	15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	40'x30' compressor bldg @ $125/sq ft	1200	SF	$125	1.00	$150,000
	Storage Sphere Pad	2500	SF	$25	1.00	$62,500
11	**EQUIPMENT**					
	500scfm 150 HP 70 psig Oil flooded rotary screw compr.	2	LS	$100,000	1.50	$300,000
	250,000cfm / 50 psig CS storage sphere	1	LS	$1,750,000	1.00	$1,750,000
15	**MECHANICAL**					
	Misc. piping	1	LS	$20,000	1.50	$30,000
	SUBTOTAL					$2,080,000
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$312,000	1.00	$312,000
	SUBTOTAL					$2,392,000
	CONTINGENCY - 30%					$718,000
	SUBTOTAL					$3,110,000
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$311,000
	General Overhead & Profit - 15%					$467,000
	Sales Tax - 7.75% on material					$121,000
	SUBTOTAL					$899,000
	Bid Market Allowance - 15%					$67,000
	TOTAL CONSTRUCTION COST					$4,076,000
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$1,223,000	1.00	$1,223,000
	SUBTOTAL					$1,223,000
	Total Project Cost					$5,299,000

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

carollo engineers

PROJECT :	Cogen Preliminary Design Riverside RWQCP	**DATE :**	15-Jun-07
		BY :	TGM
JOB # :	7472A.00	**CHECKED :**	
SUBJECT:	Fuel Cell System	**DATE :**	15-Jun-07

DIVISION	DESCRIPTION	QTY.	UNIT	UNIT PRICE	INSTALL ADJ.	TOTAL
2 thru 10	**BUILDING & SITE WORK**					
	Pad	3500	SF	$25	1.00	$87,500
11	**EQUIPMENT**					
	Fuel Cell System	1	LS	$3,720,000	1.30	$4,836,000
15	**MECHANICAL**					
	Misc. piping	1	LS	$150,000	1.68	$252,000
	SUBTOTAL					$5,175,500
16	**ELECTRICAL AND INSTRUMENTATION - 15%**	1	LS	$776,000	1.00	$776,000
	SUBTOTAL					$5,951,500
	CONTINGENCY - 30%					$1,785,000
	SUBTOTAL					$7,736,500
0	**GENERAL CONDITIONS**					
	General Conditions - 10%					$774,000
	General Overhead & Profit - 15%					$1,160,000
	Sales Tax - 7.75% on material					$300,000
	SUBTOTAL					$2,234,000
	Bid Market Allowance - 15%					$168,000
	TOTAL CONSTRUCTION COST					$10,138,500
	DESIGN, CONSTRUCTION ADMINISTRATION AND PROJECT MANAGEMENT - 30%	1	LS	$3,042,000	1.00	$3,042,000
	SUBTOTAL					$3,042,000
	Total Project Cost					$13,180,500

Installation adj. accounts for freight, taxes, installation and contractor O&P associated with installing equipment.
When listed as 1.00, these costs are included in the unit price.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT SYSTEM
CHAPTER 6: STANDBY POWER

FINAL
February 2008

Carollo Engineers...Working Wonders With Water™

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT SYSTEM
CHAPTER 6: STANDBY POWER

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STANDBY POWER

6.1 PURPOSE

The purpose of this chapter is to evaluate expansion alternatives for the Regional Water Quality Control Plant (RWQCP) standby power system that will meet California Title 22 standards and EPA reliability criteria. The chapter also presents electrical system modifications that could be implemented to address the standby power requirements.

6.2 CONCLUSIONS AND RECOMMENDATIONS

1. The existing electrical system does not have permanent standby power and the RWQCP receives power from a single utility source.
2. The RWQCP power sources (utility and cogeneration) distribute the power to the plant's substations through a single common 12-kV overhead line. Failure of this overhead line will affect both power sources.
3. The existing RWQCP electrical power system may not meet California Title 22 standards and EPA reliability criteria because it does not have two separate and independent sources of electric power supply and a redundant 12-kV distribution system.
4. The plant overflow storage capability during a power failure is estimated to be between 2 and 3 hours.
5. Recommendations:
    a. Install a 12-kV underground duct bank system to complement the in-plant single 12-kV overhead line distribution system. A 12-kV switching center will need to be provided adjacent to the cogeneration facility to distribute to this underground system.
    b. Retrofit the existing gas engine cogeneration system to a standby power generation system.
    c. Retrofit or install the fuel cell cogeneration systems so that they will provide standby power in parallel with the gas engine generators.
    d. Modify or upgrade the existing RWQCP control system and electrical system to provide a standby power system.

6.3 BACKGROUND

The EPA has electrical equipment reliability requirements for wastewater treatment plants, which include:

- Two separate and independent sources of electric power (e.g., utility and on-site generator). In this respect, independent sources include dual utility feeds, but only if

they are provided from two separate utility substations. Feeders that originate from a common utility substation do not satisfy the criterion for source independence.

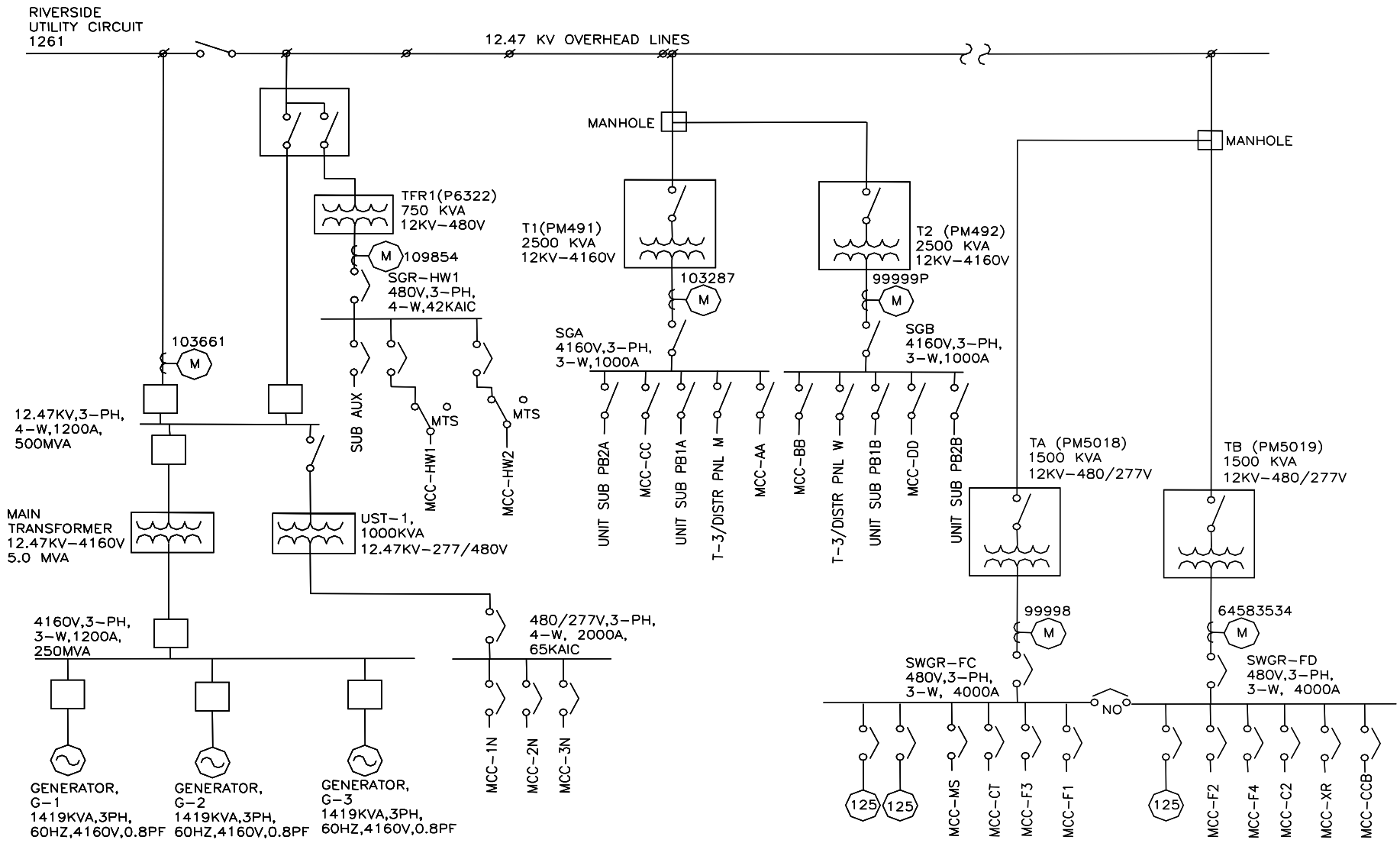
- The capacity of the backup power source shall be sufficient to operate all “vital” components during peak wastewater flow conditions (Reliability Class I).
- The independent sources of power shall be distributed to the site transformers in such a way as to minimize common mode failures from affecting both sources. For example, power source feeders cannot share common transmission/distribution poles or other common structures.

Similar reliability is also required by Title 22 water reclamation criteria. In addition, Title 22 requires a power supply reliability feature to include short-term retention or disposal for at least a 24-hour period.

The existing RWQCP cogeneration facility was designed to provide cogeneration and backup standby power through the controls in the plant Supervisory Control and Data Acquisition (SCADA) system. However, these backup standby power controls were not implemented in the plant SCADA. In normal operation, the plant cogeneration provides half of the plant’s current total load of 3,000 kW, with the balance provided by the Riverside Public Utilities.

The Riverside Public Utilities provides two feeds into the plant’s single 12-kV overhead line. These two feeds originate from the same utility substation and only the feed coming into the plant entrance on Acorn Street is in service. The other feed is disconnected and is used as a backup when the Acorn feed is out of service for maintenance. Because the two feeds are not from two separate utility substations, the plant will lose power when the utility substation requires maintenance or when the substation experiences a disturbance/electrical fault.

The existing RWQCP electrical configuration and distribution plan are shown in Figure 6.1 and Figure 6.2, respectively. As shown on both Figure 6.1 and 6.2, the plant power sources (utility and cogeneration generation) distribute the power to the plant’s substations through a single common 12-kV overhead line. Failure of this overhead line will affect both power sources. Since the existing in-plant substations are designed in a double-ended configuration, it is recommended that a new 12-kV underground duct bank system be installed as a redundant feed to the overhead line. In addition, a 12-kV switching center should be provided adjacent to cogeneration facility, to distribute the underground system to one end of the double-ended substations. The substations will then have one feed from the 12-kV overhead line and the second feed from the 12-kV underground system.



EXISTING RWQCP ELECTRICAL CONFIGURATION

FIGURE 6.1

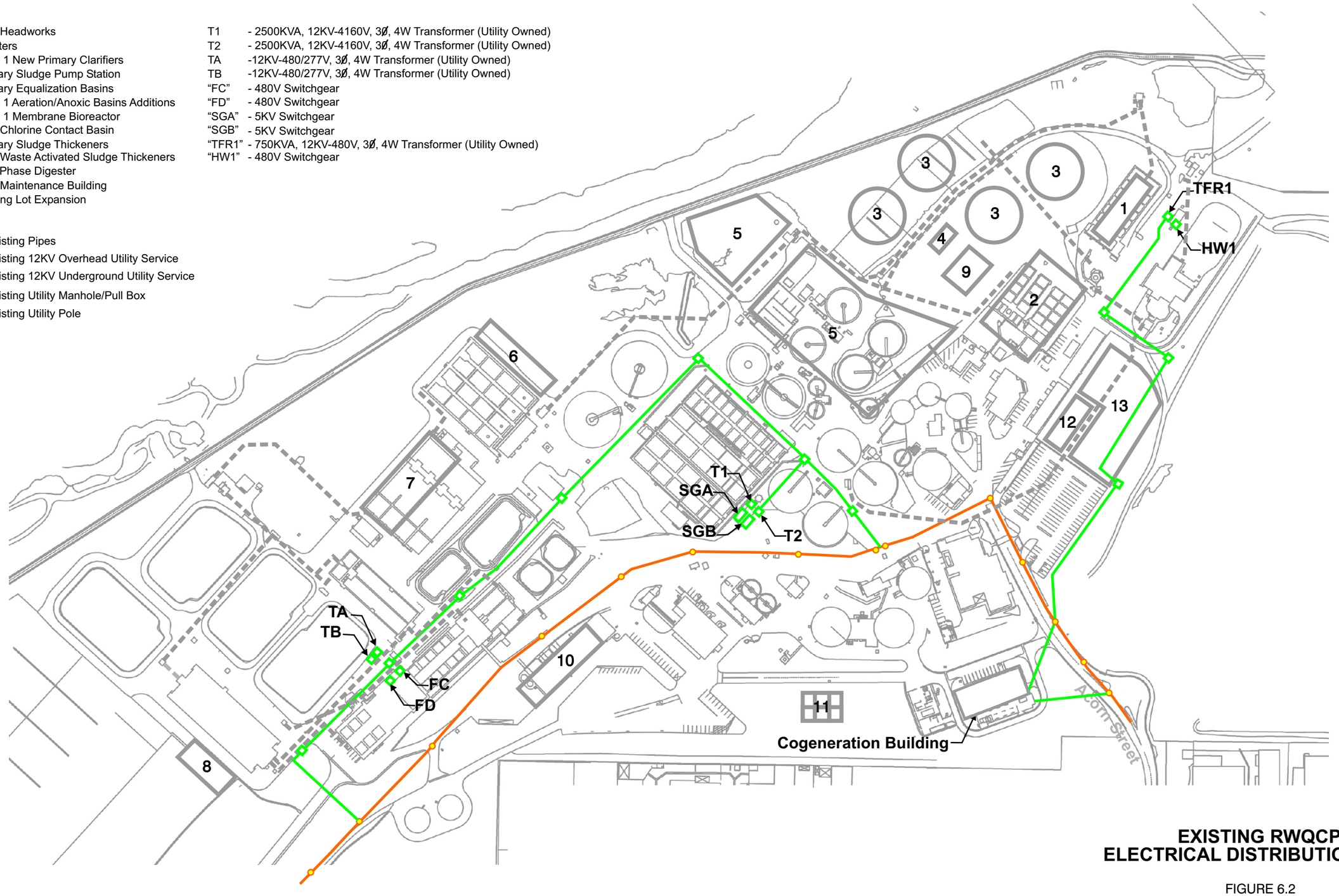
Key

1. New Headworks
2. Biofilters
3. Plant 1 New Primary Clarifiers
4. Primary Sludge Pump Station
5. Primary Equalization Basins
6. Plant 1 Aeration/Anoxic Basins Additions
7. Plant 1 Membrane Bioreactor
8. New Chlorine Contact Basin
9. Primary Sludge Thickeners
10. New Waste Activated Sludge Thickeners
11. Acid Phase Digester
12. New Maintenance Building
13. Parking Lot Expansion

T1	- 2500KVA, 12KV-4160V, 3Ø, 4W Transformer (Utility Owned)
T2	- 2500KVA, 12KV-4160V, 3Ø, 4W Transformer (Utility Owned)
TA	-12KV-480/277V, 3Ø, 4W Transformer (Utility Owned)
TB	-12KV-480/277V, 3Ø, 4W Transformer (Utility Owned)
"FC"	- 480V Switchgear
"FD"	- 480V Switchgear
"SGA"	- 5KV Switchgear
"SGB"	- 5KV Switchgear
"TFR1"	- 750KVA, 12KV-480V, 3Ø, 4W Transformer (Utility Owned)
"HW1"	- 480V Switchgear

Legend

- Existing Pipes
- Existing 12KV Overhead Utility Service
- Existing 12KV Underground Utility Service
- Existing Utility Manhole/Pull Box
- Existing Utility Pole



EXISTING RWQCP ELECTRICAL DISTRIBUTION PLAN

FIGURE 6.2

Currently, when the utility power fails, the cogeneration will shut down and the plant will not have any power except for the headwork facilities that are provided with portable backup generator hook-ups. It is estimated that the plant overflow storage capability during a power failure is between 2 and 3 hours depending on how much water is in the existing and new equalization basins.

Based on the above analysis, the existing RWQCP electrical system may not meet California Title 22 standards and EPA reliability criteria for two reasons:

1. There are no separate and independent sources of electric power supply.
2. There is no redundant power distribution system.

6.4 CRITICAL LOADS

The previous report "TM-1 Backup Power/Cogeneration," May 1992 by Montgomery, estimated that critical power need is about 70 percent of total plant running load. Based on this type of analysis on previous Carollo projects, it is anticipated that the critical loads will be about 75 percent of the total plant running load.

Based on existing and a projection of future electrical loads (estimate shown on the spreadsheet in Appendix A), estimated critical loads at the RWQCP would be 1,800 kW at the current plant flow rate of 33 mgd, and with an additional 2,500 kW required at the future plant flow rate of 52 mgd. This yields a total estimated 4,300 kW of critical loads.

6.5 EXISTING GENERATION CAPABILITIES

There are three 1,100-kW gas engine generators, yielding a total 3,300 kW for standby power. These generators are mainly fueled by digester gas, but have the capability of utilizing natural gas fuel. At present, these generators provide about half of the plant's total running loads of 3,000 kW. They parallel with the utility supply.

By end of year 2007, the RWQCP will have an additional of 1,200 kW of generation capabilities when the fuel cell system is installed. It is assumed that the installed fuel cell system can be configured to provide standby power capability, can be parallel to the gas engine generators, and have the capability of utilizing natural gas as fuel. The City of Riverside (City) also plans to install an additional 1,200-kW fuel cell system by the year 2012.

With the gas engine generators and fuel cell systems, the RWQCP would have 4,500-kW of generation capacity, which exceeds the 4,300 kW of critical loads. The generation capacity would depend on sufficient availability of fuel during a power outage.

6.6 STANDBY POWER ALTERNATIVES

6.6.1 Alternative 1 - Multiple Small Diesel Generators and Automatic Transfer Switches

In this alternative, diesel generators and transfer switches are added to each of the existing double-ended plant substations. The generators will be sized to supply the critical load for the substation.

This alternative would require:

- One 480-volt generator for each double-ended substation.
- One 4.16-kV generator for each double-ended substation.
- One automatic transfer switch for each double-ended substation.
- Modification to the existing main breakers and tie-breaker of each double-ended substation.

When the utility power fails, the cogeneration system will shut down, both main breakers will open, and the tie-breaker will close at the substations. The load will then transfer to standby diesel generators at each substation. When the utility power returns, the main and tie-breakers will return to their normal position and the load will be transferred back to the utility. The cogeneration system will be initiated and parallel back to the utility.

This alternative is relatively simple and requires moderate electrical modification to the existing system. However, this alternative does not make use of existing gas engine generation and fuel cell system capabilities. It also requires maintenance of additional low-voltage electrical equipment and does not optimize and prioritize the diesel generators capacity since these generators operate independent of each other.

6.6.2 Alternative 2 - Retrofit Existing Cogeneration Capabilities to Backup Standby Power

In this alternative, the backup standby power would be derived by operating a combination of existing gas engine generators and the fuel cell system paralleling with each other. As previously stated, the existing generation capacity exceeded the critical load requirements.

This alternative would require:

- Modification/upgrade to the existing control system. This will include generator priority sequencing and optimization, load-shedding sequencing, load adding sequencing, and power monitoring as part of a Computerized Load Management System (CLMS), which is described in Volume 9, Chapter 4 - Energy Saving Options. The control will also include remote I/O for circuit breaker control and monitoring.
- Modify the existing feeder breaker to be electrically operated.

- Develop a detailed critical load ranking for the plant to be used for load shedding and load adding sequencing.
- Retrofit the existing engine generators to meet the SCAQMD Emission Standards for the year 2012 in a standby application. This is discussed in Volume 9, Chapter 5 - Power Supply Alternatives.

When the utility power fails, the utility main breaker will open, the cogeneration system would be disconnected, and all the substation feeders to the loads will open. The gas engine generators and fuel cell system will be paralleled and reconnected back to the electrical system as standby generators. The standby generators will pick up plant loads through the closing of substation feeder breakers. The individual loads are then sequenced by the SCADA system.

When the utility power returns, the system will synchronize the natural gas engine generators with utility power if required, and transfer the power source back to the utility in a seamless transition. The fuel cell will keep running in parallel with the utility and the natural gas engine generators will be shut down.

Even though this alternative will provide a more complex control system, the advantages include a more reliable plant-wide standby power with 12-kV distribution. It also will optimize operation of the generators and fuel cell system.

In line with the City's decision to shut down the gas engine generators as cogeneration in the year 2012 to comply with SCAQMD Emission Standards and make the fuel cell system the main cogeneration system, it would be a logical approach to retrofit the gas engine generators to provide standby power.

During the project workshop on April 16, 2007, the City decided that it does not want to install a diesel generator for standby power. Instead, the City prefers to use the existing cogeneration gas engines, along with the future fuel cells, for standby power.

Appendix A

ELECTRICAL LOAD ESTIMATES

APPENDIX A
Riverside Integrated Master Plan
Electrical Load Estimates

Process Area	Approximate Connected Electrical Load (HP/kVA)	Standby Power Required (HP/kVA)	Service Transformer (as noted on Figure 6.1)
Planned Loads			
Headworks	240	0	TFR1
Primary Clarifiers	198	198	T1 & T2
Primary Equalization	375	300	T1 & T2
MBR Process	2900	2900	T1 & T2
Tertiary Filtration	0	0	
Disinfection	10	10	TA & TB
Sludge Thickening	450	0	T1 & T2
Digestion	240	0	T1 & T2
Total kVA	4413	3408	
Assumed Running 75%	3310	2556	
Total kW	2648	2045	
Optional Load			
UV/Ozone Disinfection	750	750	TA & TB
Total kVA	750	750	
Assumed Running 75%	563	563	
Total kW	450	450	
Existing Loads			
Existing kW Running	3000	2400	
Total kW	3000	2400	
Assumed Running 75%	2250	1800	
Grand Total kW	**5348**	**4295**	
Existing Gas Engine Cogeneration, kW		3300	
Fuel Cell System, kW		1200	
Total Standby Generation		**4500**	

Deficit/Excess Standby (Generation - Standby Load) **205**

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT
CHAPTER 7:
IMPLEMENTATION SCHEDULE AND COST

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 9: ENERGY MANAGEMENT
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IMPLEMENTATION SCHEDULE AND COST

7.1 PURPOSE

The purpose of this chapter is to present the costs and schedules of the projects for the Energy Management volume for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP) Integrated Master Plan. The selected projects are derived from the analyses performed and presented in Chapters 1 through 6 of this volume of the Master Plan.

7.2 CONCLUSIONS AND RECOMMENDATIONS

- Install a 1,000-kW digester gas fueled fuel cell cogeneration system.
- Add a new digester gas fueled 1,200-kW fuel cell cogeneration system prior to 2012 to replace the three existing 3,300-kW engine/generator cogeneration systems; retrofitting the existing engine generators to become natural gas fueled standby generators.
- Install a low-pressure digester gas holder to assist with digester gas control.
- Upgrade the existing RWQCP cogeneration, control, and electrical system to provide standby power and distribution reliability.
- Retrofit the existing eddy-current drives with Variable Frequency Drives (VFDs) for the three 250-hp filter influent pumps and two 100-hp waste backwash pumps. Replace the pump motors with premium efficiency motors.

7.3 BACKGROUND

The existing energy management systems are described in Volume 9, Chapter 1 - Existing Energy Systems. The City's plan to receive and treat Fats, Oils, and Greases (FOG), as noted in Volume 9, Chapter 1 - Existing Energy Systems, will generate additional digester gas beyond that which can be used by the fuel cell system currently being installed. Conservative estimates of digester gas production show that between 450 and 700 scfm of digester gas could be generated consistently based on the existing and planned digestion capacity. The planned digester gas fueled 1,000-kW fuel cell cogeneration system will require approximately 220 scfm. In order to use the additional digester gas which will be generated and to replace another of the three existing cogeneration engine generators when they are removed from cogeneration service to meet the air quality management district requirements, the plant plans to install a new digester gas fueled 1,200-kW fuel cell cogeneration system. This new cogeneration system will require 260 scfm. The remaining digester gas, if any, will be available for use in plant boilers to supplement the heat provided from the fuel cell systems for use within the plant.

7.4 COST AND SCHEDULE CRITERIA

The implementation schedule for each project consists of a planning/design period and a construction/start-up period. A 2-year duration for the planning and design period is used for each project to include a conservative schedule at the master plan level. Because the projects for energy management are relatively small, if completed as separate projects, 1.5 years may be used for the construction and start-up period. The construction and start-up period is based on the contractor being able to perform approximately $2 million per month worth of construction. When final implementation projects are established, adjustments to this schedule should be made based on experience, looking at factors such as project sequencing and equipment procurement times. For some of the projects, it may be possible to shorten the planning/design and construction/start-up schedules. However, for the master plan, the schedules will be presented based on the criteria described above.

The costs for these projects are based on the information presented in the previous chapters for Volume 9. They are based on costs in August 2006 dollars. These costs will be adjusted to their midpoint of construction before placement in the Capital Improvement Plan (CIP), which is presented in Volume 10, CIP and Overall Implementation Schedule.

7.5 ENERGY MANAGEMENT FACILITIES SCHEDULE

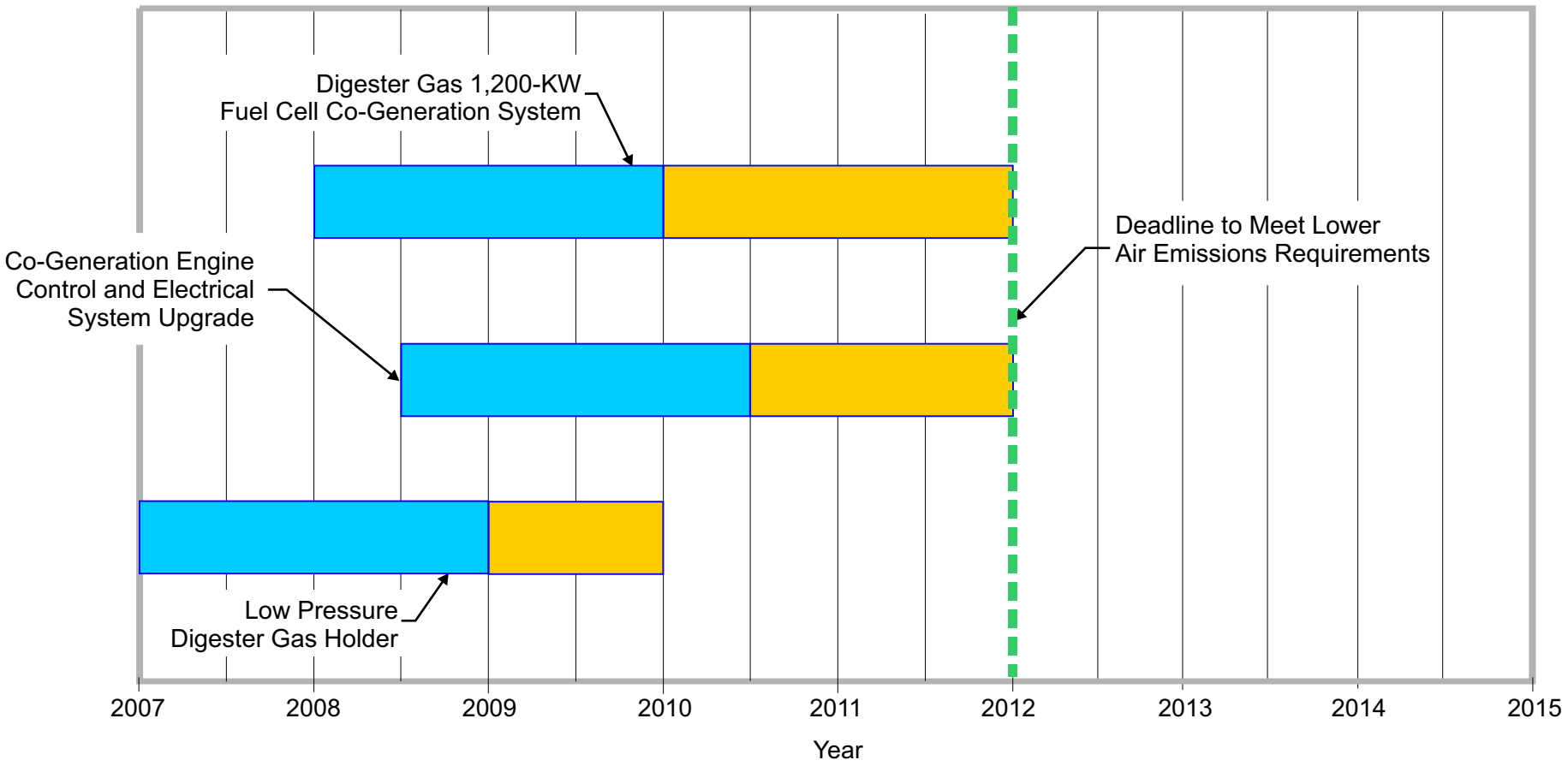
Figure 7.1 shows the schedule of the energy management facilities projects.

7.5.1 Digester Gas Fueled 1,200-kW Fuel Cell Cogeneration System

As described in Volume 9, Chapter 5 - Power Supply Alternatives, install a new digester gas fueled 1,200-kW fuel cell cogeneration system. Based on a 2-year planning/design period and a 2-year construction/start-up period this project would need to begin in 2008 to ensure additional cogeneration capacity is available when the existing engine generators are converted to standby generation use in 2012.

7.5.2 Low-Pressure Digester Gas Holder

In order to assist the plant to better manage digester gas production, a new low-pressure digester gas holder should be added as soon as possible. Gas management is currently a concern and issue at the plant and will become more of an issue as added gas production is realized from the plan to generate additional digester gas from the addition of FOG. The proposed schedule includes a 2-year planning/design period and 1-year construction/start-up period.



ENERGY MANAGEMENT FACILITIES SCHEDULE

FIGURE 7.1

7.5.3 Existing Cogeneration Engine, Control, and Electrical System Upgrade

This project should be implemented as soon as possible after the planned 1,000-kW fuel cell cogeneration system is up and running, to provide necessary standby power to the plant. The schedule is based on a 2-year planning/design period and 2-year construction/start-up period.

7.5.4 Retrofit Eddy-Current Drives with Variable Frequency Drives

This project will retrofit existing eddy-current drives with VFDs for the three 250-hp filter influent pumps and two 100-hp waste backwash pumps. It will also replace the pump motors with premium efficiency motors. This will be a small project that can be implemented independent of other energy management projects or be included in the cogeneration upgrade project.

7.6 IMPLEMENTATION COST

The total project costs of the new liquid and solids stream facilities for energy management are summarized in Table 7.1. The costs are based on an Engineering News-Record (ENR) value of 8,570 (Los Angeles, August 2006). The midpoint construction costs, adjusted for the phasing and schedule, are presented in Volume 10, CIP and Overall Implementation Schedule.

Table 7.1 Total Project Cost for Proposed Expansion of Energy Management Facilities
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Description[1]	Project Cost[2]
Digester Gas Fueled 1,200-kW Fuel Cell Cogeneration System	$13.2 M
Low-Pressure Digester Gas Holder	$1.4 M
Cogeneration Engine, Control, and Electrical System Upgrade	$4.1 M
Retrofit Eddy-Current Drives with Variable Frequency Drives	$1.0 M
Total Cost	**$19.7 M**

Notes:
(1) Details discussed in Volume 9, Energy Management.
(2) As present value (ENR value of 8,570 for Los Angeles in August 2006).

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 10: CAPITAL IMPROVEMENT PLAN AND OVERALL IMPLEMENTATION SCHEDULE
CHAPTER 1: CAPITAL COSTS AND IMPLEMENTATION SCHEDULE

FINAL
February 2008

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 10: CIP AND OVERALL IMPLEMENTATION SCHEDULE
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CAPITAL COSTS AND IMPLEMENTATION SCHEDULE

1.1 PURPOSE

The purpose of this chapter is to present the Capital Improvement Plan (CIP) for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP), based on the proposed treatment plant upgrades and collection systems projects that will occur between now and 2025. The CIP will be used as input into the Master Plan Manager™ (MPM™) and Financial Planning Tool™ (FPT™).

1.2 BACKGROUND

The RWQCP is a tertiary wastewater treatment plant that currently treats approximately 33 mgd on an average flow basis. The RWQCP has a rated capacity of approximately 40 mgd. The City seeks to develop an Integrated Master Plan for the Wastewater Systems Facilities to identify and plan for expansion and replacement needs up to the year 2025.

The expansion projects were identified based on the flow projections made in Volume 2, Chapter 3 – Population and Flow Projections, and the findings and recommendations of previous and ongoing plans and studies.

Volumes 2 through 9 and 12 of this Master Plan present details of all the proposed projects and reviews of the existing plans and studies. Estimated project costs of the proposed projects are presented in the respective chapters in these volumes. These costs are used to develop the CIP, which is presented in this chapter.

1.3 SUMMARY OF TREATMENT SYSTEM AND COLLECTION SYSTEM PROJECTS

The following summary of treatment and collection system projects is based on the high-growth scenario (2025 flow of 52.2-mgd average annual flow). As described in Volume 2, Chapter 3 – Population and Flow Projections, this flow rate is based on the City's decision (August 2006) to set the Master Plan design criteria based on the high-growth scenario. Subsequently (August 2007), after all process alternative analyses were completed, the City noticed a slowdown in the population/housing growth and decided the low-growth scenario (2025 flow of 47.3-mgd average annual flow) would be more appropriate for establishing the schedule of projects to develop the Operations and Maintenance (O&M) costs and CIP, and the user rates and connection fees.

1.3.1 Treatment System

Alternatives were evaluated and life-cycle cost analyses were performed for each of the treatment areas. Based on these analyses and the City's input, the following sections

summarize the selected projects for the liquid and solid stream treatment. Please refer to Volumes 2 through 9 and 12 for detailed analyses.

1.3.1.1 2025 Expansion Projects

1.3.1.1.1 *Preliminary Treatment*

As described in Volume 4, Chapter 5 – Preliminary Treatment, the existing headworks facility is re-rated at a capacity of 37 mgd on an average daily flow basis. A new 15-mgd (annual average flow (AA)) headworks facility is planned for the Integrated Master Plan period.

1.3.1.1.2 *Primary Treatment*

As part of the Plant 1 Primary Expansion project, Plant 1 primary clarifiers will be replaced with four new circular primary clarifiers with a combined capacity of 32-mgd AA. The expansion project will also include two primary effluent Equalization (EQ) basins with a total volume of 12.1 MG, a biofilter for odor scrubbing, a primary EQ pump station, a primary sludge pump station, and primary sludge thickening facilities.

1.3.1.1.3 *Primary Equalization*

The City has chosen to use primary effluent EQ to provide better control for downstream processes and to reduce project costs for the Membrane Bioreactors (MBRs). The 12.1-MG primary EQ basins will be uncovered and lined with Hypalon®.

Alternative treatment scenarios for the MPM™ include EQ basins lined with concrete and a Hypalon® floating cover, should the City change their decision in the future.

1.3.1.1.4 *Secondary Treatment*

Four options for expanding the RWQCP secondary treatment plant were evaluated: Conventional Activated Sludge (CAS), High Solids Retention Time (SRT) Activated Sludge, MBR, and Integrated Fixed Film Activated Sludge (IFAS). Based on the ability to achieve better effluent quality, the City chose to build a 32-mgd MBR for the future expansion. This is being separated into two phases:

1. First Phase: To convert Plant 1 from a 20-mgd CAS facility to a 26-mgd MBR facility.
2. Second Phase: To add the remaining 6-mgd capacity for a Plant 1 secondary capacity of 32.2 mgd and a total RWQCP capacity of 52.2-mgd AA.

1.3.1.1.5 *Tertiary Treatment*

There is no tertiary facility expansion required since an MBR is selected as the secondary treatment method.

1.3.1.1.6 *Disinfection*

For the Integrated Master Plan, the City decided to continue the usage of NaOCl as the disinfection method. In order to meet the 2025-projected flow, the Integrated Master Plan includes a new 8-mgd AA Chlorine Contact Basin (CCB).

In addition, ozone plus Ultraviolet (UV) is being developed as an alternate treatment scenario for the MPM^{TM}, should removal of Endocrine Disrupting Compounds (EDCs) be required by future regulations.

1.3.1.1.7 *Biosolids Handling and Treatment*

The City has selected Gravity Belt Thickeners (GBTs) for the primary solids and Waste Activated Sludge (WAS) thickening facilities. It is estimated that 14 GBT units will be required for the expansion, 9 units for primary solids thickening, and 5 units for WAS thickening.

Besides the thickening facilities, the City has also decided to install a new multi-compartment acid-phase digester for their digestion facilities. The City will continue the addition of fat-oil-grease to the digester.

1.3.1.1.8 *Energy Management*

The following summarizes the projects for the RWQCP energy management system:

- A low-pressure digester gasholder to assist with digester gas control.
- A new digester gas-fueled 1.2-MW fuel cell cogeneration system to supplement the one currently being installed.
- Conversion of existing cogeneration engines to standby to meet future Air Quality Management District requirements.
- A redundant 12-kV ductbank system.
- Upgrade the electrical control/monitoring system (i.e., Computerized Load Management System (CLMS)).
- Modifications to existing electrical equipment (e.g., breakers).
- Replace eddy-current drives with variable frequency drives.

1.3.1.1.9 *Air Quality and Emissions Control*

Two new 4.2-million British thermal units per hour (MMBtu/hr) natural gas-fired boilers will be installed to address the potential Best Available Control Technology (BACT) adjustment for Nitrogen Oxide (NO_x) emissions from boilers. In addition, the fuel cells, as described in the Energy Management section above, and the biofilters, as described in the Primary Treatment section above, will address compliance with other air quality regulatory requirements.

1.3.1.1.10 *Supervisory Control and Data Acquisition System*

The Supervisory Control and Data Acquisition (SCADA) Master Plan, which was done by WaterHammer Inc., provided a list of recommended updates for non-project related portions of the SCADA system. However, the Master Plan did not provide any costs associated with these recommendations and the information provided in the Master Plan is not sufficient to estimate these costs. As a result, a $1 million allowance was put into the CIP for the SCADA system upgrades. The $1 million will be spread over the Master Plan planning period equally, and an escalation rate will be applied to each respective year.

1.3.1.1.11 *Other Facilities and Projects*

Other projects that were proposed in the Master Plan include:

- A new maintenance building.
- Recycle Water Pump Station.
- A new 24-inch metering control valve and vault at the headworks.
- Replacement of the 42-inch pipe that connects the aeration basin with the Plant 2 splitter box with a 54-inch pipe.
- Potential raising of the existing flood control levee.

1.3.1.2 Rehabilitation and Renovation Projects

Based on the condition assessment results that Carollo Engineers performed in October 2006, a preliminary list of Rehabilitation and Replacement (R&R) projects has been compiled from the Watershed Analysis and Management Water/Wastewater Asset Manager™ (WAM™) program, using the criteria as discussed in Section 2.4.1.11 of Volume 12, Chapter 2 – Condition Assessment. Most of the 26 recommended projects would be part of either the primary expansion project or the recycle water pump station project. Only three other projects are being added to the CIP list and they are listed as the following:

- Rehabilitation of the waste gas burner.
- Replacement of the media for Biofilter Nos. 1 and 2 at the current headworks.
- A seismic upgrade to the headquarters for sewer line maintenance.

1.3.2 Collection System

The Collection System CIP includes 50 capital projects identified in the Collection System Master Plans (CSMPs) that were completed between 2002 and 2006, and the City identified separately 24 replacement projects.

The capital projects from the CSMPs cover deficiencies from all five basins: Spruce Basin, Tequesquite Basin, Arlanza Basin, Phoenix Basin, and Northside Basin. The 50 projects were classified into three priority groups, as follows:

- Priority A:
  Priority A pipes were "deficient" at the time of the study: 2002 for Spruce, 2003 for Tequesquite, and 2005 for the remaining basins.
- Priority B:
  Priority B pipes were projected to be "deficient" by 2015.
- Priority C:
  Priority C pipes were projected to be "marginally deficient" by 2020.

Of the 50 expansion projects identified in the CSMPs, 12 of the projects have either been started or the City has allocated budget for them. Consequently, they are not included in the CIP for the Integrated Master Plan.

The 24 replacement projects identified by the City include replacement of pipes in the collection system that are older than 50 years. These pipes are categorized as either being constructed before 1943, or between 1944 and 1956, as documented in the City's geographic information system (GIS).

1.4 COSTS AND SCHEDULE CRITERIA

1.4.1 Development Basis

1.4.1.1 Treatment System

As mentioned in Volume 2, Chapter 4 – Basis of Cost Estimates, the expected level of accuracy for the cost estimates for the Integrated Master Plan is Class 4, with an expected accuracy range of within 30 percent over the estimate to 15 percent under the estimate. In order to reduce the risk of under estimation, a contingency is applied to the developed estimates. The estimated project costs represent August 2006 dollars.

The implementation schedule for each project consists of a planning/design period and a construction/start-up period. A 2-year duration for the planning and design period is used for each project to include a conservative schedule at the Master Plan level. The construction and start-up period ranges from 1.5 to 4 years based on a general guideline of a contractor being able to perform approximately $2 million/month worth of construction. When final implementation projects are established, adjustments should be made to this schedule guideline based on experience, looking at factors such as project sequencing, and equipment procurement times. For some of the projects, it may be possible to shorten the planning/design and construction/start-up schedules. However, for the Master Plan, the schedules will be presented based on the criteria described above.

The costs for the selected projects are based on the information presented in the respective chapters. As stated above, they are based on costs in August 2006 dollars. These costs have been adjusted to their midpoint of construction before placement in the CIP. An escalation rate of 6 percent for the first 5 years and 4 percent for 5 years and more are applied to calculate the midpoint construction costs. They are then spread over the project duration according to Standard S-Curves for Project Costs.

Table 1.1 is a tabular representation of an S-curve for the projects in this Master Plan. This method allocates a certain percentage of the project cost for each project based on the duration of the project. It takes into account the lower percentage spending at the beginning and end of projects, and the increased spending in the middle. For projects that have partial project durations, the durations are rounded up to the next whole year for calculation of the annual capital expenditures.

Table 1.1 Standard S-Curves for Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Duration (Years)	Proportion of Project Costs Spent in Year					
	1	2	3	4	5	Total
1	100%	0%	0%	0%	0%	100%
2	30%	70%	0%	0%	0%	100%
3	10%	45%	45%	0%	0%	100%
4	4%	6%	40%	50%	0%	100%
5	4%	6%	35%	35%	20%	100%

1.4.1.2 Collection System

The costs for the Collection System CIP are based on the estimates from the CSMPs. The cost estimation methods used for the CSMPs differed from the methods applied to the wastewater treatment plant upgrades. On the direction of the City, these costs were adjusted using the Integrated Master Plan method as described in Volume 2, Chapter 4 – Basis of Cost Estimates, and then distributed evenly over a 10-year period from FY 2007/2008 through FY 2016/2017. These costs were escalated at a rate of 6 percent through 2011 and then 4 percent for the remaining years.

For the R&R projects, the costs were provided by the City. These costs were distributed evenly over 50 years (FY 2007/2008 to FY 2056/2057) and were escalated at 6 percent through 2011 and 4 percent thereafter. Because the Integrated Master Plan only covers up to year 2025, the costs for the City's replacement projects up to 2025 only will be included. Please refer to Volume 3, Chapter 1 – Wastewater Collection System, for details of the costs.

1.5 IMPLEMENTATION SCHEDULE

The implementation schedule for the projects is based on the criteria listed above. With the exception of the SCADA system and the collection system projects, the projects have a required completion date based on the RWQCP projected flow compared to the existing facility capacity. Project start dates are then determined based on the implementation criteria described in Section 1.4 above.

Table 1.2 lists the implementation schedule recommended for this Master Plan. It also lists the total project costs in August 2006 dollars. As was discussed in previous volumes, some projects are grouped into combined projects. Combined projects would be easier and less expensive for the City to design, coordinate, and manage. The construction cost is potentially lower, depending on the schedule, because the contractor can apply economies of scale to the work. However, at the Master Plan level, the reduction in cost is difficult to determine and is subject to several factors, including schedule, which will be refined during detailed planning and design. If the City chooses, other projects with similar start/completion dates can be combined later.

Table 1.2 Implementation Schedule for Treatment System Projects - Low-Growth Scenario
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project	Total Project Cost[(1)] ($ Million)	Project Duration	Date	
			Start	Completion
Primary, EQ, MBR, APAD	$185.0	5.5	Jan 2008	Jul 2013
1.2-MW Fuel Cell	$13.2	4	Jan 2008	Dec 2011
Low-Pressure Digester Gas Holder	$1.2	3	Jan 2008	Dec 2010
42-inch Pipe Upgrade (54-inch dia.) from Connecting Plant 2 Splitter Box to Aeration Basins	$0.1	1.5	Jul 2008	Dec 2009
Waste Gas Burner	$0.5	1.5	Jul 2008	Dec 2009
24-inch Meter Control Valve	$0.5	1.5	Jul 2008	Dec 2009
New Boilers	$3.0	1	Jan 2014	Dec 2014
Biofilter Nos. 1 and 2 Media	$2.1	1.5	Jul 2014	Dec 2015
O&M Building	$2.1	1.5	Jul 2014	Dec 2015
Influent Metering Project	$5.9	1.5	Jul 2014	Dec 2015
Building Headquarters for Sewer Line Maintenance	$0.3	1.5	Jul 2014	Dec 2015
Power System Projects	$5.1	2	Jan 2016	Dec 2017
New Chlorine Contact Basin	$4.0	3.5	Jul 2016	Dec 2020
New Headworks	$10.0	3.5	Jan 2019	Jul 2022

Table 1.2 Implementation Schedule for Treatment System Projects - Low-Growth Scenario Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Project	Total Project Cost[1] ($ Million)	Project Duration	Date	
			Start	Completion
Additional MBR Equipment	$12.0	4	Aug 2019	Jul 2023
WAS Thickening Facility	$17.0	3.5	Jul 2023	Dec 2026
SCADA System Upgrades	$1.0	No specific projects have been assigned at this time		
Total	**$263.0**			

Notes:
(1) Costs are in August 2006 dollars.

As discussed above, there are no set schedules for the 62 collection system projects. The project costs are distributed evenly, either over a 10-year period from FY 2007/2008 through FY 2016/2017 for the expansion projects identified in the CSMPs (total of $37.7 million, August 2006 dollars), and over a 50-year period from FY 2008/2009 through FY 2056/2057 for the projects identified by the City (total of $418 million, August 2006 dollars). For the 24 projects identified by the City, only costs for up to FY 2024/2025 are included in the CIP. Details on the 62 projects can be found in Appendix A.

1.6 CAPITAL IMPROVEMENT PLAN

The CIP over the planning period identified for the RWQCP, including all the treatment facilities and collection system projects, are summarized in Table 1.3. The costs presented are in midpoint of construction dollars, according to the criteria described above. Appendix B has the detailed costs of the individual projects.

Table 1.3 CIP - Capital Expenditures by Year ($ Million)[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
		Collection System		
Fiscal Year	Treatment Facilities	Projects Identified in CSMP	Projects Identified by the City	Total Costs
2007/2008	$3.50	$4.24	$8.85	$16.6
2008/2009	$12.38	$4.49	$9.39	$26.3
2009/2010	$20.58	$4.76	$9.95	$35.3
2010/2011	$96.13	$5.05	$10.54	$111.7
2011/2012	$87.59	$5.25	$10.97	$103.8

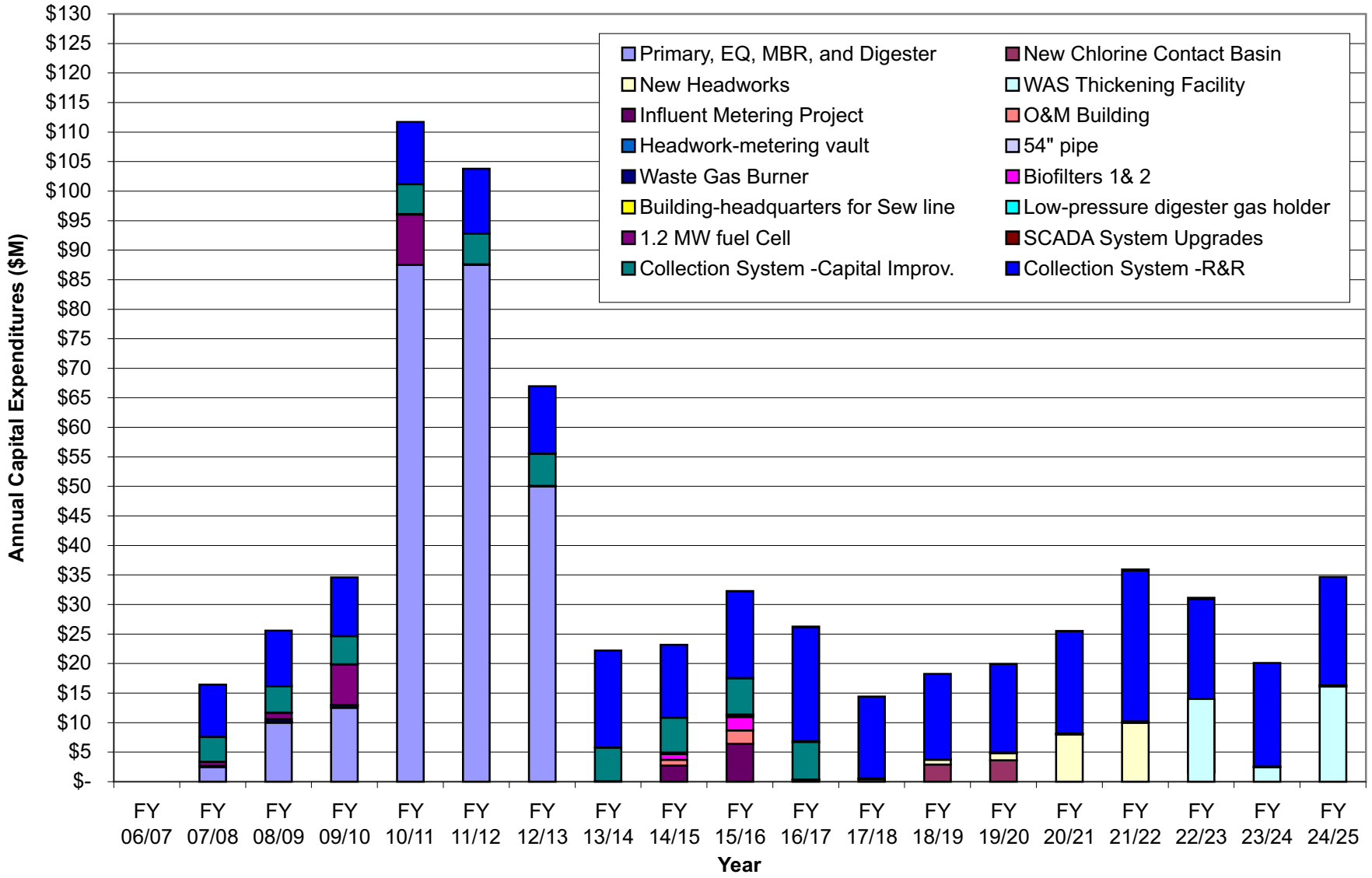
Table 1.3 CIP - Capital Expenditures by Year ($ Million)[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Fiscal Year	Treatment Facilities	Collection System		Total Costs
		Projects Identified in CSMP	Projects Identified by the City	
2012/2013	$50.09	$5.46	$11.41	$67.0
2013/2014	$4.60	$5.68	$11.86	$22.1
2014/2015	$4.93	$5.90	$12.34	$23.2
2015/2016	$13.98	$6.14	$12.83	$32.9
2016/2017	$6.41	$6.39	$13.34	$26.1
2017/2018	$0.53	-	$13.88	$14.4
2018/2019	$3.80	-	$14.43	$18.2
2019/2020	$5.94	-	$15.01	$20.9
2020/2021	$9.64	-	$15.61	$25.2
2021/2022	$20.26	-	$16.23	$36.5
2022/2023	$14.41	-	$16.88	$31.3
2023/2024	$2.55	-	$17.56	$20.1
2024/2025	$16.32	-	$18.26	$34.6
Total	**$373.6**	**$53.4**	**$239.3**	**$666.3**

Notes:
(1) Costs are escalated from August 2006 to 2011 by 6 percent, and 4 percent thereafter.

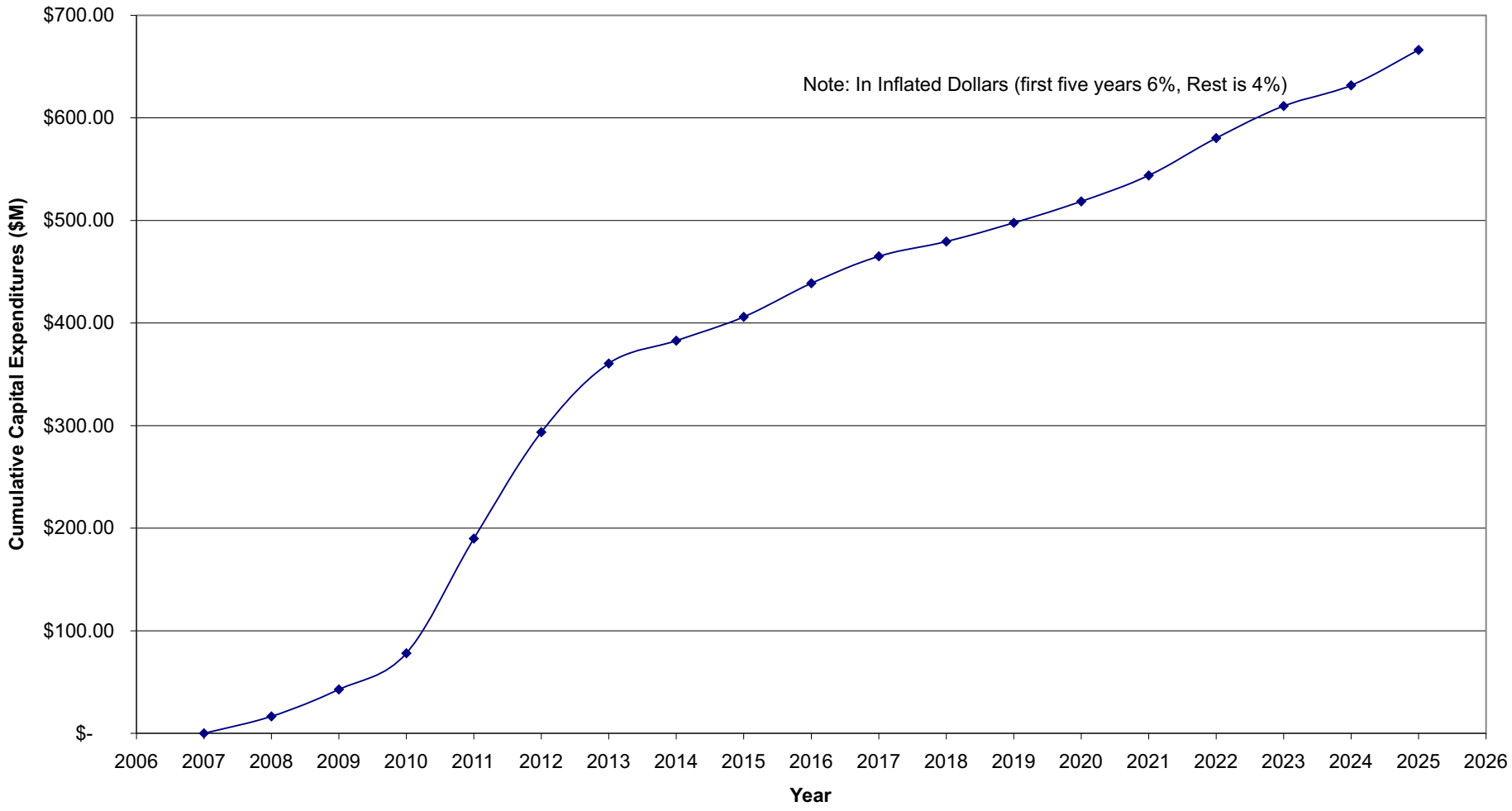
For the treatment systems, the total estimated capital costs through the year 2025 are approximately $370 million. For the collection system, the total estimated capital costs over the 10-year period are approximately $53 million, and the estimated R&R costs through the year 2025 are approximately $240 million. The total estimated CIP project costs for the Integrated Master Plan is approximately $666 million.

Figure 1.1 presents the capital expenditures by year in escalated dollars for the 19-year planning period. Figure 1.2 presents the cumulative capital expenditures for the planning period in escalated dollars. As shown in Table 1.3 and Figure 1.1, the fourth and fifth years are the highest spending years with $112 million and $104 million in capital expenditures, respectively.



ANNUAL CAPITAL EXPENDITURES

FIGURE 1.1



CUMULATIVE CAPITAL EXPENDITURES

FIGURE 1.2

1.7 ALTERNATIVE TREATMENT SCENARIOS

The four projects that will be included as alternate treatment scenarios for the MPM™ are UV plus ozone as a disinfection alternative, primary EQ basin with concrete liner, addition of a primary EQ basin Hypalon® cover, and potential raising of the existing levee. Costs and implementation schedules for these projects are shown in Table 1.4.

Table 1.4 Alternative Treatment Scenarios
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project	Project Costs[1] ($ Million)	Duration (Years)	Date		Inflated Project Cost[2] ($ Million)
			Start	Completion	
UV + Ozone	72.5	3.5	July 2012	January 2016	112.10
Primary EQ with Concrete Liner	13.6	5.0	January 2009	July 2013	17.60
Primary EQ Hypalon® Cover	2.1	5.0	January 2009	July 2013	2.70
New Levee	52.0	3.0	July 2012	July 2015	79.58

Notes:
(1) Costs in August 2006 dollars.
(2) Escalated at 6 percent for the first 5 years, then 4 percent thereafter.

Appendix A

COLLECTION SYSTEM COSTS

Table A.1 Capital Improvement Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Study Area	Priority	Location[1]	Total Project Cost (Million Dollars)[2]	Annual CIP Costs (Million Dollars)[3][4]									
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Arlanza	A	Collett Avenue	$0.38	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06
		Fillmore Street	$0.41	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06
		Golden Avenue	$0.26	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04
		RWQCP Sewer	$0.33	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05
	B	Monticello Avenue	$1.59	$0.16	$0.17	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.24
	C	Acorn Street	$1.44	$0.14	$0.15	$0.16	$0.17	$0.18	$0.19	$0.20	$0.20	$0.21	$0.22
		Arizona Avenue	$0.69	$0.07	$0.07	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11
		Collett Avenue	$0.90	$0.09	$0.09	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13	$0.14
		Fillmore Street	$0.62	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.10
		Golden Avenue	$0.73	$0.07	$0.08	$0.08	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11
		Harrison Street	$0.43	$0.04	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
		Jackson Street	$1.78	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27
		Jones Avenue	$1.07	$0.11	$0.11	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.16
		La Sierra Channel	$1.80	$0.18	$0.19	$0.20	$0.21	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28
		Magnolia Avenue	$0.55	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09
		Monroe Street	$0.51	$0.05	$0.05	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08
		RWQCP Sewer	$0.64	$0.06	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10
		Van Buren Boulevard	$6.83	$0.68	$0.72	$0.77	$0.81	$0.86	$0.90	$0.93	$0.97	$1.01	$1.05
Northside	B	Marlborough Avenue	$0.12	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	C	Fairmount Boulevard	$0.57	$0.06	$0.06	$0.06	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08	$0.09
		Fairmount Trunk	$2.43	$0.24	$0.26	$0.27	$0.29	$0.31	$0.32	$0.33	$0.34	$0.36	$0.37
		Marlborough Avenue	$0.26	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04
		Strong Street	$0.49	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08

Table A.1 Capital Improvement Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Project Study Area	Priority	Location[1]	Total Project Cost (Million Dollars)[2]	Annual CIP Costs (Million Dollars)[3][4]									
				2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Phoenix	A	Central Avenue	$0.54	$0.05	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08
		Hillside Avenue	$2.57	$0.26	$0.27	$0.29	$0.31	$0.32	$0.34	$0.35	$0.36	$0.38	$0.39
		Phoenix Avenue	$0.13	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
		Santa Ana River Pipeline	$1.52	$0.15	$0.16	$0.17	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.23
	B	Madison Street	$0.56	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09
	C	Madison Street	$1.32	$0.13	$0.14	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19	$0.19	$0.20
		Phoenix Avenue	$2.03	$0.20	$0.21	$0.23	$0.24	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31
Spruce	B	Chicago Avenue	$1.02	$0.10	$0.11	$0.11	$0.12	$0.13	$0.13	$0.14	$0.14	$0.15	$0.16
	C	Chicago Avenue	$0.44	$0.04	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07
Tequesquite	A	Eastridge Avenue	$0.21	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	B	Eastridge Avenue	$0.73	$0.07	$0.08	$0.08	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11
		Trautwein Road	$0.65	$0.06	$0.07	$0.07	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10
	C	Tequesquitte Avenue	$0.31	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
		Wood Road	$0.85	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13
		Total (Million Dollars)	**$37.71**	**$4.24**	**$4.49**	**$4.76**	**$5.05**	**$5.25**	**$5.46**	**$5.68**	**$5.90**	**$6.14**	**$6.39**

Notes:
(1) Projects categorized as "not required" and "completed" have been removed from the CIP list.
(2) Costs in 2007 dollars.
(3) Costs are distributed evenly over the 10-year period.
(4) Costs are escalated from 2005 at 6 percent through 2011, and 4 percent thereafter.

Table A.2 Pipe Replacement & Rehabilitation Costs (2008 - 2019)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Total Project Cost[1]	Annual R&R Costs (Million Dollars)[2][3]											
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Before 1943	Unknown	$22.14	$0.47	$0.50	$0.53	$0.56	$0.58	$0.60	$0.63	$0.65	$0.68	$0.71	$0.74	$0.77
	4	$0.02	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$85.96	$1.82	$1.93	$2.05	$2.17	$2.26	$2.35	$2.44	$2.54	$2.64	$2.75	$2.86	$2.97
	8	$172.87	$3.66	$3.88	$4.12	$4.36	$4.54	$4.72	$4.91	$5.11	$5.31	$5.52	$5.74	$5.97
	10	$19.16	$0.41	$0.43	$0.46	$0.48	$0.50	$0.52	$0.54	$0.57	$0.59	$0.61	$0.64	$0.66
	12	$14.15	$0.30	$0.32	$0.34	$0.36	$0.37	$0.39	$0.40	$0.42	$0.43	$0.45	$0.47	$0.49
	14	$1.93	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07
	15	$10.67	$0.23	$0.24	$0.25	$0.27	$0.28	$0.29	$0.30	$0.32	$0.33	$0.34	$0.35	$0.37
	16	$2.28	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08	$0.08
	18	$8.45	$0.18	$0.19	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29
	20	$1.40	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
	21	$6.22	$0.13	$0.14	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.21
	24	$18.54	$0.39	$0.42	$0.44	$0.47	$0.49	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64
	27	$5.43	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19
	30	$0.25	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	36	$0.45	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02
1944 to 1956	9	$0.49	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02
	4	$0.04	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$1.01	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	8	$39.86	$0.85	$0.90	$0.95	$1.01	$1.05	$1.09	$1.13	$1.18	$1.22	$1.27	$1.32	$1.38
	10	$2.64	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09
	12	$2.25	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08

Table A.2 Pipe Replacement & Rehabilitation Costs (2008 - 2019)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Total Project Cost[1]	Annual R&R Costs (Million Dollars)[2][3]											
			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	15	$0.55	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	21	$0.76	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03
Total (Million Dollars)		**$418**	**$8.85**	**$9.38**	**$9.95**	**$10.54**	**$10.96**	**$11.40**	**$11.86**	**$12.33**	**$12.83**	**$13.34**	**$13.87**	**$14.43**

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over a 50-year period.
(3) Costs are escalated from 2006 by 6 percent through 2011, and by 4 percent thereafter.

Table A.2 Pipe Replacement & Rehabilitation Costs (2020 - 2032)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Before 1943	Unknown	$0.80	$0.83	$0.86	$0.90	$0.93	$0.97	$1.01	$1.05	$1.09	$1.13	$1.18	$1.22	$1.27
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$3.09	$3.21	$3.34	$3.47	$3.61	$3.76	$3.91	$4.07	$4.23	$4.40	$4.57	$4.76	$4.95
	8	$6.21	$6.46	$6.72	$6.99	$7.27	$7.56	$7.86	$8.18	$8.50	$8.84	$9.20	$9.56	$9.95
	10	$0.69	$0.72	$0.74	$0.77	$0.81	$0.84	$0.87	$0.91	$0.94	$0.98	$1.02	$1.06	$1.10
	12	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64	$0.67	$0.70	$0.72	$0.75	$0.78	$0.81
	14	$0.07	$0.07	$0.08	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11
	15	$0.38	$0.40	$0.41	$0.43	$0.45	$0.47	$0.49	$0.50	$0.52	$0.55	$0.57	$0.59	$0.61
	16	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13

Table A.2 Pipe Replacement & Rehabilitation Costs (2020 - 2032)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
	18	$0.30	$0.32	$0.33	$0.34	$0.36	$0.37	$0.38	$0.40	$0.42	$0.43	$0.45	$0.47	$0.49
	20	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08
	21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.31	$0.32	$0.33	$0.34	$0.36
	24	$0.67	$0.69	$0.72	$0.75	$0.78	$0.81	$0.84	$0.88	$0.91	$0.95	$0.99	$1.03	$1.07
	27	$0.20	$0.20	$0.21	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31
	30	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	36	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03
1944 to 1956	9	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06
	8	$1.43	$1.49	$1.55	$1.61	$1.68	$1.74	$1.81	$1.89	$1.96	$2.04	$2.12	$2.21	$2.29
	10	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15
	12	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.12	$0.13
	15	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
	21	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
Total (Million Dollars)		**$15.00**	**$15.60**	**$16.23**	**$16.88**	**$17.55**	**$18.26**	**$18.99**	**$19.74**	**$20.53**	**$21.36**	**$22.21**	**$23.10**	**$24.02**

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over a 50-year period.
(3) Costs are escalated from 2006 by 6 percent through 2011, and by 4 percent thereafter.

Table A.2 Pipe Replacement & Rehabilitation Costs (2033 - 2045)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Before 1943	Unknown	$1.32	$1.38	$1.43	$1.49	$1.55	$1.61	$1.68	$1.74	$1.81	$1.89	$1.96	$2.04	$2.12
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$5.14	$5.35	$5.56	$5.79	$6.02	$6.26	$6.51	$6.77	$7.04	$7.32	$7.61	$7.92	$8.24
	8	$10.34	$10.76	$11.19	$11.64	$12.10	$12.59	$13.09	$13.61	$14.16	$14.72	$15.31	$15.92	$16.56
	10	$1.15	$1.19	$1.24	$1.29	$1.34	$1.39	$1.45	$1.51	$1.57	$1.63	$1.70	$1.77	$1.84
	12	$0.85	$0.88	$0.92	$0.95	$0.99	$1.03	$1.07	$1.11	$1.16	$1.21	$1.25	$1.30	$1.36
	14	$0.12	$0.12	$0.12	$0.13	$0.14	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18
	15	$0.64	$0.66	$0.69	$0.72	$0.75	$0.78	$0.81	$0.84	$0.87	$0.91	$0.95	$0.98	$1.02
	16	$0.14	$0.14	$0.15	$0.15	$0.16	$0.17	$0.17	$0.18	$0.19	$0.19	$0.20	$0.21	$0.22
	18	$0.51	$0.53	$0.55	$0.57	$0.59	$0.62	$0.64	$0.67	$0.69	$0.72	$0.75	$0.78	$0.81
	20	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.11	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13
	21	$0.37	$0.39	$0.40	$0.42	$0.44	$0.45	$0.47	$0.49	$0.51	$0.53	$0.55	$0.57	$0.60
	24	$1.11	$1.15	$1.20	$1.25	$1.30	$1.35	$1.40	$1.46	$1.52	$1.58	$1.64	$1.71	$1.78
	27	$0.32	$0.34	$0.35	$0.37	$0.38	$0.40	$0.41	$0.43	$0.44	$0.46	$0.48	$0.50	$0.52
	30	$0.01	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
	36	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04
1944 to 1956	9	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10
	8	$2.39	$2.48	$2.58	$2.68	$2.79	$2.90	$3.02	$3.14	$3.26	$3.39	$3.53	$3.67	$3.82
	10	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.22	$0.22	$0.23	$0.24	$0.25
	12	$0.13	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.22

Table A.2 Pipe Replacement & Rehabilitation Costs (2033 - 2045)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]												
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
	15	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05
	21	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07
Total (Million Dollars)		**$24.98**	**$25.98**	**$27.02**	**$28.10**	**$29.23**	**$30.40**	**$31.61**	**$32.88**	**$34.19**	**$35.56**	**$36.98**	**$38.46**	**$40.00**

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over a 50-year period.
(3) Costs are escalated from 2006 by 6 percent through 2011, and by 4 percent thereafter.

Table A.2 Pipe Replacement & Rehabilitation Costs (2046 - 2057)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]											
		2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057
Before 1943	Unknown	$2.21	$2.29	$2.39	$2.48	$2.58	$2.68	$2.79	$2.90	$3.02	$3.14	$3.27	$3.40
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
	6	$8.56	$8.91	$9.26	$9.63	$10.02	$10.42	$10.84	$11.27	$11.72	$12.19	$12.68	$13.19
	8	$17.22	$17.91	$18.63	$19.37	$20.15	$20.96	$21.79	$22.67	$23.57	$24.52	$25.50	$26.52
	10	$1.91	$1.99	$2.06	$2.15	$2.23	$2.32	$2.42	$2.51	$2.61	$2.72	$2.83	$2.94
	12	$1.41	$1.47	$1.52	$1.59	$1.65	$1.72	$1.78	$1.86	$1.93	$2.01	$2.09	$2.17
	14	$0.19	$0.20	$0.21	$0.22	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.30
	15	$1.06	$1.11	$1.15	$1.20	$1.24	$1.29	$1.35	$1.40	$1.45	$1.51	$1.57	$1.64
	16	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.29	$0.30	$0.31	$0.32	$0.34	$0.35

Table A.2 Pipe Replacement & Rehabilitation Costs (2046 - 2057)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Construction Year	Pipe Diameter (inch)	Annual R&R Costs (Million Dollars)[2][3]											
		2046	**2047**	**2048**	**2049**	**2050**	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**
	18	$0.84	$0.88	$0.91	$0.95	$0.98	$1.02	$1.07	$1.11	$1.15	$1.20	$1.25	$1.30
	20	$0.14	$0.15	$0.15	$0.16	$0.16	$0.17	$0.18	$0.18	$0.19	$0.20	$0.21	$0.21
	21	$0.62	$0.64	$0.67	$0.70	$0.73	$0.75	$0.78	$0.82	$0.85	$0.88	$0.92	$0.95
	24	$1.85	$1.92	$2.00	$2.08	$2.16	$2.25	$2.34	$2.43	$2.53	$2.63	$2.73	$2.84
	27	$0.54	$0.56	$0.59	$0.61	$0.63	$0.66	$0.68	$0.71	$0.74	$0.77	$0.80	$0.83
	30	$0.02	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04
	36	$0.04	$0.05	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07
1944 to 1956	9	$0.05	$0.05	$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.08
	4	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
	6	$0.10	$0.10	$0.11	$0.11	$0.12	$0.12	$0.13	$0.13	$0.14	$0.14	$0.15	$0.15
	8	$3.97	$4.13	$4.30	$4.47	$4.65	$4.83	$5.03	$5.23	$5.44	$5.65	$5.88	$6.11
	10	$0.26	$0.27	$0.28	$0.30	$0.31	$0.32	$0.33	$0.35	$0.36	$0.37	$0.39	$0.40
	12	$0.22	$0.23	$0.24	$0.25	$0.26	$0.27	$0.28	$0.30	$0.31	$0.32	$0.33	$0.35
	15	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08
	21	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.10	$0.10	$0.10	$0.11	$0.11	$0.12
Total (Million Dollars)		**$41.60**	**$43.26**	**$44.99**	**$46.79**	**$48.66**	**$50.61**	**$52.64**	**$54.74**	**$56.93**	**$59.21**	**$61.58**	**$64.04**

Notes:
(1) Costs in August 2006 dollars.
(2) Costs are distributed evenly over a 50-year period.
(3) Costs are escalated from 2006 by 6 percent through 2011, and by 4 percent thereafter.

Appendix B

OVERALL CIP COSTS

Table B.1 Capital Improvement Project Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Proposed Projects	Total Project Cost[1] ($ Million)	Annual CIP Costs ($ Million)[2] FY 06/07	FY 07/08	FY 08/09	FY 09/10	FY 10/11	FY 11/12	FY 12/13	FY 13/14	FY 14/15	FY 15/16	FY 16/17	FY 17/18	FY 18/19	FY 19/20	FY 20/21	FY 21/22	FY 22/23	FY 23/24	FY 24/25	Total
Plant 1 Primary Expansion, MBR, and Digester	185		2.50	10.00	12.50	87.51	87.51	50.01													250.04
MBR Equipment Upgrade	12														1.01	1.52	10.14	12.67	-	-	25.35
New Boilers	3								4.52												4.52
New Chlorine Contact Basin	4.0											0.29	0.43	2.89	3.62						7.23
New Headworks	10.0													0.80	1.20	8.00	10.01				20.01
WAS Thickening Facility[2]	17.0																	1.62	2.43	16.19	20.23
Influent Metering Project	5.9									2.74	6.39										9.13
O&M Building	2.1									0.98	2.28										3.25
Headwork-Metering Vault	0.5			0.17	0.40																0.58
54-inch Pipe	0.1			0.04	0.10																0.14
Low-Pressure Digester Gas Holder	1.2		0.15	0.68	0.68																1.51
1.2-MW Fuel Cell	13.20		0.68	1.02	6.83	8.54															17.08
Power System Projects	5.10										2.58	6.03									8.61
SCADA System Upgrades	1.0			0.066	0.070	0.074	0.079	0.082	0.085	0.089	0.092	0.096	0.100	0.104	0.108	0.112	0.117	0.121	0.126	0.131	1.65
Waste Gas Burner	0.5		0.17	0.39																	0.56
Biofilters 1 and 2	2.1									0.98	2.28										3.26
Building-Headquarters for Sewer Line	0.3									0.15	0.35										0.50
Total Treatment Expenditures	**315**	**-**	**3.50**	**12.37**	**20.58**	**96.13**	**87.59**	**50.09**	**4.60**	**4.93**	**13.98**	**6.41**	**0.53**	**3.80**	**5.94**	**9.64**	**20.26**	**14.41**	**2.55**	**16.32**	**373.65**
Collection System - Capital projects identified in the 2005 CSMP[3]	37.7		4.24	4.49	4.76	5.05	5.25	5.46	5.68	5.90	6.14	6.39									53.35
Collection System - R&R projects identified by the City[4]	159		8.85	9.39	9.95	10.54	10.97	11.41	11.86	12.34	12.83	13.34	13.88	14.43	15.01	15.61	16.23	16.88	17.56	18.26	239.29
Total Collection System Expenditures	**196.7**		**13.09**	**13.88**	**14.71**	**15.59**	**16.21**	**16.86**	**17.54**	**18.24**	**18.96**	**19.73**	**13.88**	**14.43**	**15.01**	**15.61**	**16.23**	**16.88**	**17.56**	**18.26**	**292.64**
Total for the Year		**-**	**16.6**	**26.3**	**35.3**	**111.7**	**103.8**	**67.0**	**22.1**	**23.2**	**32.9**	**26.1**	**14.4**	**18.2**	**20.9**	**25.2**	**36.5**	**31.3**	**20.1**	**34.6**	**666.3**
Cumulative Expenditure		**-**	**16.59**	**42.84**	**78.13**	**189.84**	**293.65**	**360.60**	**382.74**	**405.91**	**438.85**	**464.99**	**479.40**	**497.63**	**518.57**	**543.81**	**580.30**	**611.60**	**631.71**	**666.28**	

Notes:
(1) Project Costs in August 2006 Dollars.
(2) Costs are midpoint construction dollars spread evenly over the 19-year period.
(3) Collection system capital improvement project costs are distributed evenly over 10-year period, then escalated at 6 percent for the first 5 years, then 4 percent for the remaining years.
(4) Collection system R&R projects are distributed over a 25-year period and then escalated at 6 percent for the first 5 years, then 4 percent for the remaining years. However, for the Integrated Master Plan, only costs through year 2025 are included.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 10: CIP AND OVERALL IMPLEMENTATION SCHEDULE
CHAPTER 2: OPERATION AND MAINTENANCE COST

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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OPERATION AND MAINTENANCE COST

2.1 PURPOSE

The purpose of this chapter is to provide a summary of the additional Operation and Maintenance (O&M) costs that will occur between now and 2025 because of the treatment projects that are recommended for the City of Riverside (City) Regional Water Quality Control Plant (RWQCP). These projects are based on the analyses and recommendations presented in the other volumes of this Master Plan.

2.2 BACKGROUND

The RWQCP currently treats approximately 33 mgd. The expansion projects were identified based on the flow projections made in Volume 2, Chapter 3 - Population and Flow Projections. Figure 2.1 shows the projected average daily flow for the RWQCP for the master planning period for both the high-growth and low-growth scenarios.

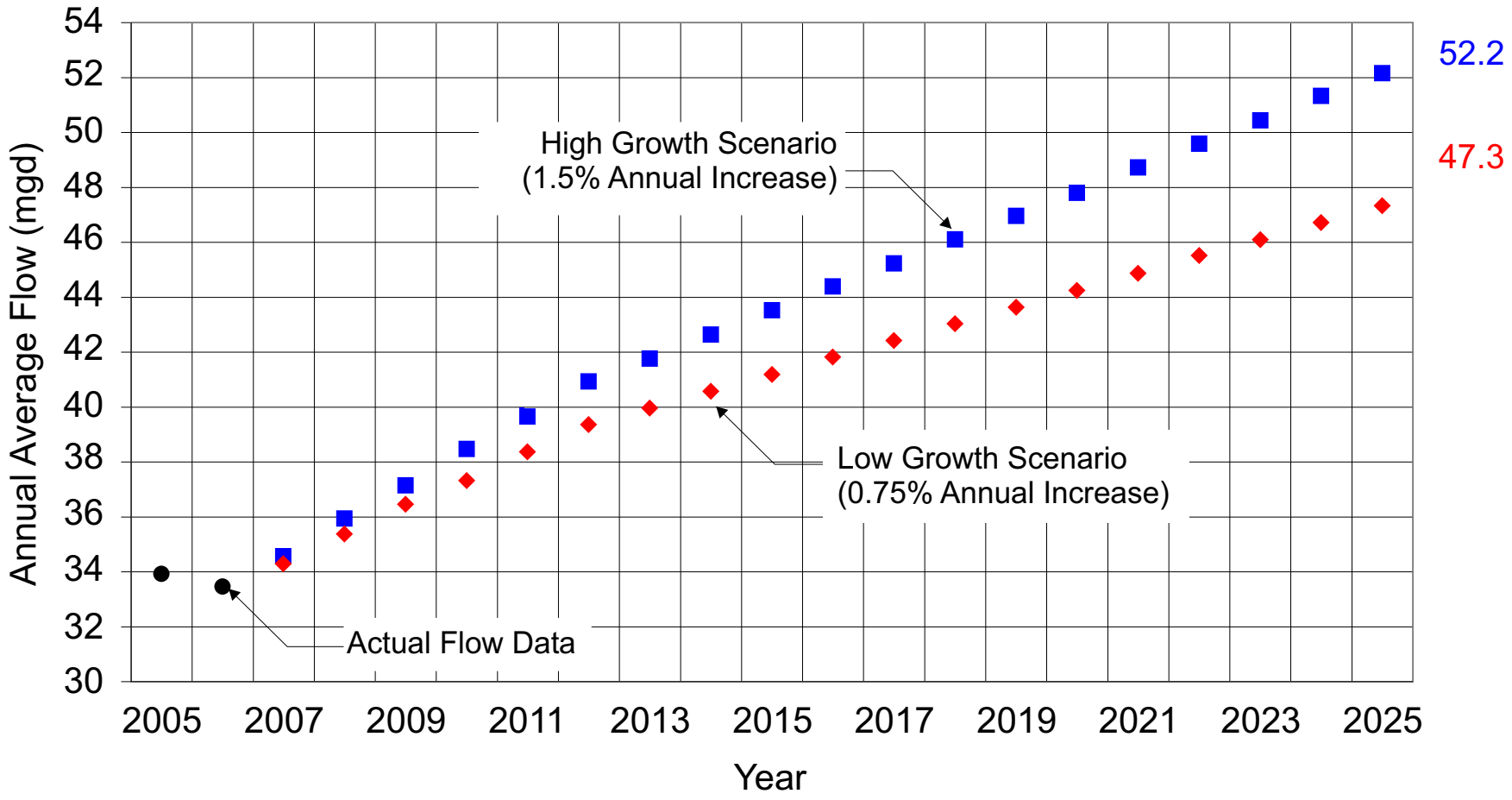
The capital costs of the master plan projects are discussed in Volume 10, Chapter 1 - Capital Costs and Implementation Schedule. These include collection system, liquid and solids treatment systems, energy management, and odor control projects.

2.3 OPERATION AND MAINTENANCE COST CRITERIA

The O&M costs for the existing facilities were provided by the City. These costs are presented in Volume 11, Chapter 3 - Financial Planning Tool. The O&M costs of the existing facilities are excluded from the discussion in this chapter. The additional O&M costs for the recommended treatment system projects are based on energy consumption, chemical supply, and labor, based on the influent flow projections. The additional O&M costs are presented in August 2006 dollars, inflated with an escalation rate of 6 percent for the first 5 years and 4 percent thereafter. The electricity rate is $0.09 per kWh in 2006 dollars.

2.4 OPERATION AND MAINTENANCE COST BREAKDOWN

This section presents the yearly average O&M costs for the major master plan projects. These costs are based on the analyses and recommendations presented in the other volumes of this Master Plan.



TOTAL PROJECTED AVERAGE DAILY FLOW FOR RWQCP

FIGURE 2.1

Table 2.1 lists the breakdown of the additional O&M costs. All costs are adjusted for inflation in the year they are assumed to occur. A brief description of these projects is presented below. The additional O&M costs in Table 2.1 do not begin until 2010, even though the master plan period begins in 2006, because no master plan projects that have additional O&M costs associated with them will be completed before 2010.

2.4.1 Collection System

The O&M costs for the recommended collection system projects are assumed to be the same as the current costs with adjustments for inflation factored in. These costs are not included in this chapter. The inflation-adjusted costs are included in the rate analysis, which is presented in Volume 11, Chapter 3 - Financial Planning Tool.

2.4.2 Treatment System

The additional O&M costs for the recommended treatment system projects are presented below.

2.4.2.1 Liquid Stream Treatment and Odor Control Projects

New Headworks: O&M costs are added from 2023, based on the requirement for additional capacity in addition to the existing capacity of approximately 45 mgd.

Plant 1 Primary Expansion: The existing Plant 1 clarifiers have gone beyond their useful life and require relatively intensive maintenance to consistently provide effective treatment. In addition, rectangular clarifiers require more O&M than circular ones at the same capacity. Therefore, the O&M costs for the existing 20-mgd rectangular clarifiers will be approximately the same as the new 32-mgd circular clarifiers, so no additional O&M costs for primary clarifiers are included. O&M costs for primary effluent equalization and biofilters are added from the year 2013, based on the requirement for additional capacity over time.

Membrane Bioreactor (MBR) Facilities: O&M costs are added from the year 2013 based on the capacity requirement. Because high-quality filtrate from the MBRs does not require tertiary filtration, credit for tertiary filter O&M costs are given. Based on the previous years budget data provided by the City, tertiary treatment costs are approximately 32 percent of the total treatment cost. Applying the ratio of 32 percent to $11.8 million for the budget year of 2006, the tertiary treatment O&M cost is $3.8 million at the capacity of 33.5 mgd. Therefore, the tertiary treatment cost for 20 mgd is approximately $2.3 million and the tertiary treatment savings for 13.5 mgd is approximately $1.5 million in 2006 dollars. Table 2.2 shows the O&M costs of the existing tertiary treatment process.

Table 2.1 Additional O&M Cost Breakdown
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
New Headworks	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,000	$42,000	$65,000
Biofilters	$0	$0	$0	$47,000	$98,000	$104,000	$110,000	$116,000	$122,000	$129,000	$136,000	$143,000	$151,000	$159,000	$168,000	$177,000
Primary Clarifiers	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Primary Sludge Pump Station	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Primary Effluent EQ	$0	$0	$0	$40,000	$84,000	$89,000	$94,000	$99,000	$104,000	$110,000	$116,000	$122,000	$129,000	$136,000	$143,000	$151,000
Primary EQ Pumps	$0	$0	$0	$26,000	$56,000	$59,000	$62,000	$66,000	$69,000	$73,000	$77,000	$81,000	$86,000	$90,000	$95,000	$100,000
Fine (perforated) Screens, MBR Facility and RAS/WAS Pumps	$0	$0	$0	$195,000	$417,000	$447,000	$478,000	$511,000	$546,000	$583,000	$622,000	$663,000	$706,000	$752,000	$796,000	$843,000
Additional MBR Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$4,000	$8,000
Primary Sludge Thickeners (GBTs)	$0	$0	$0	$204,000	$430,000	$454,000	$479,000	$506,000	$534,000	$563,000	$594,000	$626,000	$660,000	$695,000	$733,000	$772,000
WAS Thickeners (GBTs)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Chlorine Contact Basin	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9,000	$33,000	$59,000	$87,000	$117,000	$150,000
Ozone + UV 52 mgd	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$838,000	$884,000	$932,000	$982,000	$1,035,000	$1,090,000
Acid-Phase Digester	$0	$0	$0	$214,000	$452,000	$477,000	$504,000	$532,000	$561,000	$592,000	$624,000	$658,000	$693,000	$731,000	$770,000	$811,000
Reclaim and Reuse Water	$97,000	$103,000	$107,000	$111,000	$115,000	$120,000	$125,000	$130,000	$135,000	$140,000	$146,000	$152,000	$158,000	$164,000	$171,000	$178,000
Energy Management	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Additional O&M Cost	**$97,000**	**$103,000**	**$107,000**	**$837,000**	**$1,652,000**	**$1,750,000**	**$1,852,000**	**$1,960,000**	**$2,071,000**	**$2,190,000**	**$2,324,000**	**$2,478,000**	**$2,642,000**	**$2,834,000**	**$3,039,000**	**$3,255,000**
Ozone+UV Scenario Cost											**$3,153,000**	**$3,329,000**	**$3,515,000**	**$3,729,000**	**$3,957,000**	**$4,195,000**

Notes:
(1) All costs are as future value with an escalation rate of 6 percent through the year 2011 and 4 percent thereafter and adjusted based on the requirement to meet capacity over time.

Table 2.2 Existing Tertiary Treatment O&M Costs Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Treatment Process	**O&M Cost**	**Percentage**
Budget Year: 1997/1998		
Primary Treatment[1]	$1,637,000	18.6%
Secondary Treatment[1]	$1,964,000	22.3%
Tertiary Treatment[1]	$2,824,000	32.1%
Solids Treatment[1]	$2,372,000	27.0%
Plant Total[1]	**$8,797,000**	**100.0%**
Budget Year: 2006		
Plant Total	$11,760,000	
Tertiary Treatment[2]	$3,770,000	
Treatment Capacity: 33.5 mgd		
Tertiary Treatment for 20 mgd[3]	**$2,250,000**	
Tertiary Treatment Savings[3]	**$1,520,000**	

Notes:
(1) Budget data provided by the City for the August 2001 Revenue Plan.
(2) Assume the same percentage as in 1997/1998.
(3) When MBR is in operation, tertiary filters will be used for Plant 2 secondary effluent, which is 20 mgd on an annual average basis.

Disinfection: In Volume 4, Chapter 9 - Disinfection, chlorine contact basins will be used for disinfection unless future regulations require different methods. O&M costs are added from 2020, based on the requirement for additional capacity in addition to the existing capacity of 44 mgd. Ozone and UV disinfection O&M costs are calculated as an alternative to chlorine disinfection. For the ozone and UV disinfection scenario, credits are given for the existing 44-mgd chlorination and dechlorination chemical costs. O&M costs for the new ozone and UV facilities are added from 2020 as a comparison to the chlorine scenario, though the start date of the ozone and UV disinfection project is undetermined.

2.4.2.2 Solids Treatment

Primary Sludge Thickeners: Primary solids are currently thickened in the Plant 2 primary clarifiers before digestion. Separate Gravity Belt Thickeners (GBTs) will be used after the completion of Plant 1 Primary Expansion in 2013. The future O&M costs for the new primary sludge thickeners are added from the year 2013, based on the requirement to meet capacity over time.

Waste Active Sludge (WAS) Thickeners: The existing Dissolved Air Flotation Thickeners (DAFTs) will be used until 2026, when new GBTs are installed. The additional O&M costs of the GBTs are not added for the master plan period until 2025.

Digestion: Acid-Phase Anaerobic Digestion O&M costs are added from the year 2013, based on the requirement to meet capacity over time.

2.4.3 Reclamation and Reuse

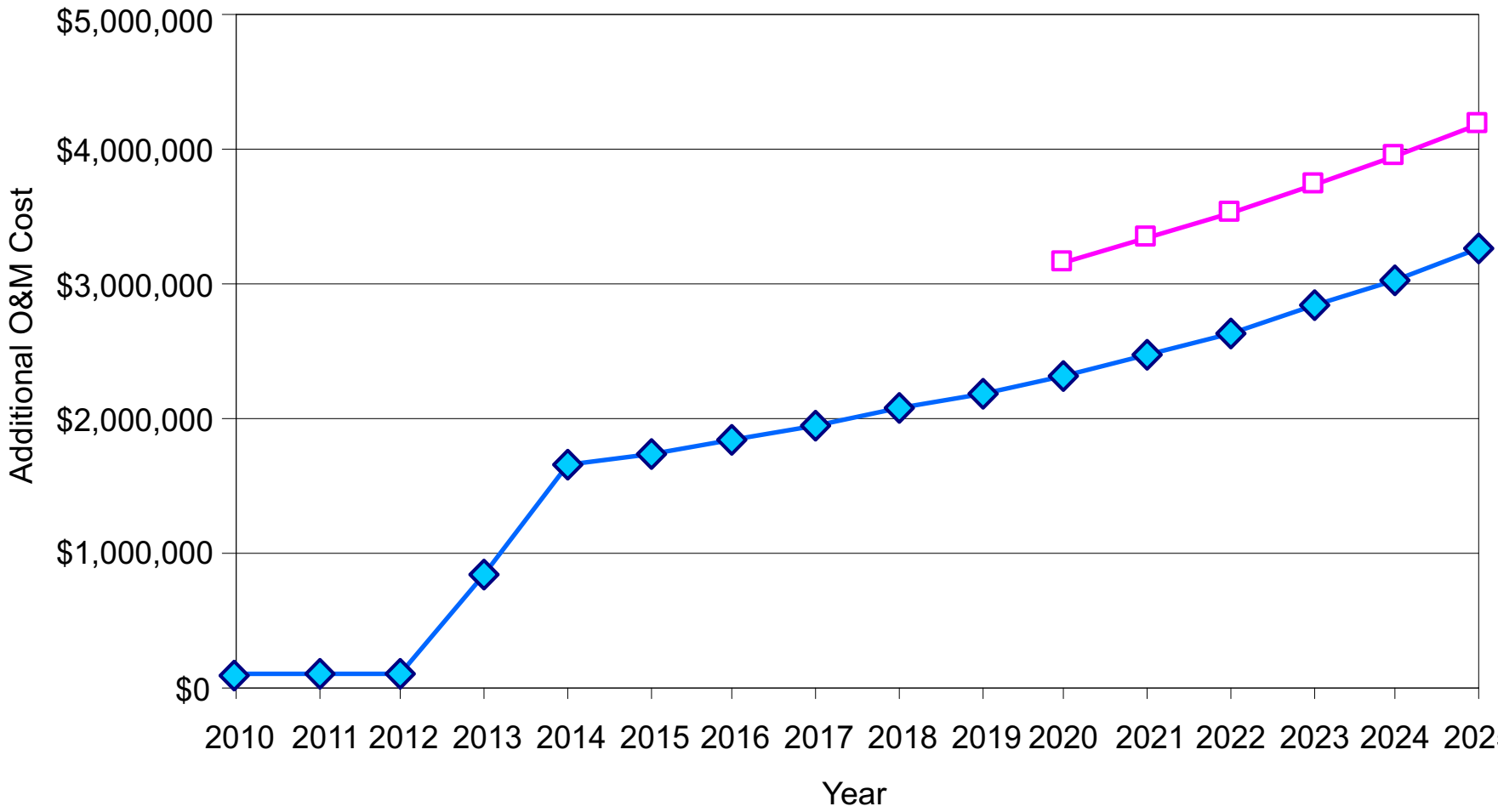
The reclamation and reuse project will be completed in 2010. The O&M costs are added from the year 2010.

2.4.4 Energy Management

There are no additional O&M costs for the energy management projects, including cogeneration engines and fuel cells, discussed in this chapter. It is assumed that the O&M costs for the fuel cells will be similar to those for the existing cogeneration engines that they will replace, so only adjustments for inflation are considered. The inflation-adjusted costs are included in the rate analysis, which is presented in Volume 11, Chapter 3 - Financial Planning Tool.

2.5 TOTAL OPERATION AND MAINTENANCE COSTS

The total additional O&M costs for all of the recommended projects from the year 2010 to the year 2025 are summarized on Figure 2.2. The total additional O&M cost increases by approximately $0.7 million in 2013, when the combined project that includes the Plant 1 Primary Expansion, MBR Facilities, and Acid-Phase Digester is completed in the midyear. Figure 2.2 shows two scenarios for the total additional O&M costs for all the projects listed in Table 2.1, from 2010 through 2025. The blue line represents the additional O&M costs for these projects using chlorine disinfection. The pink line represents the additional O&M costs for these projects if regulatory requirements lead to the installation of ozone and UV disinfection.



TOTAL ADDITIONAL O&M COSTS

FIGURE 2.2

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES
CHAPTER 1: MASTER PLAN MANAGER™

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES
CHAPTER 1: MASTER PLAN MANAGER™

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MASTER PLAN MANAGER™

1.1 PURPOSE

The City of Riverside (City) is in the process of completing their Wastewater Collection and Treatment Facilities Integrated Master Plan (Integrated Master Plan). The Integrated Master Plan began with growth and regulatory assumptions that were used to develop alternatives. The alternatives were then evaluated based on their ability to meet the growth and regulatory needs. From there, alternatives were further developed to estimate implementation costs and schedules.

The Master Plan Manager™ (MPM™) software application allows growth and regulatory assumptions to be easily updated as changes occur in the future. The purpose of this chapter is to explain the overall functionality of the MPM™ software and how the City can use it in the future to meet their needs.

1.2 CONCLUSIONS

MPM™ allows the user to create and easily update numerous options for growth and regulatory assumptions that can be combined in a variety of ways to create many scenarios. The software provides immediate scenario results that can then be compared and evaluated against one another. These analyses will help the City to identify and understand planned trigger points for various projects, the impacts to capacity and effluent quality from the different growth options, and the relative impacts to the Capital Improvement Program (CIP) in terms of cost and scheduling. All together, the City can understand potential future capacity bottlenecks, and potential failures to meet effluent quality requirements based on various growth options and selection of treatment processes. This information will allow the City to plan for flexibility, react to uncertainty, and implement projects just in time.

1.3 INTRODUCTION

The master planning process involves developing wastewater flow and pollutant load projections based on population for the desired planning time frame. These projections are then compared with existing facilities or those that are in the midst of construction in order to determine where and when treatment capacity needs will be greater than the available capacity.

Projections are also compared with existing and future regulatory requirements to determine when and for which constituents the projected effluent quality will exceed National Pollutant Discharge Elimination System (NPDES) permit limits. Once a complete scenario is developed, the impact to the CIP, in terms of costs and the implementation

schedule must be calculated. When multiple scenarios have been developed, their outputs and impacts can be compared against one another to determine the sensitivity of the system to a range of parameters.

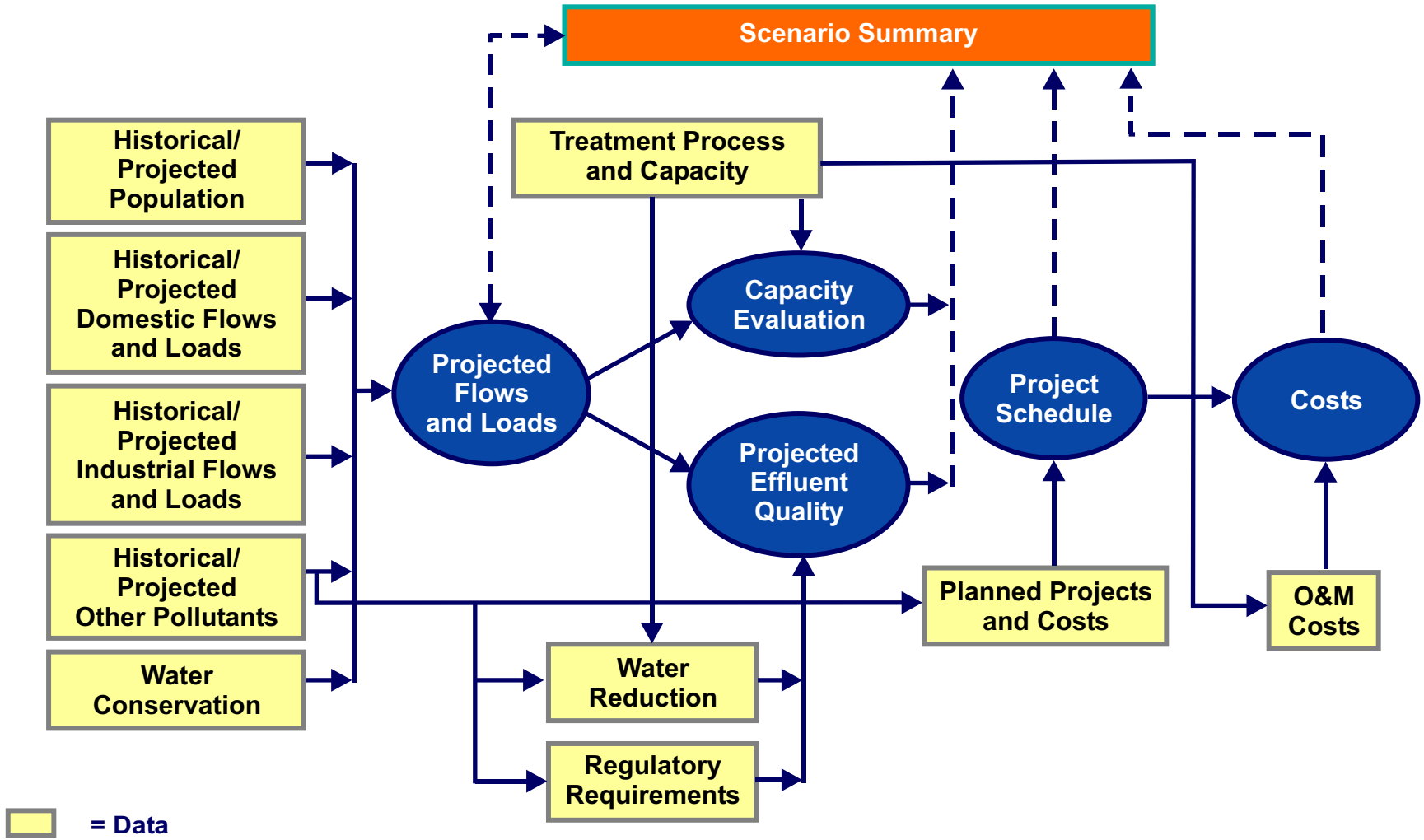
The traditional approach to master planning is limited by budget and time constraints to a limited number of projection options or combinations of options. Also, if a change is made to any of the inputs, the entire scenario must be reconfigured to determine its impacts. Developing each scenario is a time and labor-intensive process, as is performing a sensitivity analysis on the scenario.

By using a dynamic computerized planning tool, like MPM™, for the master planning process, instead of the “paper” approach, many more options and scenarios, can be developed for the same budget. In addition, sensitivity analyses can be performed for a large number of potential scenarios.

MPM™ computerizes and automates the master plan process by incorporating historical and projected flows and loads for domestic, industrial, and nontraditional pollutants; water conservation measures; treatment processes and capacities; pollutant reduction and addition; regulatory requirements; planned projects and estimated costs; and Operations and Maintenance (O&M) costs. These data are used to develop flow and load projections, perform capacity evaluations, determine effluent quality, develop project schedules, and develop overall costs. The MPM™ can produce numerous "what-if" scenarios in order to develop a sensitivity analysis.

Figure 1.1 shows the MPM™ logic diagram. Data inputs are shown in yellow, and calculations are shown in blue. Data and calculation links are denoted by solid and dashed lines, respectively. MPM™ takes historical population, flow, and load information, and using projected population, calculates projected flows and loads. In addition to traditional pollutants, MPM™ can model other pollutants including metals, pH, TDS, and trace organics. The model can also take into account water conservation in relation to projected flows and loads.

Once the projected flows and loads have been developed, MPM™ evaluates capacity and effluent quality. By comparing projected flows and loads to the existing treatment capacity, MPM™ identifies when capacity (for which major components in which year) is insufficient. By applying pollutant reduction percentages to projected flows and loads, effluent quality is calculated. When compared against the regulatory requirements, MPM™ identifies where effluent quality (for which pollutants in which years) is inadequate to meet permit needs. Based on the results of the two evaluations of capacity and effluent quality, future facilities and costs are identified through the development of the CIP, and along with O&M costs, are used by MPM™ to calculate a project schedule and overall costs per year.



MASTER PLAN MANAGER™ LOGIC DIAGRAM

FIGURE 1.1

1.4 FUNCTIONALITY

MPM™ is a software application that uses a Microsoft Access database, accompanied by a graphical user interface that is programmed in C#. The screen is divided into three areas as shown in Figure 1.2. The three areas include:

- The toolbar along the top, which allows the user to add, copy, delete, save, and many other basic functions, including developing reports and graphing.
- The “tree” on the left hand side for navigation throughout the application.
- The main screen in the middle, which displays the data and results.

The tree structure is organized in layers - the topmost layer is the scenario layer. As many scenarios as needed can be created, and each scenario contains a full tree structure underneath it. Scenarios can easily be copied and then specific data can be modified. For the City, six scenarios were developed, one for each Growth option for the cases where the City would implement additional chlorine contact basins and one for each Growth option for the cases where the City would implement ozonation and UV disinfection. The next layer is the calculation layer - these are layers in which the software is calculating results and displaying them. The lowest layer is the data option, where the user enters in data that is then used for calculations. As many data options as needed can be created to model future possibilities. The Scenario Summary page is the screen from which the user can access all the data and see immediate results pertaining to the Capacity Evaluation and Effluent Quality components of MPM™.

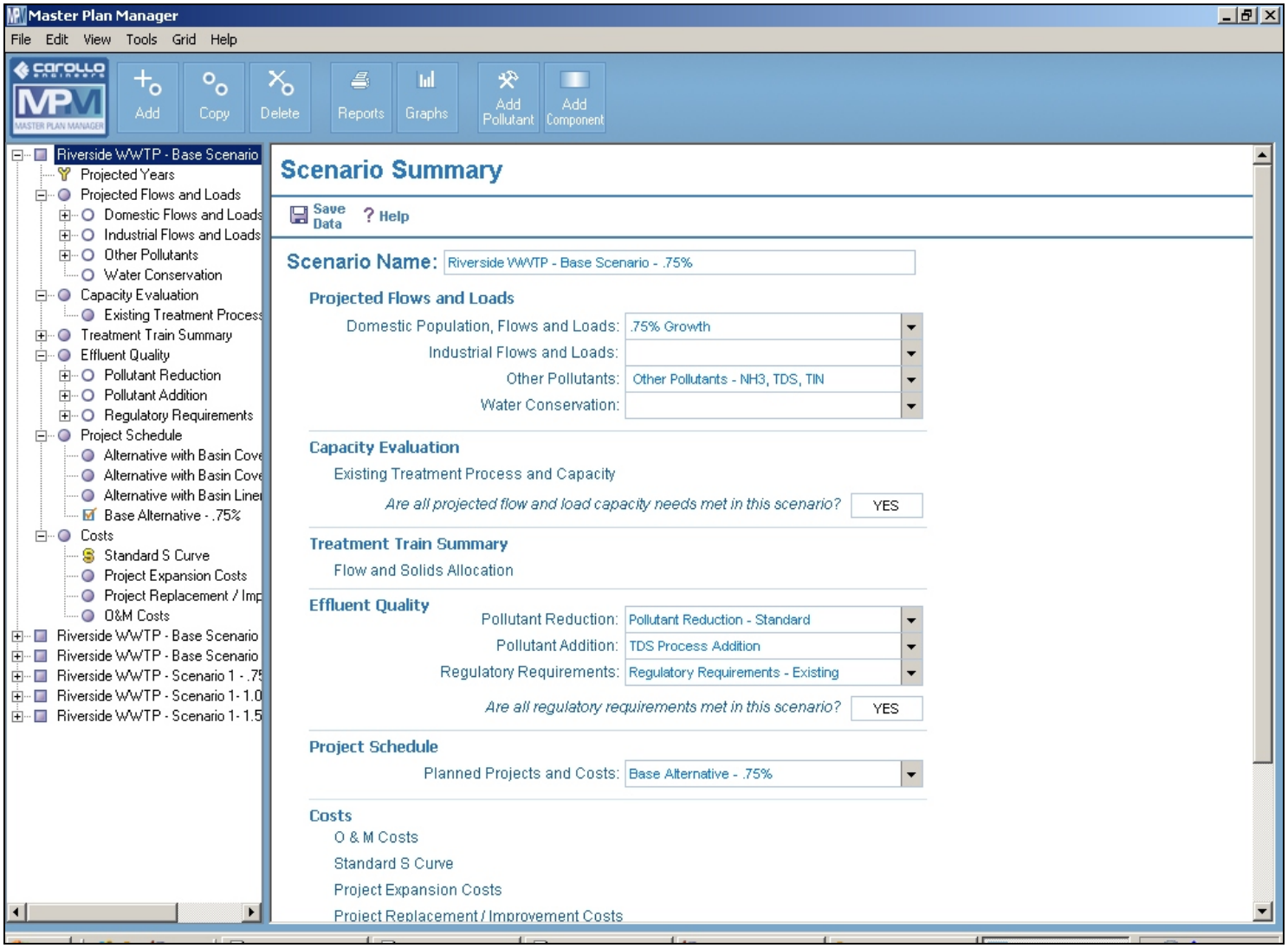
1.4.1 Projected Years

The first step in customizing MPM™ is to develop the planning time frame. Each year of the planning time frame is entered into the grid as shown in Figure 1.3. The time frame can be set for any number of years. For the City, the years 2007/2008 (denoted as 2008 in MPM™) through 2024/2025 (denoted as 2025 in MPM™) are the assumed planning horizon.

1.4.2 Projected Flows and Loads

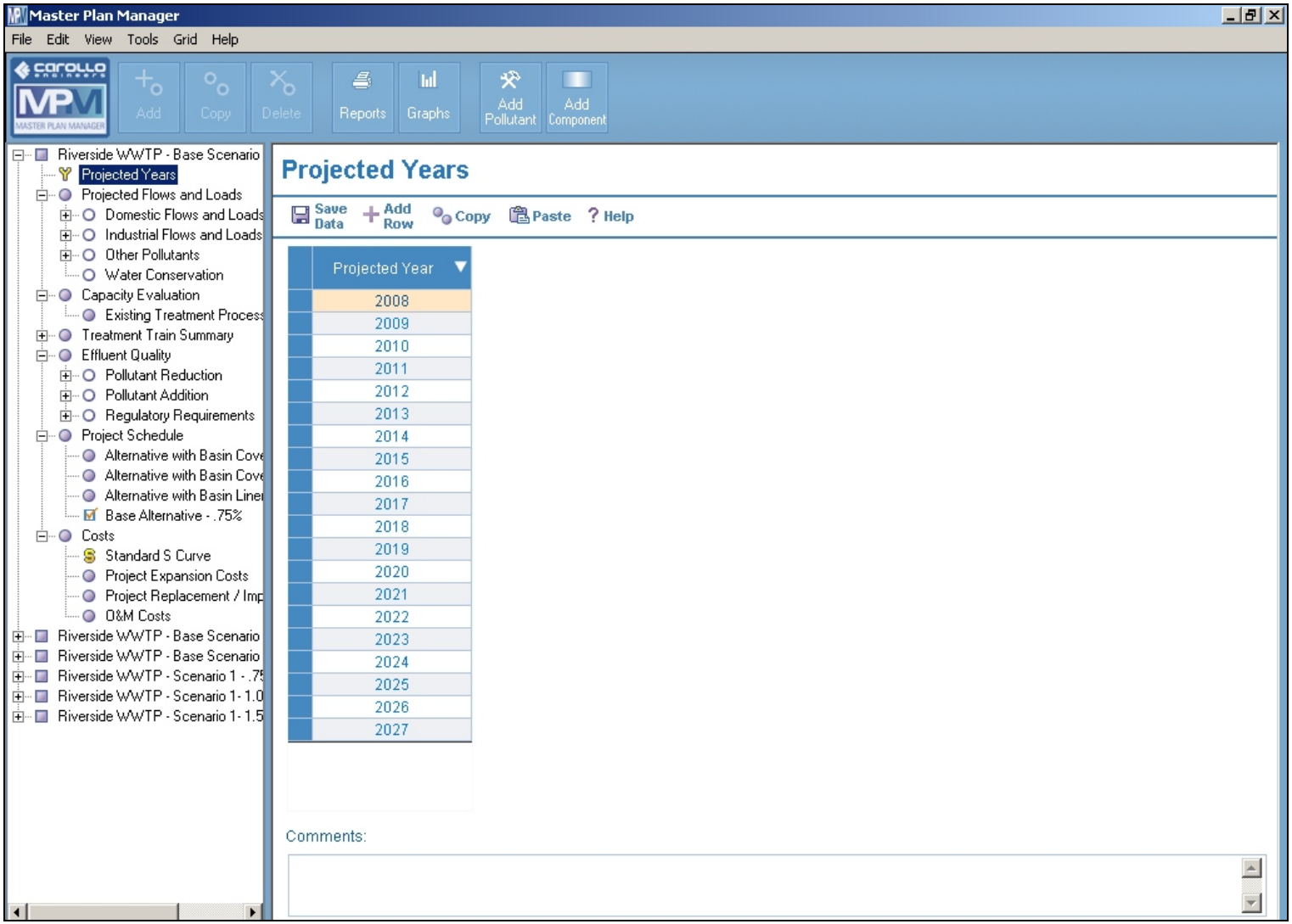
Projected population, flows, and loads are required for determining the influent concentrations as well as the capacity requirements. The projections provide information needed to size additional facilities, as well as determine if there are likely to be compliance issues with meeting NPDES permit requirements.

The flow and load portion of MPM™ is divided into four categories; D*omestic, Industrial, Other Pollutants*, and *Water Conservation*. Each of these four categories is a data option and, except for *Water Conservation*, have historical and projected data separated. All the



MASTER PLAN MANAGER OVERVIEW

FIGURE 1.2



PROJECTED YEARS

FIGURE 1.3

projected data is displayed on the *Projected Flows* and *Loads* calculations layer. For the City, data was entered for the *Domestic* and *Other Pollutant* portions.

1.4.2.1 Domestic Flows and Loads

For the *Historical Domestic* data option, the user enters any numbers of years worth of data for Flow (mgd), BOD (lbs/day), TSS (lbs/day), TN (lbs/day), and TP (lbs/day), from which MPM™ calculates average flow and concentration, as shown in Figure 1.4. For the City, data was entered for the years 2000 through 2006.

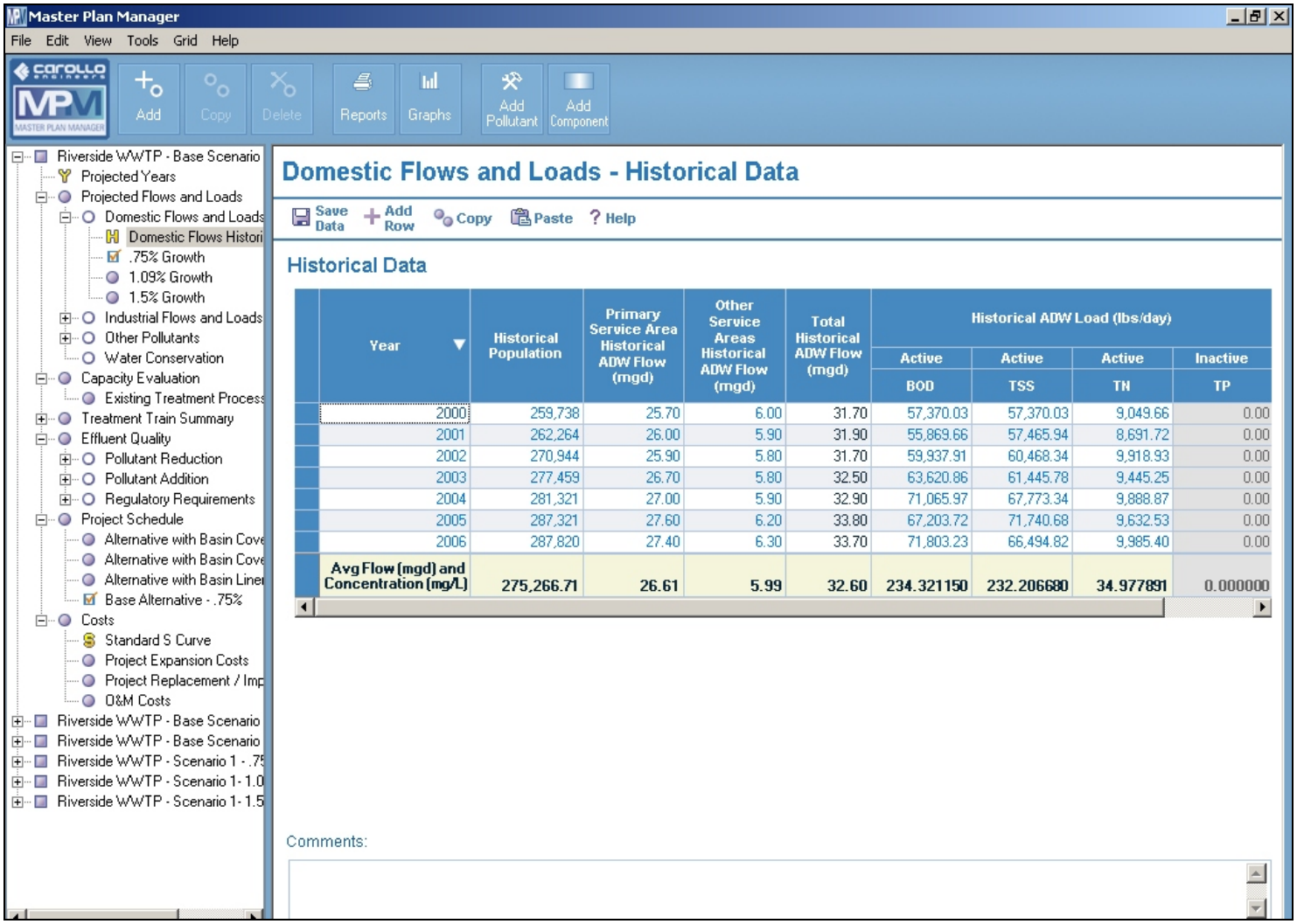
For *Projected Domestic* data options, the user enters in projected population for each projected year, and from that, and the historical averages and concentrations, MPM™ calculates projected flows and loads for Flow (mgd), BOD (lbs/day), TSS (lbs/day), TN (lbs/day), and TP (lbs/day), as displayed in Figure 1.5. For the City, projected population data was entered for 2008 through 2025. MPM™ calculated projected flows and loads for those years based on the historical per capita values.

The database structure is set up so that once historical data is entered, any number of *Projected Domestic* data options can be developed. However, the user can only create one *Historical Domestic* data option. In Figure 1.5, the main screen shown is the “0.75% Growth Domestic” data option. Three *Projected Domestic* data options are entered into MPM™, entitled “0.75% Growth”, “1.09% Growth”, and “1.5% Growth” as displayed in the tree part of the screen in Figure 1.5. Whichever data option is selected is the data that is carried forward to the Projected Flows and Loads calculations layer by simply clicking on the Selected box. This feature allows for modeling a range of outcomes. In addition, the user can easily copy and modify data options as changes occur.

1.4.2.2 Industrial Flows and Loads

The *Industrial Flows* and *Loads* portion of MPM™ is used to separate industrial flows from residential/commercial flows, and model them separately. For the City, industrial flows and loads were not modeled separately in MPM™ because industries in the City do not contribute a significant percentage of the flow, nor do they contribute a significant concentration of any pollutant. The software has the ability to model industrial flows separately if conditions in the City change in the future.

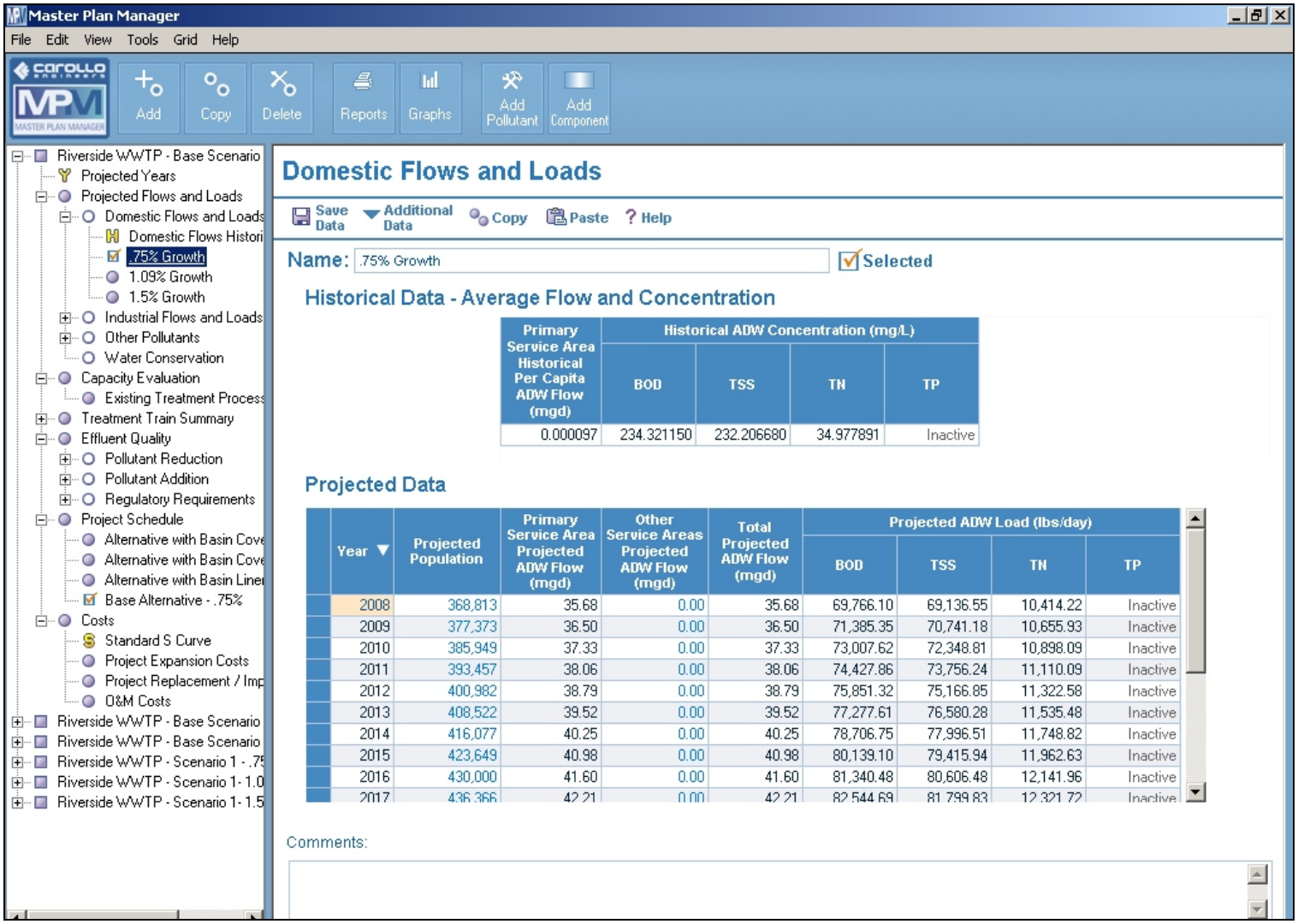
The *Industrial* portion of flows and loads is similar to the *Domestic* portion in that there is a Historical Industrial data option where data is entered for historical flow (mgd) and load (lbs/day) data for BOD, TSS, TN, and TP, for any number of years, as shown in Figure 1.6. For the *Projected Industrial* data options, the user enters in all projected flow and load data for Flow (mgd), BOD (lbs/day), TSS (lbs/day), TN (lbs/day), and TP (lbs/day) for each projected year, rather than having MPM™ calculate projected flows and loads, as displayed in Figure 1.7.



Year	Historical Population	Primary Service Area Historical ADW Flow (mgd)	Other Service Areas Historical ADW Flow (mgd)	Total Historical ADW Flow (mgd)	Historical ADW Load (lbs/day)			
					Active BOD	Active TSS	Active TN	Inactive TP
2000	259,738	25.70	6.00	31.70	57,370.03	57,370.03	9,049.66	0.00
2001	262,264	26.00	5.90	31.90	55,869.66	57,465.94	8,691.72	0.00
2002	270,944	25.90	5.80	31.70	59,937.91	60,468.34	9,918.93	0.00
2003	277,459	26.70	5.80	32.50	63,620.86	61,445.78	9,445.25	0.00
2004	281,321	27.00	5.90	32.90	71,065.97	67,773.34	9,888.87	0.00
2005	287,321	27.60	6.20	33.80	67,203.72	71,740.68	9,632.53	0.00
2006	287,820	27.40	6.30	33.70	71,803.23	66,494.82	9,985.40	0.00
Avg Flow (mgd) and Concentration (mg/L)	**275,266.71**	**26.61**	**5.99**	**32.60**	**234.321150**	**232.206680**	**34.977891**	**0.000000**

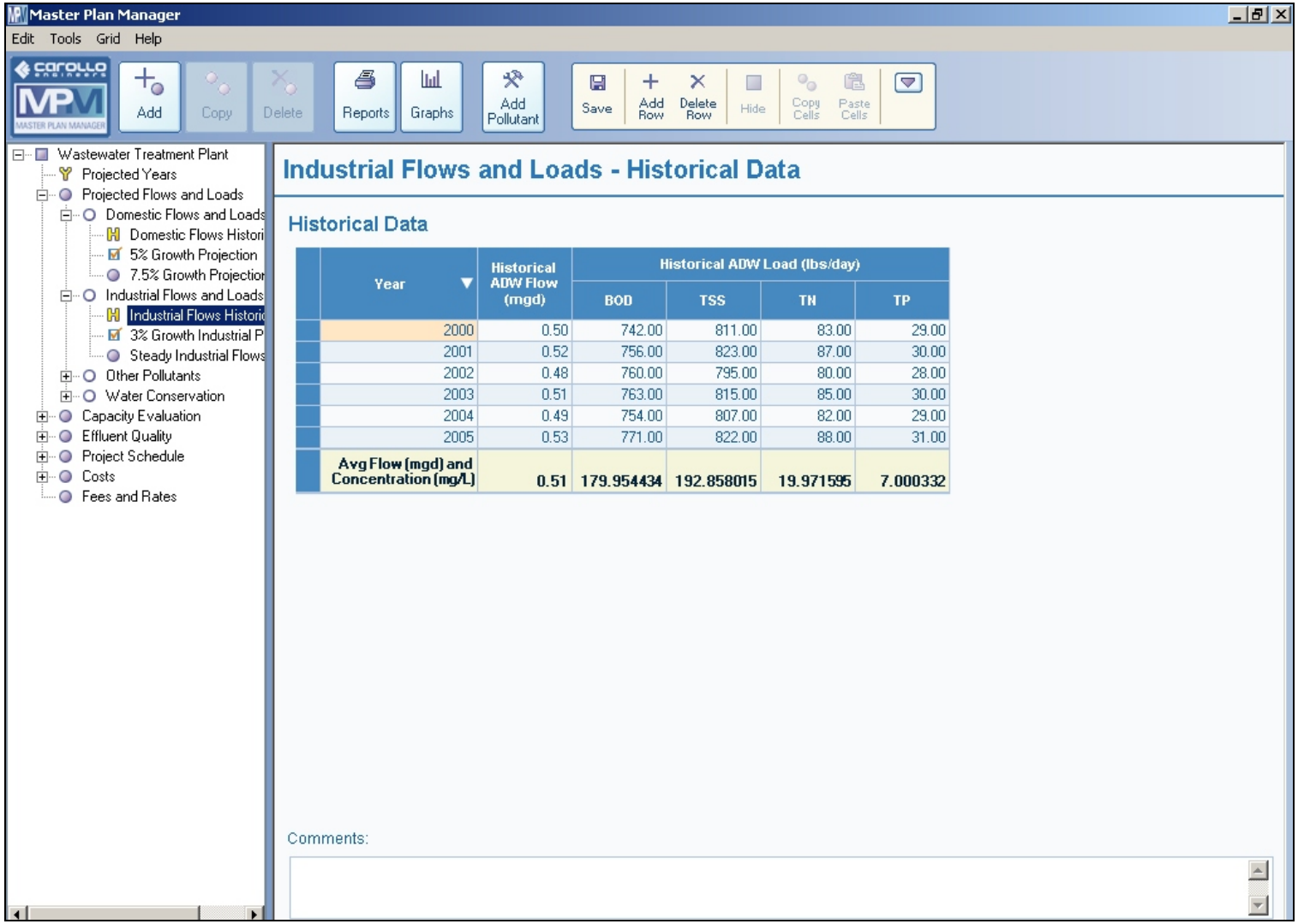
HISTORICAL DOMESTIC FLOWS AND LOADS

FIGURE 1.4



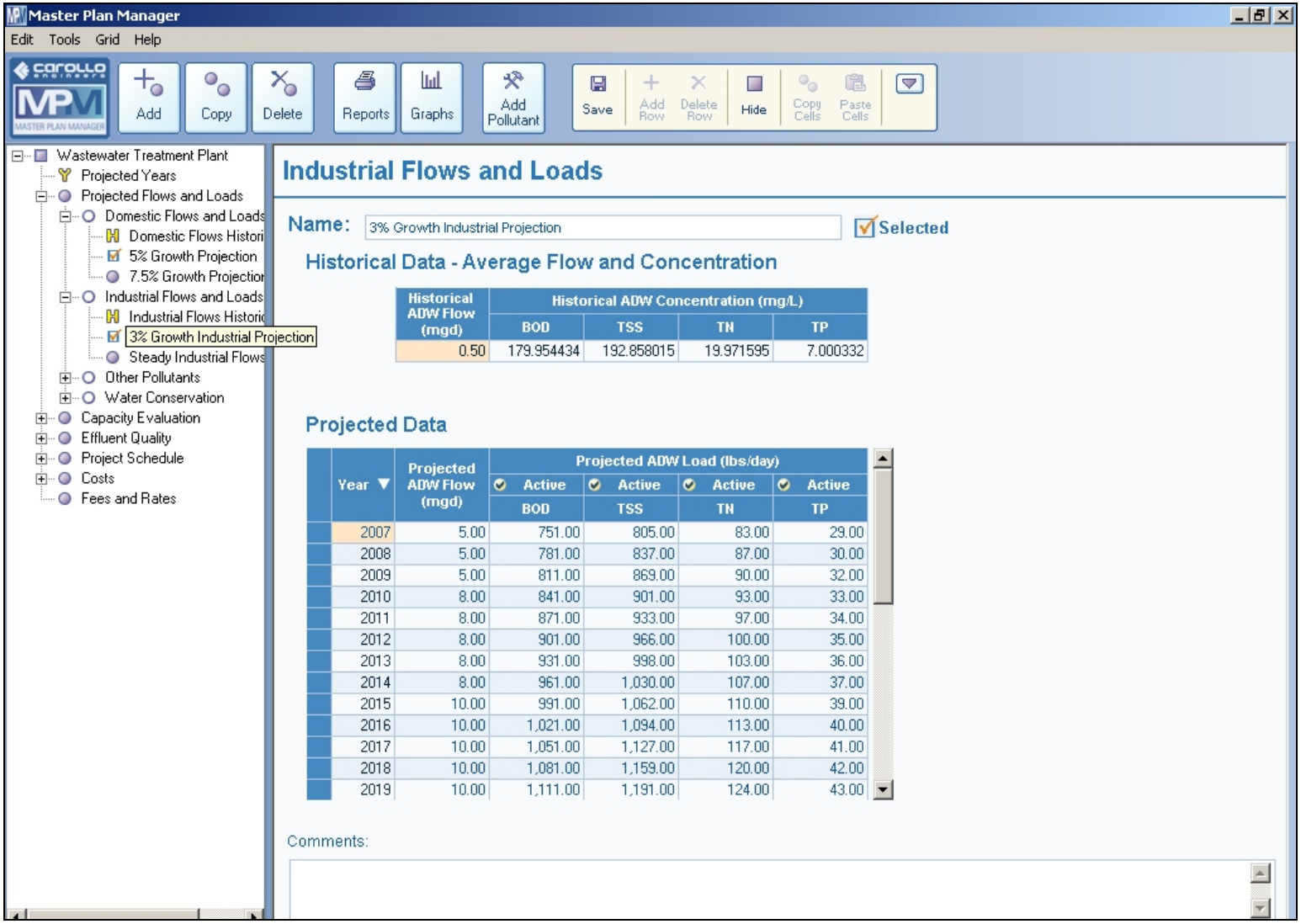
PROJECTED DOMESTIC FLOWS AND LOADS

FIGURE 1.5



HISTORICAL INDUSTRIAL FLOWS AND LOADS

FIGURE 1.6



PROJECTED INDUSTRIAL FLOWS AND LOADS

FIGURE 1.7

Similarly to the *Domestic* data, the user can only create one *Historical Industrial* data option and as many *Projected Industrial* data options as needed. Whichever data option is selected is carried forward to the *Projected Flows and Loads* calculations layer by clicking on the Selected box.

1.4.2.3 Other Pollutants

The *Other Pollutants* portion of MPM™ allows the user to address pollutants in addition to Flow, BOD, TSS, TN, and TP, including heavy metals and pharmaceuticals. The *Other Pollutant* portion has the same database structure as the *Domestic* and *Industrial Flows and Loads* portions, in which there is a *Historical Other Pollutant* data option with user entered data for as many years as desired, as shown in Figure 1.8.

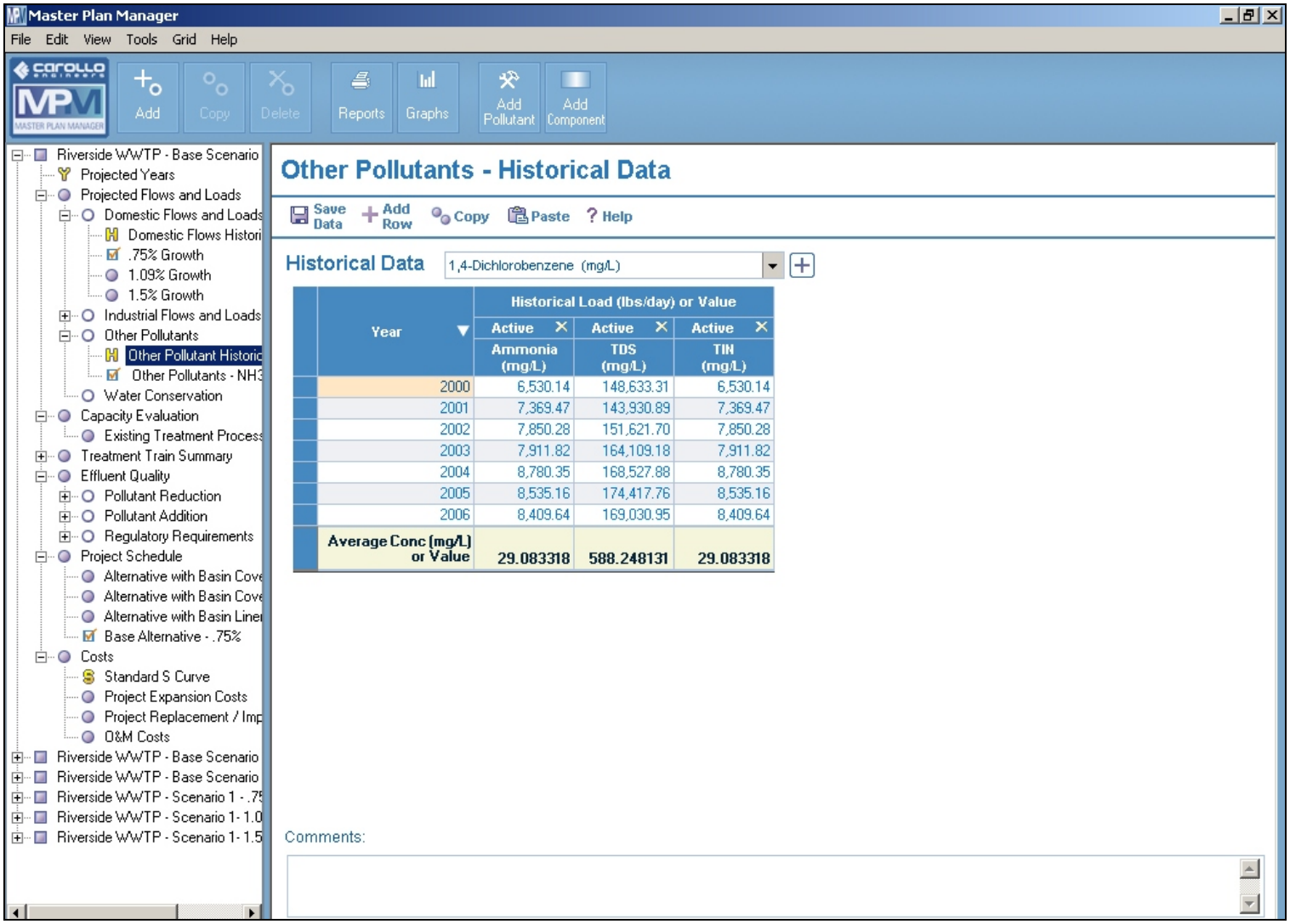
The difference in the *Other Pollutants* grid is that the pollutants in the grid are user customizable. The user selects a pollutant from the drop down menu and adds it to the grid. The user can also add pollutants that are not currently in the drop down menu. Once the grid has been created, the user enters historical data by year, as done previously for the other portions. MPM™ calculates average concentration or value. For the City, data was entered for ammonia, TDS, and TIN for the years 2000 through 2006.

For the *Projected Other Pollutants* data options, the user customizes the grid for the pollutants that are to be modeled in a fashion similar to the *Historical* data option. Here the user enters a concentration and along with the projected flow (for the data options that have been selected), MPM™ calculates the projected loads, as shown in Figure 1.9. Again, for the City, ammonia, TDS, and TIN were projected for the years 2008 through 2025.

The database structure is set up so that once historical data is entered, any number of *Projected Other Pollutant* data options can be developed, but only one *Historical Other Pollutant* data option can be created. Again, whichever data option is selected is carried forward to the *Projected Flows and Loads* calculations layer by clicking on the Selected box. This feature allows the user to model a range of outcomes and the user can easily copy and modify data options as changes occur.

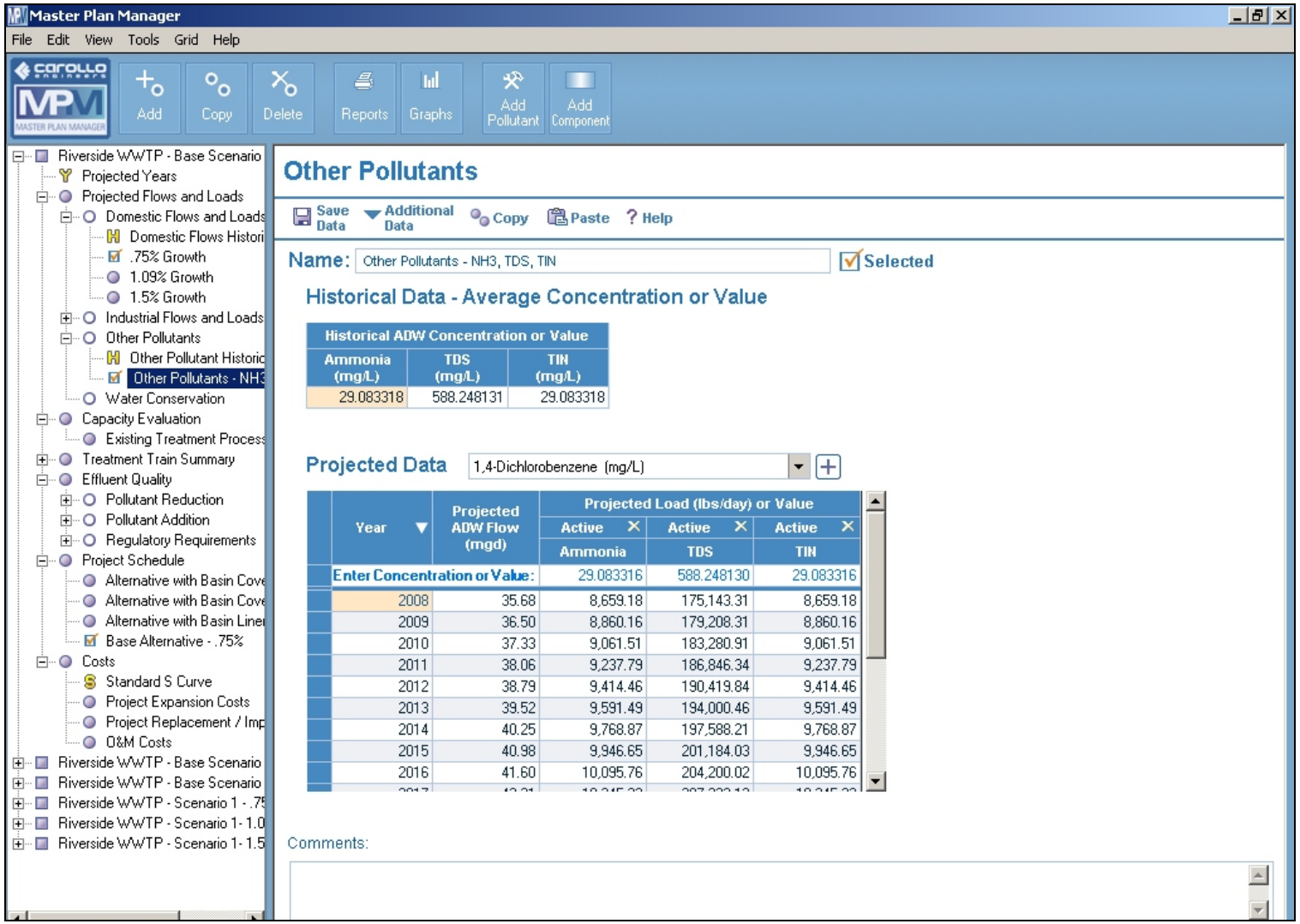
1.4.2.4 Water Conservation

Water Conservation is used to model the impacts to the projected flows and loads if flows or TDS loads are reduced due to such activities as the installation of low flush toilets or waterless urinals. No water or TDS conservation was assumed at this time for the City. However, MPM™ has the ability to model this in the future, if necessary.



HISTORICAL OTHER POLLUTANTS

FIGURE 1.8



PROJECTED OTHER POLLUTANTS

FIGURE 1.9

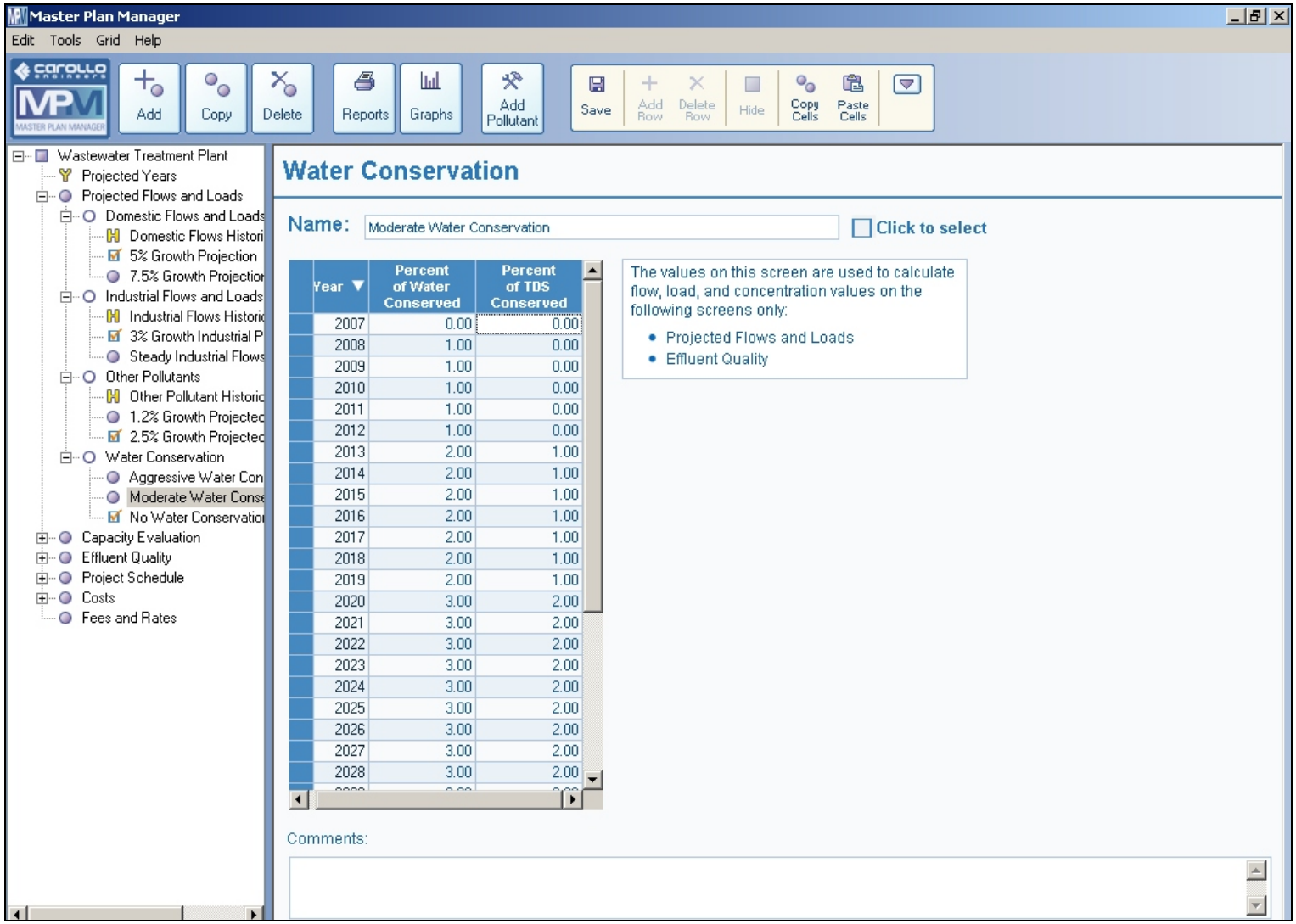
For *Water Conservation*, there is no *Historical* data in the model because historical data for water conservation is not used for any projection calculations. For the *Water Conservation* data options, as shown in Figure 1.10, the user enters overall percentages of water and TDS conservation by year which are applied to the overall *Projected Flows and Loads* calculations layer. The user can create as many *Water Conservation* data options as needed and, the selected data option is carried forward to the *Projected Flows and Loads* calculations layer by clicking on the Selected box.

1.4.2.5 Projected Flows and Loads

MPM™ integrates the data from the four portions of *Projected Flows and Loads* on the *Projected Flows and Loads* calculations layer, as shown in Figure 1.11. The grid shows all the pollutants for which there is projected data from the selected *Projected Other Pollutant* data option, and integrates the selected projected flow and load data options from both the *Projected Domestic* and *Industrial* data options. In addition, the percentages of water and TDS conserved are applied to the grid as well. The overall projected flows and loads are then used throughout MPM™. The user can enter peaking factors for maximum month, peak hour, and equalized flow peak, and these factors are used for calculating the flow or load that is handled by the facilities in the evaluation of capacity.

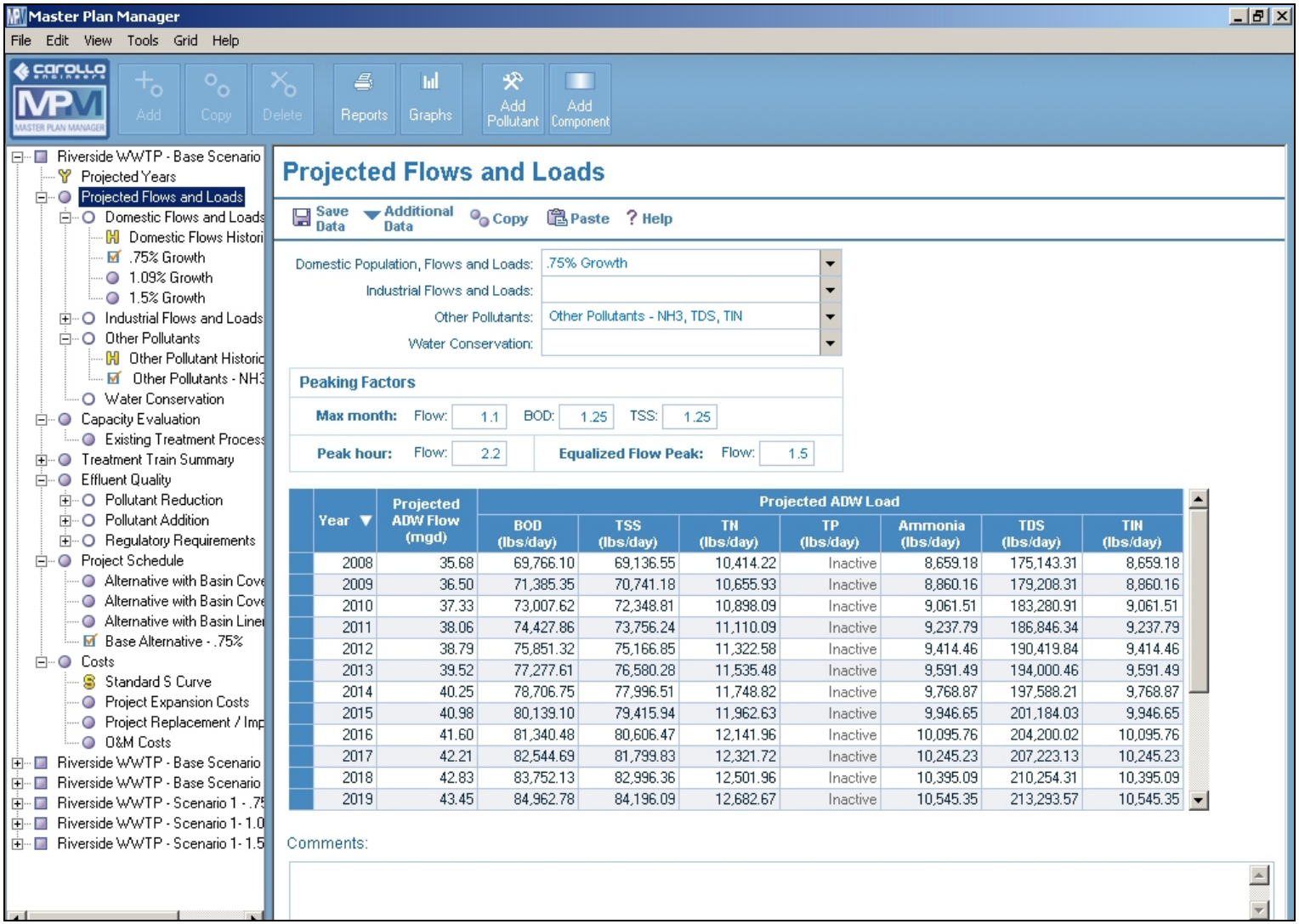
1.4.3 Existing Treatment Process and Capacity

Once flows and loads have been addressed, the existing treatment facilities need to be entered into MPM™, and this is handled on the *Existing Treatment Process and Capacity* data option. While *Existing Treatment Process and Capacity* is a data option, the user cannot create more than one as any existing facility only has one overall treatment train. A database of major components (clarifier, filter, chlorine contact basin) is provided, and new major components can be added as well. Each major component in the treatment process is “dragged” into the grid from the database, and then its associated influent capacity, capacity type, and units, averaging period, design criteria and units, number of units, and year and capacity offline (if applicable) is entered, as shown in Figure 1.12. If there are major components that do not provide treatment but do have costs associated with them, such as sodium hypochlorite disinfection, then only the Included in Costs checkbox is checked, otherwise Included in Treatment is also checked. Major components are then positioned correctly and linked together in the train. The grid then displays train and flow order. For the City, the existing treatment train information was entered and can be seen in Figure 1.12.



PROJECTED WATER CONSERVATION

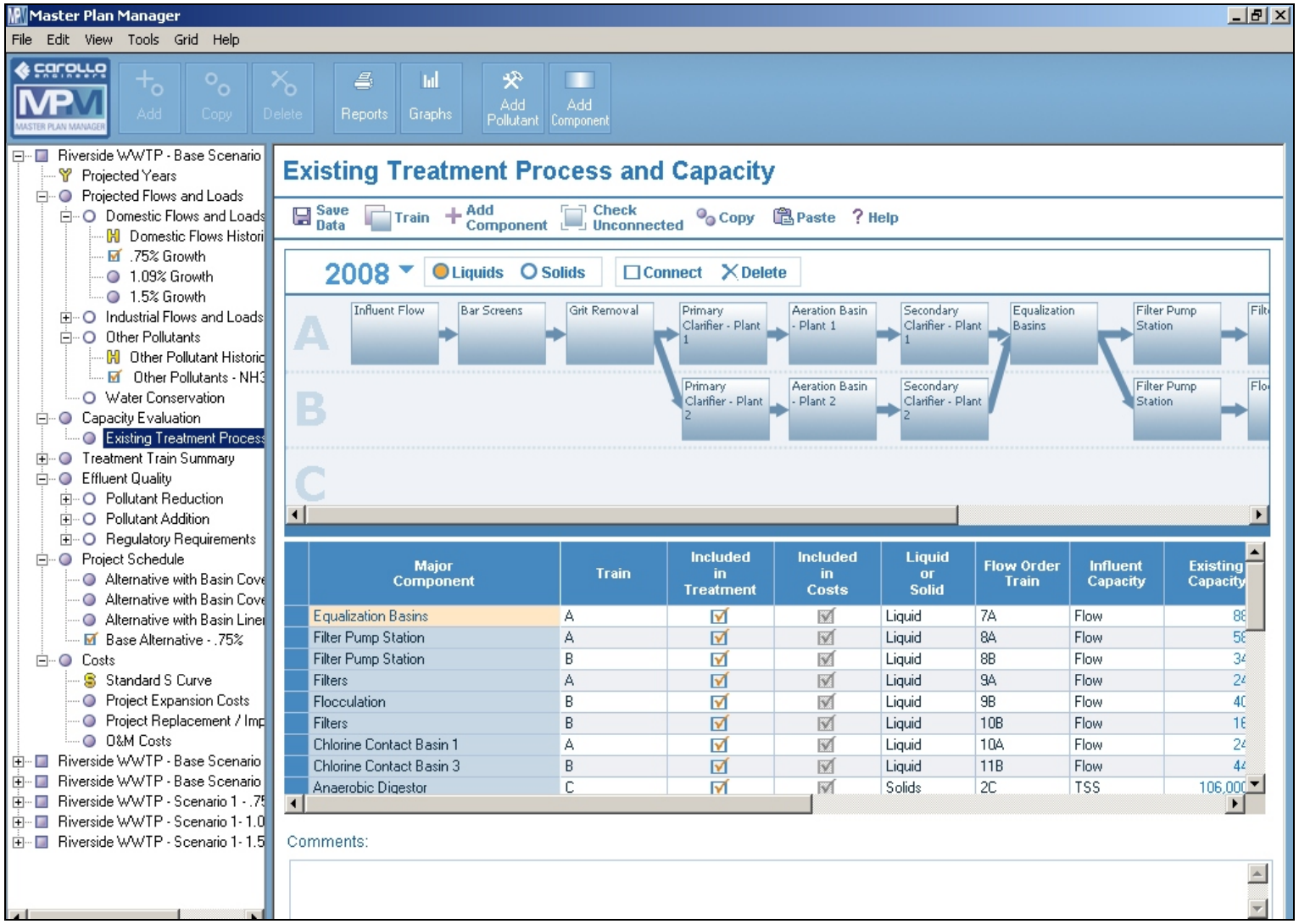
FIGURE 1.10



Year	Projected ADW Flow (mgd)	Projected ADW Load						
		BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)	Ammonia (lbs/day)	TDS (lbs/day)	TIN (lbs/day)
2008	35.68	69,766.10	69,136.55	10,414.22	Inactive	8,659.18	175,143.31	8,659.18
2009	36.50	71,385.35	70,741.18	10,655.93	Inactive	8,860.16	179,208.31	8,860.16
2010	37.33	73,007.62	72,348.81	10,898.09	Inactive	9,061.51	183,280.91	9,061.51
2011	38.06	74,427.86	73,756.24	11,110.09	Inactive	9,237.79	186,846.34	9,237.79
2012	38.79	75,851.32	75,166.85	11,322.58	Inactive	9,414.46	190,419.84	9,414.46
2013	39.52	77,277.61	76,580.28	11,535.48	Inactive	9,591.49	194,000.46	9,591.49
2014	40.25	78,706.75	77,996.51	11,748.82	Inactive	9,768.87	197,588.21	9,768.87
2015	40.98	80,139.10	79,415.94	11,962.63	Inactive	9,946.65	201,184.03	9,946.65
2016	41.60	81,340.48	80,606.47	12,141.96	Inactive	10,095.76	204,200.02	10,095.76
2017	42.21	82,544.69	81,799.83	12,321.72	Inactive	10,245.23	207,223.13	10,245.23
2018	42.83	83,752.13	82,996.36	12,501.96	Inactive	10,395.09	210,254.31	10,395.09
2019	43.45	84,962.78	84,196.09	12,682.67	Inactive	10,545.35	213,293.57	10,545.35

PROJECTED FLOWS AND LOADS

FIGURE 1.11



EXISTING TREATMENT PROCESS AND CAPACITY

FIGURE 1.12

1.4.4 Planned Projects and Costs

The CIP is developed in the *Planned Projects and Costs* data options. Here each major component is "dragged" into the grid from the existing database, similarly to the *Existing Treatment Process and Capacity* data option. For each major component, as shown in Figure 1.13, the following information is entered:

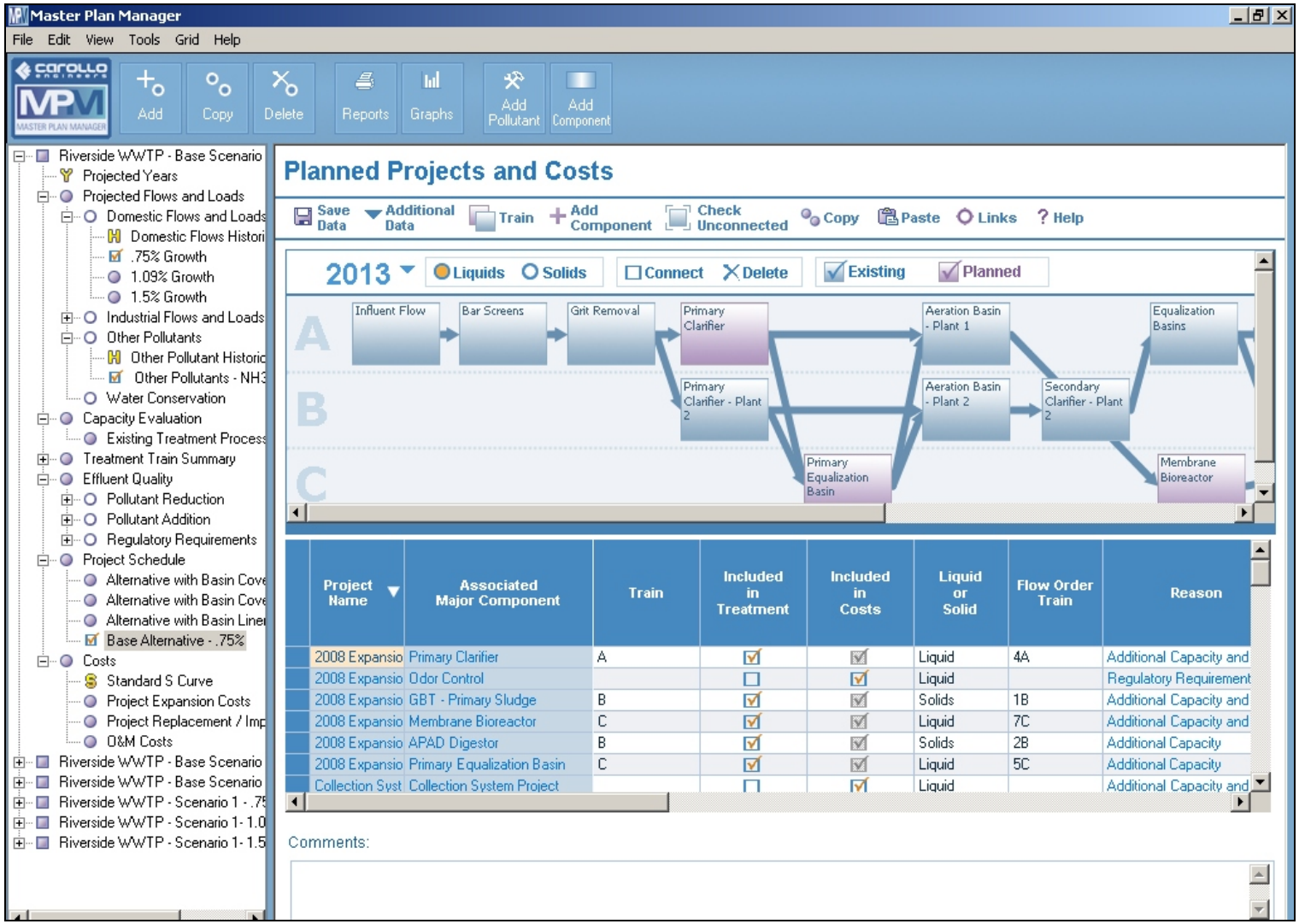
- Associated project name.
- Reason for implementation (Rehab, Regulatory Requirement, Additional Capacity, Additional Major Component, or combinations thereof).
- Capacity, type, and units.
- Number of units.
- Design length (years).
- Construction length (years).
- Year online.
- Estimated construction costs.
- Percentage allocated to expansion.
- Percentage allocated to replacement/improvement.

An Engineering, Administrative, Legal, Construction Management (EALC) factor is entered and multiplied by the estimated construction cost to calculate the total project cost for each major component. In the case of the City, an EALC factor of 1.3 was used. Major components are then positioned correctly alongside existing major components and linked together in the train. The grid then displays train and flow order.

Similar to the *Existing Treatment Process and Capacity* data option, if there are major components that do not provide treatment but do have costs associated with them, such as the Collection System Project listed in Figure 1.13, then only the Included in Costs checkbox is checked. If the major component provides treatment, then the Included in Treatment is also checked.

The projects listed in Figure 1.13 have been developed in accordance with City needs for the "0.75% Growth Domestic" data option.

Planned Projects and Costs is a data option, so as many data options as needed can be developed. In the tree structure of Figure 1.13, a total of four CIPs (*Planned Projects and Costs* data options) are displayed for the City's growth rate of 0.75 percent. The four CIPs are: 1) "Base Alternative", 2) "Alternative with Basin Cover", 3) "Alternative with Basin Liner", and 4) "Alternative with Basin Cover and Liner."



PLANNED PROJECTS AND COSTS

FIGURE 1.13

1.4.5 Flow and Solids Allocation

The *Flow and Solids Allocation* data option is used to route projected flows and loads to each major component, both existing and planned. There is only one data option per *Planned Projects and Costs* data option. The software has the ability to model multiple flow and solids allocations in order to understand the impacts to the capacity evaluation. Modeling various allocations can be done by copying the entire scenario, and changing the percentages on the new *Flow and Solids Allocation* data option. For each linkage between major components in the treatment train, the user enters the percentage of total flow that link receives for each projected year in the grid and the percentages are displayed in the train, as shown in Figure 1.14. For the City, the existing and future flow allocation percentages among the treatment trains, including Plant 1 and 2 and the two filters, were entered into the grid.

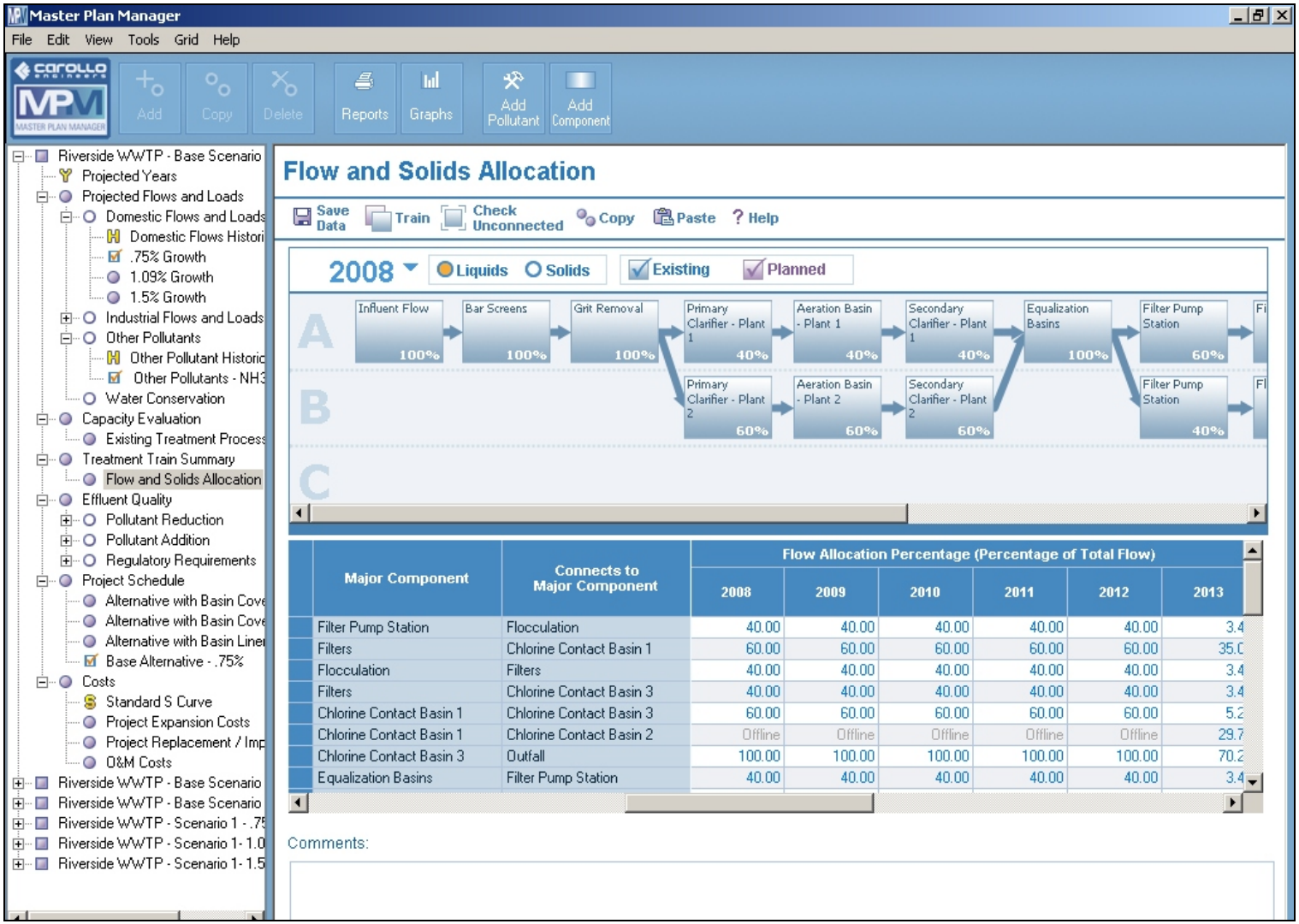
1.4.6 Treatment Train Summary

Treatment Train Summary is a calculation layer that applies the percentages for each major component link (existing and planned) from the *Flow and Solids Allocation* data option to the projected flows from the *Projected Flows and Loads* calculation layer. The result of this is that MPM™ calculates and displays the routed projected flow to each major component for each projected year, as shown for the City in Figure 1.15.

1.4.7 Capacity Evaluation

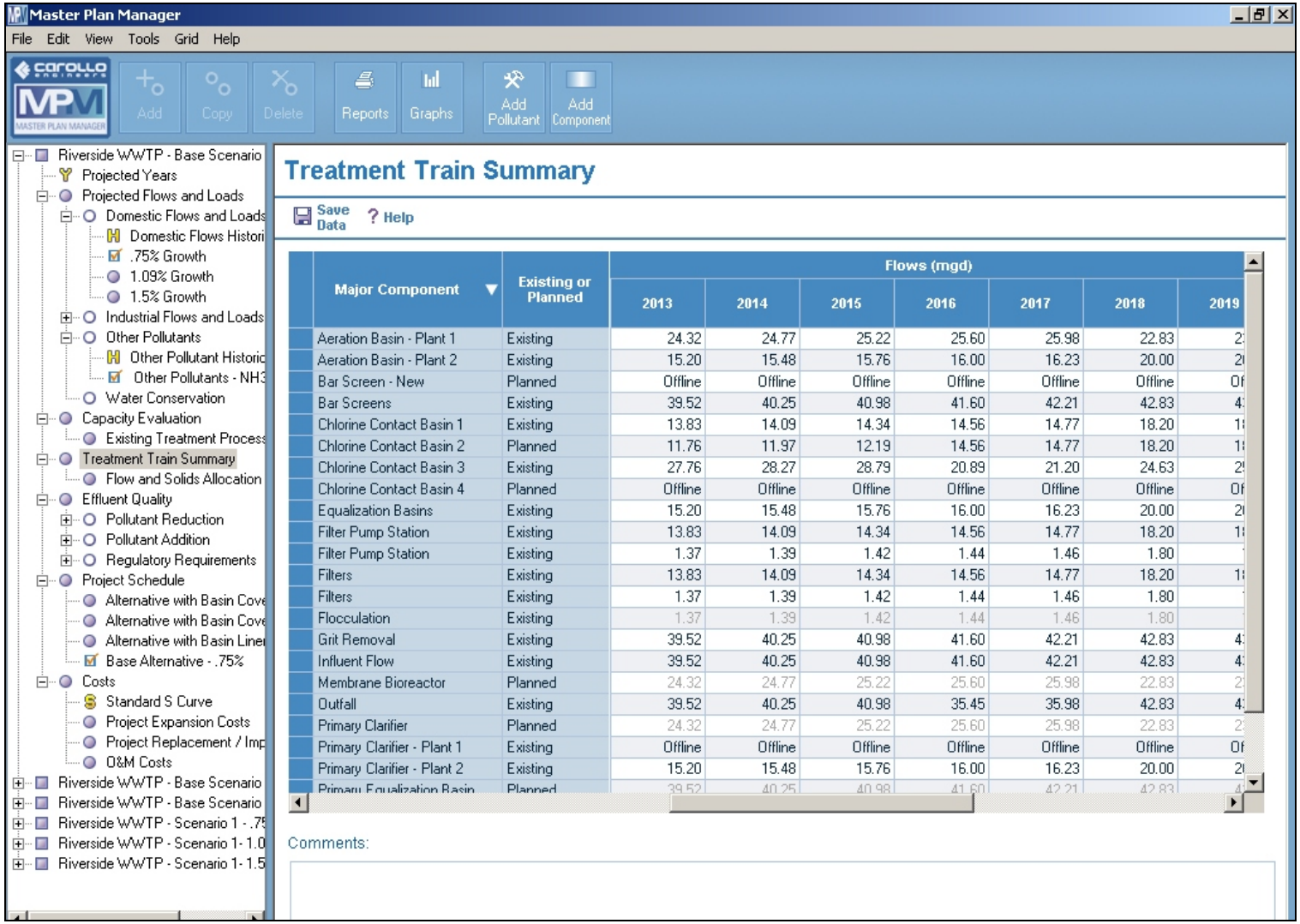
For the *Capacity Evaluation* calculation layer, MPM™ compares the *Projected Flows and Loads* values, multiplied by the respective flow and load peaking factors, if applicable, against the existing and planned major components capacity. As shown in Figure 1.16, each major component is listed, along with its capacity information, averaging period, and peaking factor. For each major component, the routed projected flow or load (adjusted by peaking factor) is displayed for each projected year. If the major component is offline, Offline is displayed instead of the flow or load. The capacity evaluation for the City's existing and planned major components for the "0.75% Growth Domestic" data option and "Base Alternative CIP" is shown in Figure 1.16.

For each major component, a YES or NO in the "Requirements Met" column indicates whether the existing or planned capacity is adequate to handle the routed projected flow or load. The *Capacity Evaluation* calculation layer for the "1.5% Growth Domestic" data option and "0.75% Base Alternative" CIP is shown in Figure 1.17, and as indicated, the requirements are not met. The red font indicates for which year a capacity issue exists in the grid.



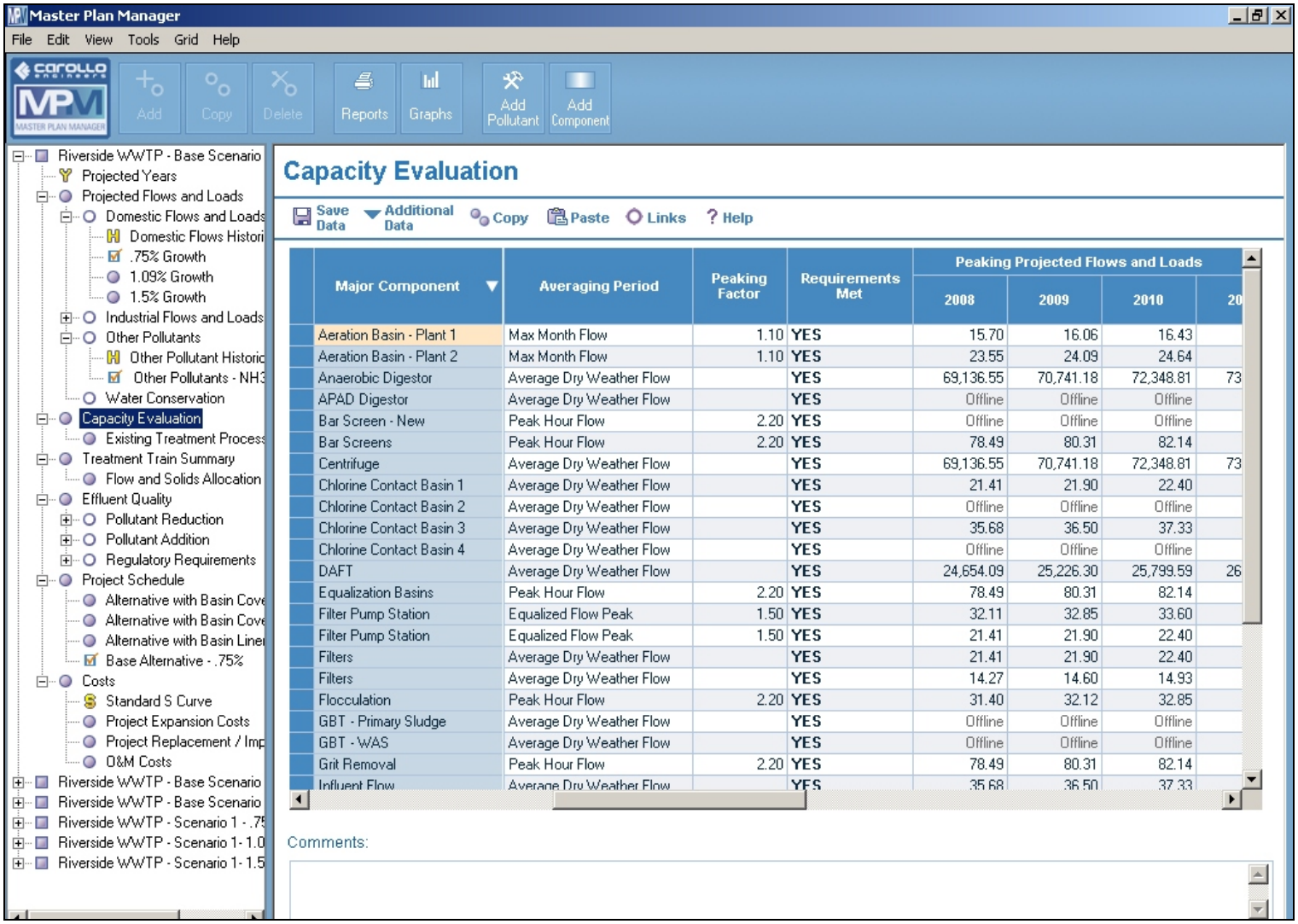
FLOW AND SOLIDS ALLOCATION

FIGURE 1.14



TREATMENT TRAIN SUMMARY

FIGURE 1.15



CAPACITY EVALUATION

FIGURE 1.16

CAPACITY EVALUATION FOR THE "1.5% GROWTH PROJECTED DOMESTIC" DATA OPTION

FIGURE 1.17

If capacity needs are not met, the user can compare the routed flow against the capacity to determine the extent of the capacity deficiency, and then has two options. The first is to change the percentage in the *Flow and Loads Allocation* data option for the respective major component linkages, while still ensuring that all flows add to 100 percent. The second is to add additional capacity via a *Planned Projects and Costs* data option. Adding additional capacity translates to adding a new project, or if the new project has already been planned for, either increasing the actual capacity listed for the planned major component, or changing the year online to an earlier year, so that the major component and its associated capacity comes online earlier. By clicking on different data options for *Projected Domestic, Industrial, Other Pollutants*, and *Water Conservation,* MPM™ will immediately display the results so that the user understands the impacts to capacity needs throughout the planning horizon. CIPs can then be adjusted as needed to meet the various needs.

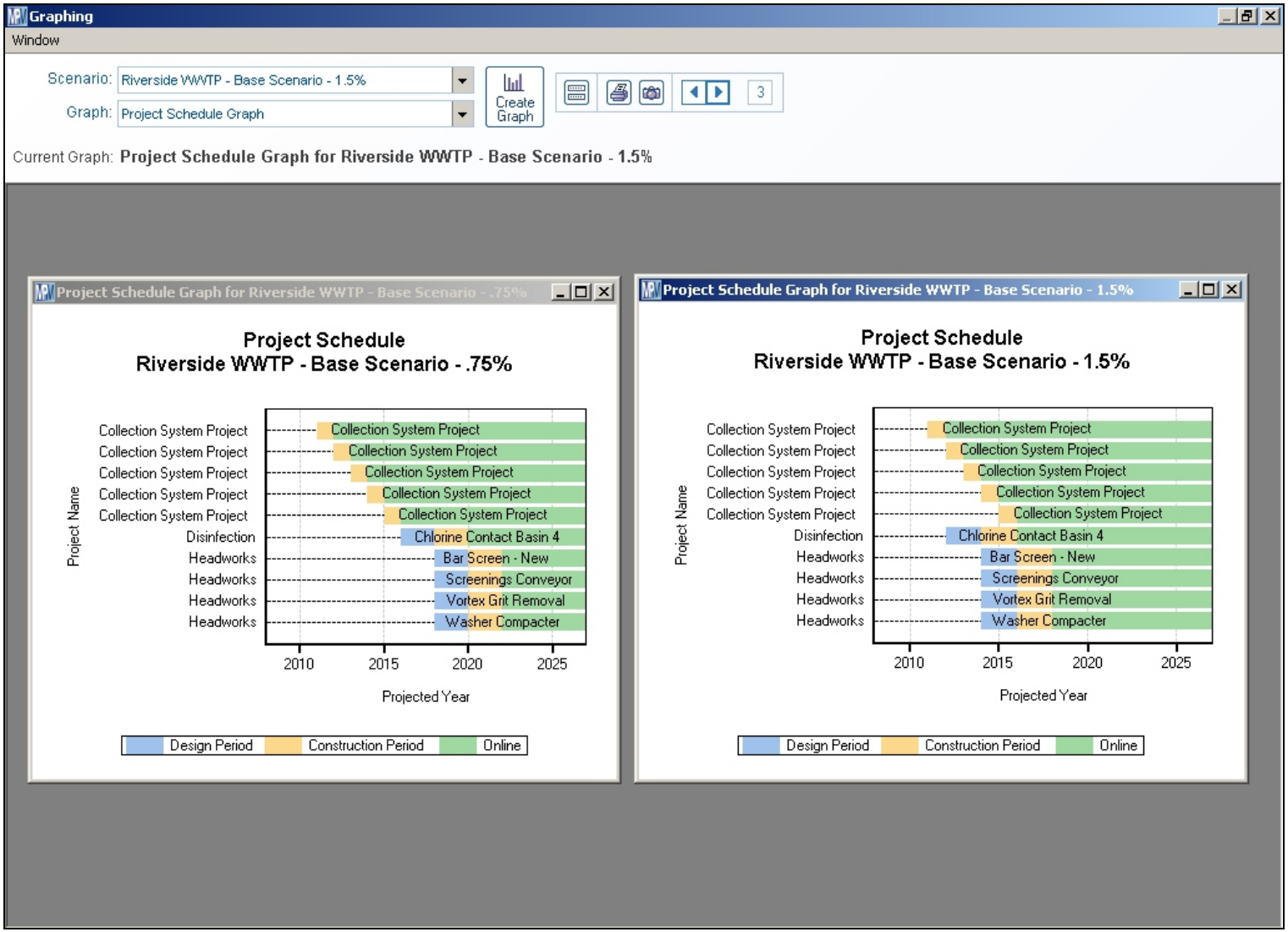
In the case of Figure 1.17, the City's planned projects need to come online in an earlier year, as the years online for the planned projects for the "0.75% Growth" *Projected Domestic* data option are not suitable for the "1.5% Growth" *Projected Domestic* data option. The user can adjust the year online in the *Planned Projects and Costs* data options. In Figure 1.18, the project schedules for the respective *Projected Domestic* data options, for both the 0.75 percent and 1.5 percent growth options, are shown; and as an example, the user can see the delay in the implementation of the Headworks project. For the 0.75 percent growth option the headworks project starts design in 2010 and in 2014 for the 1.5 percent growth option.

1.4.8 Pollutant Reduction

One step in determining the projected effluent quality is to develop the *Pollutant Reduction* data option(s). *Pollutant Reduction* is where the performance of the treatment process in terms of removing pollutants is developed. Each major component, both existing and planned, is displayed in the grid, as shown in Figure 1.19. All pollutants displayed in the *Projected Flows and Loads* calculation layer are shown in the grid as well. The user then enters the pollutant reduction percentage that applies for each major component for each pollutant. Multiple data options can be created, such that a treatment process with low, mid, and high performance can all be modeled. The selected option is then applied to the data from the *Projected Flows and Loads* calculation layer to, in part, calculate the projected effluent quality. Pollutant reduction values as determined for the City's treatment processes are displayed in Figure 1.19.

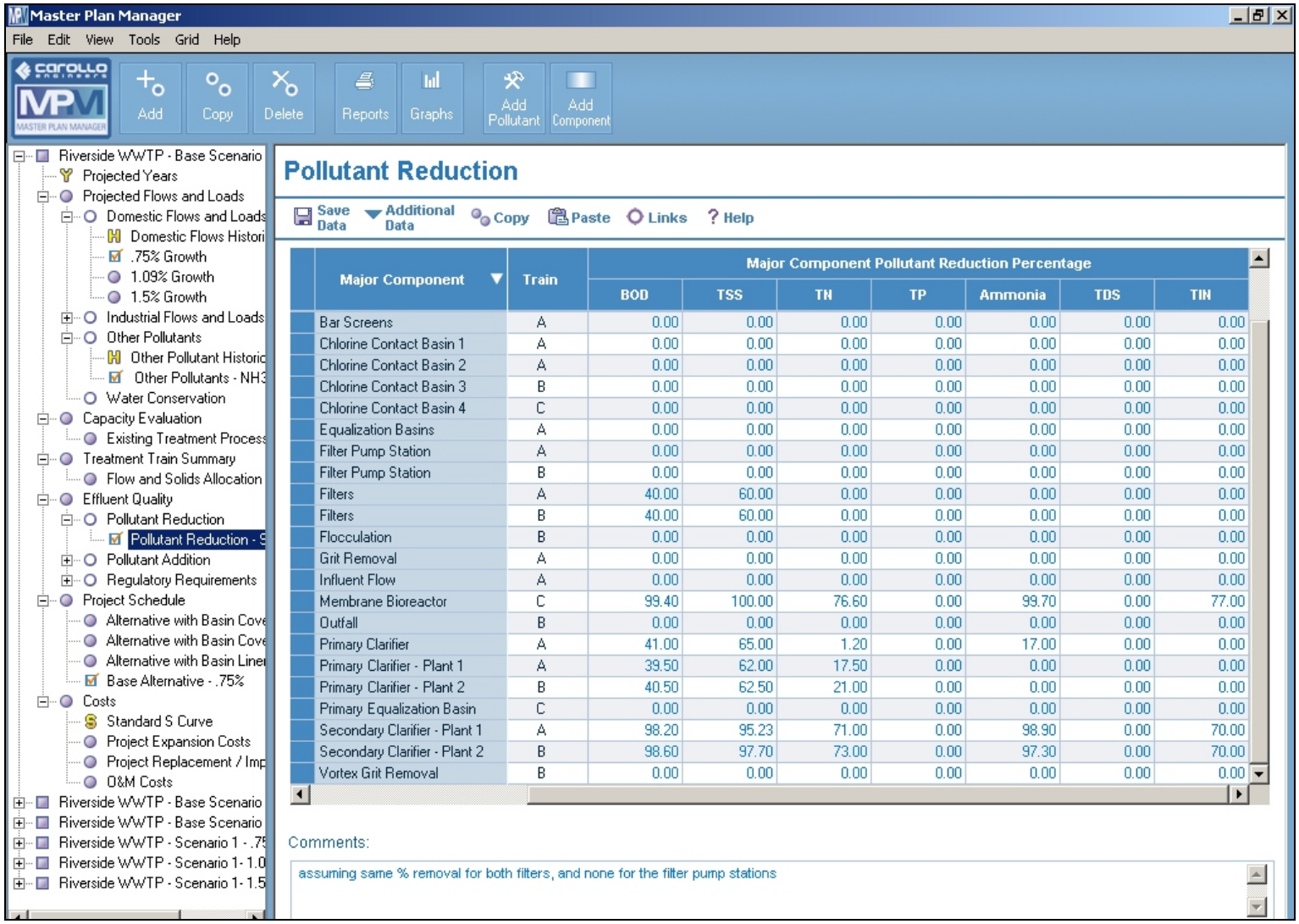
1.4.9 Pollutant Addition

Another step in determining projected effluent quality is to address the circumstances under which the treatment process actually adds constituents (pollutants) into the flow. One common example is that chlorination with sodium hypochlorite or dechlorination with



COMPARISON OF PROJECT SCHEDULES

FIGURE 1.18



Major Component	Train	Major Component Pollutant Reduction Percentage						
		BOD	TSS	TN	TP	Ammonia	TDS	TIN
Bar Screens	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorine Contact Basin 1	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorine Contact Basin 2	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorine Contact Basin 3	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chlorine Contact Basin 4	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Equalization Basins	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Filter Pump Station	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Filter Pump Station	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Filters	A	40.00	60.00	0.00	0.00	0.00	0.00	0.00
Filters	B	40.00	60.00	0.00	0.00	0.00	0.00	0.00
Flocculation	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grit Removal	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Influent Flow	A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membrane Bioreactor	C	99.40	100.00	76.60	0.00	99.70	0.00	77.00
Outfall	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Primary Clarifier	A	41.00	65.00	1.20	0.00	17.00	0.00	0.00
Primary Clarifier - Plant 1	A	39.50	62.00	17.50	0.00	0.00	0.00	0.00
Primary Clarifier - Plant 2	B	40.50	62.50	21.00	0.00	0.00	0.00	0.00
Primary Equalization Basin	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Secondary Clarifier - Plant 1	A	98.20	95.23	71.00	0.00	98.90	0.00	70.00
Secondary Clarifier - Plant 2	B	98.60	97.70	73.00	0.00	97.30	0.00	70.00
Vortex Grit Removal	B	0.00	0.00	0.00	0.00	0.00	0.00	0.00

POLLUTANT REDUCTION

FIGURE 1.19

sodium bisulfite introduces TDS. *Pollutant Addition* is a data option, as shown in Figure 1.20, where the grid shows each major component and each pollutant, and the user enters into the grid the pollutant addition concentration from each major component for each pollutant as applicable. The City's addition of TDS to their flow from the chlorination process is displayed in Figure 1.20. Since *Pollutant Addition* is a data option, as many options as needed can be developed.

1.4.10 Regulatory Requirements

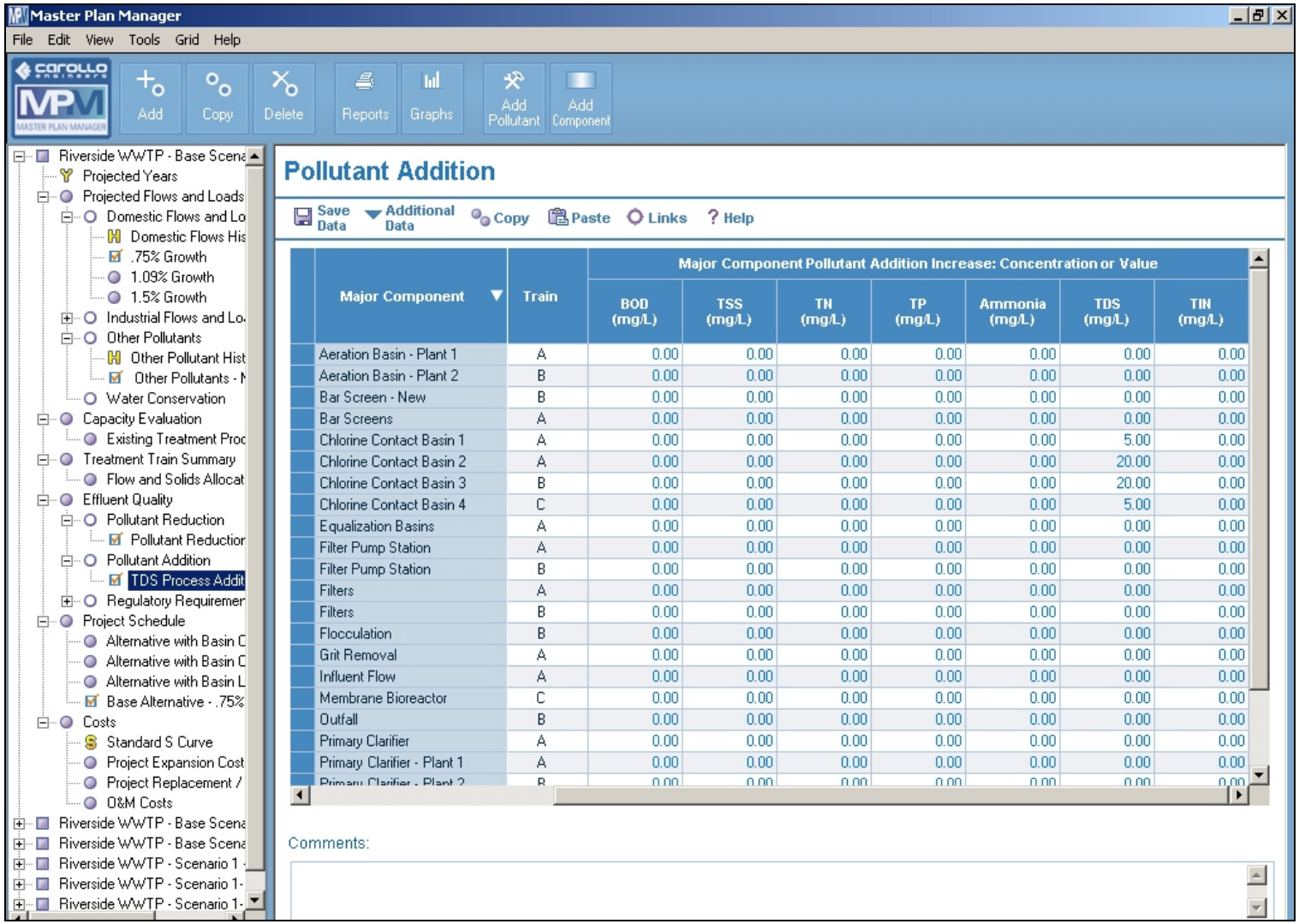
The last step needed to evaluate effluent quality is regulatory requirements. The *Regulatory Requirements* data option(s) is used to enter the NPDES permit requirements. This data can then be compared against the projected effluent quality to see if the requirements are being met. As shown in Figure 1.21, each pollutant is listed, and then for each projected year, the user enters the requirement for effluent quality. The City's effluent quality requirements for flow, TSS, BOD, ammonia, TDS, and TIN are displayed in Figure 1.21. *Regulatory Requirements* is a data option, so the user can create as many options as needed to model all future outcomes.

1.4.11 Effluent Quality

The *Effluent Quality* calculation layer compares the projected effluent quality against the effluent quality requirements that come from the selected *Regulatory Requirements* data option. The projected effluent quality is calculated by MPM™ by applying the pollutant reduction percentages from the selected *Pollutant Reduction* data option to the *Projected Flows and Loads* values, and then adding any *Pollutant Addition* data option concentrations.

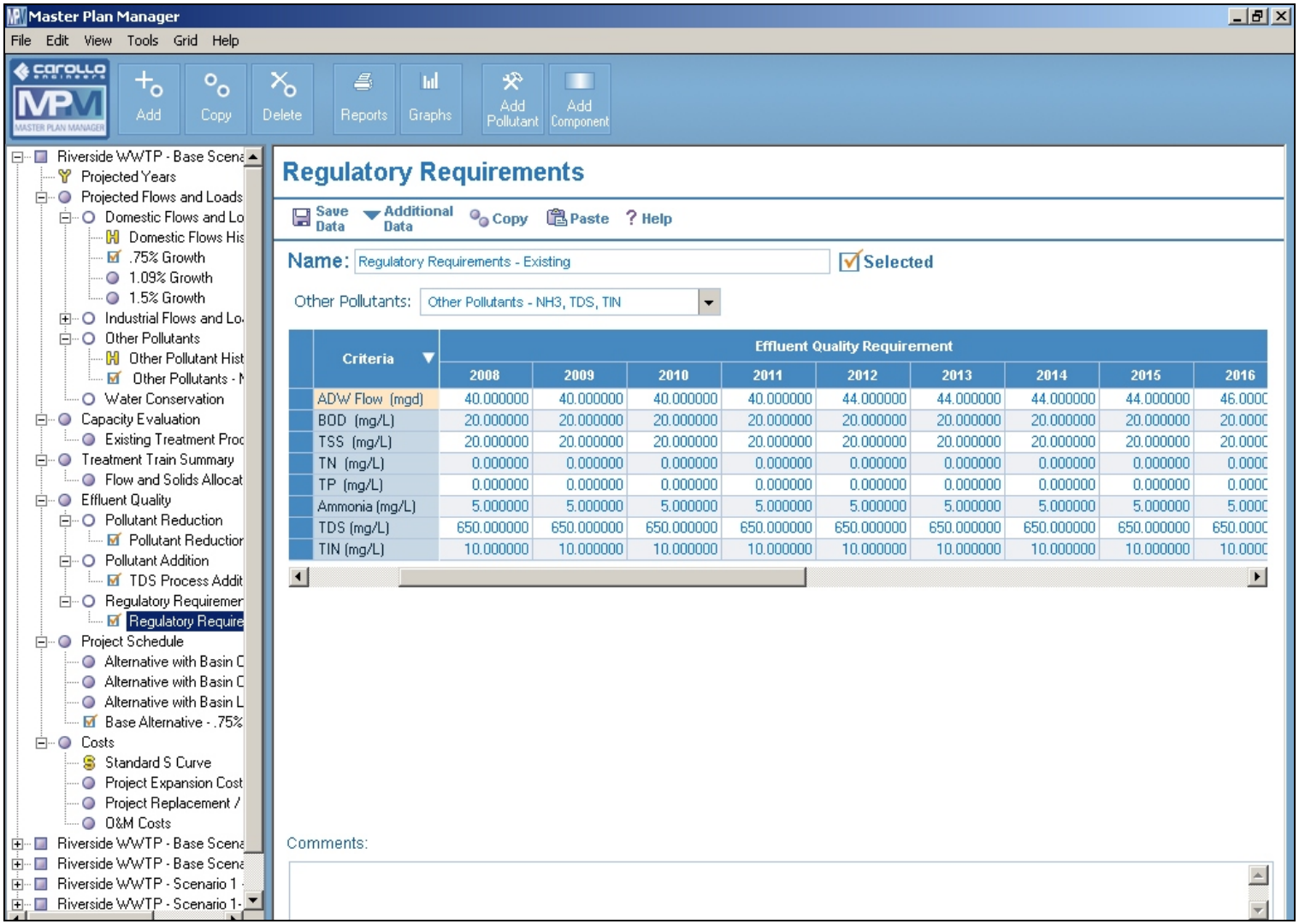
As shown in Figure 1.22, each pollutant is listed and for each projected year, the projected effluent quality value is calculated and displayed by the software. The comparison of the projected effluent quality values to the regulatory requirements is addressed by "Requirements Met". Here MPM™ displays either YES or NO as appropriate. Red font in the grid indicates for which pollutant in which year the requirements are not being met. The data shown in Figure 1.22 is the City's projected effluent quality based on the selected data options that can be seen in the tree structure.

If the requirements are not being met, the user has two choices, either to improve the estimated efficiency of the treatment process or add additional levels of treatment. The estimated performance of the treatment process can be improved through increasing the pollutant removal percentages on the *Pollutant Reduction* data option(s) (this is where multiple data options can help display the extent of the impact of pollutant removals on the projected effluent quality) or conversely decreasing pollutant addition concentrations on the *Pollutant Addition* data option(s). In order to add additional levels of treatment to get more pollutant reduction, the user can add new major components to the CIP on the P*lanned Projects and Costs* data options.



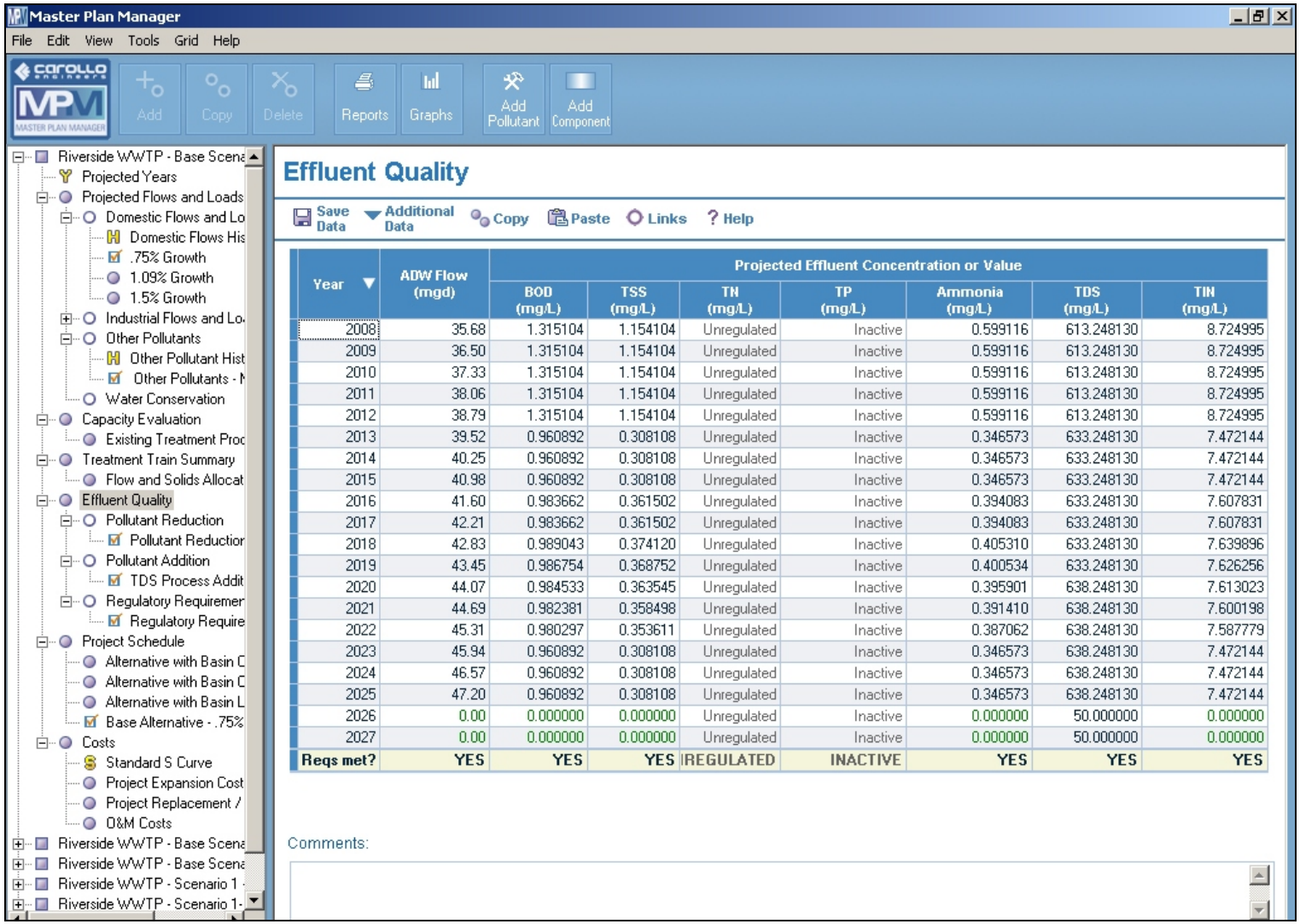
POLLUTANT ADDITION

FIGURE 1.20



REGULATORY REQUIREMENTS

FIGURE 1.21



Year	ADW Flow (mgd)	Projected Effluent Concentration or Value						
		BOD (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)	Ammonia (mg/L)	TDS (mg/L)	TIN (mg/L)
2008	35.68	1.315104	1.154104	Unregulated	Inactive	0.599116	613.248130	8.724995
2009	36.50	1.315104	1.154104	Unregulated	Inactive	0.599116	613.248130	8.724995
2010	37.33	1.315104	1.154104	Unregulated	Inactive	0.599116	613.248130	8.724995
2011	38.06	1.315104	1.154104	Unregulated	Inactive	0.599116	613.248130	8.724995
2012	38.79	1.315104	1.154104	Unregulated	Inactive	0.599116	613.248130	8.724995
2013	39.52	0.960892	0.308108	Unregulated	Inactive	0.346573	633.248130	7.472144
2014	40.25	0.960892	0.308108	Unregulated	Inactive	0.346573	633.248130	7.472144
2015	40.98	0.960892	0.308108	Unregulated	Inactive	0.346573	633.248130	7.472144
2016	41.60	0.983662	0.361502	Unregulated	Inactive	0.394083	633.248130	7.607831
2017	42.21	0.983662	0.361502	Unregulated	Inactive	0.394083	633.248130	7.607831
2018	42.83	0.989043	0.374120	Unregulated	Inactive	0.405310	633.248130	7.639896
2019	43.45	0.986754	0.368752	Unregulated	Inactive	0.400534	633.248130	7.626256
2020	44.07	0.984533	0.363545	Unregulated	Inactive	0.395901	638.248130	7.613023
2021	44.69	0.982381	0.358498	Unregulated	Inactive	0.391410	638.248130	7.600198
2022	45.31	0.980297	0.353611	Unregulated	Inactive	0.387062	638.248130	7.587779
2023	45.94	0.960892	0.308108	Unregulated	Inactive	0.346573	638.248130	7.472144
2024	46.57	0.960892	0.308108	Unregulated	Inactive	0.346573	638.248130	7.472144
2025	47.20	0.960892	0.308108	Unregulated	Inactive	0.346573	638.248130	7.472144
2026	0.00	0.000000	0.000000	Unregulated	Inactive	0.000000	50.000000	0.000000
2027	0.00	0.000000	0.000000	Unregulated	Inactive	0.000000	50.000000	0.000000
Reqs met?	YES	YES	YES	YES	REGULATED	INACTIVE	YES	YES	YES

EFFLUENT QUALITY

FIGURE 1.22

If the user chooses to address the impacts of other additional pollutants, (for example, ibuprofen) they can add it to the *Other Pollutant* data options, provide a pollutant reduction percentage (for example, 65 percent) on the *Pollutant Reduction* data options, and provide an effluent quality requirement in the *Regulatory Requirement* data options (such as 20 mg/L). By returning to the *Effluent Quality* calculation layer, they can determine if the effluent quality requirements are met, as shown in Figure 1.23. In this example, the projected effluent quality for ibuprofen, displayed in the right hand column of the grid is 14 mg/L, and therefore the permit requirements are met.

1.4.12 Project Schedule

Once all of the appropriate projects have been created and selected on the selected *Planned Projects and Costs* data option, the *Project Schedule* calculation layer displays the overall list of projects, major components, added capacity, capacity unit, design length (years), construction length (years), year design starts, year construction starts, and year online as shown in Figure 1.24. The data that is displayed is the City's project schedule for the selected data options.

1.4.13 Costs

The MPM™ divides costs into three different categories; *Project Expansion Costs*, *Project Replacement/Improvement Costs*, and *Operations and Maintenance* (O&M) *Costs* data options. There is a data option entitled *S-Curve* that contains a grid that assigns a percentage of the capital costs spent in each year, depending on the length of the project.

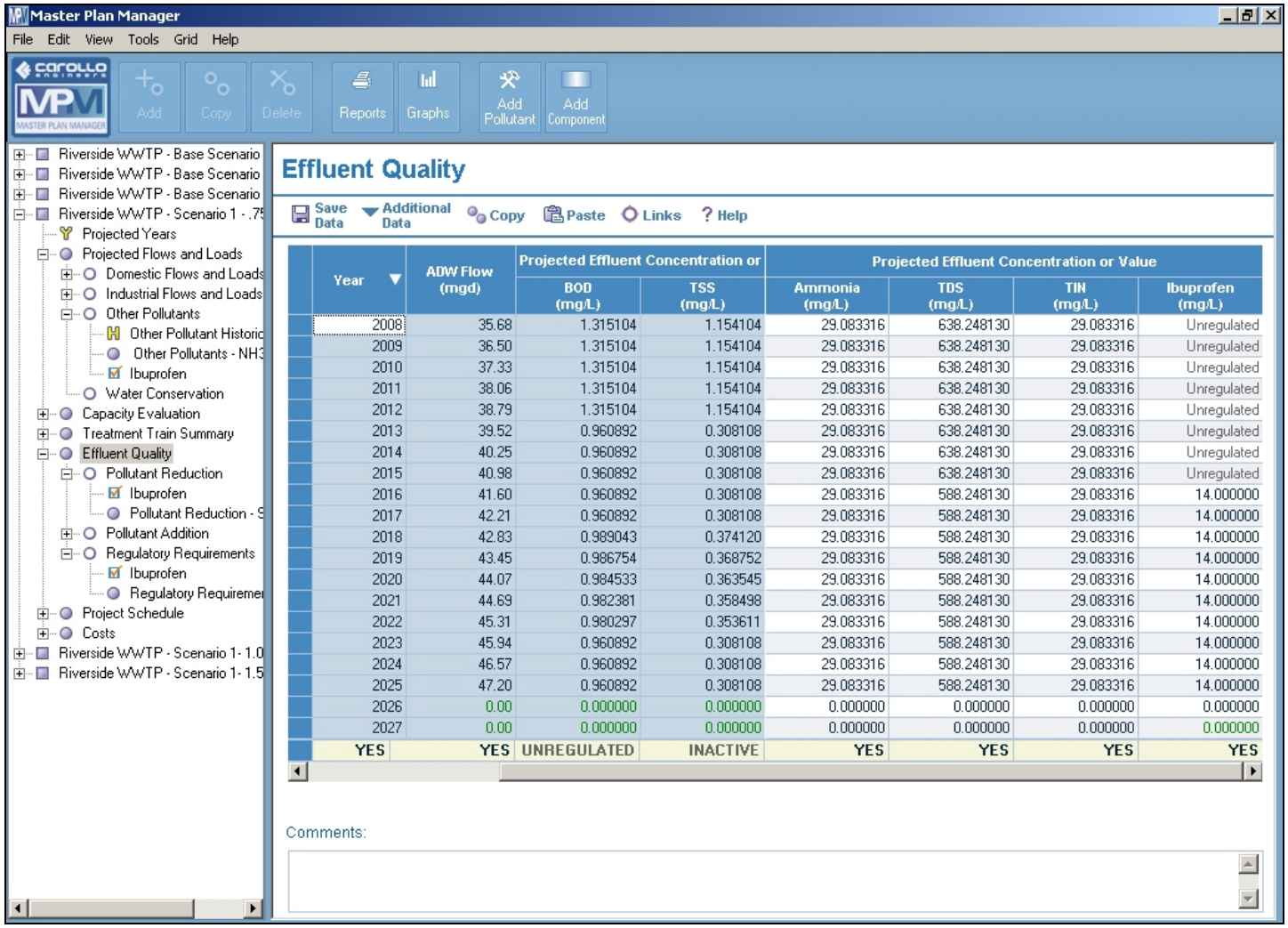
1.4.13.1 Standard S-Curve

The *Standard S-Curve* data option, as shown in Figure 1.25, lists the project duration in years and the percent by year. The grid indicates for a project of X years, the percentage of the total project cost that is spent in each year and is non-editable. MPM™ applies the *S-Curve* percentages to all the costs of the CIP projects listed on the selected *Planned Projects and Costs* data option in order to distribute costs over the appropriate years for the *Project Expansion Costs* and *Project Replacement/Improvement Costs* data options.

1.4.13.2 Project Expansion Costs

The *Project Expansion Costs* data option, as shown in Figure 1.26, displays the project name and associated major component, project duration, start date, year online, and total expansion costs for the selected *Planned Projects and Costs* data option. The City's project expansion costs per year are displayed in Figure 1.26. Expansion costs refer to the costs associated with the portion of the project that is allocated to serve additional wastewater customers.

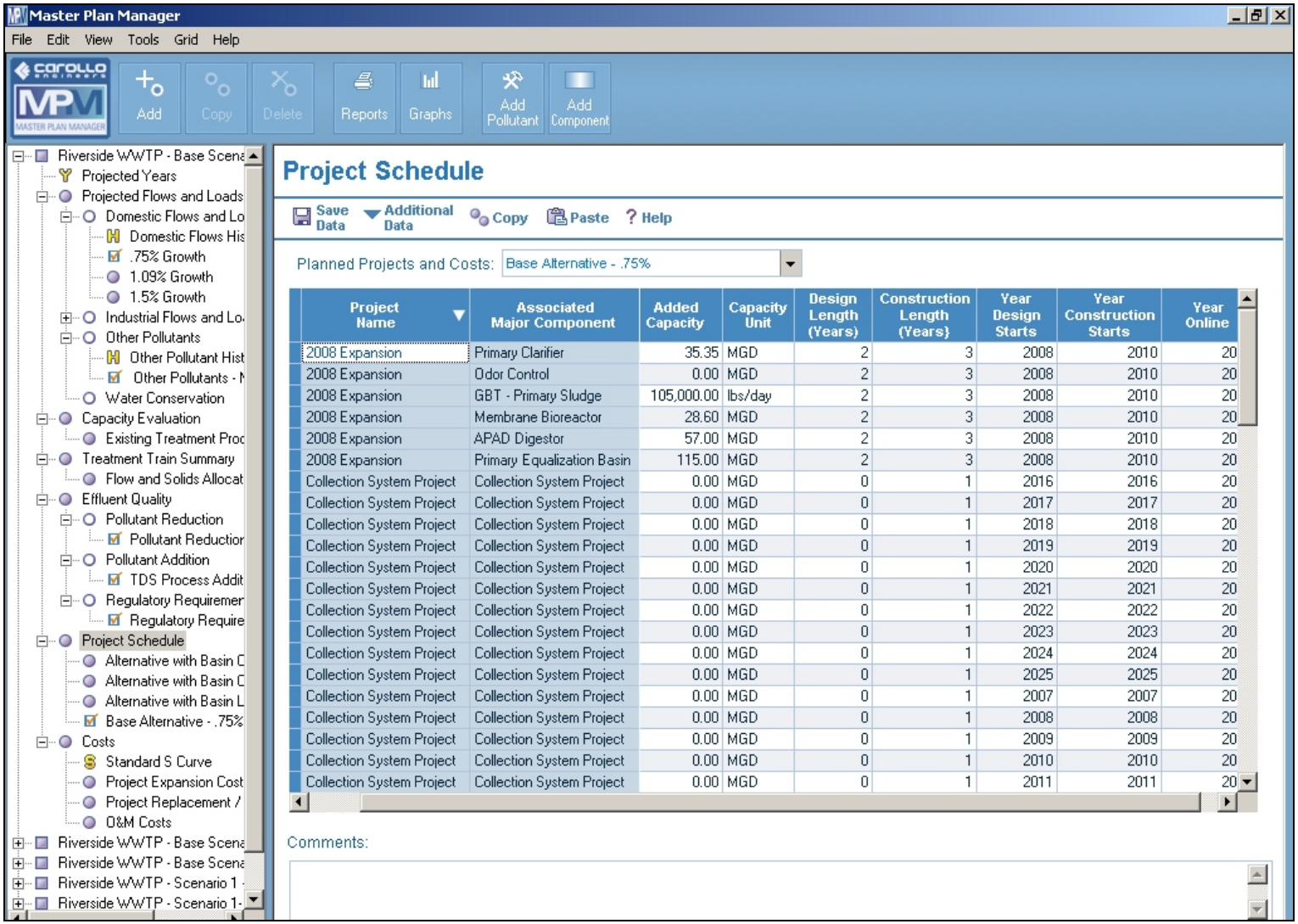
MPM™ calculates the total expansion costs for each major component by multiplying the total project costs by the expansion cost percentages on the selected P*lanned Projects and*



Year	ADW Flow (mgd)	Projected Effluent Concentration or		Projected Effluent Concentration or Value			
		BOD (mg/L)	TSS (mg/L)	Ammonia (mg/L)	TDS (mg/L)	TIN (mg/L)	Ibuprofen (mg/L)
2008	35.68	1.315104	1.154104	29.083316	638.248130	29.083316	Unregulated
2009	36.50	1.315104	1.154104	29.083316	638.248130	29.083316	Unregulated
2010	37.33	1.315104	1.154104	29.083316	638.248130	29.083316	Unregulated
2011	38.06	1.315104	1.154104	29.083316	638.248130	29.083316	Unregulated
2012	38.79	1.315104	1.154104	29.083316	638.248130	29.083316	Unregulated
2013	39.52	0.960892	0.308108	29.083316	638.248130	29.083316	Unregulated
2014	40.25	0.960892	0.308108	29.083316	638.248130	29.083316	Unregulated
2015	40.98	0.960892	0.308108	29.083316	638.248130	29.083316	Unregulated
2016	41.60	0.960892	0.308108	29.083316	588.248130	29.083316	14.000000
2017	42.21	0.960892	0.308108	29.083316	588.248130	29.083316	14.000000
2018	42.83	0.989043	0.374120	29.083316	588.248130	29.083316	14.000000
2019	43.45	0.986754	0.368752	29.083316	588.248130	29.083316	14.000000
2020	44.07	0.984533	0.363545	29.083316	588.248130	29.083316	14.000000
2021	44.69	0.982381	0.358498	29.083316	588.248130	29.083316	14.000000
2022	45.31	0.980297	0.353611	29.083316	588.248130	29.083316	14.000000
2023	45.94	0.960892	0.308108	29.083316	588.248130	29.083316	14.000000
2024	46.57	0.960892	0.308108	29.083316	588.248130	29.083316	14.000000
2025	47.20	0.960892	0.308108	29.083316	588.248130	29.083316	14.000000
2026	0.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2027	0.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
YES	YES	UNREGULATED	INACTIVE	YES	YES	YES	YES

PROJECTED EFFLUENT QUALITY OF IBUPROFEN

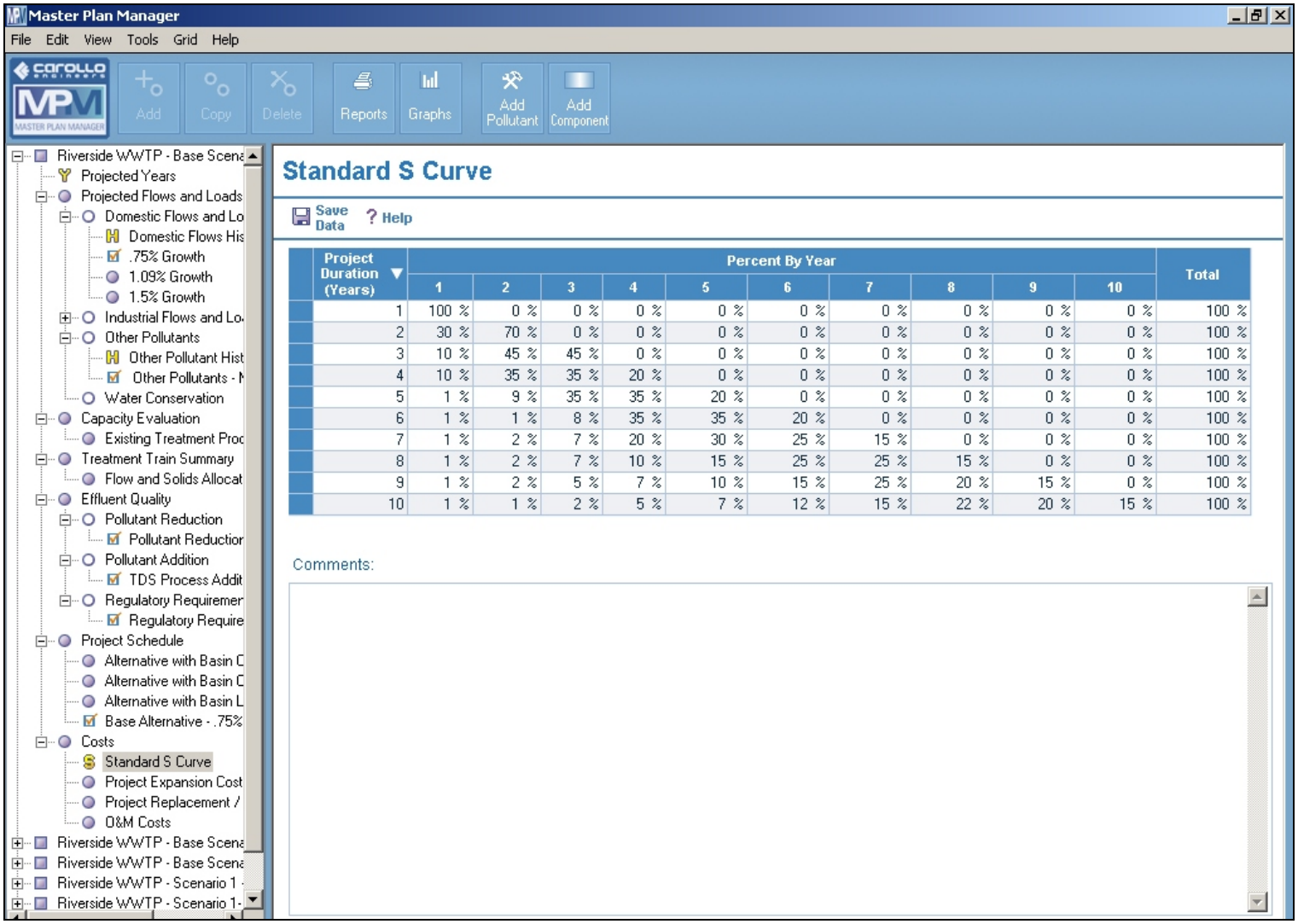
FIGURE 1.23



Project Name	Associated Major Component	Added Capacity	Capacity Unit	Design Length (Years)	Construction Length (Years)	Year Design Starts	Year Construction Starts	Year Online
2008 Expansion	Primary Clarifier	35.35	MGD	2	3	2008	2010	20
2008 Expansion	Odor Control	0.00	MGD	2	3	2008	2010	20
2008 Expansion	GBT - Primary Sludge	105,000.00	lbs/day	2	3	2008	2010	20
2008 Expansion	Membrane Bioreactor	28.60	MGD	2	3	2008	2010	20
2008 Expansion	APAD Digestor	57.00	MGD	2	3	2008	2010	20
2008 Expansion	Primary Equalization Basin	115.00	MGD	2	3	2008	2010	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2016	2016	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2017	2017	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2018	2018	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2019	2019	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2020	2020	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2021	2021	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2022	2022	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2023	2023	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2024	2024	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2025	2025	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2007	2007	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2008	2008	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2009	2009	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2010	2010	20
Collection System Project	Collection System Project	0.00	MGD	0	1	2011	2011	20

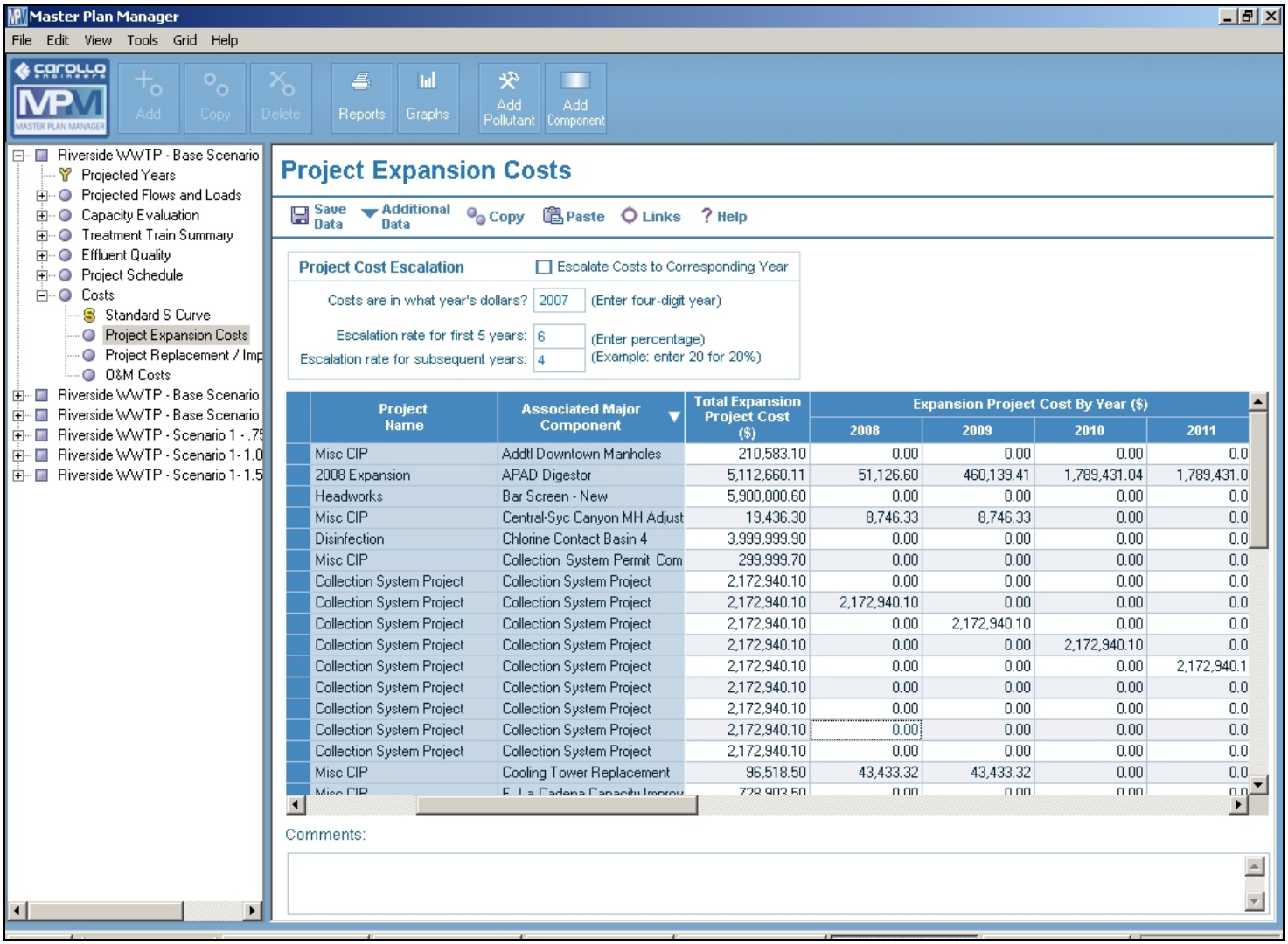
PROJECT SCHEDULE

FIGURE 1.24



STANDARD S-CURVE

FIGURE 1.25



PROJECT EXPANSION COSTS

FIGURE 1.26

Costs data option. The total expansion costs per major component are then multiplied by the appropriate percentages for the respective years from the *Standard S-Curve* data option, and MPM™ displays them for each projected year. Then the expansion costs per year are totaled at the bottom. MPM™ can escalate the costs by percentages the user enters. In the case of the City, escalation factors of 6 percent for the first 5 years and 4 percent for the subsequent years were used.

1.4.13.3 Project Replacement/Improvement Costs

The *Project Replacement/Improvement Costs* data option, as shown in Figure 1.27, displays the project name and associated major component, project duration, start date, year online, and total replacement/improvement costs for the selected *Planned Projects and Costs* data option. The City's project replacement/improvement costs per year are displayed in Figure 1.27. Replacement/improvement costs refer to the costs associated with the portion of the project that is used to serve existing wastewater customers.

MPM™ calculates the total replacement/improvement costs for each major component by multiplying the total project costs by the replacement/improvement cost percentages on the selected *Planned Projects and Costs* data option. The total replacement/improvement costs per major component are then multiplied by the appropriate percentages for the respective years from the *Standard S-Curve* data option, and MPM™ displays them for each projected year. Then the overall amount of money spent on replacement/improvement per projected year is totaled at the bottom. Similarly to the *Project Expansion Cost* data option, MPM™ can escalate the costs by percentages the user enters. In the case of the City, escalation factors of 6 percent for the first five years and 4 percent for the subsequent years were used.

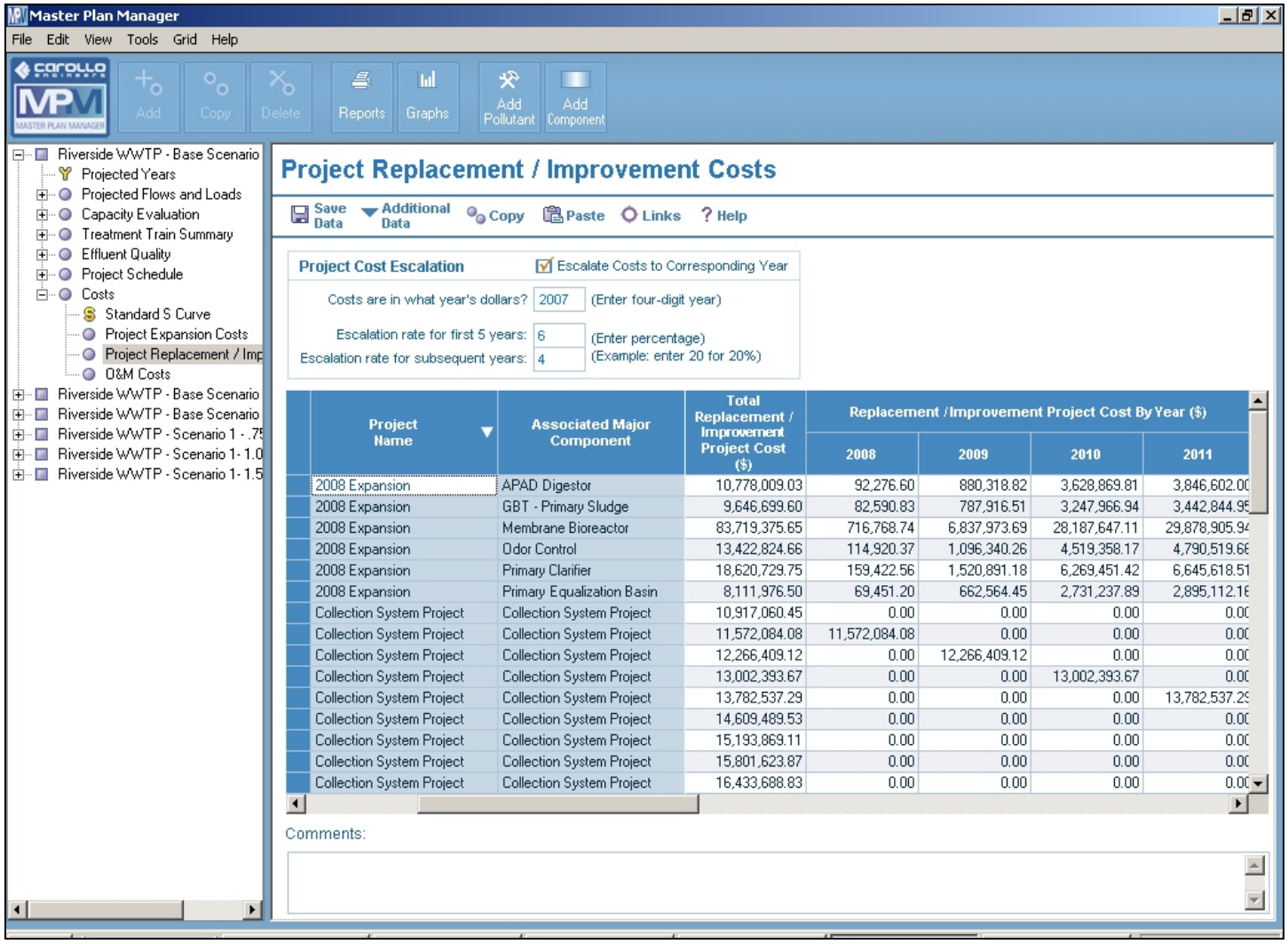
1.4.13.4 O&M Costs

The *O&M Costs* data option allows the user to enter in maintenance and operations costs for each major component (existing and planned), as well as labor and disposal costs, for each year in the planning period. As shown in Figure 1.28, the City's projected O&M costs have been entered for the selected *Planned Projects and Costs* data option.

MPM™ automatically updates each year so that if a new major component is planned to go online in a certain year, that major component will appear in the O&M grid in the right year, as well as the subsequent years. MPM™ displays the total O&M costs per projected year in the grid on the left. The costs can be escalated as well based on user-entered percentages or based on an ENR ratio. For the City, O&M costs are escalated at 3 percent a year.

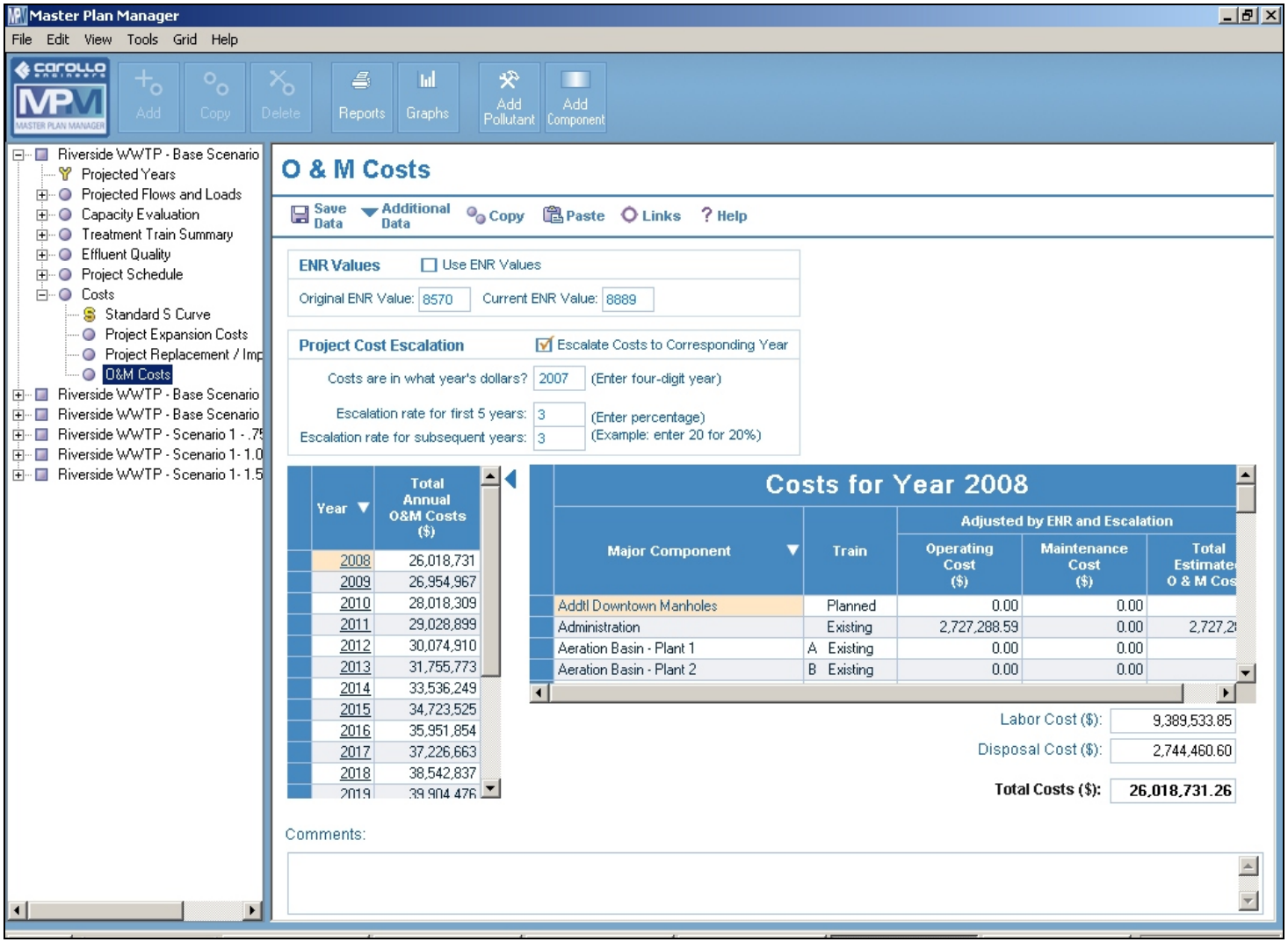
1.4.13.5 Costs

The overall expansion, replacement/improvement, and O&M costs per projected year from their respective data options are displayed on the *Costs* calculation layer, and summed for



PROJECT REPLACEMENT/ IMPROVEMENT COSTS

FIGURE 1.27



O&M COSTS

FIGURE 1.28

overall total costs per projected year. The City's total costs per year for the selected data options are shown in Figure 1.29.

1.4.14 Scenario Summary

The *Scenario Summary* is the scenario layer that is used to select different data options and see at the same time that capacity and effluent quality needs are met. The user can also navigate through MPM™ from the *Scenario Summary* scenario layer as shown on Figure 1.30.

1.4.15 Graphs

MPM™ has the ability to create a variety of graphs. The graphs can be created for any scenario and any data option. The user can print or export the graphs as well. In Figures 1.31, 1.32, 1.33, 1.34, and 1.35, Domestic Population, Projected Flows, Projected Loads, Project Schedule, and Costs based on the City's data are shown, respectively. In Figures 1.36 and 1.37 graphs for Flow and TSS capacities for the City's facilities are shown, respectively. MPM™ can also create capacity graphs for BOD, TN, and TP. These graphs can be useful for visually displaying the data, for reports, presentations, etc.

1.4.16 Reports

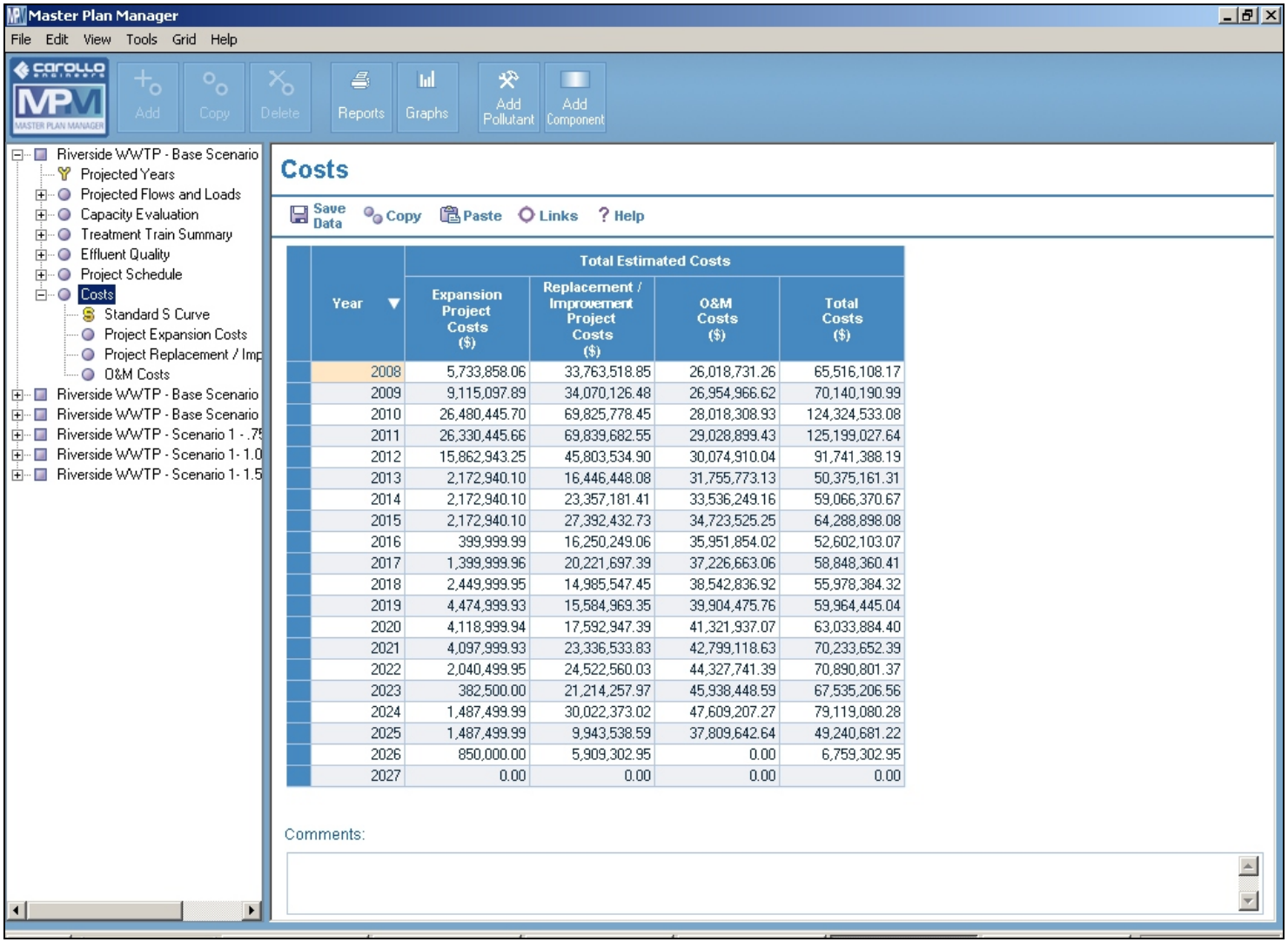
MPM™ can create reports for any layer within the tree structure - scenario, calculation, or data options, as shown in Figure 1.38. The reports can be printed or exported via either a PDF or a Comma-Separated Values file (text file). The reports are useful for doing additional analysis with the data, communicating with others, using in reports, etc.

1.4.17 Help Menu

MPM™ has a Help Menu for help understanding a function or how to perform a certain task. As shown in Figure 1.39, the user can navigate through the Help Menu based on their needs, and print as necessary.

1.5 EXISTING DATABASE

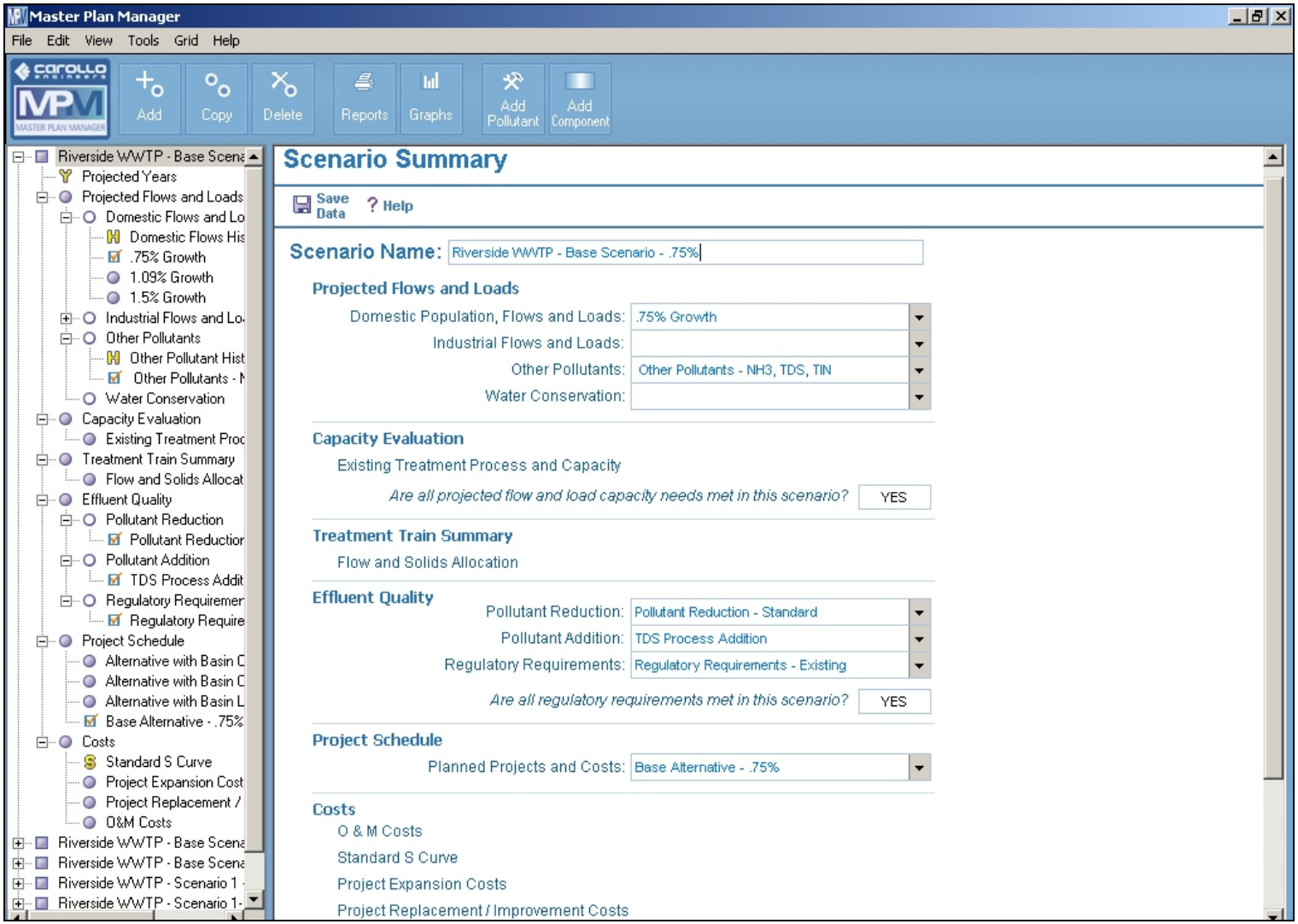
An existing database has been developed for the City. This database contains the City's data that goes along with the rest of the Master Plan deliverables. To date, six scenarios have been created with one scenario per growth rate (0.75 percent, 1.09 percent, and 1.5 percent) per disinfection option (additional chlorine contact basins or ozonation and UV). In addition, each of the six scenarios has an option to include the Levee project in the cost calculations. To include the Levee, a box needs to be checked and the CIP for that scenario is automatically updated. The default setting for each scenario is not to include the Levee project.



Year	Total Estimated Costs			
	Expansion Project Costs ($)	Replacement / Improvement Project Costs ($)	O&M Costs ($)	Total Costs ($)
2008	5,733,858.06	33,763,518.85	26,018,731.26	65,516,108.17
2009	9,115,097.89	34,070,126.48	26,954,966.62	70,140,190.99
2010	26,480,445.70	69,825,778.45	28,018,308.93	124,324,533.08
2011	26,330,445.66	69,839,682.55	29,028,899.43	125,199,027.64
2012	15,862,943.25	45,803,534.90	30,074,910.04	91,741,388.19
2013	2,172,940.10	16,446,448.08	31,755,773.13	50,375,161.31
2014	2,172,940.10	23,357,181.41	33,536,249.16	59,066,370.67
2015	2,172,940.10	27,392,432.73	34,723,525.25	64,288,898.08
2016	399,999.99	16,250,249.06	35,951,854.02	52,602,103.07
2017	1,399,999.96	20,221,697.39	37,226,663.06	58,848,360.41
2018	2,449,999.95	14,985,547.45	38,542,836.92	55,978,384.32
2019	4,474,999.93	15,584,969.35	39,904,475.76	59,964,445.04
2020	4,118,999.94	17,592,947.39	41,321,937.07	63,033,884.40
2021	4,097,999.93	23,336,533.83	42,799,118.63	70,233,652.39
2022	2,040,499.95	24,522,560.03	44,327,741.39	70,890,801.37
2023	382,500.00	21,214,257.97	45,938,448.59	67,535,206.56
2024	1,487,499.99	30,022,373.02	47,609,207.27	79,119,080.28
2025	1,487,499.99	9,943,538.59	37,809,642.64	49,240,681.22
2026	850,000.00	5,909,302.95	0.00	6,759,302.95
2027	0.00	0.00	0.00	0.00

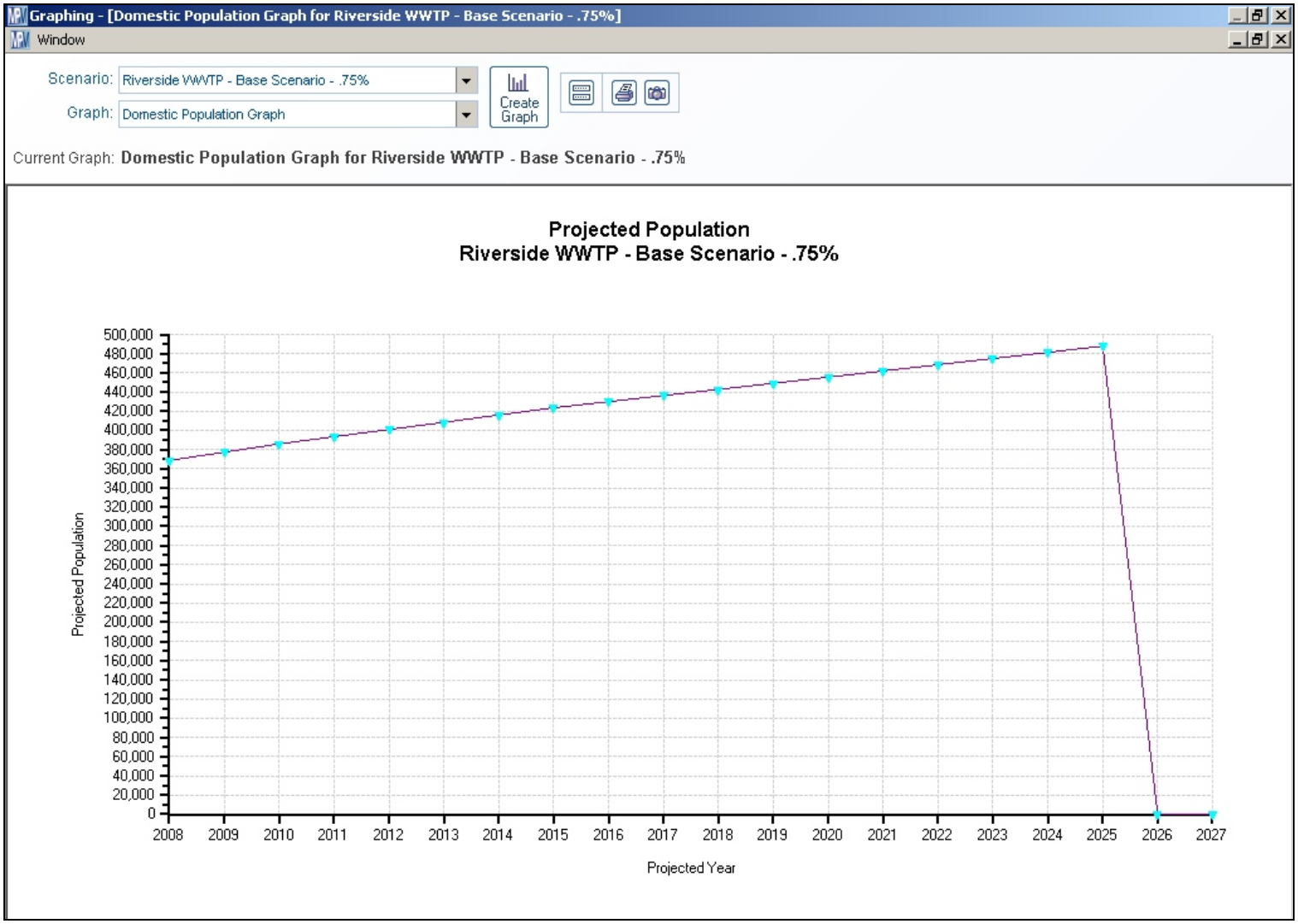
OVERALL PROJECTED COSTS

FIGURE 1.29



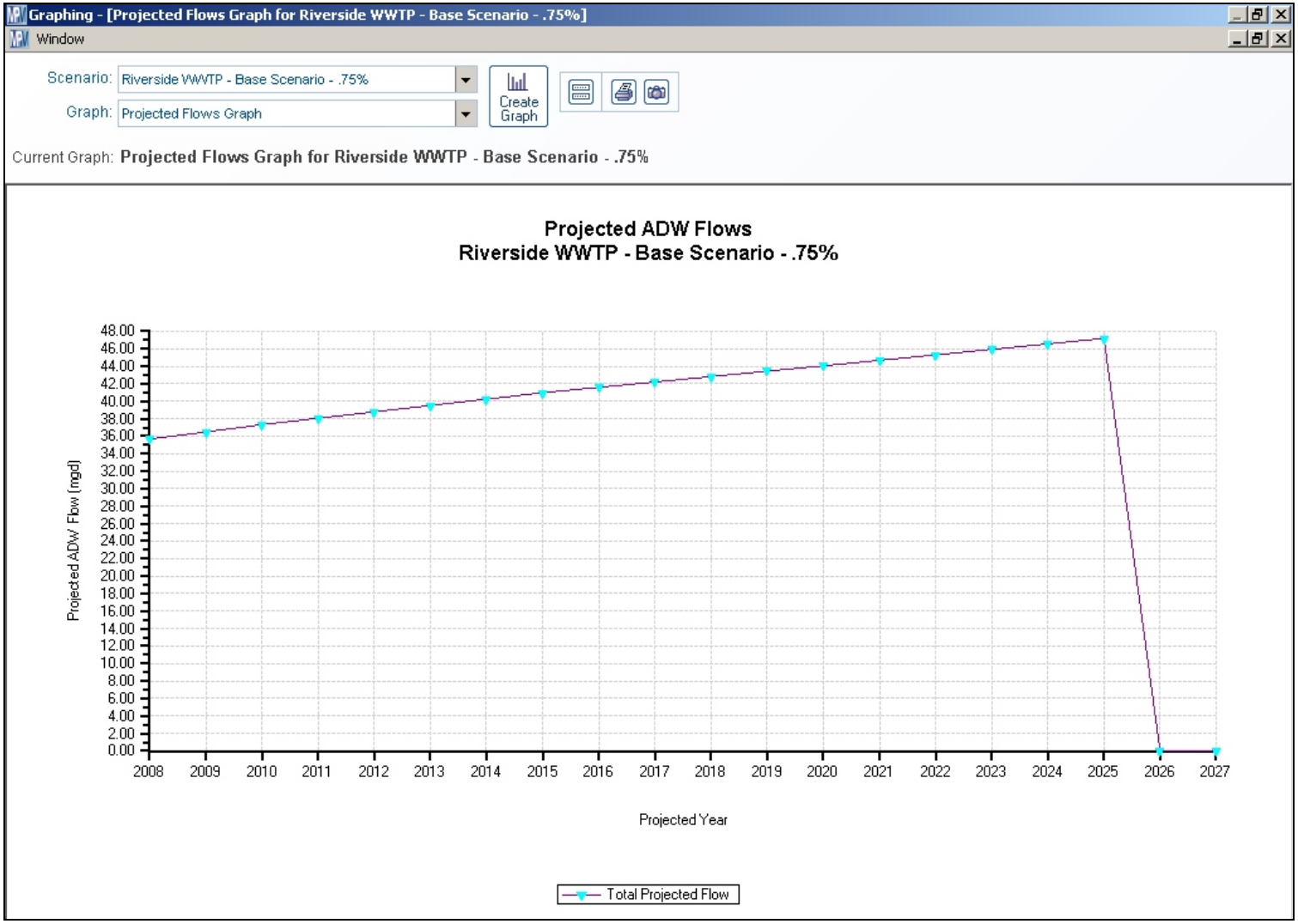
SCENARIO SUMMARY

FIGURE 1.30



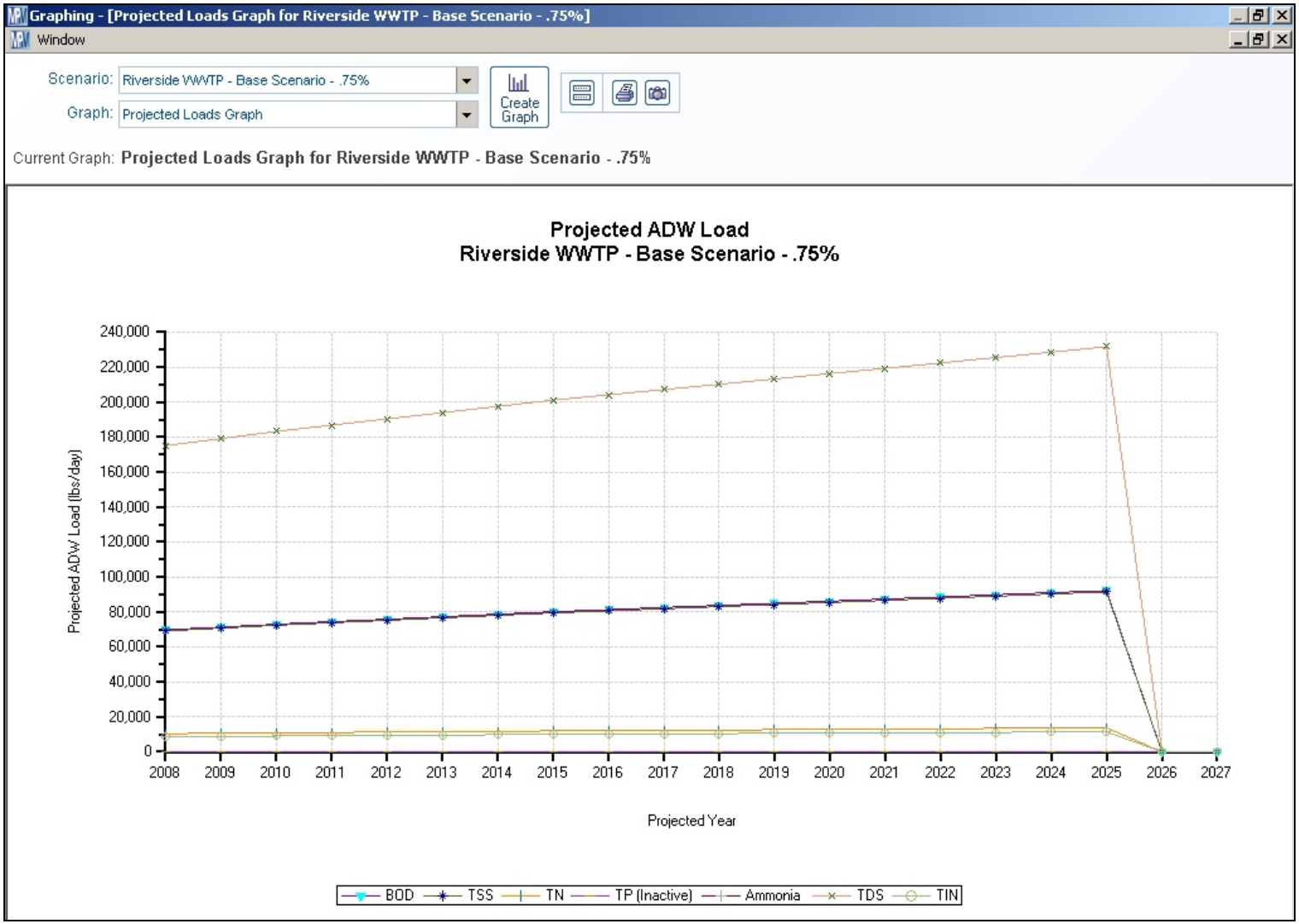
PROJECTED POPULATION GRAPH

FIGURE 1.31



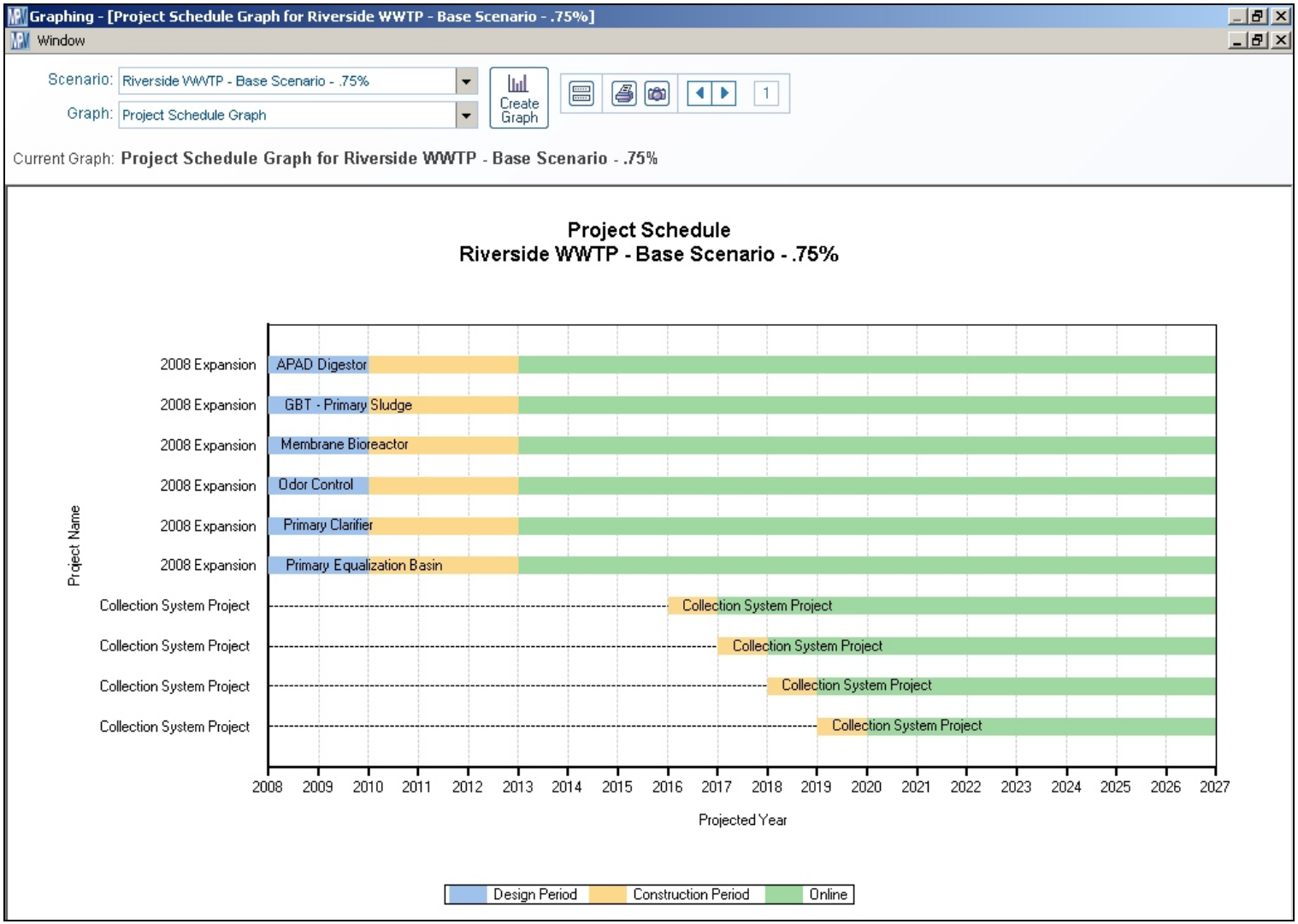
PROJECTED FLOWS GRAPH

FIGURE 1.32



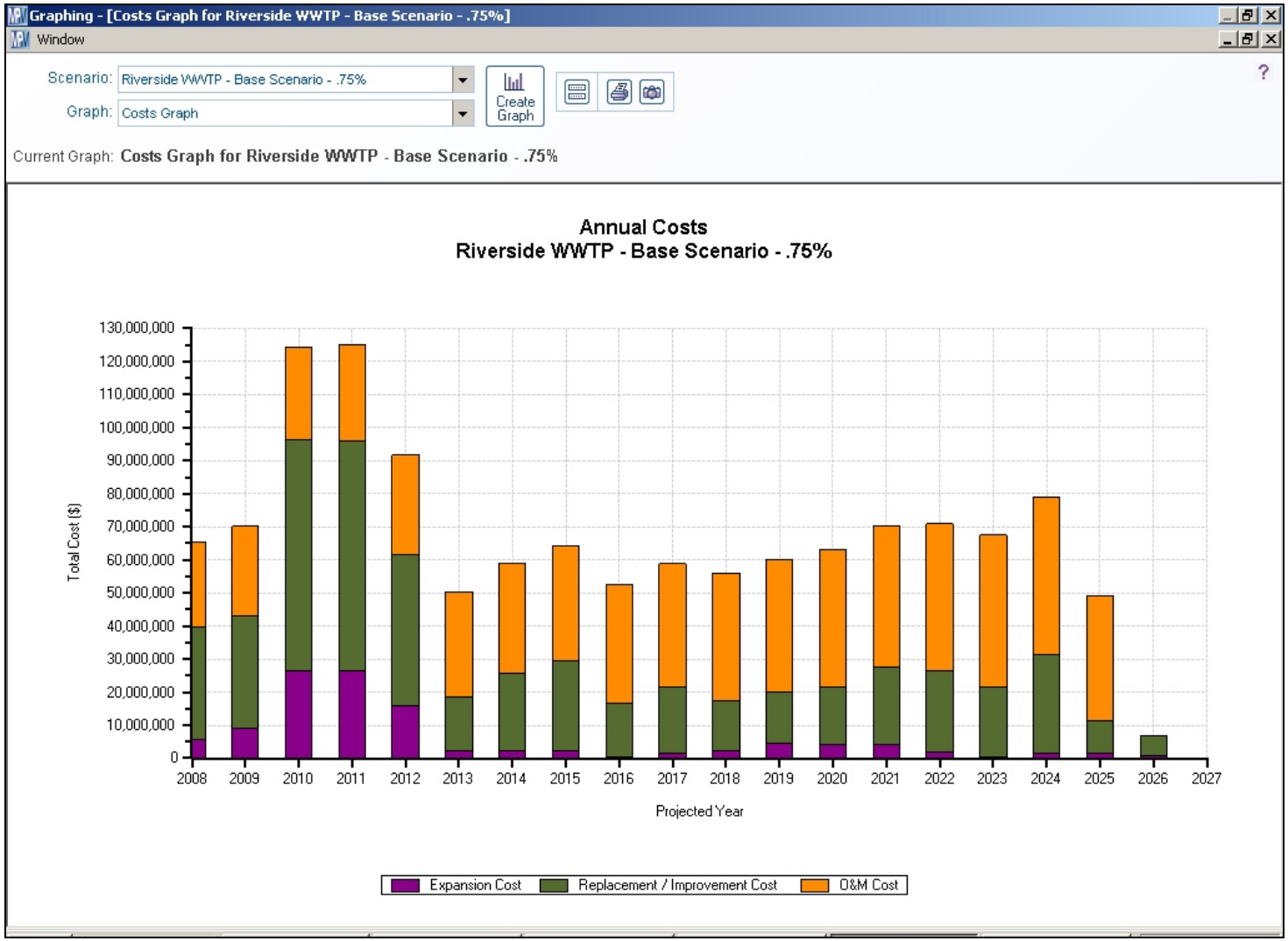
PROJECTED LOADS GRAPH

FIGURE 1.33



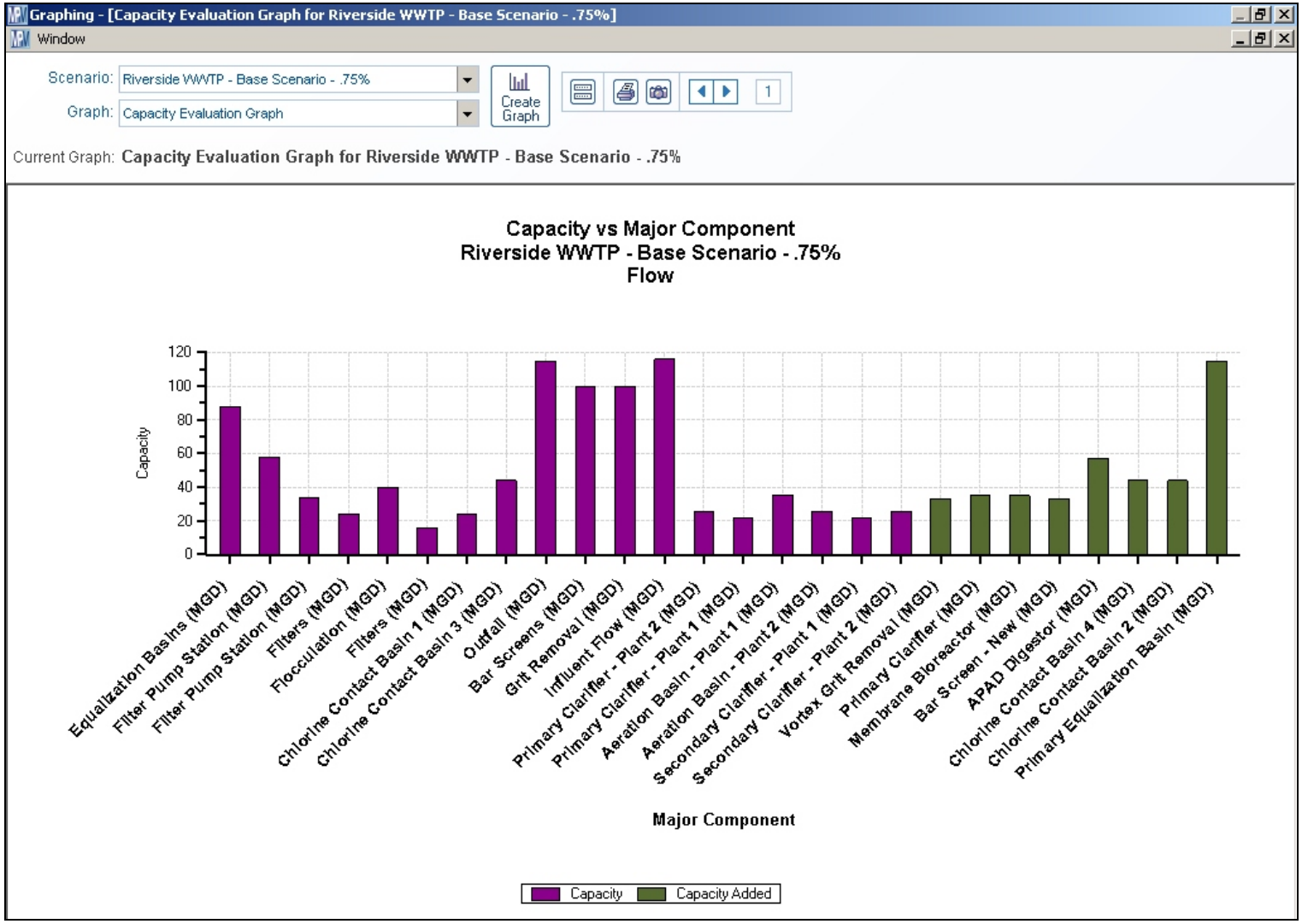
PROJECT SCHEDULE GRAPH

FIGURE 1.34



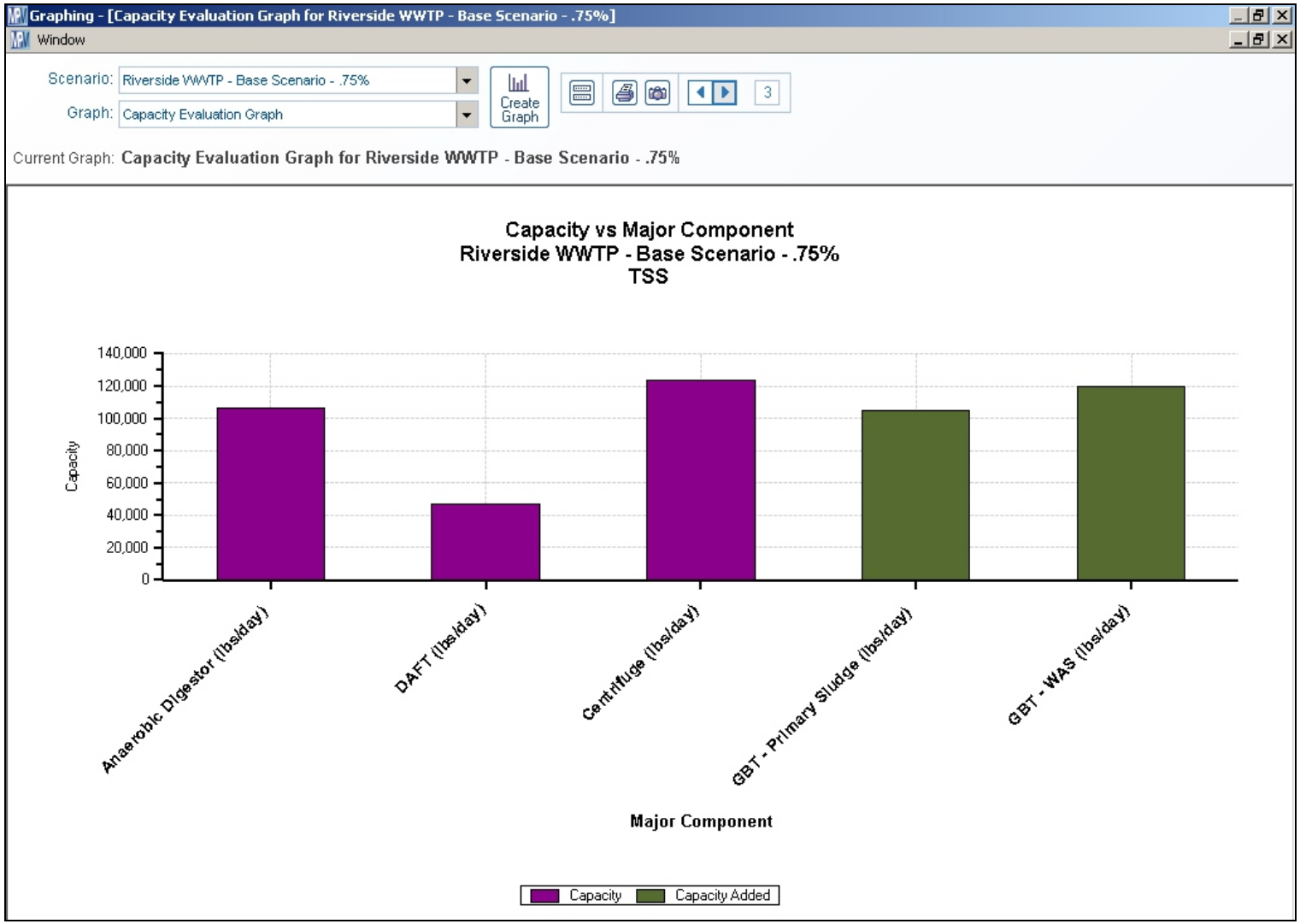
PROJECTED ANNUAL COSTS GRAPH

FIGURE 1.35



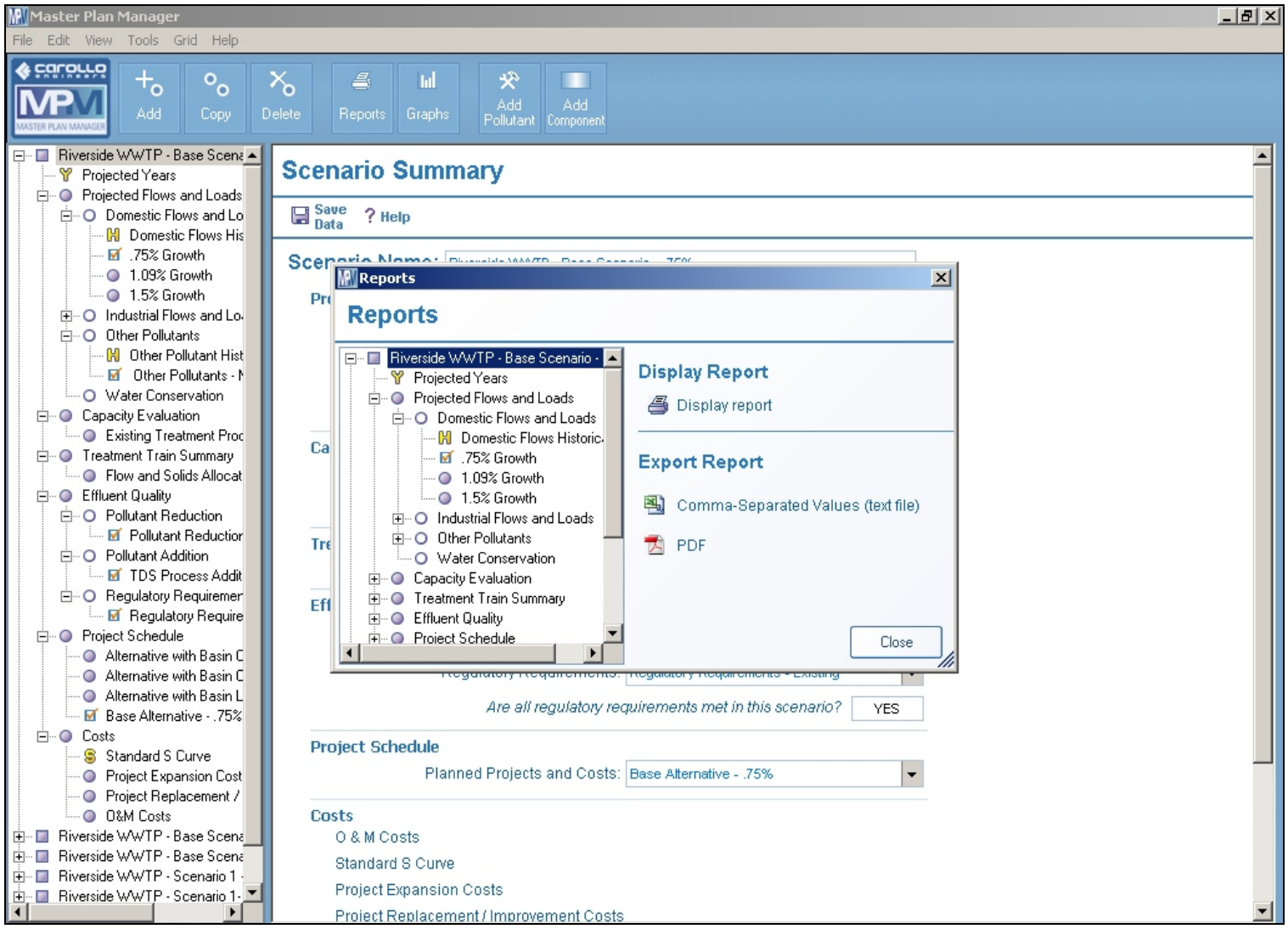
CAPACITY EVALUATION GRAPH - FLOW

FIGURE 1.36



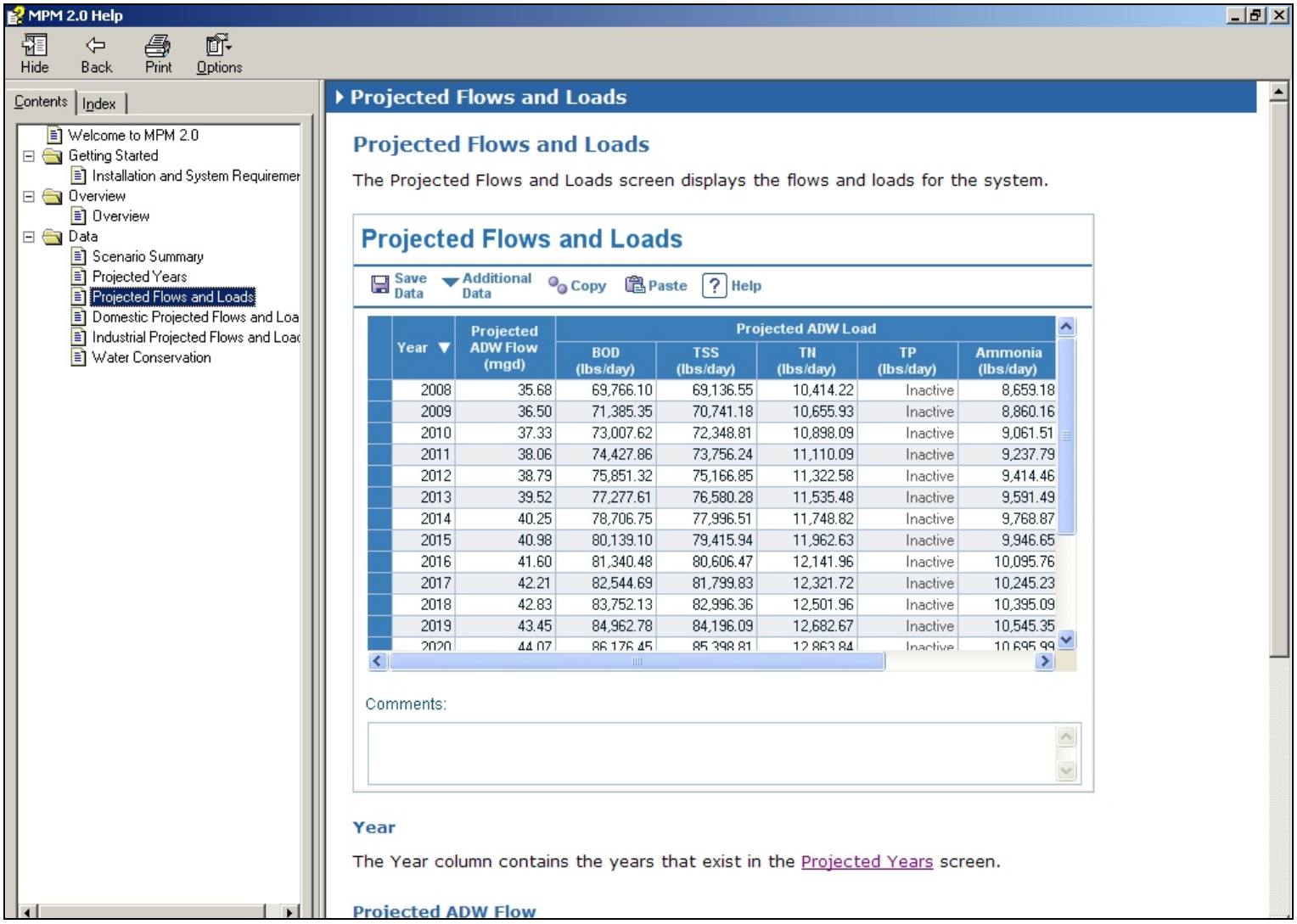
CAPACITY EVALUATION GRAPH - TSS

FIGURE 1.37



MASTER PLAN MANAGER™ REPORTS

FIGURE 1.38



MASTER PLAN MANAGER™ HELP MENU

FIGURE 1.39

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES
CHAPTER 2: FINANCIAL PLANNING TOOL

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES
CHAPTER 2: FINANCIAL PLANNING TOOL

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Chapter 2

FINANCIAL PLANNING TOOL

2.1 PURPOSE

Over the planning period for the Integrated Master Plan the City of Riverside (City) will undertake major improvements to the Regional Water Quality Control Plant (RWQCP) and the collection system. The City last adjusted sewer rates in December 1992. Since that time, the City has implemented plant upgrades without adjusting sewer rates. The purpose of this chapter is to present the results of an assessment of the rates charged to the individual users to determine if they are adequate to address current and future Operations and Maintenance (O&M) and capital costs.

The study includes assessment of both the City's sewer user rates and connection fees. The sewer user rates and sewer connection fees are designed to distribute the cost of the operation and improvement of the RWQCP equitably among all users.

2.2 CONCLUSIONS AND RECOMMENDATIONS

It is recommended that the City implement the proposed rate and connection fee increases. The City will soon begin significant improvements to the RWQCP and the collection system. In order to issue new debt necessary to fund these improvements, the wastewater utility must comply with its current bond coverage requirements. The proposed increases set the *minimum* increases necessary to meet bond coverage needs based on the current financial projections. The proposed increases include a multi-year package of rates. Due to the unknown nature of these future expenditures, it is recommended that the City monitors bond coverage on an annual basis to ensure compliance with legal coverage obligations.

The recommended user rates and connection fees are based on the deliberations and decisions of the City's Public Works and Finance Department. These include:

1. Capital Improvement Plan:

   Implement the Capital Improvement Plan (CIP) as listed in Volume 10, Chapter 1 - Capital Costs and Implementation Schedule. The recommended infrastructure and RWQCP rehabilitation and expansion programs are needed to maintain the existing infrastructure and to meet regulatory and growth requirements.

2. Fiscal Policy:
   a. Maintain the two existing reserve funds:
      1) Operating Fund Balance - Maintain a minimum operating fund balance of 15 percent of annual operating and maintenance expenses.
      2) Capital Fund Balance - Consisting of accumulated excess revenues that are not included in the operating fund.

b. Add a new *Connection Fee Fund* as a legal obligation to account for the interest earnings and expenditures of Connection Fees.

c. Maintain conservative fiscal policies that include:

   1) 1.25x debt coverage.

   2) 10 percent reserve fund for bonds.

   3) Exclude connection fee revenue from the coverage calculation.

3. Sewer Rates:

   In order to meet future annual debt coverage requirements and financial obligations for O&M, it is recommended that the City increase the annual sewer user rate from $13.05 to $19.77 per Equivalent Dwelling Unit (EDU) in FY 2008/09. It is also recommended that the City implement annual increases of between 5.5 and 17 percent in the subsequent 4 years. This projection should be revisited on a periodic basis, as the City updates its operational and capital projections.

4. Connection Fees:

   a. Implement the recommended methodology of calculating connection fees for commercial and industrial customers on an EDU basis and flow and load basis, respectively.

   b. Increase the Residential Connection Fees from $2,684 to $3,472 per EDU. In subsequent years, it is recommended that the Connection Fees be increased based on construction cost inflation.

   c. Recover commercial connection fees based on flows and loadings assumptions used as the basis for developing the City's wastewater rates. The proposed approach will more accurately account for the potential demand that future customers place on the system than under the current fee calculation.

   d. Connection fees for industrial users should reflect the actual permitted flow and loadings for the functional allocation parameters:

      1) Flow.

      2) Biochemical Oxygen Demand.

      3) Total Suspended Solids.

      4) Nitrogen.

      5) Oil and Grease.

The project calculations are presented in Appendix A of this report. A detailed list of projected user rates and connection fees are presented in Appendix B.

2.3 BACKGROUND

The City is responsible for regional wastewater collection, treatment, and disposal. In 1978, the RWQCP began operation as a regional facility. Subsequent projects added capacity and upgraded the existing primary, secondary, tertiary, and solids handling facilities to provide 40 mgd of capacity at the RWQCP on an annual average basis. In the same time period, the RWQCP has been modified to allow the plant to meet more stringent discharge limits.

The City provides service to approximately 160,500 EDUs within the City as well as from Jurupa, Rubiduox, and Edgemont Community Services Districts (CSDs). The average amount of wastewater treated is approximately 33.5 mgd on an annual average basis. Additionally, the City will begin treating wastewater from the community of Highgrove in 2008.

The projected annual average flow at the RWQCP is expected to be 49.4 mgd in FY 2024/25. This flow projection is described in more detail in Volume 2, Chapter 3 - Population and Flow Projections. This amounts to an additional 12 mgd of flow on an annual average basis.

2.4 SCOPE OF WORK

The scope of financial planning for this chapter includes the following:

- A revenue requirement analysis.
- Evaluation of the City's sewer user rates.
- Evaluation of the City's sewer connection fees.

This financial study uses the FY 2007/08 staff-developed operating and maintenance budget as the basis for future O&M expenditures. The financial study includes the development of user rates designed to distribute the cost of operation and improvements of the RWQCP and sewer collection system proportionally to all of the users based on wastewater flow and strength characteristics.

The costs and use of the customers outside the City, known as the Community Services Districts (CSDs); Rubiduox, Edgemont, Jurupa, and Highgrove, were also evaluated. Costs to users outside the City are addressed in the service agreements with each specific community.

2.5 ASSUMPTIONS AND DATA

2.5.1 Flow and Growth Assumptions

According to Volume 2, Chapter 3 - Population and Flow Projections, the population of the City's service area is projected to grow at 0.6 percent per year from 2006, resulting in a projected population of 353,397 by the year 2025. The average flow rate at the treatment plant is projected to increase to 49.4 million gallons a day by 2025. Applying a 90 percent confidence interval for the flow projection, leads to a projected flow of 47.3 mgd on an annual average basis for the low growth scenario and a flow of 52.2 mgd for the high-growth scenario. As is stated on the Volume 2, Chapter 3 - Population and Flow Projections, the Master Plan facilities are sized for a flow of 52.2 mgd. However, the cash flow and timing of the facilities is based on the low-growth scenario of 47.3 mgd for the Capital Improvement Plan, User Rates, and Connection Fees.

Table 2.1 presents the historic population for the City. In addition, the City projects that the population will be 353,397 in the year 2025. A linear increase is applied to the projected population for the years between 2006 and 2025. These values are presented in Table 2.2. Based on the assumption that the future flow per capita will be the same as the historic average of 96.6 gallons per day per capita, the projected flows for Riverside are calculated, as shown in Table 2.2. Table 2.2 also includes flow projections for the CSDs and Highgrove. These values were provided by the City.

Table 2.1 Historical and Projected Population[(1)]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Fiscal Years 2000-2001 Through 2006-2007	
Fiscal Year	**Historical Population**
2000-2001	259,738
2001-2002	262,264
2002-2003	270,944
2003-2004	277,459
2004-2005	281,775
2005-2006	287,321
2006-2007	287,820

Notes:
(1) Source: City of Riverside.

Table 2.2 Projected Population and Average Daily Flows for RRWQCP (mgd)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Flow (mgd)				
Flow Source	**2006**	**2010**	**2015**	**2020**	**2025**
Population[(1)]	287,820	301,626	318,883	336,140	353,397
City of Riverside Flows[(1)]	27.4	29.2	30.8	32.5	34.1
Community Service District Flows					
Jurupa	3.5	4.2	5.1	6.0	6.9
Rubidoux	2.1	2.3	2.5	2.8	3.1
Edgemont	0.6	0.6	0.7	0.8	0.9

Table 2.2 Projected Population and Average Daily Flows for RRWQCP (mgd) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
	Flow (mgd)				
Flow Source	**2006**	**2010**	**2015**	**2020**	**2025**
Highgrove	0	1.6	3.0	3.7	4.4
Total City Flows	33.5	37.8	42.2	45.8	49.4

Notes:
(1) Source: Volume 2, Chapter 3 - Population and Flow Projections.

2.5.1.1 Equivalent Dwelling Units

The number of customers or connections to a sewer system is often expressed in EDUs. An EDU is a measurement of the demand on sewer and treatment facilities in terms of flow and strength that is equivalent to that produced by a single-family home. Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Nitrogen (Nit), and O/G (Oil and Grease) are the measured wastewater parameters that determine influent strengths. Both residential and commercial monthly user rates, as well as connection fees are based on EDUs.

The number of existing EDUs is calculated by taking the total existing RWQCP influent flow and loading values, and dividing them by the flow and loading values of a single-family home, which are 220 gallons per day for flow, 227.5 mg/l for BOD, 259 mg/l for TSS, 31 mg/l for Nitrogen (as ammonia), and 63 mg/l for O/G. The number of future EDUs is calculated using the same method based on an estimated future additional flow of 12 mgd. Table 2.3 shows the number of existing and future EDUs.

Table 2.3 Existing and Future EDUs Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
	EDU
Existing Riverside EDUs	124,545
Existing CSD EDUs	28,182
Future Riverside and CSD EDUs	53,382
Total EDUs by 2025	**215,311**

2.5.2 Approach to User Rate Analysis

For the purposes of this study, new FY 2008/09 rates were developed based on cost-of-service rate principals in accordance with Proposition 218. The proposed rates allocate costs based on contributed flow, BOD, TSS, Nit, and O/G. In years beginning in FY 2009/10, rates are increased evenly for all customer classes based on the revenue requirement analysis. This approach will be discussed further throughout the report.

Single-family and multi-family residential, and basic commercial users are billed a flat sewer user rate based on Resolution No. 18155. The single-family residential (SFR) sewer user rate is based on typical flow and loadings for an average 3-bedroom home. Non-residential users are billed on square footage and estimated flows and loadings. Based on its sampling program, the City maintains a list of average flow and wastewater strength discharges for each user rate category, which is used to develop the user rates. The average flow and loading data for other customer categories are used to calculate the user rates for these respective categories as well. Large industrial or individual users discharging 25,000 gallons or more per day, known as “Special Billing Users,” pay individually calculated user rates, based on measured sewer flows and strengths. These charges are outlined in City of Riverside Resolution No. 18155, Section 1 (b) and Section 2 (b).

The City currently has 48 different residential and commercial user codes. Some areas of the City have sewer lines that must flow to pumping facilities to pump the waste uphill to a gravity feed line. The gravity lines carry the waste downhill to the RWQCP. The pumping process requires additional equipment, maintenance and power. A surcharge is added to the sewer services in these areas.

2.5.3 Connection Fee Categories

A Connection Fee is a one-time charge imposed when a building or structure is newly connected to the City’s system, or when an existing structure or category of use is expanded or increased. The current charge is $2,684 per EDU, calculated based on the flow and sewer loadings for an average 3-bedroom home. Commercial and industrial connection fees are currently charged based on the square feet of space occupied. The current charge is $700 for the first 3,000 square feet and $700 for each additional 3,000 square feet thereafter. It is recommended that the City begin charging commercial and industrial customers based on assumed EDUs for commercial categories, and based on flow and load for industries. Adjustments to the charge are delineated in Section 5.0.

2.5.4 Capital Improvement Program

The CIP has been developed to meet anticipated regulatory requirements, increased population, additional treatment requirements, energy, other resource-savings considerations and air quality protection needs. The anticipated projects that are listed in the CIP, Volume 10, Chapter 1 - Capital Costs and Implementation Schedule.

As included in this financial analysis and shown in the appendix of this report, the CIP totals approximately $683 million between FY 2007/08 and FY 2024/25. Of this total, $186 million ($137 million in August 2006 dollars) will be undertaken to provide capacity for projected growth, while $498 million will be undertaken for replacement/rehabilitation and treatment upgrades. The total CIP expenditures over the next 5 years are projected to total $346 million; an annual average of $69 million.

2.5.5 Functional Allocation

Once projected annual expenditures have been determined, it is necessary to allocate these costs to billable constituents. Billable constituents are parameters that can be measured both at the treatment facilities and for each user, and include flow and strength (BOD, TSS, Nit, and O/G). For example, sewer flow is monitored at the treatment plant and can be estimated for an individual user. The process of assigning costs to billable constituents is developed by first allocating the physical system to the billable constituents on a unit cost basis. For example, the headworks is primarily sized based on maximum day flows. Consequently, the headworks is allocated 100 percent to sewer flow. Following the allocation of the physical system, operating and maintenance costs are allocated. O&M costs attributed to a particular unit process, such as the headworks, are assigned directly to the same billable constituent breakdown. An example of these allocations is shown later in this report chapter.

The allocation of capital expenditures by unit process is illustrated in Table 2.4.

Table 2.4 Capital Cost Allocation to Billable Constituents
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Treatment Process	Allocation Percentages (%)		
	Flow	BOD	TSS
Preliminary Treatment	100%		
Primary Clarifiers	80%		20%
Sludge Thickening		100%	
MBR Facility	100%		
Digestion		45%	55%
Pipe and Sewer Lines	100%		

The allocation of O&M expenditures by unit process is illustrated in Table 2.5.

Table 2.5 Operation and Maintenance Cost Allocation to Billable Constituents
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Treatment Process	Allocation Percentages (%)					
	Pumping	Flow	BOD	TSS	Nit	O/G
Administration[(1)]	3%	52%	25%	15%	3%	2%
Collection System Maintenance	5%	95%				
Treatment		44%	33%	17%	5%	2%
Environmental Compliance[(1)]	3%	52%	25%	15%	3%	2%
Sewer System Plant Maintenance[(1)]	3%	52%	25%	15%	3%	2%
Laboratory Services[(1)]	3%	52%	25%	15%	3%	2%
Debt Service[(1)]	3%	52%	25%	15%	3%	2%

Table 2.5 Operation and Maintenance Cost Allocation to Billable Constituents Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside						
	Allocation Percentages (%)					
Treatment Process	Pumping	Flow	BOD	TSS	Nit	O/G
Cogeneration and Landfill			45%	50%		5%
Capital Project Service[(1)]	3%	52%	25%	15%	3%	2%

Notes:
(1) Percentage based on weighted average for all other allocated costs.

2.5.6 Operations and Maintenance Expenditures

The revenue requirement analysis uses the City's FY 2007/08 budgets as the basis for forecasting future revenue needs. Expenditures are assumed to increase commensurate with cost inflation and projected cost increases associated with increases in wastewater flows due to growth and higher treatment standards.

Revenues and expenses are projected for future fiscal years using the following annual escalation factors:

- General Cost Inflation: 3 percent.
- Capital Cost Inflation: 6 percent for the first 5 years, 4 percent thereafter.
- Customer Demand Growth: 0.6 percent.
- Fund Earnings: 4 percent.
- Labor Cost Inflation: 3 percent.
- Insurance Inflation: 5 percent.

2.5.7 Existing Financial Information

The background financial information supplied by the City included: existing debt service and future payments, current capital and operating fund balance, utility tax percentage, operating fund reserve requirement, and other miscellaneous financial information.

2.6 REVENUE REQUIREMENT ANALYSIS

2.6.1 Introduction

The revenue requirement analysis determines the amount of rate revenue needed in a given year to meet a utility's expected financial obligations. At least two separate tests must be met in order for rates to be sufficient:

1. Cash Flow Test:

   A utility must generate annual utility revenues adequate to meet general cash needs.

2. Bond Coverage Test:

   Annual rate revenues must satisfy debt coverage obligations.

The cash flow test identifies projected cash requirements in each given year. Cash requirements include operations and maintenance expenses, debt service payments, replacement funding, additions to fund balances, and rate funded capital expenditures. These expenses are compared to total annual projected revenues. Revenues that are available to meet this requirement include user rate revenue, interest earnings, non-operating revenues and miscellaneous revenues. Shortfalls are then used to estimate needed rate increases.

The bond coverage test measures the ability of a utility to meet both legal and policy-driven revenue obligations. The City is required to collect sufficient funds through user rates to meet all ongoing operational and maintenance expenses, as well as 1.25 times the annual debt service requirements due in a year.

Revenues must be sufficient to satisfy both tests. If revenues are found to be deficient through one or both of the tests, then the greater deficiency (shortfall) drives the rate increase.

2.6.2 Capital Funding Sources

The City projects $683 million in future RWQCP treatment improvements and future collection system capital improvements. The City expects to fund these improvements through a combination of sewer revenues, capital reserve funds, and revenue bonds. The City expects to issue approximately $440 million in revenue bonds over the study period. Operating and maintenance expenses can be funded by sewer revenues and operating reserve funds, but not by revenue bonds or connection fees.

2.6.2.1 Current Revenues

User Rates - User rates can be increased to accumulate reserves to cash fund capital projects. The City established a Capital Fund to finance annual increments of the capital improvement program.

For this analysis, we have used a “rate smoothing” strategy for meeting future rate requirements. Projected rate increases in FY 2009/10 and beyond are designed to both flatten annual rate increases and allow for the accumulation of reserve funds. The accumulation of reserves is minimal, but can help reduce long-term costs to the customers by reducing the City’s debt requirements and help achieve the best possible bond rating.

Connection Fees - are a one-time charge imposed on new development requiring wastewater service or existing users that increase demand on the system. These fees recover an equitable share of growth-related costs. Connection Fees can only be used to fund capital projects, not operating and maintenance expenses.

2.6.2.2 New Debt

The City can issue Revenue Bonds to fund capital-related projects. It is assumed that the City will continue to issue new debt throughout the study period. To issue new debt, the utility is legally required to maintain a 1.25 times coverage ratio on the annual debt service. This means that rates must cover annual cash operating expenses plus 125 percent of the maximum annual debt service payments. This coverage requirement is delineated within The Sewer Refunding Revenue Bonds, Series 1993, dated February 1, 1993. Revenue Bonds can only be used to fund capital projects, not operating and maintenance expenses.

Table 2.6 below describes the City's existing outstanding debt service balance as of July 1, 2007.

Table 2.6 Outstanding Certificates of Participation Debt as of FY 2008/09 Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

	Outstanding Debt Principal	Maturity Year
SRF Loan - Headworks Project	$4,735,503	FY 2018/19
SRF Loan - Cogeneration Project	$3,833,656	FY 2020/21
Sewer Refunding Revenue Bond	$21,350,000	FY 2012/13
Pension Obligation Bonds (POB)	$3,389,137	FY 2024/25
Total Long-Term Debt	**$33,308,296**	

Source:
Finance Department of The City of Riverside.

2.6.2.3 Reserve Funds

The City currently maintains two categories for its reserve fund balances. The following table delineates the projected reserve fund balances for FY 2007/08.

Table 2.7 FY 2007/08 Reserve Fund Balances (Millions of Dollars) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside

Operating Fund Balance	$11.5
Capital Fund Balance	$43.9
Total	**$55.4**

Source:
FY 2007/08 projected beginning fund balances provided by the City of Riverside. Operating fund is based on minimum cash flow needs. All other fund balances are assumed to be available to fund capital projects.

- *The Operating Reserve Fund* was established to fund operation, maintenance, and revenue bonds debt service expenses for the first half of the fiscal year.

- *The Capital Reserve Fund* was established to fund annual increments of the capital improvement program, as well as asset replacement and rehabilitation.

The Minimum Operating Fund Reserve Requirement is established as 15 percent of annual operations and maintenance expense while the Maximum Operating Fund Reserve Requirement is not more than 20 percent of annual operations and maintenance expense. Any funds exceeding the maximum operating fund reserve requirement will be transferred to the Capital Fund in the following year.

In addition to these two reserve funds, it is recommended that the City establish one additional fund as follows:

- *The Connection Fee Fund* as a legal obligation to account for the interest earnings and expenditures of Connection Fees. This fund will help the City track Connection Fee revenues and expenditures as required under California Government Code 66000.

2.6.3 Results

The results of the revenue requirements are summarized in Table 2.8. Annual rate increases are shown expressed on a percentage basis.

With the exception of FY 2008/09, rate increases have been levelized (smoothed), to allow for gradual increase, eliminating significant rate spikes. Rate levelization provides two significant benefits. First, increasing rates over a multi-year period can help reduce rate shock to a utility's customers and allow them to better plan for projected increases. Second, by increasing rates over time in anticipation of large capital expenditures, the City will temporarily generate excess cash reserves, which can be used to cash fund a greater portion of the CIP, thus reducing the magnitude and costs of borrowing. Further, bond-rating agencies (Moody's, Fitch ICBA, and Standard and Poor's) have placed increasingly greater weight on good business practices when assigning credit ratings. These business practices include, among other criteria, balancing cash and debt financing, as well as the implementation of proactive rate increases, which demonstrate a municipality's commitment to fiscal prudence, as well as to generate the revenues necessary to meet its stated and required level-of-service and environmental objectives.

2.7 RATE STRUCTURE ANALYSIS

2.7.1 Introduction

User rates are developed to equitably allocate costs to system users to operate, service debt, and perform repairs and replacements for wastewater collection and treatment

Table 2.8 Revenue Requirements
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	FY2008	FY2009	FY2010	FY2011	FY2012
Revenues	**2009**	**2010**	**2011**	**2012**	**2013**
User Charges	$19,997,152	$29,608,604	$34,264,475	$40,340,494	$46,477,327
Interest Earnings	185,592	341,355	447,734	852,883	1,263,329
Miscellaneous Revenues	661,468	681,312	701,751	722,804	744,488
Connection Fee Revenues	-	-	-	-	-
Total Revenues	$20,844,212	$30,631,271	$35,413,960	$41,916,181	$48,485,144
Expenditures					
Ongoing Operating Expenses					
Operating Expenses	26,261,421	28,053,924	29,751,273	31,377,205	32,997,711
Other Operating Expenses					
Debt Service	7,605,640	8,922,305	14,967,569	20,972,326	25,512,912
Rate Funded Capital	-	-	-	-	-
Replacement Funding	-	-	-	-	-
Total Expenditures	$33,867,062	$36,976,229	$44,718,842	$52,349,531	$58,510,624
Revenues to Meet Minimum Operating Fund	-	-	-	-	-
Operating Revenues Surplus (Deficiency[(1)]	$(8,558,490)	$731,865	$581,916	$456,527	$3,226,616
Bond Coverage Surplus (Deficiency)[(1)]	$(10,825,314)	$(2,641,311)	$(6,792,374)	$(6,771,959)	$(3,048,783)
Maximum (Deficiency)[(1)]	$(10,825,314)	$(2,641,311)	$(6,792,374)	$(6,771,959)	$(3,048,783)
Utility Tax Added	$(703,645)	$(171,685)	$(441,504)	$(440,177)	$(198,171)
Projected Rate Increase		**15.00%**	**17.00%**	**14.50%**	**5.50%**

Notes:
(1) Surplus (deficiency) before rate increase.

systems. The overall approach begins by developing unit costs for each billable constituent: flow, BOD, TSS, Nit, and O/G. Costs are then allocated to customer classes. The overall procedure used to develop the user rates is as follows:

- Revenue Needs:
  Define the annual revenue that must be recovered from user rates and permit users.
- Functional Allocation:
  Determine the percentage allocation of O&M and capital costs to the billable constituents: flow, BOD, TSS, Nit, and O/G.
- Unit Costs:
  Develop unit costs for each billable constituent by dividing the total cost allocated to that constituent by the total wastewater flow or loadings of that constituent.
- Customer Category Rates:
  Assign cost to customer classes based on usage, then develop rates for each customer category.

Community Services Districts revenues are assumed to reduce the City's overall revenue requirements collected through inside City user rates.

Residential and Commercial Customers. The user rates for commercial categories are based on its respective flow and loading strength. The estimated flow and loading levels are based on the City's sampling program.

Industrial Customers. The City charges industrial user rates to customers discharging high-strength or high-volume wastes into the sewer system. Customers subject to industrial sewer service charges are billed directly by the City. The fee charged to each customer is based on the customer's flow, and the concentration of BOD, TSS, Nit, and O/G.

2.7.2 Revenue Needs

The revenue needs are defined as the amount of revenues that must be recovered through user rates and industrial user charges in order to cover annual expenditures less any offsetting revenues. Offsetting revenues and other rate adjustments can include interest earnings, CSD payments, over or under collection of rates, coverage driven increase adjustments, and other non-operating revenues.

Expenditures and offsetting revenues for FY 2008/09 are as follows:

Table 2.9 Expenditures and Off-Setting Revenues
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	FY 2008
Expenditures	**2009**
Ongoing Operating Expenses	
Operating Expenses	$26,261,421

Table 2.9 Expenditures and Off-Setting Revenues Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
	FY 2008
Expenditures	**2009**
Other Operating Expenses	
Debt Service	$7,605,640
Rate Funded Capital Improvements	-
Replacement Funding	-
Additions to Fund Balances	-
Utility Taxes	$703,645
Less Off-Setting Revenues	
Over/Under Collection of Rates	-
Coverage Driven Rate Increase	$2,266,823
CSD Revenues	$(6,568,458)
Interest Earnings	$(354,485)
Misc. Revenue	$(681,312)
Connection Fees Revenue	-
Total Revenue Needs	$29,233,276

In FY 2008/09, $29.2 million must be recovered through user rates to cover the City's annual expenditures.

2.7.3 Functional Allocation

To develop user rates, unit rates per unit of flow, BOD, TSS, Nit, and O/G are applied to standard flow and loading factors developed for most customer categories.

Table 2.10 presents a summary of the allocation percentage basis:

Table 2.10 Allocation Percentage Basis Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside						
Description	**Pumping**	**Flow**	**BOD**	**TSS**	**Nit**	**O/G**
Treatment Expenditures		44%	33%	17%	5%	2%
Collection System Maintenance	5%	95%				
CoGen/Landfill			45%	50%		5%
Non-Assignable Costs	3%	52%	25%	15%	3%	2%

Table 2.11 illustrates how expenditures and offsetting revenues are allocated to flow, BOD, TSS, Nit, and O/G based on the allocation percentage listed above.

Table 2.11 Functional Allocation of Costs
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Expenditures	Functional Allocation						
	Pumping	Flow	BOD	TSS	Nit	O/G	
Ongoing Operating Expenses							
Operating Expenses	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Other Operating Expenses							
Debt Service	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Rate Funded Capital	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Replacement Funding	0%	44%	33%	17%	5%	2%	As Treatment Expenditures
Additions to Fund Balances	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Utility Taxes	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Less Off-Setting Revenues							
Over/Under Collection of Rates	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Coverage Driven Rate Increase	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
CSD Revenues	3%	52%	25%	15%	3%	2%	
Interest Earnings	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Misc. Revenue	3%	52%	25%	15%	3%	2%	As Non-Assignable Expenditures
Connection Fees Revenue		55%	37%	7%			As Non-Assignable Expenditures
Total Revenue Needs							

The resulting overall percentage allocation is shown in Figure 2.1.

Table 2.12 shows the total cost allocated to each billable constituent using the resulting overall percentage allocation in the pie chart.

Table 2.12 Total Cost Allocation
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Pumping	Flow	BOD	TSS	Nit	O/G
Total Cost Allocation	$975,913	$15,272,365	$7,256,865	$4,280,449	$992,969	$454,714

2.7.4 Customer Category User Rates

Single-family and multi-family residential, and basic commercial users are billed a flat monthly user rate. Non-residential users are billed a user rate per hundred cubic feet of water use per month.

Table 2.13 lists the customer categories that are charged a flat monthly user rate:

Table 2.13 Customer Categories with a Flat Monthly User Rate
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

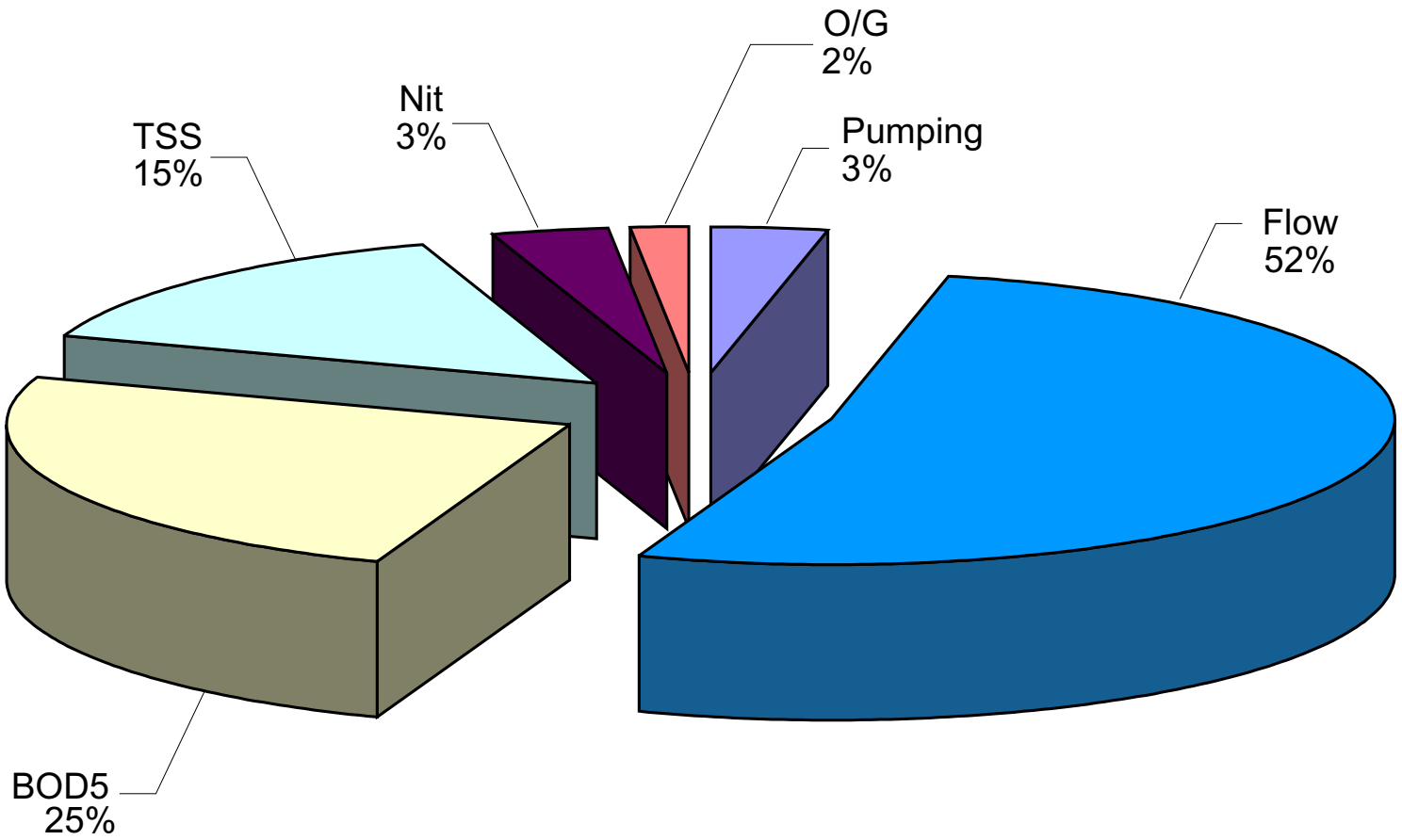
Residential Sewer Rates
Residence on Septic System
Basic Multi-Family Dwelling Unit
Basic Single Family Dwelling Unit
Basic Single Family Dwelling - Pumping
Basic Multi-Family Dwelling Units - Pumping
Commercial Sewer Rates
Basic Commercial
Basic Commercial - Pumping

Table 2.14 lists the customer categories that are charged a rate per unit of CCF:

Table 2.14 Customer Categories with a Rate per Unit CCF Charge
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Commercial Rate Structure - Non-Pumping (per CCF)
Department and Retail Stores
Hotels and Motels
Laundromats

Table 2.14 Customer Categories with a Rate per Unit CCF Charge Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside
Laundries
Markets
Mortuaries
Professional Offices
Repair Shops and Service Stations
Restaurants
Other Commercial
Hospitals
Churches and Halls
Schools "B"
Other Commercial "A"
Other Commercial "B"
Commercial Rate Structure - Pumping (per CCF)
Department and Retail Stores
Hotels and Motels
Laundromats
Laundries
Markets
Mortuaries
Professional Offices
Repair Shops and Service Stations
Restaurants
Other Commercial
Hospitals
Churches and Halls
Schools "B"
Other Commercial "A"
Other Commercial "B"



BILLABLE CONSTITUENT COST ALLOCATIONS

FIGURE 2.1

2.7.5 Unit Cost Calculation

2.7.5.1 Residential and Commercial User Flat Monthly Rate Calculation

Residential and commercial user rates are calculated based on flow and strength (BOD, TSS, Nit, O/G) assumptions developed through the City's sampling program. To develop user rates, unit rates per unit of flow, BOD, TSS, Nit, and O/G are applied to the flow and loading assumptions.

1. EDU Defined Equivalents Calculation.

The number of existing users was determined using flow and loading data. The number of EDUs was determined by taking the total flow and loading data and dividing by the Single-Family Residential average flow and loading data. The projected number of customers served in the City of Riverside for the FY 2008/09, identified in EDUs, is 126,145.

The number of EDUs from the CSDs was also determined using the same method. The projected number of customers in the CSDs for the FY 2008/09, identified in EDUs, is 32,727. The total number of EDUs from the City and the CSDs is 158,873.

Table 2.15 presents the per-EDU flow and load information.

Table 2.15 Average Flow and Load Information per EDU
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Flow (gpd)	BOD (mg/l)	TSS (mg/l)	Nit (mg/l)	O/G (mg/l)
City of Riverside	220	227.5	259	31	63

Source:
August 2001 Revenue Plan Report.

2. Total Annual Flow and Loading.

Based on the annual flows and loadings from the City of Riverside, the totals are as follows:

Table 2.16 Total Annual Flow and Loads
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Description	Flow (CCF)	BOD Load (lbs)	TSS Load (lbs)	Nit Load (lbs)	O/G Load (lbs)
Customer Information Total Annual Flow and Loads	12,640,077	19,606,504	18,902,948	2,381,362	5,867,960

3. Unit Cost Calculation.

The unit costs were calculated by taking the cost allocations for flow, BOD, TSS, Nit, and O/G and dividing them by the total annual flow and loads. Table 2.17 presents the unit cost per flow, BOD, TSS, Nit, and O/G.

Table 2.17 Unit Cost Calculation
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Pumping	Flow	BOD	TSS	Nit	O/G
Cost Allocation	$975,913	$15,272,365	$7,256,865	$4,280,449	$992,969	$454,714
÷	Total Flow (CCF)	Total Flow (CCF)	Total BOD (lbs)	Total TSS (lbs)	Total Nit (lbs)	Total O/G (lbs)
Total Annual Flow and Loads	2,855,724	12,640,077	19,606,504	18,902,948	2,381,362	5,867,960
=	$/CCF	$/CCF	$/lbs BOD	$/lbs TSS	$/lbs Nit	$/lbs O/G
Unit Costs	$0.34	$1.21	$0.37	$0.23	$0.42	$0.08

Lower elevation areas within the City require lift stations to pump sewage up to the grade of the treatment plant. To account for this additional cost, some customers are charged a pumping rate. To calculate the additional pumping charge, the total operating and maintenance cost related to pumping was divided among the lower elevation customers. This rate is then added to the rate per unit of regular flow to get the unit cost for customers who require pumping services.

Table 2.18 shows the unit costs for non-pumping and pumping customer categories:

Table 2.18 Unit Costs for Non-Pumping and Pumping Customer Categories
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Flow	BOD	TSS	Nit	O/G
Unit Costs for Non-Pumping Customer Categories	$1.21	$0.37	$0.23	$0.42	$0.08
Unit Costs for Pumping Customer Categories	$1.55	$0.37	$0.23	$0.42	$0.08

4. Example of Flat Monthly User Rate Calculation.

<u>Single-Family Residential Customer (Non-Pumping)</u>

The first step in calculating the monthly user rates is to calculate the monthly units for each flow, BOD, TSS, Nit, and O/G. This is obtained by taking the total monthly flow in hundred cubic feet and loading in pounds from the single-family residential category and dividing it by the total number of single-family residential accounts.

Table 2.19 shows the resulting monthly units of flow, BOD, TSS, Nit, and O/G for the single-family residential (non-pumping) category:

Table 2.19 Monthly Charge per Single-Family Residential
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Flow (ccf)	BOD (lbs)	TSS (lbs)	Nit (lbs)	O/G (lbs)
Monthly SFR Units of Flows and Loads	8.95	12.70	14.45	1.72	3.52

The monthly charge per category is then calculated by multiplying the monthly units of flow, BOD, TSS, Nit, and O/G from Table 2.19 with its respective unit costs from Table 2.18. The resulting monthly charge for the single-family residential (non-pumping) category is presented in Table 2.20.

Table 2.20 Monthly Charge per Single-Family Residential Customer (Non-Pumping)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Flow	BOD	TSS	Nit	O/G
Equivalent Dwelling Unit	CCF/Month	BOD (lbs)	TSS (lbs)	Nit (lbs)	O/G (lbs)
Monthly SFR Units of Flows and Loads	8.95	12.70	14.45	1.72	3.52
X	$/CCF	$/lbs	$/lbs	$/lbs	$/lbs
Unit Costs for Non-Pumping Customer Categories	$1.21	$0.37	$0.23	$0.42	$0.08
=					
Monthly Rate per SFR	$10.81	$4.70	$3.27	$0.72	$0.27
Total Monthly Rate	**$19.77**				

The monthly flat rate for a single-family residential customer (non-pumping) is $19.77.

Basic Commercial Customer (pumping)

The same procedure is repeated for the Basic Commercial Customer. Table 2.21 shows the monthly units for that category, and the resulting flat monthly charge.

Table 2.21 Monthly Rate per Basic Commercial Customer (Pumping)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Basic Commercial Customer (Pumping)	Flow	BOD	TSS	Nit	O/G
	CCF/Month	BOD (lbs)	TSS (lbs)	Nit (lbs)	O/G (lbs)
Monthly Units of Flows and Loads	8.95	12.70	14.45	1.40	4.74

Table 2.21 Monthly Rate per Basic Commercial Customer (Pumping) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
Basic Commercial Customer (Pumping)	**Flow**	**BOD**	**TSS**	**Nit**	**O/G**
X	$/CCF	$/lbsBOD	$/lbsTSS	$/lbsNit	$/lbsO/G
Unit Costs for Pumping Customer Categories	$1.55	$0.37	$0.23	$0.42	$0.08
=					
Monthly Rate per Basic Commercial Customer	$13.87	$4.70	$3.27	$0.58	$0.37
Total Monthly Rate	**$22.79**				

The monthly flat rate for a basic commercial customer is $22.79.

2.7.5.2 Non-Residential User Rate Per Unit Calculation

The SFR user rate is based on typical flow and loadings for an average 3-bedroom home. Other user categories have their own typical flow and loading assumptions on a per 1,000 square foot basis. The rate calculation for non-residential customers is similar to residential rate calculations. The calculation is shown below in Table 2.22 for a Department and Retail Store.

The first step in calculating the rate per unit is to calibrate the flow and loadings such that the resulting quantities are based on one unit of flow in hundred cubic feet (CCF) or 748 gallons. For example, if the BOD concentration of a Department and Retail Store is 150 mg/L and the flow assumption is 748 gallons, the conversion will result in an average amount of 0.94 pounds of BOD in this customer category per unit flow. The same conversion applies to TSS, Nit, and O/G. These pounds per flow will then be multiplied by the unit costs to obtain the rate per unit flow.

1. Example of a rate per unit CCF calculation for a Department and Retail Store (non-pumping).

Table 2.22 Rate per Unit Flow for a Department and Retail Store (Non-Pumping) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside					
Department and Retail Stores (Non-Pumping)	**Flow**	**BOD**	**TSS**	**Nit**	**O/G**
Billing unit (CCF) and load (mg/L)	1	150	140	25	85
=	CCF/Month	BOD (lbs)	TSS (lbs)	Nit (lbs)	O/G (lbs)
Quantity per unit CCF	748	0.94	0.87	0.16	0.53
X	$/CCF	$/lbsBOD	$/lbsTSS	$/lbsNit	$/lbsO/G

Table 2.22	Rate per Unit Flow for a Department and Retail Store (Non-Pumping) Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Department and Retail Stores (Non-Pumping)	**Flow**	**BOD**	**TSS**	**Nit**	**O/G**
Unit Costs for Non-Pumping Customer Categories	$1.21	$0.37	$0.23	$0.42	$0.08
=					
Rate per Unit CCF	$1.21	$0.35	$0.20	$0.07	$0.04
Total Rate per Unit CCF	**$1.86**				

The monthly unit rate shown in Table 2.22 is calculated based on the return flows to the sewer system. These return factors were developed through a sampling program conducted by the City. The rate, as shown above, is based on returned sewage. However, the City collects commercial wastewater rates based on actual water usage. Consequently, the unit rate is adjusted to account for water usage as follows:

Returned Sewer Rate X Total Returned Sewage/Total Water Consumption.

$1.86 per CCF sewer flow X 110,578 CCF sewer flow/145,498 CCF water consumption = $1.41 per CCF water consumption.

The rate per unit CCF of water consumption for a Department and Retail Store customer is $1.41.

2. Example of a rate per unit CCF calculation for an industrial customer.

The City's industrial users, also known as special billing customers, are charged individually based on the measured quantity of each of the billable constituents. The calculation of the total charge is based on the user's flows and loads. Aside from flow, TSS, Nit, and O/G, The City bills its industrial customers based on its Chemical Oxygen Demand (COD), instead of BOD. Table 2.23 presents the unit costs that are recommended.

Table 2.23	Proposed Industrial User Rates Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
	$/CCF	**$/lb C.O.D**	**$/lb TSS**	**$/lb Nit**	**$/lb O/G**
Unit Costs	$1.21	$0.19	$0.23	$0.42	$0.08

2.7.6 Proposed User Rates

It is recommended that the City adopt a sewer user rate of $19.77 per EDU per year for FY 2008/09, based on the total revenue requirement need. In subsequent years, we recommend that the City increase sewer user rates between 5.5 percent and 17 percent

annually over the following 5 years, as illustrated in Table 2.24. The table also shows what the rate per EDU would have been if it had been increased at a rate of 3 percent per year since the last increase in 1992. Three percent per year is the approximate annual increase in the Engineering News-Record Construction Cost Index between 1993 and 2007. The proposed rates are higher than the 3 percent increase. However, if the City had implemented annual rate increases of 3 percent since 1992, the proposed rates would not have been as high due to the available cash reserves that would have been generated. The proposed rates are based on the minimum necessary annual increases. These rates do not include a buffer if revenue projections do not match estimates. However, these rates are still very low in comparison to most of the other cities/agencies in the Inland Empire area. A table showing the rate comparison to other cities/agencies is included in Appendix C.

Table 2.24 Projected Sewer User Rates
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Fiscal Year	Proposed Monthly Single-Family Residence Rate	Proposed % Increase	3% Increase from 1992
Existing	$13.05		$20.33
2007-08	$13.05		$20.94
2008-09	$19.77	51.5	$21.57
2009-10	$22.74	15.0	$22.22
2010-11	$26.60	17.0	$22.88
2011-12	$30.46	14.5	$23.57
2012-13	$32.11	5.4	$24.28
2013-14	$32.11	0.0	$25.01
2014-15	$32.34	0.7	$25.76
2015-16	$33.08	2.3	$26.53
2016-17	$33.81	2.2	$27.32
2017-18	$34.46	1.9	$28.14
2018-19	$34.93	1.4	$28.99
2019-20	$35.38	1.3	$29.86
2020-21	$35.95	1.6	$30.75
2021-22	$36.88	2.6	$31.68
2022-23	$37.89	2.7	$32.63
2023-24	$38.53	1.7	$33.60
2024-25	$39.30	2.0	$34.61

2.8 CONNECTION FEES ANALYSIS

2.8.1 Introduction

Connection Fees are one-time fees paid at the time property is developed and connected to the Sewer System. The fees are levied to pay a portion of the City's capital costs and for access to capacity in the Sewer System. Currently, the City has Connection Fees of $2,684 per residential unit (3-bedroom) and $700 for the first 3,000 square feet and $700 for each additional 3,000 square feet, for commercial and industrial users. Under the current industrial user ordinance, additional connection fees, referred to as Pollutant Exceedance Fees, can be imposed on industrial users who place larger than average demands on the Sewer System. Connection Fees are reviewed annually to reflect the changes in the value of the Sewer System to which a new customer is connecting.

Connection fees are designed to recover capital costs of providing capacity for new users. They may fund future capacity expansion projects. The underlying premise is to charge each new user the estimated reasonable cost of providing capital facilities necessary to provide sewer service (i.e., require growth to pay for growth). Absent such charges, existing customers would be required to bear the burden of all capital costs, including capacity-related costs, through user rates. Consequently, new customers would receive the benefit of sewer availability, without themselves paying for that capacity.

Similar to the City’s sewer user rates, the connection fee is equal to the capital costs required to support the sewer flows and loadings estimated for an average 3-bedroom single-family residence, or per EDU.

Pursuant to the agreements with the CSDs, the CSDs are either required to directly fund a portion of the capital costs to construct the RWQCP or to pay connection fees. The CSDs are required to pay for the construction costs of certain sewer collection, transmission, treatment, and disposal facilities to be used by the CSDs and are obligated to make certain payments to the City for certain services arising from the Sewer System (including any standby or availability charges).

2.8.2 Methodology

The connection fees, as calculated for this study, evaluate future expansion related capital expenditures only. These costs will be incurred to provide available capacity for new system users. As expressed in the formula below, the connection fee is calculated by dividing the future expansion CIP costs by the total number of future connections expressed in EDUs.

$$\text{Connection Fees per EDU} = \frac{\text{Expansion Capital Costs}}{\text{Future Users (EDUs)}}$$

2.8.2.1 Approach and Assumptions

The following assumptions were used in calculating the connection fee alternatives:

- Future Facilities:

  The cost of future expansion facilities is projected to total $186 million ($137 million in August 2006 dollars) through FY 2024/25. Collection system improvements are assumed to be the responsibility of the inside City users only, excluding any CSD contributions. Treatment improvements are assumed to benefit all future users, including future inside City and CSD customers. The CIP used within this analysis represents the City's projected expenditures at this point in time.

- Flow and Load Basis:

  All connection fee calculation alternatives included in this report are based upon an EDU flow of 220 gpd. Strength characteristics are assumed to equal to 227.5 mg/l BOD, 259 mg/l TSS, 31mg/l Nit, and 63 mg/l O/G, commensurate with single-family residential strength assumptions.

- Available Remaining EDUs:

  The RWQCP is projected to produce an additional capacity of 12 mgd with the City's CIP. This extra capacity will serve 56,375 new EDUs that are projected to connect through the planning period. 21,364 EDUs will benefit from the collection system improvements.

2.8.2.2 Connection Fees Calculation

Table 2.25 presents the expansion costs divided by the projected number of new EDUs to obtain the connection fee per EDU.

Table 2.25 Connection Fee Calculation
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	Total Treatment Costs	Total Collection Costs
Expansion Cost	$101,271,619	$35,802,281
÷		
New EDUs	56,375	21,364
=		
Connection Fee per EDU	$1,796	$1,676

The total collection fee charge to inside City new development will total $3,472, with $1,796 allocated for treatment and $1,676 allocated for collection.

2.8.2.3 Commercial Connection Fee Calculation

Currently, the City charges commercial and industrial customers $700 for the first 3,000 square feet and $700 for each additional 3,000 square feet. However, the City does not track the floor space of the different commercial property categories. It is recommended that a new and more equitable methodology to calculate commercial and industrial connection fees be applied, based on anticipated sewer flow and loading strength.

Under the new methodology, the number of EDUs per basic commercial unit was calculated according to the following formula:

% of Allocation to Flow X Total Flow in Category +
Number of Accounts in Category X Flow per EDU

% of Allocation to BOD X Total Flow in Category X BOD Concentration in Category +
Number of Accounts in Category X Flow per EDU X BOD Concentration per EDU

% of Allocation to TSS X Total Flow in Category X TSS Concentration in Category =
Number of Accounts in Category X Flow per EDU X TSS Concentration per EDU

Number of EDUs per Basic Commercial Unit.

Once the EDU basis for each commercial category is calculated, it is multiplied by the single-family residential connection fee of $3,472 to obtain the connection fee for that category.

The connection fee for a basic Department and Retail Store (non-pumping):

2.4 EDUs X $3,472 = $8,472

Table 2.26 provides the EDU basis and resulting connection fees for commercial customers. The connection fees presented are based on an average assumption. An actual fee should be calculated for each connection fee applicant based on the expected flow and loadings to be contributed.

Table 2.26 Commercial Customers Connection Fees
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

User Rate Categories	EDU Basis	Proposed Fees FY2007/08	Existing Fees
Commercial Sewer Rates			
Basic Commercial (Flat Rate)	1.0	$3,472	N/A
Basic Commercial - Pumping (Flat Rate)	1.0	$3,472	N/A
Commercial Rate Structure			
Department and Retail Stores	2.4	$8,472	$9,333

Table 2.26 Commercial Customers Connection Fees
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

User Rate Categories	EDU Basis	Proposed Fees FY2007/08	Existing Fees
Hotels and Motels	45.4	$157,693	$40,920
Laundromats	10.3	$35,726	N/A
Laundries	23.5	$81,492	N/A
Markets	11.6	$40,256	$4,667
Mortuaries	9.5	$32,853	$3,639
Professional Offices	3.0	$10,552	$7,000
Repair Shops and Service Stations	3.4	$11,675	$700
Restaurants	12.5	$43,300	$1,167
Other Commercial	5.0	$17,258	$4,305
Hospitals	41.2	$142,988	$9,333
Churches and Halls	4.2	$14,600	$2,333
Schools "B"	10.3	$35,846	N/A
Other Commercial "A"	13.0	$45,267	$2,971
Other Commercial "B"	3.1	$10,721	N/A
Commercial Rate Structure - Pumping			
Department and Retail Stores	3.7	$12,898	
Hotels and Motels	17.4	$60,285	$9,333
Laundromats	13.3	$46,261	$40,920
Laundries	0.8	$2,931	N/A
Markets	20.4	$70,967	N/A
Mortuaries	1.9	$6,602	$4,667
Professional Offices	14.3	$49,670	$3,639
Repair Shops and Service Stations	3.9	$13,534	$7,000
Restaurants	23.2	$80,566	$700
Other Commercial	4.3	$14,793	$1,167
Hospitals	19.5	$67,824	$4,305
Churches and Halls	3.7	$12,828	$9,333
Schools "B"	3.4	$11,969	$2,333
Other Commercial "A"	14.9	$51,890	N/A
Other Commercial "B"	2.5	$8,699	$2,971

2.8.3 Industrial Connection Fee

The same formula that is used to calculate the connection fee for commercial units should be used for Industrial Users. The formula is as follows:

% of Allocation to Flow X Total Flow +
Flow per EDU

% of Allocation to BOD X Total Flow X BOD Concentration +
Flow per EDU X BOD Concentration per EDU

% of Allocation to TSS X Total Flow X TSS Concentration =
Flow per EDU X TSS Concentration per EDU

Number of EDUs per Industry.

The current percent of allocation to flow, BOD, and TSS are 55 percent, 37 percent, and 7 percent, respectively. Applying these values to the formulas calculates the number of EDUs per industry, which can then be multiplied times the single-family residential connection fee of $3,472. This calculation should be performed separately for each industry.

2.8.4 Proposed Connection Fee

It is recommended that the City adopt the residential connection fees and commercial-industrial connection fees as presented above.

This analysis assumes that the connection fees will be escalated each year to reflect the current value of the facilities or the current cost of capital projects. The City can apply an annual cost escalator based on such commonly accepted price indicators as the Engineering News Record Construction Cost Index for Los Angeles, or the Consumer Price Index (CPI).

It should be noted that the proposed connection fees are low in comparison to most of the other cities/agencies in the Inland Empire area. A table showing the fee comparison to other cities/agencies is included in Appendix C.

Appendix A

PROJECT CALCULATIONS

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

ASSUMPTIONS

ASSUMPTIONS

Beginning Year of Study		2008	
Rate Calculations FYE		2009	
Collection System Projects		15%	
Debt Service Coverage Requirement			
- Senior Debt		1.25	
Reserve Account		0.50	of Maximum Annual Debt Service
Minimum Operating Fund Reserve		15.0%	of Annual Operating Costs
Maximum Operating Fund Reserve		20.0%	of Annual Operating Costs
Utility Tax		6.5%	based on revenue (there is no utility tax on wholesale users)
Current FY2006/07 Riverside Customers		127,290	Number of accounts
Escalated FY2007/2008 Riverside Customers		129,862	Number of accounts
Community Service Districts			
Edgemont Customers		6,600	Population
Rubidoux Customers		26,000	Population
Jurupa Customers		72,000	Population
Total Customers in the Financial Study FY2007/08			
Existing Riverside Sewer Connection Fees per SFR		$2,684	
Commercial and Industrial Customers	(1)	$700	for the first 3000 square feet of building space
	(2)	$700	for each additional square feet
	(3)	$38.50	per foot of frontage for use of existing pipelines, if applicable

Annual Connection Fee Escalation

(●) Yes ( ) No — Annual Cost Inflation Added

	ECONOMIC ESCALATORS	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015
1	General Cost Inflation	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
2	Capital Cost Inflation	6.0%	6.0%	6.0%	6.0%	4.0%	4.0%	4.0%	4.0%
3	Customer Growth	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.5%
4	Fund Earnings	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
5	Labor Cost Inflation	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
6	One Time Exp/Rev	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%	-100.0%
7	Cust. Growth + Gen. Inflation	5.0%	5.0%	5.0%	5.0%	4.9%	4.9%	4.8%	4.5%
8	No Annual Increases	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	Insurance Inflation	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%

CONNECTION FEES		FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015
Riverside Connection Fees		$ 3,472	$ 3,681	$ 3,901	$ 4,135	$ 4,384	$ 4,559	$ 4,741	$ 4,931
Existing Accounts		127,290	129,851	132,412	135,049	137,685	140,322	142,959	145,596
Added Accounts		2,561	2,561	2,637	2,637	2,637	2,637	2,637	2,182
Total Accounts		129,851	132,412	135,049	137,685	140,322	142,959	145,596	147,778
Outside City Connection Fees		$ 1,796	$ 1,904	$ 2,018	$ 2,140	$ 2,268	$ 2,359	$ 2,453	$ 2,551
New EDUs based on FY06/07[1]									
- Riverside	124,545	800	800	800	800	800	800	800	800
- Jurupa CSD	15,909	636	636	818	818	818	818	818	818
- Rubidoux CSD	9,545	182	182	182	182	182	182	182	273
- Edgemont CSD	2,727	-	-	91	91	91	91	91	91
- Highgrove	-	1,455	1,455	1,273	1,273	1,273	1,273	1,273	636
	152,727	3,073	3,073	3,164	3,164	3,164	3,164	3,164	2,618

[1] Conservative basis (based on last year's new connections) vs. 1.5% growth

Percentage Growth								
- Riverside	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
- Jurupa CSD	4.0%	3.8%	4.8%	4.5%	4.3%	4.2%	4.0%	3.8%
- Rubidoux CSD	1.9%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	2.5%
- Edgemont CSD	0.0%	0.0%	3.3%	3.2%	3.1%	3.0%	2.9%	2.9%
- Highgrove		100.0%	43.8%	30.4%	23.3%	18.9%	15.9%	6.9%
Composite	2.0%	2.0%	2.0%	2.0%	1.9%	1.9%	1.8%	1.5%

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Revenues and O&M Expenditures

REVENUES

			Actuals	Actuals	Original Budget	Revised Budget	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
			FY 2005	FY 2006	FY 2007	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Operating Revenues			2006	2007	2008	2008	2009	2010	2011	2012	2013	2014
340351	Grading Plan Review Fees	General Cost Inflation	$ 9,270	$ 11,275		$ 11,613	$ 11,962	$ 12,320	$ 12,690	$ 13,071	$ 13,463	$ 13,867
348020	Sewer Unit of Benefit Fee	General Cost Inflation	134,070	80,698		83,119	85,613	88,181	90,826	93,551	96,358	99,248
348110	Commercial	[Riverside Growth]	3,707,655	3,934,637		3,959,911	3,985,184	5,900,627	6,828,484	8,039,360	9,262,354	9,826,267
348130	Residential Sewage	[Riverside Growth]	9,779,748	9,835,141		9,898,316	9,961,490	14,749,391	17,068,692	20,095,433	23,152,469	24,562,043
348253	Commercial Sewer Spec Billing	[Riverside Growth]	945,331	977,261		983,538	989,816	1,465,562	1,696,017	1,996,767	2,300,527	2,440,588
348253	Residential Pumping	[Riverside Growth]	4,046,863	4,091,840		4,118,123	4,144,407	6,136,379	7,101,307	8,360,561	9,632,419	10,218,862
348401	Commercial Pumping	[Riverside Growth]	860,578	904,634		910,445	916,256	1,356,646	1,569,974	1,848,373	2,129,559	2,259,211
348403	Recycled Water	General Cost Inflation	14,022	22,760		23,443	24,146	24,870	25,617	26,385	27,177	27,992
348410	Waste Disposal Fees	General Cost Inflation	240,789	478,274		492,622	507,401	522,623	538,302	554,451	571,084	588,217
348510	Industrial Waste Permits	General Cost Inflation	28,821	21,875		22,531	23,207	23,903	24,621	25,359	26,120	26,903
348550	Enforcemnt Notice of Violation	General Cost Inflation	4,224	1,000		1,030	1,061	1,093	1,126	1,159	1,194	1,230
348553	Enforcement Cease & Desist Ord	General Cost Inflation	-	-		-	-	-	-	-	-	-
348558	Enforcement - Inspection Fees	General Cost Inflation	-	-		-	-	-	-	-	-	-
349012	Misc Receipts-Other Charges	General Cost Inflation	1,083	-		-	-	-	-	-	-	-
371100	Interest From Investments	[CALCULATED]	213,211	150,500		402,500	185,592	341,355	447,734	852,883	1,263,329	1,490,139
371110	GASB31 Adjustment	General Cost Inflation	51,393	-		-	-	-	-	-	-	-
371200	Interest From Loans	General Cost Inflation	-	-		-	-	-	-	-	-	-
371300	All Other Interest Income	General Cost Inflation	608,945	-		-	-	-	-	-	-	-
374000	Refunds and Reimbursements	General Cost Inflation	32	1,272		1,310	1,349	1,390	1,432	1,475	1,519	1,564
374200	Miscellaneous Receipts	General Cost Inflation	2,128	2,262		2,330	2,400	2,472	2,546	2,622	2,701	2,782
374800	Bad Debt Recovery	General Cost Inflation	4,500	50		52	53	55	56	58	60	61
380020	Sale of Equipment	General Cost Inflation	-	-		-	-	-	-	-	-	-
380030		General Cost Inflation	-	4,031		4,152	4,276	4,405	4,537	4,673	4,813	4,958
380100	Damage Claim Recoveries	General Cost Inflation	-	-		-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
Total Operating Revenues			**$ 20,652,664**	**$ 20,517,510**	**$ -**	**$ 20,915,035**	**$ 20,844,212**	**$ 30,631,271**	**$ 35,413,960**	**$ 41,916,181**	**$ 48,485,144**	**$ 51,563,933**

			FY 2005	FY 2006	FY 2007	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
CSD Operating Revenues			2006	2007	2008	2008	2009	2010	2011	2012	2013	2014
348135	Highgrove Residential Sewage	[Highgrove Growth]	-	-		226,909	453,818	959,829	1,439,744	2,077,550	2,828,838	3,457,123
348160	Yucaipa Community Service	Customer Growth	50,026	64,041		65,329	66,618	99,967	117,207	139,758	163,030	175,063
348170	Rubidoux Community Service	[Rubidoux Growth]	565,705	1,238,070		1,261,652	1,285,235	1,925,676	2,254,428	2,684,366	3,127,053	3,353,402
348180	Jurupa Community Service	[Jurupa Growth]	1,110,008	2,167,512		2,254,212	2,340,913	3,608,219	4,338,063	5,296,209	6,316,833	6,926,632
348190	Edgemont Community Service	[Edgemont Growth]	153,713	317,776		317,776	317,776	483,132	573,524	691,993	816,342	886,035
0000	[Other]	Customer Growth				-	-	-	-	-	-	-
0000	[Other]	Customer Growth				-	-	-	-	-	-	-
0000	[Other]	Customer Growth				-	-	-	-	-	-	-
0000	[Other]	Customer Growth				-	-	-	-	-	-	-
Total CSD Operating Revenues			**$ 1,879,452**	**$ 3,787,399**	**$ -**	**$ 4,125,879**	**$ 4,464,360**	**$ 7,076,823**	**$ 8,722,967**	**$ 10,889,877**	**$ 13,252,096**	**$ 14,798,255**

			FY 2005	FY 2006	FY 2007	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Connection Fee Revenues			2006	2007	2008	2008	2009	2010	2011	2012	2013	2014
348010	Sewer Connection Fees	[CALCULATED]	$ 3,923,404	$ 1,982,770		$ 2,777,789	$ 2,944,457	$ 3,121,124	$ 3,308,392	$ 3,506,895	$ 3,647,171	$ 3,793,058
348015	HighgroveSewer Connection Fees	[CALCULATED]	$ -	$ 2,949,880		$ 2,949,880	$ 2,949,880	$ 2,949,880	$ 2,949,880	$ 2,886,412	$ 3,001,868	$ 3,121,943
348031	Rubidoux CSD Improvement Fees	One Time Exp/Rev	-	-		-	-	-	-	-	-	-
348032	Jurupa CSD Improvement Fees	Capital Cost Inflation	-	-		-	-	-	*1,750,519*	*1,855,550*	*1,929,772*	*2,006,963*

				FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
348033	Edgemont CSD Improvement Fees	One Time Exp/Rev		-	-		-	-	-	-	-	-	-
0002	[Other]	General Cost Inflation					-	-	-	-	-	-	-
0001	[Other]	General Cost Inflation					-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-	-
Total Connection Fee Revenues				$ 3,923,404	$ 4,932,650	$ -	$ 5,727,669	$ 5,894,337	$ 6,071,004	$ 8,008,791	$ 8,248,857	$ 8,578,812	$ 8,921,964

EXPENDITURES

Public Works / Public Works-Sewer Sys-Admin

				FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
411100	Salaries-Regular	Labor Cost Inflation		$ 702,390	$ 751,961	$ 1,339,837	$ 985,433	$ 1,014,996	$ 1,045,446	$ 1,076,809	$ 1,109,113	$ 1,142,387	$ 1,176,658
411110	Salaries-Temp & Part Time	Labor Cost Inflation		3,638	372	-	-	-	-	-	-	-	-
411130	Compensatory Time	Labor Cost Inflation		3,246	7,600	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation		47,695	57,350	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation		32,124	40,556	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation		15,443	18,703	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation		11,165	6,383	-	-	-	-	-	-	-	-
411250	Industrial Accident	Labor Cost Inflation		1,199	936	-	-	-	-	-	-	-	-
411260	Bereavement Leave	Labor Cost Inflation		6,508	5,591	-	-	-	-	-	-	-	-
411280	Jury Duty	Labor Cost Inflation		1,564	5,580	-	-	-	-	-	-	-	-
411292	Administrative Leave	Labor Cost Inflation		135	2,305	-	-	-	-	-	-	-	-
411310	Night Shift Premium	Labor Cost Inflation		25	19	-	-	-	-	-	-	-	-
411410	Vacation Payoffs	Labor Cost Inflation		2,365	3,636	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation		121	-	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation		4,037	(4,404)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation		127,638	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation		32,031	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation		3,100	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation		23,886	17,808	49,457	36,375	38,194	40,103	42,109	44,214	46,425	48,746
412220	Health Insurance	Insurance Inflation		84,876	106,332	165,402	121,651	127,734	134,120	140,826	147,868	155,261	163,024
412221	Retiree Health Insurance	Insurance Inflation		470	748	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation		4,612	6,074	9,056	6,661	6,994	7,343	7,710	8,096	8,501	8,926
412230	Life Insurance	Insurance Inflation		3,905	4,318	3,820	2,810	2,950	3,098	3,252	3,415	3,586	3,765
412240	Unemployment Insurance	Insurance Inflation		498	450	660	485	510	535	562	590	620	651
412250	Disability Insurance	Insurance Inflation		494	650	1,360	1,000	1,050	1,103	1,158	1,216	1,277	1,340
412310	PERS Retirement	General Cost Inflation		182,619	195,671	305,578	224,749	231,491	238,436	245,589	252,957	260,545	268,362
412320	Medicare OASDI	General Cost Inflation		11,919	10,732	19,262	14,167	14,592	15,030	15,481	15,945	16,423	16,916
412400	Deferred Compensation	Labor Cost Inflation		19,000	22,745	30,000	22,065	22,727	23,408	24,111	24,834	25,579	26,346
413120	Overtime At 1.5 Rate	Labor Cost Inflation		746	136	150	110	114	117	121	124	128	132
413210	Holiday O/T-Straight/Non-Sched	Labor Cost Inflation		257	354	-	-	-	-	-	-	-	-
419910	Salaries Adjustment Factor	Labor Cost Inflation		-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation		195,401	349,311	97,630	71,806	73,960	76,179	78,464	80,818	83,242	85,740
421043	Prof Svcs Regulatory Comp	General Cost Inflation		-	-	120,100	88,332	90,982	93,711	96,523	99,418	102,401	105,473
421100	Outside Legal Services	General Cost Inflation		2,000	16,179	10,000	7,355	7,576	7,803	8,037	8,278	8,526	8,782
422100	Telephone	General Cost Inflation		19,486	16,793	17,400	12,797	13,181	13,577	13,984	14,404	14,836	15,281
422120	Telephone - Cellular	General Cost Inflation		12,984	18,574	18,600	13,680	14,090	14,513	14,949	15,397	15,859	16,335
423400	Motor Pool Equipment Rental	General Cost Inflation		6,201	10,300	6,500	4,781	4,924	5,072	5,224	5,381	5,542	5,708
424130	Maint/Repair of Bldgs & Improv	General Cost Inflation		460	-	100	74	76	78	80	83	85	88
424220	All Other Equip Maint/Repair	General Cost Inflation		3,606	4,741	13,500	9,929	10,227	10,534	10,850	11,175	11,511	11,856
424230	Central Garage Charges	General Cost Inflation		2,158	-	2,500	1,839	1,894	1,951	2,009	2,069	2,132	2,196
425200	Periodicals & Dues	General Cost Inflation		67,692	68,424	77,871	57,273	58,991	60,761	62,584	64,461	66,395	68,387
425300	Photo & Recording Supplies	General Cost Inflation		-	-	300	221	227	234	241	248	256	263
425400	General Office Expense	General Cost Inflation		23,215	19,484	24,300	17,872	18,409	18,961	19,530	20,115	20,719	21,341
425500	Postage	Customer Growth		2,658	2,455	2,200	1,618	1,650	1,683	1,716	1,749	1,781	1,814
425600	Central Printing Charges	General Cost Inflation		992	2,072	2,000	1,471	1,515	1,561	1,607	1,656	1,705	1,756
425610	Outside Printing Expense	General Cost Inflation		1,096	1,091	1,500	1,103	1,136	1,170	1,206	1,242	1,279	1,317
425800	Computer Equip Purc Undr $5000	General Cost Inflation		2,028	2,842	2,500	1,839	1,894	1,951	2,009	2,069	2,132	2,196

				FY 2005	FY 2006	FY 2007	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
				2006	2007	2008	2008	2009	2010	2011	2012	2013	2014
426100	Janitorial Supplies	General Cost Inflation		-	18	500	368	379	390	402	414	426	439
426200	Clothing/Linen/Safety Supplies	General Cost Inflation		37	8	-	-	-	-	-	-	-	-
426710	Work Boot Reimbursement	General Cost Inflation		-	164	150	110	114	117	121	124	128	132
426800	Special Department Supplies	General Cost Inflation		2,777	5,675	3,000	2,206	2,273	2,341	2,411	2,483	2,558	2,635
427100	Travel & Meeting Expense	General Cost Inflation		6,996	14,638	17,265	12,698	13,079	13,472	13,876	14,292	14,721	15,162
427200	Training	General Cost Inflation		4,284	8,373	13,950	10,260	10,568	10,885	11,211	11,548	11,894	12,251
428400	Insurance / All Other	Insurance Inflation		27,915	25,199	67,317	49,511	51,986	54,586	57,315	60,181	63,190	66,349
428420	Insurance Charges - Direct	Insurance Inflation		61,626	98,686	90,657	66,677	70,011	73,511	77,187	81,046	85,099	89,354
443300	Uncollect Accounts-Bad Debts	General Cost Inflation		51,823	59,115	89,544	65,858	67,834	69,869	71,965	74,124	76,348	78,638
452005	Education Reimbursement Prog	General Cost Inflation			-	1,000	735	758	780	804	828	853	878
462100	Automotive Equipment	Capital Cost Inflation			48,324	-	-	-	-	-	-	-	-
881100	General Fund Allocation Chgs	General Cost Inflation		162,435	113,173	496,706	365,321	376,281	387,569	399,196	411,172	423,507	436,212
881200	Central Service Alloc Charges	General Cost Inflation		610,715	738,641	-	-	-	-	-	-	-	-
882101	Utilization Chgs from 101 Fund	General Cost Inflation		676,476	520,330	1,052,197	773,877	797,094	821,007	845,637	871,006	897,136	924,050
882102	Utilization Chgs from 102 Fund	General Cost Inflation		11,220	3,636	-	-	-	-	-	-	-	-
882510	Utilization Chgs from 510 Fund	General Cost Inflation		481,359	482,527	577,600	424,817	437,562	450,689	464,209	478,136	492,480	507,254
894101	Interfund Services to 101 Fund	General Cost Inflation		(10,398)	(1,445)	-	-	-	-	-	-	-	-
894230	Interfund Services to 230 Fund	General Cost Inflation		(601)	(842)	-	-	-	-	-	-	-	-
894260	Interfund Services to 260 Fund	General Cost Inflation		(13,192)	(24,457)	-	-	-	-	-	-	-	-
894410	Interfund Services to 410 Fund	General Cost Inflation		(5,429)	(4,701)	-	-	-	-	-	-	-	-
894431	Interfund Services to 431 Fund	General Cost Inflation		(336)	(2,056)	-	-	-	-	-	-	-	-
894432	Interfund Services to 432 Fund	General Cost Inflation		(336)	(978)	-	-	-	-	-	-	-	-
894540	Interfund Services to 540 Fund	General Cost Inflation		(4,395)	(284,294)	-	-	-	-	-	-	-	-
894551	Interfund Services to 551 Fund	General Cost Inflation		(249,332)	(318,771)	-	-	-	-	-	-	-	-
0000	City Retirement Plan	General Cost Inflation			10	10	8	8	8	8	8	9	9
0000	Office Furniture & Equipment	General Cost Inflation			778,049	801,391	589,413	607,095	625,308	644,067	663,389	683,291	703,790
0000	[Other]	General Cost Inflation					-	-	-	-	-	-	-
0000	Additional Admin In Lieu	General Cost Inflation					-	-	749,382	1,107,065	1,582,076	2,064,923	2,275,975
				$ 3,481,327	$ 4,033,897	$ 5,532,870	$ 4,069,355	$ 4,197,122	$ 5,078,390	$ 5,572,214	$ 6,187,763	$ 6,815,693	$ 7,176,527

Public Works / PW-Sewer-Collection Syst Maint

				FY 2005	FY 2006	FY 2007	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
				2006	2007	2008	2008	2009	2010	2011	2012	2013	2014
411100	Salaries-Regular	Labor Cost Inflation		$ 505,971	$ 544,998	$ 870,124	$ 867,038	$ 893,049	$ 919,840	$ 947,436	$ 975,859	$ 1,005,134	$ 1,035,288
411110	Salaries-Temp & Part Time	Labor Cost Inflation		2,121	-	-	-	-	-	-	-	-	-
411130	Compensatory Time	Labor Cost Inflation		12,315	11,221	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation		41,223	33,812	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation		25,353	31,187	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation		15,050	12,680	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation		6,068	1,895	-	-	-	-	-	-	-	-
411250	Industrial Accident	Labor Cost Inflation		6,861	17,027	-	-	-	-	-	-	-	-
411260	Bereavement Leave	Labor Cost Inflation		2,202	1,070	-	-	-	-	-	-	-	-
411292	Administrative Leave	Labor Cost Inflation		3,690	4,520	-	-	-	-	-	-	-	-
411310	Night Shift Premium	Labor Cost Inflation		108	-	-	-	-	-	-	-	-	-
411320	Temporary Foreman Pay	Labor Cost Inflation		347	805	200	199	205	211	218	224	231	238
411410	Vacation Payoffs	Labor Cost Inflation		8,429	1,298	-	-	-	-	-	-	-	-
411420	Sick Leave Payoff	Labor Cost Inflation		975	-	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation		4,019	269	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation		3,315	(3,315)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation		4,580	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation		(7,338)	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation		2,030	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation		18,099	13,509	32,387	32,272	33,886	35,580	37,359	39,227	41,188	43,248
412220	Health Insurance	Insurance Inflation		82,417	95,313	136,192	135,709	142,494	149,619	157,100	164,955	173,203	181,863
412221	Retiree Health Insurance	Insurance Inflation		1,195	1,538	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation		3,973	5,331	8,628	8,597	9,027	9,479	9,953	10,450	10,973	11,521
412230	Life Insurance	Insurance Inflation		1,017	1,073	2,282	2,274	2,388	2,507	2,632	2,764	2,902	3,047
412240	Unemployment Insurance	Insurance Inflation		378	345	427	425	447	469	493	517	543	570

412250	Disability Insurance	Insurance Inflation	1,365	1,558	1,768	1,762	1,850	1,942	2,039	2,141	2,248	2,361
412310	PIERS Retirement	General Cost Inflation	138,083	146,477	200,125	199,415	205,398	211,560	217,906	224,444	231,177	238,112
412320	Medicare OASDI	General Cost Inflation	7,267	8,332	12,613	12,568	12,945	13,334	13,734	14,146	14,570	15,007
412330	City Retirement Plan	General Cost Inflation	79	-	-	-	-	-	-	-	-	-
412400	Deferred Compensation	Labor Cost Inflation	3,400	3,055	9,000	8,968	9,237	9,514	9,800	10,094	10,396	10,708
413110	Overtime At Straight Rate	Labor Cost Inflation	29,251	29,647	40,000	39,858	41,054	42,285	43,554	44,861	46,206	47,593
413120	Overtime At 1.5 Rate	Labor Cost Inflation	91,986	65,658	30,000	29,894	30,790	31,714	32,666	33,646	34,655	35,695
413130	Overtime At Double Time Rate	Labor Cost Inflation	19,981	16,794	8,000	7,972	8,211	8,457	8,711	8,972	9,241	9,519
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation	18,294	10,651	12,100	12,057	12,419	12,791	13,175	13,570	13,977	14,397
422100	Telephone	General Cost Inflation	2,590	2,710	3,000	2,989	3,079	3,171	3,267	3,365	3,465	3,569
422120	Telephone - Cellular	General Cost Inflation	7,544	10,443	12,000	11,957	12,316	12,686	13,066	13,458	13,862	14,278
422200	Electric	Cust. Growth + Gen. Inflation	186,634	179,180	255,000	254,096	266,730	280,043	293,912	308,358	323,403	339,070
422300	Gas	General Cost Inflation	123	140	500	498	513	529	544	561	578	595
422500	Water	General Cost Inflation	7,634	9,193	10,000	9,965	10,263	10,571	10,889	11,215	11,552	11,898
422600	Other Utilities	General Cost Inflation	5,614	5,112	6,000	5,979	6,158	6,343	6,533	6,729	6,931	7,139
422700	Refuse/Disposal Fees	Customer Growth	-	1,378	5,500	5,480	5,589	5,700	5,811	5,922	6,034	6,145
423100	Equipment Rental	General Cost Inflation	1,901	2,630	8,000	7,972	8,211	8,457	8,711	8,972	9,241	9,519
423400	Motor Pool Equipment Rental	General Cost Inflation	95,872	53,475	100,000	99,645	102,635	105,714	108,885	112,152	115,516	118,982
424120	Constr & Maint Materials	General Cost Inflation	1,295	5,582	8,800	8,769	9,032	9,303	9,582	9,869	10,165	10,470
424130	Maint/Repair of Bldgs & Improv	General Cost Inflation	1,078	1,765	2,000	1,993	2,053	2,114	2,178	2,243	2,310	2,380
424220	All Other Equip Maint/Repair	General Cost Inflation	21,665	23,643	17,000	16,940	17,448	17,971	18,510	19,066	19,638	20,227
424230	Central Garage Charges	General Cost Inflation	44,062	94,611	55,000	54,805	56,449	58,143	59,887	61,683	63,534	65,440
424240	Central Communications Chg	General Cost Inflation	130	132	400	399	411	423	436	449	462	476
425200	Periodicals & Dues	General Cost Inflation	1,168	1,238	1,200	1,196	1,232	1,269	1,307	1,346	1,386	1,428
425300	Photo & Recording Supplies	General Cost Inflation	129	300	800	797	821	846	871	897	924	952
425400	General Office Expense	General Cost Inflation	4,933	2,821	5,000	4,982	5,132	5,286	5,444	5,608	5,776	5,949
425600	Central Printing Charges	General Cost Inflation	-	82	100	100	103	106	109	112	116	119
425700	Software Purchase/Licensing	General Cost Inflation	3,567	2,409	3,000	2,989	3,079	3,171	3,267	3,365	3,465	3,569
425800	Computer Equip Purc Undr $5000	General Cost Inflation	4,387	3,496	2,500	2,491	2,566	2,643	2,722	2,804	2,888	2,975
426100	Janitorial Supplies	General Cost Inflation	291	442	500	498	513	529	544	561	578	595
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	11,101	15,102	14,130	14,080	14,502	14,937	15,385	15,847	16,322	16,812
426300	Motor Fuels & Lubricants	General Cost Inflation	24,355	19,299	30,000	29,894	30,790	31,714	32,666	33,646	34,655	35,695
426600	Chemical Supplies	Cust. Growth + Gen. Inflation	18,978	17,573	47,500	47,332	49,685	52,165	54,748	57,439	60,242	63,160
426700	Maintenance Tools/Supplies	General Cost Inflation	11,876	19,623	15,100	15,046	15,498	15,963	16,442	16,935	17,443	17,966
426710	Work Boot Reimbursement	General Cost Inflation	-	-	2,100	2,093	2,155	2,220	2,287	2,355	2,426	2,499
426800	Special Department Supplies	General Cost Inflation	9,362	9,201	10,500	10,463	10,777	11,100	11,433	11,776	12,129	12,493
427100	Travel & Meeting Expense	General Cost Inflation	2,666	2,224	2,000	1,993	2,053	2,114	2,178	2,243	2,310	2,380
427200	Training	General Cost Inflation	1,889	1,858	10,000	9,965	10,263	10,571	10,889	11,215	11,552	11,898
428400	Insurance /AllOther	Insurance Inflation	21,153	19,114	44,082	43,926	46,122	48,428	50,849	53,392	56,061	58,865
448000	Employee Meal Allowance	General Cost Inflation	58	68	204	203	209	216	222	229	236	243
450095	Street Replacement Charge	Capital Cost Inflation	1,196,478	1,074,019	1,304,084	1,299,459	1,377,426	1,460,072	1,547,676	1,640,537	1,706,158	1,774,404
462100	Automotive Equipment	Capital Cost Inflation	21,970	-	854,000	850,971	902,029	956,151	1,013,520	1,074,331	1,117,305	1,161,997
462200	Machinery & Equip	Capital Cost Inflation	-	134,946	-	-	-	-	-	-	-	-
881100	General Fund Allocation Chgs	General Cost Inflation	16,401	14,119	139,710	139,214	143,391	147,693	152,123	156,687	161,388	166,229
881200	Central Service Alloc Charges	General Cost Inflation	62,876	96,751	-	-	-	-	-	-	-	-
884101	Interfund Charges from 101 Fnd	General Cost Inflation	-	-	26,000	25,908	26,685	27,486	28,310	29,159	30,034	30,935
894101	Interfund Services to 101 Fund	General Cost Inflation	-	(206)	(7,500)	(7,473)	(7,698)	(7,929)	(8,166)	(8,411)	(8,664)	(8,924)
0000	Jury Duty	General Cost Inflation	829	854	851	877	903	930	958	987	1,016	
0000	Interfund Services to 540 Fund	General Cost Inflation	(767)	(790)	(787)	(811)	(835)	(860)	(886)	(912)	(940)	
0000	[Other]	General Cost Inflation			-	-	-	-	-	-	-	
0000	[Other]	General Cost Inflation			-	-	-	-	-	-	-	
Total Public Works / PW-Sewer-Collection Syst Maint			**2,843,884**	**3,143,216**	**4,352,120**	**4,336,684**	**$ 4,541,685**	**$ 4,757,288**	**$ 4,983,880**	**$ 5,222,055**	**$ 5,418,142**	**$ 5,621,669**

Public Works / PW-Sewer Systems-Treatment			**FY 2005 2006**	**FY 2006 2007**	**FY 2007 2008**	**FY 2007 2008**	**FY 2008 2009**	**FY 2009 2010**	**FY 2010 2011**	**FY 2011 2012**	**FY 2012 2013**	**FY 2013 2014**
411100	Salaries - Regular	Labor Cost Inflation	$ 1,427,745	$ 1,596,630	$ 1,988,112	$ 1,875,177	$ 1,931,432	$ 1,989,375	$ 2,049,056	$ 2,110,528	$ 2,173,844	$ 2,239,059

411130	Compensatory Time	Labor Cost Inflation	38,830	43,206	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation	103,541	117,084	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation	22,438	31,246	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation	37,551	62,757	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation	14,248	9,151	-	-	-	-	-	-	-	-
411260	Bereavement Leave	Labor Cost Inflation	5,481	3,655	-	-	-	-	-	-	-	-
411280	Jury Duty	Labor Cost Inflation	1,880	2,318	-	-	-	-	-	-	-	-
411310	Night Shift Premium	Labor Cost Inflation	25,645	28,012	20,000	18,864	19,430	20,013	20,613	21,231	21,868	22,524
411320	Temporary Foreman Pay	Labor Cost Inflation	14	-	500	472	486	500	515	531	547	563
411410	Vacation Payoffs	Labor Cost Inflation	21,310	-	-	-	-	-	-	-	-	-
411420	Sick Leave Payoff	Labor Cost Inflation	7,786	-	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation	6,881	-	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation	8,433	(8,433)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation	38,594	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation	12,574	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation	5,262	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation	45,491	33,598	74,006	69,802	73,292	76,957	80,805	84,845	89,087	93,541
412220	Health Insurance	Insurance Inflation	179,678	187,296	244,154	230,285	241,799	253,889	266,583	279,913	293,908	308,604
412221	Retiree Health Insurance	Insurance Inflation	2,150	2,744	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation	9,248	9,819	14,152	13,348	14,015	14,716	15,452	16,225	17,036	17,888
412230	Life Insurance	Insurance Inflation	4,869	5,549	5,434	5,125	5,382	5,651	5,933	6,230	6,541	6,868
412240	Unemployment Insurance	Insurance Inflation	948	852	986	930	976	1,025	1,077	1,130	1,187	1,246
412250	Disability Insurance	Insurance Inflation	2,290	2,311	2,312	2,181	2,290	2,404	2,524	2,651	2,783	2,922
412310	PERS Retirement	General Cost Inflation	360,703	379,233	457,261	431,286	444,225	457,551	471,278	485,416	499,979	514,978
412320	Medicare OASDI	General Cost Inflation	16,340	17,719	28,826	27,189	28,004	28,844	29,710	30,601	31,519	32,465
412400	Deferred Compensation	Labor Cost Inflation	24,800	34,145	33,000	31,125	32,059	33,021	34,012	35,032	36,083	37,165
413110	Overtime At Straight Rate	Labor Cost Inflation	-	-	4,000	3,773	3,886	4,003	4,123	4,246	4,374	4,505
413120	Overtime At 1.5 Rate	Labor Cost Inflation	78,331	77,957	100,000	94,319	97,149	100,064	103,065	106,157	109,342	112,622
413130	Overtime At Double Time Rate	Labor Cost Inflation	26,452	37,106	25,000	23,580	24,287	25,016	25,766	26,539	27,336	28,156
413210	Holiday OIT-Straight/Non-Sched	Labor Cost Inflation	14,452	16,178	25,000	23,580	24,287	25,016	25,766	26,539	27,336	28,156
413230	Holiday O1T-StrtlSubj To Retir	Labor Cost Inflation	15,113	14,061	15,000	14,148	14,572	15,010	15,460	15,924	16,401	16,893
413240	OIT 1.5 Rate Sub To Retirement	Labor Cost Inflation	245	-	-	-	-	-	-	-	-	-
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation	443,912	108,858	42,700	40,274	41,483	42,727	44,009	45,329	46,689	48,090
421043	Prof Svcs Regulatory Comp	General Cost Inflation	-	-	216,263	203,978	210,097	216,400	222,892	229,579	236,467	243,561
422100	Telephone	General Cost Inflation	6,587	6,165	6,000	5,659	5,829	6,004	6,184	6,369	6,561	6,757
422120	Telephone - Cellular	General Cost Inflation	7,974	5,073	7,000	6,602	6,800	7,004	7,215	7,431	7,654	7,884
422200	Electric	Cust. Growth + Gen. Inflation	1,807,019	1,666,652	1,800,000	1,697,750	1,782,166	1,871,120	1,963,785	2,060,306	2,160,829	2,265,509
422300	Gas	General Cost Inflation	33,641	-	5,100	4,810	4,955	5,103	5,256	5,414	5,576	5,744
422500	Water	Cust. Growth + Gen. Inflation	50,880	74,325	85,000	80,172	84,158	88,358	92,734	97,292	102,039	106,982
422600	Other Utilities	General Cost Inflation	52,767	49,408	61,200	57,724	59,455	61,239	63,076	64,968	66,917	68,925
422700	Refuse/Disposal Fees	Cust. Growth + Gen. Inflation	1,980,352	1,961,680	2,825,000	2,664,525	2,797,011	2,936,618	3,082,052	3,233,536	3,391,302	3,555,590
423100	Equipment Rental	General Cost Inflation	1,064	-	4,000	3,773	3,886	4,003	4,123	4,246	4,374	4,505
423400	Motor Pool Equipment Rental	General Cost Inflation	49,495	41,326	50,000	47,160	48,575	50,032	51,533	53,079	54,671	56,311
424130	Maint/Repair of Bldgs & Improv	General Cost Inflation	1,354	-	-	-	-	-	-	-	-	-
424220	All Other Equip Maint/Repair	General Cost Inflation	9,010	15,356	17,150	16,176	16,661	17,161	17,676	18,206	18,752	19,315
424230	Central Garage Charges	General Cost Inflation	5,799	6,296	15,000	14,148	14,572	15,010	15,460	15,924	16,401	16,893
424240	Central Communications Chg	General Cost Inflation	-	-	4,000	3,773	3,886	4,003	4,123	4,246	4,374	4,505
425200	Periodicals & Dues	General Cost Inflation	4,851	5,078	7,550	7,121	7,335	7,555	7,781	8,015	8,255	8,503
425300	Photo & Recording Supplies	General Cost Inflation	-	-	250	236	243	250	258	265	273	282
425400	General Office Expense	General Cost Inflation	8,619	8,576	10,100	9,526	9,812	10,106	10,410	10,722	11,044	11,375
425500	Postage	Cust. Growth + Gen. Inflation	-	-	-	-	-	-	-	-	-	-
425600	Central Printing Charges	General Cost Inflation	-	114	500	472	486	500	515	531	547	563
425700	Software Purchase/Licensing	General Cost Inflation	1,943	1,458	10,000	9,432	9,715	10,006	10,307	10,616	10,934	11,262
425800	Computer Equip Purc Undr $5000	General Cost Inflation	2,185	1,219	5,000	4,716	4,857	5,003	5,153	5,308	5,467	5,631
426100	Janitorial Supplies	General Cost Inflation	155	193	600	566	583	600	618	637	656	676
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	14,053	11,995	26,738	25,219	25,976	26,755	27,558	28,384	29,236	30,113
426300	Motor Fuels & Lubricants	General Cost Inflation	8,946	15,657	14,000	13,205	13,601	14,009	14,429	14,862	15,308	15,767

426600	Chemical Supplies	Cust. Growth + Gen. Inflation	983,509	1,624,992	2,764,500	2,607,462	2,737,110	2,873,728	3,016,047	3,164,287	3,318,674	3,479,444
426700	Maintenance Tools/Supplies	General Cost Inflation	969	1,689	1,000	943	971	1,001	1,031	1,062	1,093	1,126
426710	Work Boot Reimbursement	General Cost Inflation	-	-	3,900	3,678	3,789	3,902	4,020	4,140	4,264	4,392
426800	Special Department Supplies	General Cost Inflation	44,265	22,539	21,200	19,996	20,596	21,213	21,850	22,505	23,181	23,876
427100	Travel &MeetingExpense	General Cost Inflation	1,521	2,357	3,200	3,018	3,109	3,202	3,298	3,397	3,499	3,604
427200	Training	General Cost Inflation	4,986	10,462	17,500	16,506	17,001	17,511	18,036	18,578	19,135	19,709
428400	Insurance / All Other	Insurance Inflation	53,154	47,526	100,731	95,009	99,759	104,747	109,985	115,484	121,258	127,321
448000	Employee Meal Allowance	General Cost Inflation	404	247	1,020	962	991	1,021	1,051	1,083	1,115	1,149
452005	Education Reimbursement Prog	General Cost Inflation	-	208	1,000	943	971	1,001	1,031	1,062	1,093	1,126
462308	Off Furn & Eq/Computer Acqustn	General Cost Inflation	1,849	-	-	-	-	-	-	-	-	-
440301	City Funds	General Cost Inflation	2,662	-	-	-	-	-	-	-	-	-
881100	General Fund Allocation Chgs	General Cost Inflation	53,298	33,595	451,109	425,484	438,248	451,396	464,937	478,886	493,252	508,050
881200	Central Service Alloc Charges	General Cost Inflation	217,346	320,398	-	-	-	-	-	-	-	-
882510	Utilization Chgs from 510 Fund	General Cost Inflation	-	2,145	3,533	3,332	3,432	3,535	3,641	3,751	3,863	3,979
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation				-	-	-	-	-	-	-
Total Public Works / PW-Sewer Systems-Treatment			**$ 8,413,892**	**$ 8,749,779**	**$ 11,619,587**	**$ 10,959,532**	**$ 11,435,692**	**$ 11,934,878**	**$ 12,453,812**	**$ 12,993,237**	**$ 13,553,925**	**$ 14,136,673**

Public Works / PW-Sewer-Environmental Complia			**FY 2005 2006**	**FY 2006 2007**	**FY 2006 2007**	**FY 2007 2008**	**FY 2008 2009**	**FY 2009 2010**	**FY 2010 2011**	**FY 2011 2012**	**FY 2012 2013**	**FY 2013 2014**
411100	Salaries - Regular	Labor Cost Inflation	$ 388,281	$ 416,862	$ 584,941	$ 448,023	$ 461,464	$ 475,307	$ 489,567	$ 504,254	$ 519,381	$ 534,963
411130	Compensatory Time	Labor Cost Inflation	9,253	3,648	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation	20,357	17,306	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation	17,135	19,733	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation	9,602	8,132	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation	5,640	3,167	-	-	-	-	-	-	-	-
411280	Jury Duty	Labor Cost Inflation	630	671	-	-	-	-	-	-	-	-
411292	Administrative Leave	Labor Cost Inflation	891	237	-	-	-	-	-	-	-	-
411410	Vacation Payoffs	Labor Cost Inflation	14,279	5,078	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation	2,977	1,672	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation	2,223	(2,223)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation	3,575	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation	(707)	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation	3,458	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation	13,344	10,040	21,774	16,677	17,511	18,387	19,306	20,271	21,285	22,349
412220	Health Insurance	Insurance Inflation	46,017	52,481	76,427	58,538	61,464	64,538	67,765	71,153	74,710	78,446
412221	Retiree Health Insurance	Insurance Inflation	402	622	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation	2,726	2,969	4,556	3,490	3,664	3,847	4,040	4,242	4,454	4,676
412230	Life Insurance	Insurance Inflation	1,360	1,334	1,580	1,210	1,271	1,334	1,401	1,471	1,545	1,622
412240	Unemployment Insurance	Insurance Inflation	278	255	291	223	234	246	258	271	284	299
412250	Disability Insurance	Insurance Inflation	617	668	952	729	766	804	844	886	931	977
412310	PERS Retirement	General Cost Inflation	101,620	105,450	134,535	103,044	106,135	109,320	112,599	115,977	119,456	123,040
412320	Medicare OASDI	General Cost Inflation	6,025	6,039	8,480	6,495	6,690	6,891	7,097	7,310	7,530	7,755
412400	Deferred Compensation	Labor Cost Inflation	7,400	6,109	9,000	6,893	7,100	7,313	7,533	7,759	7,991	8,231
413110	Overtime At Straight Rate	Labor Cost Inflation	47	-	-	-	-	-	-	-	-	-
413120	Overtime At 1.5 Rate	Labor Cost Inflation	11,768	1,017	4,000	3,064	3,156	3,250	3,348	3,448	3,552	3,658
413130	Overtime At Double Time Rate	Labor Cost Inflation	12	-	200	153	158	163	167	172	178	183
413210	Holiday O/T-StraightlNon-Sched	Labor Cost Inflation	-	-	150	115	118	122	126	129	133	137
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation	3,568	6,074	13,000	9,957	10,256	10,563	10,880	11,207	11,543	11,889
422100	Telephone	General Cost Inflation	5,230	5,360	5,100	3,906	4,023	4,144	4,268	4,397	4,528	4,664
422120	Telephone - Cellular	General Cost Inflation	6,274	5,572	7,500	5,744	5,917	6,094	6,277	6,465	6,659	6,859
423100	Equipment Rental	General Cost Inflation	-	-	500	383	394	406	418	431	444	457
423400	Motor Pool Equipment Rental	General Cost Inflation	28,386	29,290	30,000	22,978	23,667	24,377	25,109	25,862	26,638	27,437
424220	All Other Equip Maint/Repair	General Cost Inflation	3,251	3,013	6,800	5,208	5,365	5,525	5,691	5,862	6,038	6,219

424230	Central Garage Charges	General Cost Inflation	-	343	15,000	11,489	11,834	12,189	12,554	12,931	13,319	13,718
425200	Periodicals & Dues	General Cost Inflation	3,947	2,024	4,115	3,152	3,246	3,344	3,444	3,547	3,654	3,763
425300	Photo & Recording Supplies	General Cost Inflation	86	-	250	191	197	203	209	216	222	229
425400	General Office Expense	General Cost Inflation	8,381	5,978	8,600	6,587	6,785	6,988	7,198	7,414	7,636	7,865
425500	Postage	Customer Growth	159	344	500	383	391	398	406	414	422	429
425600	Central Printing Charges	General Cost Inflation	1,416	1,879	4,000	3,064	3,156	3,250	3,348	3,448	3,552	3,658
425700	Software Purchase/Licensing	General Cost Inflation	-	226	500	383	394	406	418	431	444	457
425800	Computer Equip Purc Undr $5000	General Cost Inflation	8,286	5,556	5,000	3,830	3,945	4,063	4,185	4,310	4,440	4,573
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	5,759	8,717	10,000	7,659	7,889	8,126	8,370	8,621	8,879	9,146
426300	Motor Fuels & Lubricants	General Cost Inflation	320	68	500	383	394	406	418	431	444	457
426700	Maintenance Tools/Supplies	General Cost Inflation	6,493	12,867	5,000	3,830	3,945	4,063	4,185	4,310	4,440	4,573
426710	Work Boot Reimbursement	General Cost Inflation	-	-	1,200	919	947	975	1,004	1,034	1,066	1,097
426800	Special Department Supplies	General Cost Inflation	742	1,960	6,000	4,596	4,733	4,875	5,022	5,172	5,328	5,487
427100	Travel & Meeting Expense	General Cost Inflation	1,282	26	1,000	766	789	813	837	862	888	915
427200	Training	General Cost Inflation	2,420	5,600	9,500	7,276	7,495	7,719	7,951	8,190	8,435	8,688
428400	Insurance I All Other	Insurance Inflation	15,593	14,206	29,638	22,701	23,836	25,027	26,279	27,593	28,972	30,421
448000	Employee Meal Allowance	General Cost Inflation	-	-	50	38	39	41	42	43	44	46
462100	Automotive Equipment	General Cost Inflation	-	24,585	-	-	-	-	-	-	-	-
881100	General Fund Allocation Chgs	General Cost Inflation	23,084	16,822	62,642	47,979	49,419	50,901	52,428	54,001	55,621	57,290
881200	Central Service Alloc Charges	General Cost Inflation	40,953	32,852	-	-	-	-	-	-	-	-
0000	Bereavement Leave	General Cost Inflation		3,388	3,489	2,672	2,753	2,835	2,920	3,008	3,098	3,191
0000	Maint/Repair of Bldgs & Improv	General Cost Inflation		-	-	-	-	-	-	-	-	-
0000	Janitorial Supplies	General Cost Inflation		-	-	-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
Total Public Works / PW-Sewer-Environmental Complia			**$ 834,840**	**$ 848,019**	**$ 1,076,770**	**$ 824,729**	**$ 851,538**	**$ 879,255**	**$ 907,912**	**$ 937,543**	**$ 968,183**	**$ 999,867**

Public Works / PW-Sewer Systems-Plant Maint			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
411100	Salaries-Regular	Labor Cost Inflation	$ 1,224,471	$ 1,316,299	$ 1,855,193	$ 1,495,886	$ 1,540,762	$ 1,586,985	$ 1,634,594	$ 1,683,632	$ 1,734,141	$ 1,786,166
411110	Salaries-Temp & Part Time	Labor Cost Inflation	1,630	2,330	-	-	-	-	-	-	-	-
411130	Compensatory Time	Labor Cost Inflation	27,967	23,056	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation	84,985	83,608	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation	58,995	69,409	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation	38,655	41,449	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation	7,147	7,300	-	-	-	-	-	-	-	-
411250	Industrial Accident	Labor Cost Inflation	29	-	-	-	-	-	-	-	-	-
411260	Bereavement Leave	Labor Cost Inflation	4,368	5,715	-	-	-	-	-	-	-	-
411280	Jury Duty	Labor Cost Inflation	5,889	14,278	-	-	-	-	-	-	-	-
411292	Administrative Leave	Labor Cost Inflation	3,735	9,421	-	-	-	-	-	-	-	-
411410	Vacation Payoffs	Labor Cost Inflation	4,754	9,735	-	-	-	-	-	-	-	-
411420	Sick Leave Payoff	Labor Cost Inflation	1,143	-	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation	3,049	1,513	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation	7,338	(7,338)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation	25,068	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation	990	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation	949	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation	46,164	35,058	69,078	55,699	58,484	61,408	64,479	67,703	71,088	74,642
412220	Health Insurance	Insurance Inflation	172,522	198,581	302,363	243,802	255,992	268,792	282,232	296,343	311,160	326,718
412221	Retiree Health Insurance	Insurance Inflation	2,594	2,647	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation	10,083	11,218	16,614	13,396	14,066	14,769	15,508	16,283	17,097	17,952
412230	Life Insurance	Insurance Inflation	3,045	3,712	4,861	3,920	4,116	4,321	4,537	4,764	5,002	5,253
412240	Unemployment Insurance	Insurance Inflation	968	893	906	731	767	805	846	888	932	979
412250	Disability Insurance	Insurance Inflation	3,002	2,921	3,944	3,180	3,339	3,506	3,681	3,865	4,059	4,262
412310	PERS Retirement	General Cost Inflation	341,269	361,085	426,686	344,047	354,368	364,999	375,949	387,228	398,845	410,810
412320	Medicare OASDI	General Cost Inflation	19,004	19,981	26,885	21,678	22,328	22,998	23,688	24,399	25,131	25,885
412330	City Retirement Plan	General Cost Inflation	134	129	-	-	-	-	-	-	-	-
412400	Deferred Compensation	Labor Cost Inflation	13,600	22,727	18,000	14,514	14,949	15,398	15,860	16,335	16,825	17,330

413110	Overtime At Straight Rate	Labor Cost Inflation	2,628	1,333	10,000	8,063	8,305	8,554	8,811	9,075	9,347	9,628
413120	Overtime At 1.5 Rate	Labor Cost Inflation	59,285	34,707	35,000	28,221	29,068	29,940	30,838	31,763	32,716	33,698
413130	Overtime At Double Time Rate	Labor Cost Inflation	4,789	3,256	5,000	4,032	4,153	4,277	4,405	4,538	4,674	4,814
413210	Holiday 0/T-Straight/Non-Sched	Labor Cost Inflation	-	-	1,000	806	831	855	881	908	935	963
413230	Holiday OIT-Strt/Subj To Retir	Labor Cost Inflation	700	829	-	-	-	-	-	-	-	-
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation	101,960	28,134	101,500	81,842	84,297	86,826	89,431	92,114	94,877	97,723
422100	Telephone	General Cost Inflation	6,018	6,205	6,000	4,838	4,983	5,133	5,287	5,445	5,608	5,777
422120	Telephone - Cellular	General Cost Inflation	5,191	6,958	8,500	6,854	7,059	7,271	7,489	7,714	7,945	8,184
422700	Refuse/Disposal Fees	Customer Growth	4,860	6,769	12,000	9,676	9,867	10,063	10,260	10,456	10,653	10,849
423100	Equipment Rental	General Cost Inflation	2,990	376	14,300	11,530	11,876	12,233	12,600	12,978	13,367	13,768
423400	Motor Pool Equipment Rental	General Cost Inflation	63,346	61,481	68,000	54,830	56,475	58,169	59,914	61,712	63,563	65,470
424120	Constr & Maint Materials	General Cost Inflation	810	-	5,000	4,032	4,153	4,277	4,405	4,538	4,674	4,814
424130	Maint/Repair of Bldgs & Improv	General Cost Inflation	(484,960)	(353,776)	86,600	69,828	71,922	74,080	76,303	78,592	80,949	83,378
424200	Maintenance & Repair - General	General Cost Inflation	6,456	8,914	-	-	-	-	-	-	-	-
424210	Auto Equip Repair/Parts/Sere	General Cost Inflation	18	-	-	-	-	-	-	-	-	-
424220	All Other Equip Maint/Repair	General Cost Inflation	210,441	292,862	397,160	320,239	329,847	339,742	349,934	360,432	371,245	382,383
424230	Central Garage Charges	General Cost Inflation	26,173	25,979	30,000	24,190	24,915	25,663	26,433	27,226	28,042	28,884
424240	Central Communications Chg	General Cost Inflation	5,571	5,404	9,600	7,741	7,973	8,212	8,458	8,712	8,974	9,243
425200	Periodicals & Dues	General Cost Inflation	1,938	2,165	2,000	1,613	1,661	1,711	1,762	1,815	1,869	1,926
425400	General Office Expense	General Cost Inflation	12,916	5,203	8,700	7,015	7,225	7,442	7,665	7,895	8,132	8,376
425700	Software Purchase/Licensing	General Cost Inflation	1,587	589	1,500	1,209	1,246	1,283	1,322	1,361	1,402	1,444
425800	Computer Equip Purc Undr $5000	General Cost Inflation	4,444	11,118	12,000	9,676	9,966	10,265	10,573	10,890	11,217	11,554
426100	Janitorial Supplies	General Cost Inflation	12,248	6,743	6,000	4,838	4,983	5,133	5,287	5,445	5,608	5,777
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	38,144	24,832	31,787	25,631	26,400	27,192	28,007	28,847	29,713	30,604
426300	Motor Fuels & Lubricants	General Cost Inflation	11,133	6,771	11,000	8,870	9,136	9,410	9,692	9,983	10,282	10,591
426400	Horticultural Supplies	General Cost Inflation	5,224	3,891	15,500	12,498	12,873	13,259	13,657	14,067	14,489	14,923
426600	Chemical Supplies	Cust. Growth + Gen. Inflation	-	352	5,100	4,112	4,317	4,532	4,757	4,990	5,234	5,487
426700	Maintenance Tools/Supplies	General Cost Inflation	17,931	8,606	10,100	8,144	8,388	8,640	8,899	9,166	9,441	9,724
426710	Work Boot Reimbursement	General Cost Inflation	-	-	4,500	3,628	3,737	3,849	3,965	4,084	4,206	4,333
426800	Special Department Supplies	General Cost Inflation	12,019	12,232	11,650	9,394	9,675	9,966	10,265	10,573	10,890	11,217
427200	Training	General Cost Inflation	5,942	29,060	22,100	17,820	18,354	18,905	19,472	20,056	20,658	21,278
428400	Insurance / All Other	Insurance Inflation	53,949	49,604	93,992	75,788	79,577	83,556	87,734	92,121	96,727	101,563
448000	Employee Meal Allowance	General Cost Inflation	-	-	102	82	85	87	90	93	95	98
450011	Clark Fund Botany Gallery	General Cost Inflation	19	(45)	-	-	-	-	-	-	-	-
462100	Automotive Equipment	Capital Cost Inflation	-	24,773	-	-	-	-	-	-	-	-
462200	Machinery & Equip	Capital Cost Inflation	-	502	-	-	-	-	-	-	-	-
881100	General Fund Allocation Chgs	General Cost Inflation	38,673	31,352	217,586	175,445	180,708	186,129	191,713	197,465	203,388	209,490
881200	Central Service Alloc Charges	General Cost Inflation	152,894	144,072	-	-	-	-	-	-	-	-
882540	Utilization Chgs from 540 Fund	General Cost Inflation	-	95,933	-	-	-	-	-	-	-	-
884101	Interfund Charges from 101 Fnd	General Cost Inflation	113	-	-	-		-				
894540	Interfund Services to 540 Fund	General Cost Inflation	105,526	(139)	-	-	-	-	-	-	-	-
0000	Interfund Charges from 540 Fnd	General Cost Inflation		-	-	-	-	-	-	-	-	-
0000	Postage	General Cost Inflation		32	33	27	27	28	29	30	31	32
0000	Travel & Meeting Expense	General Cost Inflation		901	928	748	771	794	818	842	868	894
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
Total Public Works / PW-Sewer Systems-Plant Maint			**$ 2,604,523**	**$ 2,823,702**	**$ 3,968,768**	**$ 3,200,110**	**$ 3,304,026**	**$ 3,411,460**	**$ 3,522,530**	**$ 3,637,366**	**$ 3,756,103**	**$ 3,878,881**

Public Works / PW-Sewer-Laboratory Services			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
411100	Salaries - Regular	Labor Cost Inflation	$ 297,620	$ 318,594	$ 399,589	$ 312,167	$ 321,532	$ 331,178	$ 341,114	$ 351,347	$ 361,888	$ 372,744
411110	Salaries-Temp & Part Time	Labor Cost Inflation	8,751	1,101	-	-	-	-	-	-	-	-
411130	Compensatory Time	Labor Cost Inflation	4,164	3,244	-	-	-	-	-	-	-	-
411210	Vacation	Labor Cost Inflation	18,043	27,820	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation	13,004	16,293	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation	7,881	8,606	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation	2,420	1,851	-	-	-	-	-	-	-	-
411250	Industrial Accident	Labor Cost Inflation	791	139	-	-	-	-	-	-	-	-

411260	Bereavement Leave	Labor Cost Inflation	1,392	-	-	-	-	-	-	-	-	-	-
411430	Compensatory Time Payoff	Labor Cost Inflation	433	-	-	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation	1,757	(1,758)	-	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation	11,561	-	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation	8,168	-	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation	(794)	-	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation	8,619	6,626	14,875	11,621	12,202	12,812	13,452	14,125	14,831	15,573	
412220	Health Insurance	Insurance Inflation	44,655	49,366	53,086	41,472	43,546	45,723	48,009	50,409	52,930	55,576	
412221	Retiree Health Insurance	Insurance Inflation	694	806	-	-	-	-	-	-	-	-	
412222	Dental Insurance	Insurance Inflation	2,032	2,479	2,755	2,152	2,260	2,373	2,492	2,616	2,747	2,884	
412230	Life Insurance	Insurance Inflation	526	588	1,046	817	858	901	946	993	1,043	1,095	
412240	Unemployment Insurance	Insurance Inflation	179	168	198	155	162	171	179	188	197	207	
412250	Disability Insurance	Insurance Inflation	666	685	680	531	558	586	615	646	678	712	
412310	PERS Retirement	General Cost Inflation	70,696	75,393	91,902	71,796	73,950	76,168	78,453	80,807	83,231	85,728	
412320	Medicare OASDI	General Cost Inflation	4,544	4,616	5,790	4,523	4,659	4,799	4,943	5,091	5,244	5,401	
412400	Deferred Compensation	Labor Cost Inflation	2,400	3,055	3,000	2,344	2,414	2,486	2,561	2,638	2,717	2,798	
413120	Overtime At 1.5 Rate	Labor Cost Inflation	2,383	327	2,000	1,562	1,609	1,658	1,707	1,759	1,811	1,866	
413210	Holiday OfT-Straight/Non-Sched	Labor Cost Inflation	-	-	1,000	781	805	829	854	879	906	933	
413220	Holiday OIT-1.5 Rate/Non-Sched	Labor Cost Inflation	388	-	-	-	-	-	-	-	-	-	
413230	Holiday OIT-Strt/Subj To Retir	Labor Cost Inflation	1,773	805	2,000	1,562	1,609	1,658	1,707	1,759	1,811	1,866	
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-	
421000	Professional Services	General Cost Inflation	66,007	45,527	93,100	72,732	74,914	77,161	79,476	81,860	84,316	86,845	
422100	Telephone	General Cost Inflation	2,306	2,175	2,500	1,953	2,012	2,072	2,134	2,198	2,264	2,332	
422120	Telephone - Cellular	General Cost Inflation	361	448	1,000	781	805	829	854	879	906	933	
424220	All Other Equip Maint/Repair	General Cost Inflation	18,623	12,466	30,000	23,437	24,140	24,864	25,610	26,378	27,169	27,985	
424230	Central Garage Charges	General Cost Inflation	-	-	2,040	1,594	1,642	1,691	1,741	1,794	1,848	1,903	
425200	Periodicals & Dues	General Cost Inflation	4,291	576	7,800	6,094	6,276	6,465	6,659	6,858	7,064	7,276	
425400	General Office Expense	General Cost Inflation	3,316	964	5,000	3,906	4,023	4,144	4,268	4,396	4,528	4,664	
425600	Central Printing Charges	General Cost Inflation	58	-	-	-	-	-	-	-	-	-	
425700	Software Purchase/Licensing	General Cost Inflation	-	-	1,020	797	821	845	871	897	924	951	
425800	Computer Equip Purc Undr $5000	General Cost Inflation	2,500	1,978	1,000	781	805	829	854	879	906	933	
426100	Janitorial Supplies	General Cost Inflation	194	385	150	117	121	124	128	132	136	140	
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	4,956	6,661	9,929	7,757	7,989	8,229	8,476	8,730	8,992	9,262	
426300	Motor Fuels & Lubricants	General Cost Inflation	71	-	150	117	121	124	128	132	136	140	
426600	Chemical Supplies	Cust. Growth + Gen. Inflation	12,702	11,721	19,500	15,234	15,991	16,789	17,621	18,487	19,389	20,328	
426700	Maintenance Tools/Supplies	General Cost Inflation	-	7	200	156	161	166	171	176	181	187	
426710	Work Boot Reimbursement	General Cost Inflation	-	-	900	703	724	746	768	791	815	840	
426800	Special Department Supplies	General Cost Inflation	38,859	44,770	68,500	53,514	55,119	56,773	58,476	60,230	62,037	63,898	
427100	Travel & Meeting Expense	General Cost Inflation	3,065	-	2,000	1,562	1,609	1,658	1,707	1,759	1,811	1,866	
427200	Training	General Cost Inflation	2,420	1,991	9,000	7,031	7,242	7,459	7,683	7,913	8,151	8,395	
428400	Insurance / All Other	Insurance Inflation	10,071	9,374	20,245	15,816	16,607	17,437	18,309	19,224	20,185	21,195	
462200	Machinery & Equip	Capital Cost Inflation	5,448	-	-	-	-	-	-	-	-	-	
881100	General Fund Allocation Chgs	General Cost Inflation	6,984	5,233	55,863	43,641	44,951	46,299	47,688	49,119	50,592	52,110	
881200	Central Service Alloc Charges	General Cost Inflation	44,181	36,697	-	-	-	-	-	-	-	-	
0000	Jury Duty	General Cost Inflation		877	904	706	727	749	771	795	818	843	
0000	Administrative Leave	General Cost Inflation		314	323	252	260	268	276	284	293	301	
0000	Night Shift Premium	General Cost Inflation		59	60	47	49	50	51	53	55	56	
0000	Temporary Foreman Pay	General Cost Inflation		284	293	229	236	243	250	258	265	273	
0000	Overtime At Straight Rate	General Cost Inflation		211	218	170	175	180	186	191	197	203	
0000	[Other]	General Cost Inflation					-						
0006	[Other]	General Cost Inflation					-	-	-	-	-	-	
0000	[Other]	General Cost Inflation					-	-	-	-	-	-	
0000	[Other]	General Cost Inflation					-	-	-	-	-	-	
Total Public Works / PW-Sewer-Laboratory Services			**$ 741,159**	**$ 703,522**	**$ 909,616**	**$ 710,611**	**$ 733,681**	**$ 757,534**	**$ 782,188**	**$ 807,671**	**$ 834,012**	**$ 861,243**	

Public Works / PW-Sewer Systems Debt Service			**FY 2005 2006**	**FY 2006 2007**	**FY 2007 2008**	**FY 2007 2008**	**FY 2008 2009**	**FY 2009 2010**	**FY 2010 2011**	**FY 2011 2012**	**FY 2012 2013**	**FY 2013 2014**
481000	SRF Loan - Headworks Project	[CALCULATED]	$ 477,387.05	$ 477,387.04	$ 477,387.04	$ 477,387.05	$ 477,387.05	$ 477,387.05	$ 477,387.05	$ 477,387.05	$ 477,387.05	$ 477,387.05

481020	SRF Loan - Cogeneration Project	[CALCULATED]	339,474	339,474	339,474	339,474	339,474	339,474	339,474	339,474	339,474	339,474
482000	Sewer Refunding Revenue Bond	[CALCULATED]	4,900,000	4,869,000	4,869,000	4,861,000	4,852,000	4,839,000	4,876,000	4,870,000	4,864,000	-
0000	Pension Obligation Bonds (POB)	[CALCULATED]	298,011	298,011	298,011	298,011	298,011	298,011	298,011	298,011	298,011	298,011
0000	Revenue Bonds - NEW	[CALCULATED]		-	-	-	1,638,768	2,968,433	8,976,697	14,987,454	19,534,040	21,718,261
0000	SRF Loan - NEW	[CALCULATED]		-	-	-	-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
Total Public Works / PW-Sewer Systems Debt Service			**$ 6,014,872**	**$ 5,983,872**	**$ 5,983,872**	**$ 5,975,872**	**$ 7,605,640**	**$ 8,922,305**	**$ 14,967,569**	**$ 20,972,326**	**$ 25,512,912**	**$ 22,833,133**

Public Works / PW-Sewer Sys-CoGen/Landfill			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
411100	Salaries - Regular	Labor Cost Inflation	$ 88,975	$ 92,232	$ 119,042	$ 81,310	$ 83,750	$ 86,262	$ 88,850	$ 91,516	$ 94,261	$ 97,089
411210	Vacation	Labor Cost Inflation	7,183	19,186	-	-	-	-	-	-	-	-
411220	Holidays & Special Days Off	Labor Cost Inflation	2,542	481	-	-	-	-	-	-	-	-
411240	Sick Leave	Labor Cost Inflation	4,279	1,230	-	-	-	-	-	-	-	-
411245	Family Illness Sick Leave	Labor Cost Inflation	1,059	781	-	-	-	-	-	-	-	-
411510	Accrued Payroll	Labor Cost Inflation	678	(679)	-	-	-	-	-	-	-	-
411521	Accrued Sick Leave Yr End Only	Labor Cost Inflation	471	-	-	-	-	-	-	-	-	-
411522	Accrued Vacation Year-End Only	Labor Cost Inflation	1,588	-	-	-	-	-	-	-	-	-
411530	Accrued Comp. Time Earned	Labor Cost Inflation	46	-	-	-	-	-	-	-	-	-
412210	Workers Compensation Ins	Insurance Inflation	2,688	2,004	4,431	3,027	3,178	3,337	3,504	3,679	3,863	4,056
412220	Health Insurance	Insurance Inflation	17,220	18,758	19,830	13,545	14,222	14,933	15,680	16,464	17,287	18,151
412221	Retiree Health Insurance	Insurance Inflation	275	293	-	-	-	-	-	-	-	-
412222	Dental Insurance	Insurance Inflation	911	985	1,076	735	772	810	851	893	938	985
412230	Life Insurance	Insurance Inflation	50	50	298	204	214	224	236	247	260	273
412240	Unemployment Insurance	Insurance Inflation	56	51	58	40	42	44	46	48	51	53
412250	Disability Insurance	Insurance Inflation	271	274	272	186	195	205	215	226	237	249
412310	PERS Retirement	General Cost Inflation	21,749	23,005	27,378	18,700	19,261	19,839	20,434	21,047	21,679	22,329
412320	Medicare OASDI	General Cost Inflation	900	1,040	1,727	1,180	1,215	1,251	1,289	1,328	1,367	1,409
413110	Overtime At Straight Rate	Labor Cost Inflation	8,103	10,665	7,000	4,781	4,925	5,072	5,225	5,381	5,543	5,709
413120	Overtime At 1.5 Rate	Labor Cost Inflation	16,672	20,034	25,000	17,076	17,588	18,116	18,659	19,219	19,796	20,390
413130	Overtime At Double Time Rate	Labor Cost Inflation	3,177	731	5,000	3,415	3,518	3,623	3,732	3,844	3,959	4,078
413210	Holiday OIT-Straight/Non-Sched	Labor Cost Inflation	635	1,923	-	-	-	-	-	-	-	-
413230	Holiday Olf-Strt/Subj To Retir	Labor Cost Inflation	1,482	2,394	-	-	-	-	-	-	-	-
419910	Salaries Adjustment Factor	Labor Cost Inflation	-	-	-	-	-	-	-	-	-	-
421000	Professional Services	General Cost Inflation	86,355	-	180,700	123,425	127,128	130,942	134,870	138,916	143,084	147,376
421043	Prof Svcs Regulatory Comp	General Cost Inflation	-	-	50,000	34,152	35,177	36,232	37,319	38,438	39,591	40,779
422100	Telephone	General Cost Inflation	216	-	1,000	683	704	725	746	769	792	816
422120	Telephone - Cellular	General Cost Inflation	1,240	1,408	2,100	1,434	1,477	1,522	1,567	1,614	1,663	1,713
422200	Electric	Cust. Growth + Gen. Inflation	40,973	32,381	62,000	42,348	44,454	46,673	48,984	51,392	53,899	56,511
422300	Gas	General Cost Inflation	143,768	153,397	550,000	375,672	386,942	398,550	410,507	422,822	435,506	448,572
422500	Water	General Cost Inflation	339	479	1,000	683	704	725	746	769	792	816
422600	Other Utilities	General Cost Inflation	1,240	935	1,200	820	844	870	896	923	950	979
422700	Refuse/Disposal Fees	Customer Growth	-	-	2,000	1,366	1,393	1,421	1,448	1,476	1,504	1,532
423100	Equipment Rental	General Cost Inflation	-	-	1,200	820	844	870	896	923	950	979
424130	Maint/Repair of Bldgs & Improv	General Cost Inflation	1,361	12	5,000	3,415	3,518	3,623	3,732	3,844	3,959	4,078
424200	Maintenance & Repair - General	General Cost Inflation	1,814	-	-	-	-	-	-	-	-	-
424220	All Other Equip Maint/Repair	General Cost Inflation	58,918	56,054	488,700	333,801	343,815	354,130	364,754	375,696	386,967	398,576
424230	Central Garage Charges	General Cost Inflation	-	-	2,040	1,393	1,435	1,478	1,523	1,568	1,615	1,664
425200	Periodicals & Dues	General Cost Inflation	330	240	400	273	281	290	299	308	317	326
425400	General Office Expense	General Cost Inflation	150	30	1,000	683	704	725	746	769	792	816
426100	Janitorial Supplies	General Cost Inflation	54	17	250	171	176	181	187	192	198	204
426200	Clothing/Linen/Safety Supplies	General Cost Inflation	604	493	1,554	1,061	1,093	1,126	1,160	1,195	1,231	1,267
426300	Motor Fuels & Lubricants	General Cost Inflation	7,281	17,876	30,000	20,491	21,106	21,739	22,391	23,063	23,755	24,468
426600	Chemical Supplies	Cust. Growth + Gen. Inflation	1,037	-	12,700	8,675	9,106	9,560	10,034	10,527	11,041	11,576
426700	Maintenance Tools/Supplies	General Cost Inflation	1,085	45	1,000	683	704	725	746	769	792	816

426710	Work Boot Reimbursement	General Cost Inflation	-	-	300	205	211	217	224	231	238	245
426800	Special Department Supplies	General Cost Inflation	209	529	500	342	352	362	373	384	396	408
427100	Travel & Meeting Expense	General Cost Inflation	-	-	510	348	359	370	381	392	404	416
427200	Training	General Cost Inflation	1,585	352	3,261	2,227	2,294	2,363	2,434	2,507	2,582	2,660
428400	Insurance / All Other	Insurance Inflation	3,141	2,835	6,031	4,119	4,325	4,542	4,769	5,007	5,258	5,520
448000	Employee Meal Allowance	General Cost Inflation	-	-	153	105	108	111	114	118	121	125
881100	General Fund Allocation Chgs	General Cost Inflation	7,782	3,850	81,928	55,960	57,639	59,368	61,149	62,984	64,873	66,819
881200	Central Service Alloc Charges	General Cost Inflation	42,180	59,795	-	-	-	-	-	-	-	-
0000	Compensatory Time	General Cost Inflation		406	418	285	294	303	312	321	331	341
0000	Administrative Leave	General Cost Inflation		60	62	42	44	45	46	48	49	50
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
0000	[Other]	General Cost Inflation					-	-	-	-	-	-
Total Public Works I PW-Sewer Sys-CoGen/Landfill			**$ 582,672**	**$ 526,633**	**$ 1,698,119**	**$ 1,159,882**	**$ 1,196,108**	**$ 1,233,502**	**$ 1,272,072**	**$ 1,311,855**	**$ 1,352,889**	**$ 1,395,214**

Public Works / PW-Sewer-Capital Project Serv			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
422100	Telephone	General Cost Inflation	$ -	$ -	$ 2,500	$ 160	$ 165	$ 170	$ 175	$ 180	$ 185	$ 191
422120	Telephone - Cellular	General Cost Inflation	-	-	3,000	192	$ 198	$ 204	$ 210	$ 216	$ 222	$ 229
424220	All Other Equip Maint/Repair	General Cost Inflation	-	77	5,500	352	$ 362	$ 373	$ 384	$ 396	$ 408	$ 420
425200	Periodicals & Dues	General Cost Inflation	-	-	2,600	166	$ 171	$ 176	$ 182	$ 187	$ 193	$ 199
425300	Photo & Recording Supplies	General Cost Inflation	-	-	1,300	83	$ 86	$ 88	$ 91	$ 94	$ 96	$ 99
425400	General Office Expense	General Cost Inflation	1,979	-	2,325	149	$ 153	$ 158	$ 162	$ 167	$ 172	$ 178
425500	Postage	Customer Growth	-	-	200	13	$ 13	$ 13	$ 14	$ 14	$ 14	$ 14
425600	Central Printing Charges	General Cost Inflation	-	-	1,000	64	$ 66	$ 68	$ 70	$ 72	$ 74	$ 76
426800	Special Department Supplies	General Cost Inflation	-	-	1,600	102	$ 105	$ 109	$ 112	$ 115	$ 119	$ 122
427100	Travel & Meeting Expense	General Cost Inflation	-	-	2,000	128	$ 132	$ 136	$ 140	$ 144	$ 148	$ 153
427200	Training	General Cost Inflation	-	-	1,800	115	$ 119	$ 122	$ 126	$ 130	$ 133	$ 137
0000	[Other]	General Cost Inflation	-	-	-	-	$ -	$ -	$ -	$ -	$ -	$ -
0000	[Other]	General Cost Inflation	-	-	-	-	-	-	-	-	-	-
Total Public Works / PW-Sewer-Capital Project Serv			**$ 1,979**	**$ 77**	**$ 23,825**	**$ 1,523**	**$ 1,569**	**$ 1,616**	**$ 1,664**	**$ 1,714**	**$ 1,765**	**$ 1,818**

Additional O&M Treatment Costs (developed by Carollo)			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
0000	New Headworks	[CALCULATED]										
0000	Biofilters	[CALCULATED]								-	-	93,000
0000	Primary Clarifiers	[CALCULATED]										
0000	Primary Sludge Pump Station	[CALCULATED]										
0000	Primary Effluent EQ	[CALCULATED]								-	-	80,000
0000	Primary EQ Pumps	[CALCULATED]								-	-	53,000
0000	Fine (perforated) Screens	[CALCULATED]								$ -		
0000	MBR Facility and RAS/WAS Pumps	[CALCULATED]								-	-	389,000
0000	Primary Sludge Thickeners (GBTs)	[CALCULATED]								-	-	407,000
0000	WAS Thickeners (GBTs)	[CALCULATED]										
0000	Chlorine Contact Basin	[CALCULATED]										
0000	Acid-Phase Digester	[CALCULATED]									-	428,000
0000	Cogeneration Engines	[CALCULATED]										
0000	Fuel Cells	[CALCULATED]										
0000	Reclaim and Reuse Water	[CALCULATED]						-	255,000	278,000	297,000	313,000
0000	Energy Management	[CALCULATED]										
0000	[Other]	[CALCULATED]										
0000	[Other]	[CALCULATED]										
Total Additional O&M Treatment Costs (developed by Carollo)			**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 255,000**	**$ 278,000**	**$ 297,000**	**$ 1,763,000**

Total Operating Expenditures	**$ 25,519,148**	**$ 26,812,718**	**$ 35,165,547**	**$ 31,238,299**	**$ 33,867,062**	**$ 36,976,229**	**$ 44,718,842**	**$ 52,349,531**	**$ 58,510,624**	**$ 58,668,024**

Replacement Funding			FY 2005 2006	FY 2006 2007	FY 2007 2008	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014
	Replacement Funding	Capital Cost Inflation	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
			$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Debt Service

TOTAL DEBT SERVICE

Total Debt Service	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Principal Payments	$ 4,036,437	$ 4,284,195	$ 4,547,463	$ 4,826,257	$ 5,623,915	$ 6,283,754	$ 8,235,317	$ 5,331,552	$ 6,444,402	$ 6,892,663
Interest Payments	1,947,435	1,691,677	3,058,178	4,096,048	9,343,655	14,688,571	17,277,595	17,501,581	17,857,145	18,220,612
Total Annual Payments	5,983,872	5,975,872	7,605,640	8,922,305	14,967,569	20,972,326	25,512,912	22,833,133	24,301,547	25,113,275
Added Reserve Requirement	*$0*	*$0*	*$2,979,579*	*$2,417,572*	*$10,027,178*	*$10,200,889*	*$5,248,053*	*$900,550*	*$1,090,029*	*$1,204,777*
Senior Bond Debt Service										
Principal Payments	$ 4,036,437	$ 4,284,195	$ 4,547,463	$ 4,826,257	$ 5,623,915	$ 6,283,754	$ 8,235,317	$ 5,331,552	$ 6,444,402	$ 6,892,663
Interest Payments	1,947,435	1,691,677	3,058,178	4,096,048	9,343,655	14,688,571	17,277,595	17,501,581	17,857,145	18,220,612
Total Annual Payments	$ 5,983,872	$ 5,975,872	$ 7,605,640	$ 8,922,305	$ 14,967,569	$ 20,972,326	$ 25,512,912	$ 22,833,133	$ 24,301,547	$ 25,113,275
Junior Bond Debt Service										
Principal Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	-	-	-	-	-	-	-	-	-	-
Total Annual Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

EXISTING DEBT SERVICE

Total Existing Senior Bond Debt		FY 2006 **2007**	FY 2007 **FY 2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Principal Payments		$ 4,036,437	$ 4,284,195	$ 4,547,463	$ 4,826,257	$ 5,130,598	$ 5,365,505	$ 5,610,998	$ 887,098	$ 908,827	$ 931,209
Interest Payments		1,947,435	1,691,677	1,419,409	1,127,615	860,274	619,367	367,874	227,774	206,045	183,663
Total Annual Payments		$ 5,983,872	$ 5,975,872	$ 5,966,872	$ 5,953,872	$ 5,990,872	$ 5,984,872	$ 5,978,872	$ 1,114,872	$ 1,114,872	$ 1,114,872
SRF Loan - Headworks Project											
Principal Payments	$ 4,735,503	$ 380,326	$ 387,034	$ 393,861	$ 400,808	$ 407,877	$ 415,071	$ 422,393	$ 429,843	$ 437,425	$ 445,140
Interest Payments		97,061	90,353	83,527	76,579	69,510	62,316	54,994	47,544	39,962	32,247
Total Annual Payments	$ 5,728,645	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387	$ 477,387
SRF Loan - Cogeneration Project											
Principal Payments	$ 3,833,656	$ 249,491	$ 254,667	$ 259,949	$ 265,342	$ 270,846	$ 276,464	$ 282,199	$ 288,053	$ 294,028	$ 300,127
Interest Payments		89,982	84,807	79,524	74,132	68,628	63,010	57,275	51,421	45,445	39,346
Total Annual Payments	$ 4,752,632	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474	$ 339,474
Sewer Refunding Revenue Bond											
Principal Payments	$ 21,350,000	$ 3,285,000	$ 3,515,000	$ 3,760,000	$ 4,020,000	$ 4,305,000	$ 4,520,000	$ 4,745,000			
Interest Payments		1,584,000	1,346,000	1,092,000	819,000	571,000	350,000	119,000			
Total Annual Payments	$ 29,162,000	$ 4,869,000	$ 4,861,000	$ 4,852,000	$ 4,839,000	$ 4,876,000	$ 4,870,000	$ 4,864,000	$ -	$ -	$ -
Pension Obligation Bonds (POB)											
Principal Payments	$ 3,389,137	$ 121,620	$ 127,495	$ 133,653	$ 140,108	$ 146,875	$ 153,969	$ 161,406	$ 169,202	$ 177,374	$ 185,942
Interest Payments		176,391	170,517	164,359	157,903	151,136	144,042	136,605	128,809	120,637	112,070
Total Annual Payments	$ 5,350,471	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011	$ 298,011

All Other Utility Debt	$ 33,308,296	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Principal Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments		-	-	-	-	-	-	-	-	-	-
Total Annual Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Payments											
Interest Payments											
Total Annual Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Principal Payments											
Interest Payments											
Total Annual Payments		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

FUTURE DEBT SERVICE

Revenue Bonds[1]	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Principal Payments	$ -	$ -	$ -	$ -	$ 493,316	$ 918,249	$ 2,624,319	$ 4,444,454	$ 5,535,574	$ 5,961,453
Interest Payments	-	-	1,638,768	2,968,433	8,483,381	14,069,204	16,909,721	17,273,807	17,651,101	18,036,950
Total Annual Payments	$ -	$ -	$ 1,638,768	$ 2,968,433	$ 8,976,697	$ 14,987,454	$ 19,534,040	$ 21,718,261	$ 23,186,675	$ 23,998,403
Added Reserve Requirement	*$0*	*$0*	*$2,979,579*	*$2,417,572*	*$10,027,178*	*$10,200,889*	*$5,248,053*	*$900,550*	*$1,090,029*	*$1,204,777*

[1] **Interest only on the first 2 years per conversation with City on April 9th**

SRF Loan	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Principal Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Annual Payments	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Added Reserve Requirement	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*	*$0*

Debt Assumptions

Revenue Bonds[1]	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Debt Proceeds	$ -	$ -	$ 29,211,557	$ 23,701,690	$ 98,305,666	$ 100,008,719	$ 51,451,496	$ 8,828,922	$ 10,686,561	$ 11,811,542
Term of Bond	30 years	30 years	30 years	30 years	30 years	30 years	30 years	30 years	30 years	30 years
Interest Rate	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Issuance Costs	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Reserve Requirement	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%

SRF Loan	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Debt Proceeds	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Term of Bond	20 years	20 years	20 years	20 years	20 years	20 years	20 years	20 years	20 years	20 years
Interest Rate	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
Issuance Costs	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Reserve Requirement	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Capital Funding & Fund Reserves

CAPITAL FUNDING

REPLACEMENT/SYSTEMWIDE IMPROVEMENTS

Capital Expenditures	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
R&R / System-Wide Improvements	$ -	$ 15,939,354	$ 42,056,294	$ 23,077,370	$ 76,682,788	$ 77,912,531	$ 44,917,388	$ 13,947,252	$ 18,483,342	$ 17,715,411
Expansion Projects	-	23,491,457	9,401,232	7,458,743	34,978,797	35,129,753	21,091,696	2,691,516	5,451,577	5,191,144
	$ -	$ 39,430,811	$ 51,457,527	$ 30,536,113	$ 111,661,586	$ 113,042,284	$ 66,009,084	$ 16,638,768	$ 23,934,918	$ 22,906,555

Available Revenues	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Connection Fee Revenues & Reserves	$ -	$ 10,832,962	$ 5,894,337	$ 6,071,004	$ 8,008,791	$ 8,248,857	$ 8,578,812	$ 2,691,516	$ 5,451,577	$ 5,191,144
Grants	-	-	-	-	-	-	-	-	-	-
Developer Contributions	-	-	-	-	-	-	-	-	-	-
Use of Capital Reserves	-	28,597,849	16,351,633	763,419	5,347,128	4,784,708	5,978,776	5,118,330	7,796,781	5,903,870
Use of SRF Loan	-	-	-	-	-	-	-	-	-	-
Use of Revenue Bond Proceeds	$ -	-	29,211,557	23,701,690	98,305,666	100,008,719	51,451,496	8,828,922	10,686,561	11,811,542
Rate Funded Capital	-	-	-	-	-	-	0	-	-	-
	$ -	$ 39,430,811	$ 51,457,527	$ 30,536,113	$ 111,661,586	$ 113,042,284	$ 66,009,084	$ 16,638,768	$ 23,934,918	$ 22,906,555

Bond Issues	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Revenue Bonds (input override)										
SRF Loans										
SRF Loan Issuance										

Available Revenues	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
- Grants	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
- Developer Contributions	-	-	-	-	-	-	-	-	-	-

FUND RESERVES

OPERATING FUND

Operating Fund	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Beginning Balance	$ 4,300,000	$ 11,500,000	$ 5,302,615	$ 6,773,412	$ 7,395,246	$ 8,943,768	$ 10,469,906	$ 11,702,125	$ 11,733,605	$ 12,282,714
Cash Flow	(2,507,809)	(6,197,385)	2,221,086	5,876,996	6,250,938	7,402,085	6,262,518	7,694,164	6,351,439	6,645,658
less: Transfer to Capital Fund	-	-	(750,289)	(5,255,163)	(4,702,416)	(5,875,947)	(5,030,299)	(7,662,684)	(5,802,329)	(6,212,184)
Ending Fund Balance	$ 1,792,191	$ 5,302,615	$ 6,773,412	$ 7,395,246	$ 8,943,768	$ 10,469,906	$ 11,702,125	$ 11,733,605	$ 12,282,714	$ 12,716,188

Note: Beginning Balance for FY2006/07 from Terri on 6/13. Money has been repaid by redevelopment.

CAPITAL FUNDS

Capital Reserve	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Beginning Balance	$ 24,000,000	$ 43,900,000	$ 16,070,401	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Interest Earnings	420,000	768,250	281,232	13,130	91,965	82,292	102,829	88,030	134,097	101,541
Transfers from Operating Fund	-	-	-	750,289	5,255,163	4,702,416	5,875,947	5,030,299	7,662,684	5,802,329
Replacement Funding (Previous Year)	-	-	-	-	-	-	-	-	-	-
Grants	-	-	-	-	-	-	-	-	-	-
Developer Contributions	-	-	-	-	-	-	-	-	-	-
SRF Loan	-	-	-	-	-	-	-	-	-	-
Bond Proceeds	-	-	29,211,557	23,701,690	98,305,666	100,008,719	51,451,496	8,828,922	10,686,561	11,811,542
less: Use of Funds	-	(28,597,849)	(45,563,190)	(24,465,109)	(103,652,795)	(104,793,427)	(57,430,273)	(13,947,252)	(18,483,342)	(17,715,411)
Ending Fund Balance	$ 24,420,000	$ 16,070,401	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Connection Fee Fund	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Beginning Balance		$ 4,932,650	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,230,448	$ 8,652,369
Interest Earnings	-	172,643	-	-	-	-	-	-	218,066	302,833
Connection Fee Revenues	4,932,650	5,727,669	5,894,337	6,071,004	8,008,791	8,248,857	8,578,812	8,921,964	7,655,432	7,961,650
less: Use of Funds for Debt Service	-	-	-	-	-	-	-	-	-	-
less: Use of Funds for Capital	-	(10,832,962)	(5,894,337)	(6,071,004)	(8,008,791)	(8,248,857)	(8,578,812)	(2,691,516)	(5,451,577)	(5,191,144)
Ending Fund Balance	$ 4,932,650	$ -	$ -	$ -	$ -	$ -	$ -	$ 6,230,448	$ 8,652,369	$ 11,725,708

BOND RESERVES

Bond Reserve	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Beginning Balance		$ -	$ -	$ 2,979,579	$ 5,397,151	$ 15,424,329	$ 25,625,219	$ 30,873,271	$ 31,773,821	$ 32,863,850
New Reserve Requirements	-	-	2,979,579	2,417,572	10,027,178	10,200,889	5,248,053	900,550	1,090,029	1,204,777
less: Use of Bond Reserve	-	-	-	-	-	-	-	-	-	-
Ending Fund Balance	$ -	$ -	$ 2,979,579	$ 5,397,151	$ 15,424,329	$ 25,625,219	$ 30,873,271	$ 31,773,821	$ 32,863,850	$ 34,068,628

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

REVENUE REQUIREMENTS

CASH FLOW SUFFICIENCY TEST

OPERATING EXPENDITURES

Revenues	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
User Service Fees	$ 19,743,513	$ 19,870,333	$ 19,997,152	$ 29,608,604	$ 34,264,475	$ 40,340,494	$ 46,477,327	$ 49,306,971	$ 49,610,060	$ 50,264,497
CSD Operating Revenues	3,787,399	4,125,879	4,464,360	7,076,823	8,722,967	10,889,877	13,252,096	14,798,255	15,414,396	16,143,379
Interest Earnings (from Operating Fund and Bond Reserves)	150,500	402,500	185,592	341,355	447,734	852,883	1,263,329	1,490,139	1,522,760	1,580,130
Miscellaneous Revenues	623,497	642,202	661,468	681,312	701,751	722,804	744,488	766,823	789,827	813,522
Connection Fee Revenues (for Debt Service)	-	-	-	-	-	-	-	-	-	-
Total Revenues	$ 24,304,909	$ 25,040,914	$ 25,308,571	$ 37,708,094	$ 44,136,927	$ 52,806,058	$ 61,737,240	$ 66,362,188	$ 67,337,043	$ 68,801,528
	-	-	10,779,577	5,145,131	6,832,854	6,945,557	3,035,902	-	427,968	1,425,072

Expenditures	FY 2006 **2007**	FY 2007 **2008**	FY 2008 **2009**	FY 2009 **2010**	FY 2010 **2011**	FY 2011 **2012**	FY 2012 **2013**	FY 2013 **2014**	FY 2014 **2015**	FY 2015 **2016**
Ongoing Operating Expenses										
Public Works / Public Works-Sewer Sys-Admin	$ 4,033,897	$ 4,069,355	$ 4,197,122	$ 5,078,390	$ 5,572,214	$ 6,187,763	$ 6,815,693	$ 7,176,527	$ 7,331,159	$ 7,520,564
Public Works / PW-Sewer-Collection Syst Maint	3,143,216	4,336,684	4,541,685	4,757,288	4,983,880	5,222,055	5,418,142	5,621,669	5,831,649	6,049,579
Public Works / PW-Sewer Systems-Treatment	8,749,779	10,959,532	11,435,692	11,934,878	12,453,812	12,993,237	13,553,925	14,136,673	14,712,936	15,311,213
Public Works / PW-Sewer-Environmental Complia	848,019	824,729	851,538	879,255	907,912	937,543	968,183	999,867	1,032,632	1,066,519
Public Works / PW-Sewer Systems-Plant Maint	2,823,702	3,200,110	3,304,026	3,411,460	3,522,530	3,637,366	3,756,103	3,878,881	4,005,794	4,137,043
Public Works / PW-Sewer-Laboratory Services	703,522	710,611	733,681	757,534	782,188	807,671	834,012	861,243	889,329	918,365
Public Works I PW-Sewer Sys-CoGen/Landfill	526,633	1,159,882	1,196,108	1,233,502	1,272,072	1,311,855	1,352,889	1,395,214	1,438,653	1,483,455
Public Works / PW-Sewer-Capital Project Serv	77	1,523	1,569	1,616	1,664	1,714	1,765	1,818	1,872	1,928
Additional O&M Treatment Costs (developed by Carollo)	-	-	-	-	255,000	278,000	297,000	1,763,000	1,868,000	1,979,000
Other Operating Expenses										
Public Works / PW-Sewer Systems Debt Service	5,983,872	5,975,872	7,605,640	8,922,305	14,967,569	20,972,326	25,512,912	22,833,133	24,301,547	25,113,275
Rate Funded Capital	-	-	-	-	-	-	0	-	-	-
Replacement Funding & Misc. Capital	-	-	-	-	-	-	-	-	-	-
Subtotal Expenditures	$ 26,812,718	$ 31,238,299	$ 33,867,062	$ 36,976,229	$ 44,718,842	$ 52,349,531	$ 58,510,624	$ 58,668,024	$ 61,413,572	$ 63,580,942
Revenues to Meet Minimum Operating Fund	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Expenditures	$ 26,812,718	$ 31,238,299	$ 33,867,062	$ 36,976,229	$ 44,718,842	$ 52,349,531	$ 58,510,624	$ 58,668,024	$ 61,413,572	$ 63,580,942
Operating Expenditure Surplus (Deficiency) Before Rate Increas	**$ (2,507,809)**	**$ (6,197,385)**	**$ (8,558,490)**	**$ 731,865**	**$ (581,916)**	**$ 456,527**	**$ 3,226,616**	**$ 7,694,164**	**$ 5,923,470**	**$ 5,220,586**
Total Ongoing Operating Expenses	$ 20,828,846	$ 25,262,427	$ 26,261,421	$ 28,053,924	$ 29,751,273	$ 31,377,205	$ 32,997,711	$ 35,834,891	$ 37,112,025	$ 38,467,667

BOND COVERAGE TEST

Allowable Revenues	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
User Service Fees	$ 19,743,513	$ 19,870,333	$ 19,997,152	$ 29,608,604	$ 34,264,475	$ 40,340,494	$ 46,477,327	$ 49,306,971	$ 49,610,060	$ 50,264,497
CSD Operating Revenues	3,787,399	4,125,879	4,464,360	7,076,823	8,722,967	10,889,877	13,252,096	14,798,255	15,414,396	16,143,379
Interest Earnings (incl. Interest from Cap. Fund)	570,500	1,170,750	466,824	354,485	539,699	935,176	1,366,158	1,578,169	1,656,857	1,681,671
Miscellaneous Revenues	623,497	642,202	661,468	681,312	701,751	722,804	744,488	766,823	789,827	813,522
Total Revenues	$ 24,724,909	$ 25,809,164	$ 25,589,803	$ 37,721,224	$ 44,228,892	$ 52,888,350	$ 61,840,069	$ 66,450,218	$ 67,471,140	$ 68,903,069

Expenditures	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Ongoing Operating Expenses	$ 20,828,846	$ 25,262,427	$ 26,261,421	$ 28,053,924	$ 29,751,273	$ 31,377,205	$ 32,997,711	$ 35,834,891	$ 37,112,025	$ 38,467,667
Senior Debt Service [1]	7,488,590	7,488,590	10,153,696	12,308,611	21,269,993	28,283,104	31,891,141	29,813,914	30,788,899	31,866,520
Total Expenditures	$ 28,317,436	$ 32,751,017	$ 36,415,117	$ 40,362,535	$ 51,021,266	$ 59,660,309	$ 64,888,852	$ 65,648,805	$ 67,900,924	$ 70,334,188
Bond Coverage Surplus (Deficiency) Before Rate Increase	**$ (3,592,527)**	**$ (6,941,853)**	**$ (10,825,314)**	**$ (2,641,311)**	**$ (6,792,374)**	**$ (6,771,959)**	**$ (3,048,783)**	**$ 801,413**	**$ (429,784)**	**$ (1,431,119)**

(1) Debt coverage test set at 125% of the maximum annual debt service.

REVENUE REQUIREMENT & RATE IMPACTS

REVENUE REQUIREMENT	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Maximum Revenue Surplus (Deficiency) Before Rate Increase	$ (3,592,527)	$ (6,941,853)	$ (10,825,314)	$ (2,641,311)	$ (6,792,374)	$ (6,771,959)	$ (3,048,783)	$ 801,413	$ (429,784)	$ (1,431,119)
Utility Tax	$ (233,514)	$ (451,220)	$ (703,645)	$ (171,685)	$ (441,504)	$ (440,177)	$ (198,171)	$ -	$ (27,936)	$ (93,023)
Total Revenue Surplus (Deficiency)	$ (3,826,041)	$ (7,393,074)	$ (11,528,959)	$ (2,812,996)	$ (7,233,878)	$ (7,212,136)	$ (3,246,954)	$ 801,413	$ (457,720)	$ (1,524,142)

Rate Increases (Fiscal Year Basis)	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Month of Adoption	July	July	July	July	July	July	July	July	July	July
Calculated Rate Increase	16.26%	30.81%	47.13%	7.67%	16.83%	14.08%	5.44%	0.00%	0.70%	2.30%
Input		0.00%		15.00%	17.00%	14.50%				

RATE INCREASES (Calendar Year Basis) [1]	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
	Calculated Increase	Inputted Increase	Calculated Increase	Inputted Increase	Inputted Increase	Inputted Increase	Calculated Increase	Calculated Increase	Calculated Increase	Calculated Increase
Total Annual Rate Increase	**0.00%**	**0.00%**	**47.13%**	**15.00%**	**17.00%**	**14.50%**	**5.44%**	**0.00%**	**0.70%**	**2.30%**
Cumulative Rate Increase	***0.00%***	***0.00%***	***47.13%***	***69.20%***	***97.96%***	***126.67%***	***138.99%***	***138.99%***	***140.67%***	***146.20%***

USER RATE (Basic Single Family Dwelling)	$13.05	$13.05	$13.05	*$19.77*	$22.74	$26.60	$30.46	$32.11	$32.11	$32.34	$33.08

	FY 2006 2007	FY 2007 2008	FY 2008 2009	FY 2009 2010	FY 2010 2011	FY 2011 2012	FY 2012 2013	FY 2013 2014	FY 2014 2015	FY 2015 2016
Net Cash Flow After Rate Increase	$ (2,507,809)	$ (6,197,385)	$ 2,221,086	$ 5,876,996	$ 6,250,938	$ 7,402,085	$ 6,262,518	$ 7,694,164	$ 6,351,439	$ 6,645,658

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Functional Allocation

PLANT-IN EXPENDITURES

Year of Costs 2009

	Allocation of Plant	Original Cost	Customers	Pumping	Flow	COD	TSS	NIT	O/G	Check	Notes:
1	Land	$ 2,698,000			44%	33%	17%	5%	2%	100%	As Typical Treatment P
2	Buildings and Structures	$ 176,829,000			44%	33%	17%	5%	2%	100%	As Typical Treatment P
3	Accumulated Depreciation - Buildings	$ (61,397,000)								100%	As all others
4	Improvements other than Buildings	$ 40,744,000								100%	As all others
5	Accumulated Dep. - Impvts other than Buildings	$ (8,224,000)								100%	As all others
6	Machinery and Equipment	$ 6,748,000								100%	As all others
7	Accumulated Dep. - Machinery and Equipment	$ (4,580,000)								100%	As all others
8	[Other]	$ -								100%	
9	[Other]	$ -								100%	
10	[Other]	$ -								100%	
11	[Other]	$ -								100%	
12	[Other]	$ -								100%	
13	[Other]	$ -								100%	
14	[Other]	$ -								100%	
15	[Other]	$ -								100%	
16	[Other]	$ -								100%	
	Subtotals:	*$ 152,818,000*	$ -	$ -	$ 78,547,980	$ 58,477,318	$ 30,089,378	$ 9,157,434	$ 3,254,889		
	Re-Allocation of "As All Others":		-	-	(11,685,919)	(8,699,921)	(4,476,525)	(1,362,391)	(484,244)		
	Total Allocation:	**$ 152,818,000**	**$ -**	**$ -**	**$ 66,862,061**	**$ 49,777,398**	**$ 25,612,852**	**$ 7,795,043**	**$ 2,770,646**		
	Percentage Allocation:		**0%**	**0%**	**44%**	**33%**	**17%**	**5%**	**2%**		

Year of Costs 2009

	Allocation of Operating Expenses	CSD		Customers	Pumping	Flow	COD	TSS	NIT	O/G	As All Others [1]	Check
Public Works / Public Works-Sewer Sys-Admin												
411100	Salaries-Regular		$ 1,014,996								100%	100%
411110	Salaries-Temp & Part Time		$ -								100%	200%
411130	Compensatory Time		$ -								100%	100%
411210	Vacation		$ -								100%	200%
411220	Holidays & Special Days Off		$ -								100%	100%
411240	Sick Leave		$ -								100%	200%
411245	Family Illness Sick Leave		$ -								100%	100%
411250	Industrial Accident		$ -								100%	200%
411260	Bereavement Leave		$ -								100%	100%
411280	Jury Duty		$ -								100%	200%
411292	Administrative Leave		$ -								100%	100%
411310	Night Shift Premium		$ -								100%	100%
411410	Vacation Payoffs		$ -								100%	100%
411430	Compensatory Time Payoff		$ -								100%	100%
411510	Accrued Payroll		$ -								100%	100%
411521	Accrued Sick Leave Yr End Only		$ -								100%	100%
411522	Accrued Vacation Year-End Only		$ -								100%	100%
411530	Accrued Comp. Time Earned		$ -								100%	100%
412210	Workers Compensation Ins		$ 38,194								100%	100%
412220	Health Insurance		$ 127,734								100%	100%
412221	Retiree Health Insurance		$ -								100%	100%
412222	Dental Insurance		$ 6,994								100%	100%
412230	Life Insurance		$ 2,950								100%	100%
412240	Unemployment Insurance		$ 510								100%	100%

412250	Disability Insurance		$	1,050							100%	***100%***
412310	PERS Retirement		$	231,491							100%	***100%***
412320	Medicare OASDI		$	14,592							100%	***100%***
412400	Deferred Compensation		$	22,727							100%	***100%***
413120	Overtime At 1.5 Rate		$	114							100%	***100%***
413210	Holiday O/T-Straight/Non-Sched		$	-							100%	***100%***
419910	Salaries Adjustment Factor		$	-							100%	***100%***
421000	Professional Services		$	73,960							100%	***100%***
421043	Prof Svcs Regulatory Comp		$	90,982							100%	***100%***
421100	Outside Legal Services		$	7,576							100%	***100%***
422100	Telephone		$	13,181							100%	***100%***
422120	Telephone - Cellular		$	14,090							100%	***100%***
423400	Motor Pool Equipment Rental		$	4,924							100%	***0%***
424130	Maint/Repair of Bldgs & Improv		$	76							100%	***0%***
424220	All Other Equip Maint/Repair		$	10,227							100%	***0%***
424230	Central Garage Charges		$	1,894							100%	***100%***
425200	Periodicals & Dues		$	58,991							100%	***100%***
425300	Photo & Recording Supplies		$	227							100%	***100%***
425400	General Office Expense		$	18,409							100%	***100%***
425500	Postage		$	1,650							100%	***100%***
425600	Central Printing Charges		$	1,515							100%	***100%***
425610	Outside Printing Expense		$	1,136							100%	***100%***
425800	Computer Equip Purc Undr $5000		$	1,894							100%	***100%***
426100	Janitorial Supplies		$	379							100%	***100%***
426200	Clothing/Linen/Safety Supplies		$	-							100%	***100%***
426710	Work Boot Reimbursement		$	114							100%	***100%***
426800	Special Department Supplies		$	2,273							100%	***100%***
427100	Travel & Meeting Expense		$	13,079							100%	***100%***
427200	Training		$	10,568							100%	***0%***
428400	Insurance / All Other		$	51,986							100%	***0%***
428420	Insurance Charges - Direct		$	70,011							100%	***0%***
443300	Uncollect Accounts-Bad Debts		$	67,834							100%	***100%***
452005	Education Reimbursement Prog		$	758							100%	***100%***
462100	Automotive Equipment		$	-							100%	***100%***
881100	General Fund Allocation Chgs		$	376,281							100%	***100%***
881200	Central Service Alloc Charges		$	-							100%	***100%***
882101	Utilization Chgs from 101 Fund		$	797,094							100%	***100%***
882102	Utilization Chgs from 102 Fund		$	-							100%	***100%***
882510	Utilization Chgs from 510 Fund		$	437,562							100%	***100%***
894101	Interfund Services to 101 Fund		$	-							100%	***100%***
894230	Interfund Services to 230 Fund		$	-							100%	***100%***
894260	Interfund Services to 260 Fund		$	-							100%	***100%***
894410	Interfund Services to 410 Fund		$	-							100%	***100%***
894431	Interfund Services to 431 Fund		$	-							100%	***100%***
894432	Interfund Services to 432 Fund		$	-							100%	***100%***
894540	Interfund Services to 540 Fund		$	-							100%	***100%***
894551	Interfund Services to 551 Fund		$	-							100%	***100%***
0000	City Retirement Plan		$	8							100%	***100%***
0000	Office Furniture & Equipment		$	607,095							100%	***100%***
0000	[Other]		$	-							100%	***100%***
0000	Additional Admin In Lieu		$	-							100%	***100%***
Public Works / PW-Sewer-Collection Syst Maint												
411100	Salaries-Regular		$	893,049		15%	85%				0%	***100%***
411110	Salaries-Temp & Part Time		$	-		15%	85%				0%	***100%***
411130	Compensatory Time		$	-		15%	85%				0%	***100%***
411210	Vacation		$	-		15%	85%				0%	***100%***
411220	Holidays & Special Days Off		$	-		15%	85%				0%	***100%***
411240	Sick Leave		$	-		15%	85%				0%	***100%***
411245	Family Illness Sick Leave		$	-		15%	85%				0%	***100%***
411250	Industrial Accident		$	-		15%	85%				0%	***100%***
411260	Bereavement Leave		$	-		15%	85%				0%	***100%***
411292	Administrative Leave		$	-		15%	85%				0%	***100%***
411310	Night Shift Premium		$	-		15%	85%				0%	***100%***
411320	Temporary Foreman Pay		$	205		15%	85%				0%	***100%***

411410	Vacation Payoffs	$	-		15%	85%				0%	100%
411420	Sick Leave Payoff	$	-		15%	85%				0%	100%
411430	Compensatory Time Payoff	$	-		15%	85%				0%	100%
411510	Accrued Payroll	$	-		15%	85%				0%	100%
411521	Accrued Sick Leave Yr End Only	$	-		15%	85%				0%	100%
411522	Accrued Vacation Year-End Only	$	-		15%	85%				0%	100%
411530	Accrued Comp. Time Earned	$	-		15%	85%				0%	100%
412210	Workers Compensation Ins	$	33,886		15%	85%				0%	100%
412220	Health Insurance	$	142,494		15%	85%				0%	100%
412221	Retiree Health Insurance	$	-		15%	85%				0%	100%
412222	Dental Insurance	$	9,027		15%	85%				0%	100%
412230	Life Insurance	$	2,388		15%	85%				0%	100%
412240	Unemployment Insurance	$	447		15%	85%				0%	100%
412250	Disability Insurance	$	1,850		15%	85%				0%	100%
412310	PIERS Retirement	$	205,398		15%	85%				0%	100%
412320	Medicare OASDI	$	12,945		15%	85%				0%	100%
412330	City Retirement Plan	$	-		15%	85%				0%	100%
412400	Deferred Compensation	$	9,237		15%	85%				0%	100%
413110	Overtime At Straight Rate	$	41,054		15%	85%				0%	100%
413120	Overtime At 1.5 Rate	$	30,790		15%	85%				0%	100%
413130	Overtime At Double Time Rate	$	8,211		15%	85%				0%	100%
419910	Salaries Adjustment Factor	$	-		15%	85%				0%	100%
421000	Professional Services	$	12,419			100%				0%	100%
422100	Telephone	$	3,079			100%				0%	100%
422120	Telephone - Cellular	$	12,316			100%				0%	100%
422200	Electric	$	266,730		100%					0%	100%
422300	Gas	$	513			100%				0%	100%
422500	Water	$	10,263			100%				0%	100%
422600	Other Utilities	$	6,158			100%				0%	100%
422700	Refuse/Disposal Fees	$	5,589			100%				0%	100%
423100	Equipment Rental	$	8,211			100%				0%	100%
423400	Motor Pool Equipment Rental	$	102,635			100%				0%	100%
424120	Constr & Maint Materials	$	9,032			100%				0%	100%
424130	Maint/Repair of Bldgs & Improv	$	2,053			100%				0%	100%
424220	All Other Equip Maint/Repair	$	17,448		100%	0%				0%	100%
424230	Central Garage Charges	$	56,449			100%				0%	100%
424240	Central Communications Chg	$	411			100%				0%	100%
425200	Periodicals & Dues	$	1,232			100%				0%	100%
425300	Photo & Recording Supplies	$	821			100%				0%	100%
425400	General Office Expense	$	5,132			100%				0%	100%
425600	Central Printing Charges	$	103			100%				0%	100%
425700	Software Purchase/Licensing	$	3,079			100%				0%	100%
425800	Computer Equip Purc Undr $5000	$	2,566			100%				0%	100%
426100	Janitorial Supplies	$	513			100%				0%	100%
426200	Clothing/Linen/Safety Supplies	$	14,502			100%				0%	100%
426300	Motor Fuels & Lubricants	$	30,790		100%					0%	100%
426600	Chemical Supplies	$	49,685		100%					0%	100%
426700	Maintenance Tools/Supplies	$	15,498			100%				0%	100%
426710	Work Boot Reimbursement	$	2,155			100%				0%	100%
426800	Special Department Supplies	$	10,777			100%				0%	100%
427100	Travel & Meeting Expense	$	2,053			100%				0%	100%
427200	Training	$	10,263			100%				0%	100%
428400	Insurance /AllOther	$	46,122			100%				0%	100%
448000	Employee Meal Allowance	$	209			100%				0%	100%
450095	Street Replacement Charge	$	1,377,426			100%				0%	100%
462100	Automotive Equipment	$	902,029			100%				0%	100%
462200	Machinery & Equip	$	-			100%				0%	100%
881100	General Fund Allocation Chgs	$	143,391			100%				0%	100%
881200	Central Service Alloc Charges	$	-			100%				0%	100%
884101	Interfund Charges from 101 Fnd	$	26,685			100%				0%	100%
894101	Interfund Services to 101 Fund	$	(7,698)			100%				0%	100%
0000	Jury Duty	$	877							100%	100%
0000	Interfund Services to 540 Fund	$	(811)							100%	100%
0000	[Other]	$	-							100%	100%

0000	[Other]		$	-							100%	***100%***
Public Works / PW-Sewer Systems-Treatment												
411100	Salaries - Regular		$	1,931,432			44%	33%	17%	5%	2%	0%	***100%***
411130	Compensatory Time		$	-			44%	33%	17%	5%	2%	0%	***100%***
411210	Vacation		$	-			44%	33%	17%	5%	2%	0%	***100%***
411220	Holidays & Special Days Off		$	-			44%	33%	17%	5%	2%	0%	***100%***
411240	Sick Leave		$	-			44%	33%	17%	5%	2%	0%	***100%***
411245	Family Illness Sick Leave		$	-			44%	33%	17%	5%	2%	0%	***100%***
411260	Bereavement Leave		$	-			44%	33%	17%	5%	2%	0%	***100%***
411280	Jury Duty		$	-			44%	33%	17%	5%	2%	0%	***100%***
411310	Night Shift Premium		$	19,430			44%	33%	17%	5%	2%	0%	***100%***
411320	Temporary Foreman Pay		$	486			44%	33%	17%	5%	2%	0%	***100%***
411410	Vacation Payoffs		$	-			44%	33%	17%	5%	2%	0%	***100%***
411420	Sick Leave Payoff		$	-			44%	33%	17%	5%	2%	0%	***100%***
411430	Compensatory Time Payoff		$	-			44%	33%	17%	5%	2%	0%	***100%***
411510	Accrued Payroll		$	-			44%	33%	17%	5%	2%	0%	***100%***
411521	Accrued Sick Leave Yr End Only		$	-			44%	33%	17%	5%	2%	0%	***100%***
411522	Accrued Vacation Year-End Only		$	-			44%	33%	17%	5%	2%	0%	***100%***
411530	Accrued Comp. Time Earned		$	-			44%	33%	17%	5%	2%	0%	***100%***
412210	Workers Compensation Ins		$	73,292			44%	33%	17%	5%	2%	0%	***100%***
412220	Health Insurance		$	241,799			44%	33%	17%	5%	2%	0%	***100%***
412221	Retiree Health Insurance		$	-			44%	33%	17%	5%	2%	0%	***100%***
412222	Dental Insurance		$	14,015			44%	33%	17%	5%	2%	0%	***100%***
412230	Life Insurance		$	5,382			44%	33%	17%	5%	2%	0%	***100%***
412240	Unemployment Insurance		$	976			44%	33%	17%	5%	2%	0%	***100%***
412250	Disability Insurance		$	2,290			44%	33%	17%	5%	2%	0%	***100%***
412310	PERS Retirement		$	444,225			44%	33%	17%	5%	2%	0%	***100%***
412320	Medicare OASDI		$	28,004			44%	33%	17%	5%	2%	0%	***100%***
412400	Deferred Compensation		$	32,059			44%	33%	17%	5%	2%	0%	***100%***
413110	Overtime At Straight Rate		$	3,886			44%	33%	17%	5%	2%	0%	***100%***
413120	Overtime At 1.5 Rate		$	97,149			44%	33%	17%	5%	2%	0%	***100%***
413130	Overtime At Double Time Rate		$	24,287			44%	33%	17%	5%	2%	0%	***100%***
413210	Holiday OIT-Straight/Non-Sched		$	24,287			44%	33%	17%	5%	2%	0%	***100%***
413230	Holiday O1T-StrtlSubj To Retir		$	14,572			44%	33%	17%	5%	2%	0%	***100%***
413240	OIT 1.5 Rate Sub To Retirement		$	-			44%	33%	17%	5%	2%	0%	***100%***
419910	Salaries Adjustment Factor		$	-			44%	33%	17%	5%	2%	0%	***100%***
421000	Professional Services		$	41,483			44%	33%	17%	5%	2%	0%	***100%***
421043	Prof Svcs Regulatory Comp		$	210,097			44%	33%	17%	5%	2%	0%	***100%***
422100	Telephone		$	5,829			44%	33%	17%	5%	2%	0%	***100%***
422120	Telephone - Cellular		$	6,800			44%	33%	17%	5%	2%	0%	***100%***
422200	Electric		$	1,782,166			44%	33%	17%	5%	2%	0%	***100%***
422300	Gas		$	4,955			44%	33%	17%	5%	2%	0%	***100%***
422500	Water		$	84,158			44%	33%	17%	5%	2%	0%	***100%***
422600	Other Utilities		$	59,455			44%	33%	17%	5%	2%	0%	***100%***
422700	Refuse/Disposal Fees		$	2,797,011			44%	33%	17%	5%	2%	0%	***100%***
423100	Equipment Rental		$	3,886			44%	33%	17%	5%	2%	0%	***100%***
423400	Motor Pool Equipment Rental		$	48,575			44%	33%	17%	5%	2%	0%	***100%***
424130	Maint/Repair of Bldgs & Improv		$	-			44%	33%	17%	5%	2%	0%	***100%***
424220	All Other Equip Maint/Repair		$	16,661			44%	33%	17%	5%	2%	0%	***100%***
424230	Central Garage Charges		$	14,572			44%	33%	17%	5%	2%	0%	***100%***
424240	Central Communications Chg		$	3,886			44%	33%	17%	5%	2%	0%	***100%***
425200	Periodicals & Dues		$	7,335			44%	33%	17%	5%	2%	0%	***100%***
425300	Photo & Recording Supplies		$	243			44%	33%	17%	5%	2%	0%	***100%***
425400	General Office Expense		$	9,812			44%	33%	17%	5%	2%	0%	***100%***
425500	Postage		$	-			44%	33%	17%	5%	2%	0%	***100%***
425600	Central Printing Charges		$	486			44%	33%	17%	5%	2%	0%	***100%***
425700	Software Purchase/Licensing		$	9,715			44%	33%	17%	5%	2%	0%	***100%***
425800	Computer Equip Purc Undr $5000		$	4,857			44%	33%	17%	5%	2%	0%	***100%***
426100	Janitorial Supplies		$	583			44%	33%	17%	5%	2%	0%	***100%***
426200	Clothing/Linen/Safety Supplies		$	25,976			44%	33%	17%	5%	2%	0%	***100%***
426300	Motor Fuels & Lubricants		$	13,601			44%	33%	17%	5%	2%	0%	***100%***
426600	Chemical Supplies		$	2,737,110			44%	33%	17%	5%	2%	0%	***100%***
426700	Maintenance Tools/Supplies		$	971			44%	33%	17%	5%	2%	0%	***100%***

426710	Work Boot Reimbursement	$	3,789			44%	33%	17%	5%	2%	0%	100%
426800	Special Department Supplies	$	20,596			44%	33%	17%	5%	2%	0%	100%
427100	Travel &MeetingExpense	$	3,109			44%	33%	17%	5%	2%	0%	100%
427200	Training	$	17,001			44%	33%	17%	5%	2%	0%	100%
428400	Insurance / All Other	$	99,759			44%	33%	17%	5%	2%	0%	100%
448000	Employee Meal Allowance	$	991			44%	33%	17%	5%	2%	0%	100%
452005	Education Reimbursement Prog	$	971			44%	33%	17%	5%	2%	0%	100%
462308	Off Furn & Eq/Computer Acqustn	$	-			44%	33%	17%	5%	2%	0%	100%
440301	City Funds	$	-			44%	33%	17%	5%	2%	0%	100%
881100	General Fund Allocation Chgs	$	438,248			44%	33%	17%	5%	2%	0%	100%
881200	Central Service Alloc Charges	$	-			44%	33%	17%	5%	2%	0%	100%
882510	Utilization Chgs from 510 Fund	$	3,432			44%	33%	17%	5%	2%	0%	100%
0000	[Other]	$	-								100%	0%
0000	[Other]	$	-								100%	0%
0000	[Other]	$	-								100%	0%
0000	[Other]	$	-								100%	0%
Public Works / PW-Sewer-Environmental Complia												
411100	Salaries - Regular	$	461,464								100%	0%
411130	Compensatory Time	$	-								100%	0%
411210	Vacation	$	-								100%	0%
411220	Holidays & Special Days Off	$	-								100%	0%
411240	Sick Leave	$	-								100%	0%
411245	Family Illness Sick Leave	$	-								100%	100%
411280	Jury Duty	$	-								100%	100%
411292	Administrative Leave	$	-								100%	100%
411410	Vacation Payoffs	$	-								100%	100%
411430	Compensatory Time Payoff	$	-								100%	100%
411510	Accrued Payroll	$	-								100%	100%
411521	Accrued Sick Leave Yr End Only	$	-								100%	100%
411522	Accrued Vacation Year-End Only	$	-								100%	100%
411530	Accrued Comp. Time Earned	$	-								100%	100%
412210	Workers Compensation Ins	$	17,511								100%	100%
412220	Health Insurance	$	61,464								100%	100%
412221	Retiree Health Insurance	$	-								100%	100%
412222	Dental Insurance	$	3,664								100%	100%
412230	Life Insurance	$	1,271								100%	100%
412240	Unemployment Insurance	$	234								100%	100%
412250	Disability Insurance	$	766								100%	100%
412310	PERS Retirement	$	106,135								100%	100%
412320	Medicare OASDI	$	6,690								100%	100%
412400	Deferred Compensation	$	7,100								100%	0%
413110	Overtime At Straight Rate	$	-								100%	0%
413120	Overtime At 1.5 Rate	$	3,156								100%	0%
413130	Overtime At Double Time Rate	$	158								100%	0%
413210	Holiday O/T-StraightlNon-Sched	$	118								100%	0%
419910	Salaries Adjustment Factor	$	-								100%	0%
421000	Professional Services	$	10,256								100%	0%
422100	Telephone	$	4,023								100%	0%
422120	Telephone - Cellular	$	5,917								100%	0%
423100	Equipment Rental	$	394								100%	0%
423400	Motor Pool Equipment Rental	$	23,667								100%	0%
424220	All Other Equip Maint/Repair	$	5,365								100%	0%
424230	Central Garage Charges	$	11,834								100%	0%
425200	Periodicals & Dues	$	3,246								100%	0%
425300	Photo & Recording Supplies	$	197								100%	0%
425400	General Office Expense	$	6,785								100%	0%
425500	Postage	$	391								100%	0%
425600	Central Printing Charges	$	3,156								100%	0%
425700	Software Purchase/Licensing	$	394								100%	0%
425800	Computer Equip Purc Undr $5000	$	3,945								100%	0%
426200	Clothing/Linen/Safety Supplies	$	7,889								100%	0%

426300	Motor Fuels & Lubricants		$	394							100%	*0%*
426700	Maintenance Tools/Supplies		$	3,945							100%	*0%*
426710	Work Boot Reimbursement		$	947							100%	*0%*
426800	Special Department Supplies		$	4,733							100%	*0%*
427100	Travel & Meeting Expense		$	789							100%	*0%*
427200	Training		$	7,495							100%	*0%*
428400	Insurance I All Other		$	23,836							100%	*0%*
448000	Employee Meal Allowance		$	39							100%	*0%*
462100	Automotive Equipment		$	-							100%	*0%*
881100	General Fund Allocation Chgs		$	49,419							100%	*0%*
881200	Central Service Alloc Charges		$	-							100%	*0%*
0000	Bereavement Leave		$	2,753							100%	*0%*
0000	Maint/Repair of Bldgs & Improv		$	-							100%	*0%*
0000	Janitorial Supplies		$	-							100%	*0%*
0000	[Other]		$	-							100%	*0%*
Public Works / PW-Sewer Systems-Plant Maint												
411100	Salaries-Regular		$	1,540,762							100%	*100%*
411110	Salaries-Temp & Part Time		$	-							100%	*100%*
411130	Compensatory Time		$	-							100%	*0%*
411210	Vacation		$	-							100%	*0%*
411220	Holidays & Special Days Off		$	-							100%	*0%*
411240	Sick Leave		$	-							100%	*0%*
411245	Family Illness Sick Leave		$	-							100%	*0%*
411250	Industrial Accident		$	-							100%	*0%*
411260	Bereavement Leave		$	-							100%	*0%*
411280	Jury Duty		$	-							100%	*0%*
411292	Administrative Leave		$	-							100%	*0%*
411410	Vacation Payoffs		$	-							100%	*0%*
411420	Sick Leave Payoff		$	-							100%	*0%*
411430	Compensatory Time Payoff		$	-							100%	*0%*
411510	Accrued Payroll		$	-							100%	*0%*
411521	Accrued Sick Leave Yr End Only		$	-							100%	*0%*
411522	Accrued Vacation Year-End Only		$	-							100%	*0%*
411530	Accrued Comp. Time Earned		$	-							100%	*0%*
412210	Workers Compensation Ins		$	58,484							100%	*0%*
412220	Health Insurance		$	255,992							100%	*0%*
412221	Retiree Health Insurance		$	-							100%	*0%*
412222	Dental Insurance		$	14,066							100%	*0%*
412230	Life Insurance		$	4,116							100%	*0%*
412240	Unemployment Insurance		$	767							100%	*100%*
412250	Disability Insurance		$	3,339							100%	*100%*
412310	PERS Retirement		$	354,368							100%	*100%*
412320	Medicare OASDI		$	22,328							100%	*0%*
412330	City Retirement Plan		$	-							100%	*0%*
412400	Deferred Compensation		$	14,949							100%	*0%*
413110	Overtime At Straight Rate		$	8,305							100%	*0%*
413120	Overtime At 1.5 Rate		$	29,068							100%	*0%*
413130	Overtime At Double Time Rate		$	4,153							100%	*0%*
413210	Holiday 0/T-Straight/Non-Sched		$	831							100%	*0%*
413230	Holiday OIT-Strt/Subj To Retir		$	-							100%	*0%*
419910	Salaries Adjustment Factor		$	-							100%	*0%*
421000	Professional Services		$	84,297							100%	*0%*
422100	Telephone		$	4,983							100%	*0%*
422120	Telephone - Cellular		$	7,059							100%	*0%*
422700	Refuse/Disposal Fees		$	9,867							100%	*0%*
423100	Equipment Rental		$	11,876							100%	*0%*
423400	Motor Pool Equipment Rental		$	56,475							100%	*0%*
424120	Constr & Maint Materials		$	4,153							100%	*0%*
424130	Maint/Repair of Bldgs & Improv		$	71,922							100%	*100%*
424200	Maintenance & Repair - General		$	-							100%	*100%*
424210	Auto Equip Repair/Parts/Sere		$	-							100%	*100%*
424220	All Other Equip Maint/Repair		$	329,847							100%	*100%*
424230	Central Garage Charges		$	24,915							100%	*100%*

424240	Central Communications Chg		$	7,973							100%	***100%***
425200	Periodicals & Dues		$	1,661							100%	***100%***
425400	General Office Expense		$	7,225							100%	***100%***
425700	Software Purchase/Licensing		$	1,246							100%	***100%***
425800	Computer Equip Purc Undr $5000		$	9,966							100%	***100%***
426100	Janitorial Supplies		$	4,983							100%	***100%***
426200	Clothing/Linen/Safety Supplies		$	26,400							100%	***100%***
426300	Motor Fuels & Lubricants		$	9,136							100%	***100%***
426400	Horticultural Supplies		$	12,873							100%	***100%***
426600	Chemical Supplies		$	4,317							100%	***100%***
426700	Maintenance Tools/Supplies		$	8,388							100%	***100%***
426710	Work Boot Reimbursement		$	3,737							100%	***100%***
426800	Special Department Supplies		$	9,675							100%	***100%***
427200	Training		$	18,354							100%	***0%***
428400	Insurance / All Other		$	79,577							100%	***0%***
448000	Employee Meal Allowance		$	85							100%	***0%***
450011	Clark Fund Botany Gallery		$	-							100%	***0%***
462100	Automotive Equipment		$	-							100%	***0%***
462200	Machinery & Equip		$	-							100%	***0%***
881100	General Fund Allocation Chgs		$	180,708							100%	***0%***
881200	Central Service Alloc Charges		$	-							100%	***0%***
882540	Utilization Chgs from 540 Fund		$	-							100%	***0%***
884101	Interfund Charges from 101 Fnd		$	-							100%	***0%***
894540	Interfund Services to 540 Fund		$	-							100%	***0%***
0000	Interfund Charges from 540 Fnd		$	-							100%	***0%***
0000	Postage		$	27							100%	***0%***
0000	Travel & Meeting Expense		$	771							100%	***0%***
0000	[Other]		$	-							100%	***0%***
Public Works / PW-Sewer-Laboratory Services												
411100	Salaries - Regular		$	321,532							100%	***0%***
411110	Salaries-Temp & Part Time		$	-							100%	***0%***
411130	Compensatory Time		$	-							100%	***0%***
411210	Vacation		$	-							100%	***0%***
411220	Holidays & Special Days Off		$	-							100%	***0%***
411240	Sick Leave		$	-							100%	***0%***
411245	Family Illness Sick Leave		$	-							100%	***0%***
411250	Industrial Accident		$	-							100%	***0%***
411260	Bereavement Leave		$	-							100%	***0%***
411430	Compensatory Time Payoff		$	-							100%	***0%***
411510	Accrued Payroll		$	-							100%	***0%***
411521	Accrued Sick Leave Yr End Only		$	-							100%	***0%***
411522	Accrued Vacation Year-End Only		$	-							100%	***0%***
411530	Accrued Comp. Time Earned		$	-							100%	***0%***
412210	Workers Compensation Ins		$	12,202							100%	***0%***
412220	Health Insurance		$	43,546							100%	***0%***
412221	Retiree Health Insurance		$	-							100%	***0%***
412222	Dental Insurance		$	2,260							100%	***0%***
412230	Life Insurance		$	858							100%	***0%***
412240	Unemployment Insurance		$	162							100%	***0%***
412250	Disability Insurance		$	558							100%	***0%***
412310	PERS Retirement		$	73,950							100%	***0%***
412320	Medicare OASDI		$	4,659							100%	***0%***
412400	Deferred Compensation		$	2,414							100%	***0%***
413120	Overtime At 1.5 Rate		$	1,609							100%	***0%***
413210	Holiday OfT-Straight/Non-Sched		$	805							100%	***0%***
413220	Holiday OIT-1.5 Rate/Non-Sched		$	-							100%	***0%***
413230	Holiday OIT-Strt/Subj To Retir		$	1,609							100%	***0%***
419910	Salaries Adjustment Factor		$	-							100%	***0%***
421000	Professional Services		$	74,914							100%	***0%***
422100	Telephone		$	2,012							100%	***0%***
422120	Telephone - Cellular		$	805							100%	***0%***
424220	All Other Equip Maint/Repair		$	24,140							100%	***0%***
424230	Central Garage Charges		$	1,642							100%	***0%***
425200	Periodicals & Dues		$	6,276							100%	***0%***

425400	General Office Expense		$	4,023							100%	0%
425600	Central Printing Charges		$	-							100%	0%
425700	Software Purchase/Licensing		$	821							100%	0%
425800	Computer Equip Purc Undr $5000		$	805							100%	0%
426100	Janitorial Supplies		$	121							100%	0%
426200	Clothing/Linen/Safety Supplies		$	7,989							100%	0%
426300	Motor Fuels & Lubricants		$	121							100%	0%
426600	Chemical Supplies		$	15,991							100%	0%
426700	Maintenance Tools/Supplies		$	161							100%	0%
426710	Work Boot Reimbursement		$	724							100%	0%
426800	Special Department Supplies		$	55,119							100%	0%
427100	Travel & Meeting Expense		$	1,609							100%	0%
427200	Training		$	7,242							100%	0%
428400	Insurance / All Other		$	16,607							100%	0%
462200	Machinery & Equip		$	-							100%	0%
881100	General Fund Allocation Chgs		$	44,951							100%	0%
881200	Central Service Alloc Charges		$	-							100%	0%
0000	Jury Duty		$	727							100%	0%
0000	Administrative Leave		$	260							100%	0%
0000	Night Shift Premium		$	49							100%	0%
0000	Temporary Foreman Pay		$	236							100%	0%
0000	Overtime At Straight Rate		$	175							100%	0%
0000	[Other]		$	-							100%	0%
0006	[Other]		$	-							100%	0%
0000	[Other]		$	-							100%	0%
0000	[Other]		$	-							100%	0%
Public Works / PW-Sewer Systems Debt Service												
481000	SRF Loan - Headworks Project		$	477,387							100%	0%
481020	SRF Loan - Cogeneration Project		$	339,474							100%	0%
482000	Sewer Refunding Revenue Bond		$	4,852,000							100%	0%
0000	Pension Obligation Bonds (POB)		$	298,011							100%	0%
0000	Revenue Bonds - NEW		$	1,638,768							100%	0%
0000	SRF Loan - NEW		$	-							100%	0%
0000	[Other]		$	-							100%	0%
0000	[Other]		$	-							100%	0%
0000	[Other]		$	-							100%	0%
0000	[Other]		$	-							100%	0%
Public Works I PW-Sewer Sys-CoGen/Landfill												
411100	Salaries - Regular		$	83,750				45%	50%		5%	0% 100%
411210	Vacation		$	-				45%	50%		5%	0% 100%
411220	Holidays & Special Days Off		$	-				45%	50%		5%	0% 100%
411240	Sick Leave		$	-				45%	50%		5%	0% 100%
411245	Family Illness Sick Leave		$	-				45%	50%		5%	0% 100%
411510	Accrued Payroll		$	-				45%	50%		5%	0% 100%
411521	Accrued Sick Leave Yr End Only		$	-				45%	50%		5%	0% 100%
411522	Accrued Vacation Year-End Only		$	-				45%	50%		5%	0% 100%
411530	Accrued Comp. Time Earned		$	-				45%	50%		5%	0% 100%
412210	Workers Compensation Ins		$	3,178				45%	50%		5%	0% 100%
412220	Health Insurance		$	14,222				45%	50%		5%	0% 100%
412221	Retiree Health Insurance		$	-				45%	50%		5%	0% 100%
412222	Dental Insurance		$	772				45%	50%		5%	0% 100%
412230	Life Insurance		$	214				45%	50%		5%	0% 100%
412240	Unemployment Insurance		$	42				45%	50%		5%	0% 100%
412250	Disability Insurance		$	195				45%	50%		5%	0% 100%
412310	PERS Retirement		$	19,261				45%	50%		5%	0% 100%
412320	Medicare OASDI		$	1,215				45%	50%		5%	0% 100%
413110	Overtime At Straight Rate		$	4,925				45%	50%		5%	0% 100%
413120	Overtime At 1.5 Rate		$	17,588				45%	50%		5%	0% 100%
413130	Overtime At Double Time Rate		$	3,518				45%	50%		5%	0% 100%
413210	Holiday OIT-Straight/Non-Sched		$	-				45%	50%		5%	0% 100%
413230	Holiday OIf-Strt/Subj To Retir		$	-				45%	50%		5%	0% 100%
419910	Salaries Adjustment Factor		$	-				45%	50%		5%	0% 100%
421000	Professional Services		$	127,128				45%	50%		5%	0% 100%

421043	Prof Svcs Regulatory Comp		$	35,177				45%	50%		5%	0%	100%
422100	Telephone		$	704				45%	50%		5%	0%	100%
422120	Telephone - Cellular		$	1,477				45%	50%		5%	0%	100%
422200	Electric		$	44,454				45%	50%		5%	0%	100%
422300	Gas		$	386,942				45%	50%		5%	0%	100%
422500	Water		$	704				45%	50%		5%	0%	100%
422600	Other Utilities		$	844				45%	50%		5%	0%	100%
422700	Refuse/Disposal Fees		$	1,393				45%	50%		5%	0%	100%
423100	Equipment Rental		$	844				45%	50%		5%	0%	100%
424130	Maint/Repair of Bldgs & Improv		$	3,518				45%	50%		5%	0%	100%
424200	Maintenance & Repair - General		$	-				45%	50%		5%	0%	100%
424220	All Other Equip Maint/Repair		$	343,815				45%	50%		5%	0%	100%
424230	Central Garage Charges		$	1,435				45%	50%		5%	0%	100%
425200	Periodicals & Dues		$	281				45%	50%		5%	0%	100%
425400	General Office Expense		$	704				45%	50%		5%	0%	100%
426100	Janitorial Supplies		$	176				45%	50%		5%	0%	100%
426200	Clothing/Linen/Safety Supplies		$	1,093				45%	50%		5%	0%	100%
426300	Motor Fuels & Lubricants		$	21,106				45%	50%		5%	0%	100%
426600	Chemical Supplies		$	9,106				45%	50%		5%	0%	100%
426700	Maintenance Tools/Supplies		$	704				45%	50%		5%	0%	100%
426710	Work Boot Reimbursement		$	211				45%	50%		5%	0%	100%
426800	Special Department Supplies		$	352				45%	50%		5%	0%	100%
427100	Travel & Meeting Expense		$	359				45%	50%		5%	0%	100%
427200	Training		$	2,294				45%	50%		5%	0%	100%
428400	Insurance / All Other		$	4,325				45%	50%		5%	0%	100%
448000	Employee Meal Allowance		$	108				45%	50%		5%	0%	100%
881100	General Fund Allocation Chgs		$	57,639				45%	50%		5%	0%	100%
881200	Central Service Alloc Charges		$	-				45%	50%		5%	0%	100%
0000	Compensatory Time		$	294								100%	0%
0000	Administrative Leave		$	44								100%	0%
0000	[Other]		$	-								100%	0%
0000	[Other]		$	-								100%	0%
Public Works / PW-Sewer-Capital Project Serv													
422100	Telephone		$	165								100%	100%
422120	Telephone - Cellular		$	198								100%	100%
424220	All Other Equip Maint/Repair		$	362								100%	0%
425200	Periodicals & Dues		$	171								100%	0%
425300	Photo & Recording Supplies		$	86								100%	0%
425400	General Office Expense		$	153								100%	100%
425500	Postage		$	13								100%	100%
425600	Central Printing Charges		$	66								100%	100%
426800	Special Department Supplies		$	105								100%	100%
427100	Travel & Meeting Expense		$	132								100%	100%
427200	Training		$	119								100%	100%
0000	[Other]		$	-								100%	100%
0000	[Other]		$	-								100%	100%
Additional O&M Treatment Costs (developed by Carollo)													
0000	New Headworks		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Biofilters		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Primary Clarifiers		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Primary Sludge Pump Station		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Primary Effluent EQ		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Primary EQ Pumps		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Fine (perforated) Screens		$	-			44%	33%	17%	5%	2%	0%	100%
0000	MBR Facility and RAS/WAS Pumps		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Primary Sludge Thickeners (GBTs)		$	-			44%	33%	17%	5%	2%	0%	100%
0000	WAS Thickeners (GBTs)		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Chlorine Contact Basin		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Acid-Phase Digester		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Cogeneration Engines		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Fuel Cells		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Reclaim and Reuse Water		$	-			44%	33%	17%	5%	2%	0%	100%
0000	Energy Management		$	-			44%	33%	17%	5%	2%	0%	100%

0000	[Other]		$ -									100%	*0%*
0000	[Other]		$ -									100%	*0%*
												100%	*100%*
												100%	*100%*
	Subtotals:		$ 33,867,062	$ -	$ 573,300	$ 8,971,748	$ 4,263,044	$ 2,514,549	$ 583,319	$ 267,122	$ 16,693,980		
	Re-Allocation of "As All Others":			-	557,306	8,721,450	4,144,112	2,444,397	567,046	259,669			
	Total Allocation:		**$ 33,867,062**	**$ -**	**$ 1,130,606**	**$ 17,693,198**	**$ 8,407,156**	**$ 4,958,946**	**$ 1,150,365**	**$ 526,791**			
	Percentage Allocation:			**0%**	**3%**	**52%**	**25%**	**15%**	**3%**	**2%**			

(1) "As All Others" costs are re-allocated based on functional cost allocation to billable constituents

		FY 2008	Functional Allocation								
Expenditures		**2009**	**Customer**	**Pumping**	**Flow**	**BOD_5**	**TSS**	**NIT**	**O/G**		
Ongoing Operating Expenses											
Operating Expenses	$	26,261,421		3%	52%	25%	15%	3%	2%	0%	*100%*
Other Operating Expenses											
Debt Service	$	7,605,640		3%	52%	25%	15%	3%	2%	0%	*100%*
Rate Funded Capital Improvements	$	-		3%	52%	25%	15%	3%	2%	0%	*100%*
Replacement Funding	$	-		0%	44%	33%	17%	5%	2%	0%	*100%*
Additions to Fund Balances	$	-								100%	*0%*
Utility Tax	$	703,645								100%	*0%*
										100%	*0%*
Less Off-Setting Revenues											
Over/Under Collection of Rates	$	-								100%	*0%*
Rate Increase Due to Delay	$	-								100%	*0%*
Coverage Driven Increase	$	2,266,823								100%	*0%*
CSD Revenues	$	(6,568,458)								100%	*0%*
Interest Earnings	$	(354,485)								100%	*0%*
Misc Revenue	$	(681,312)								100%	*0%*
Connection Fees Revenues	$	-			55%	37%	7%			0%	*100%*
	Subtotals:	$ 29,233,276	$ -	$ 1,130,606	$ 17,693,198	$ 8,407,156	$ 4,958,946	$ 1,150,365	$ 526,791	$ (4,633,786)	
	Re-Allocation of "As All Others":		-	(154,693)	(2,420,833)	(1,150,290)	(678,497)	(157,396)	(72,077)		
	Total Allocation:	**$ 29,233,276**	**$ -**	**$ 975,913**	**$ 15,272,365**	**$ 7,256,865**	**$ 4,280,449**	**$ 992,969**	**$ 454,714**		
	Percentage Allocation:		**0%**	**3%**	**52%**	**25%**	**15%**	**3%**	**2%**		

	Pumping	Flow	BOD5	TSS	Nit	O/G
	$ 975,913	$ 15,272,365	$ 7,256,865	$ 4,280,449	$ 992,969	$ 454,714

RATE CALCULATION

	Customer	**Pumping**	**Flow**	**BOD_5**	**TSS**	**NIT**	**O/G**	
Total Cost Allocation	$ -	$ 975,913	$ 15,272,365	$ 7,256,865	$ 4,280,449	$ 992,969	$ 454,714	$ 29,233,276
	Annual # of Accounts	Total Flow (CCF)	Total Flow (CCF)	Total B.O.D. (lbs)	Total T.S.S. (lbs)	Total Nit (lbs)	Total O/G (lbs)	
Customer Information excluding CSDs - (Totals)	129,862	2,855,724	12,640,077	19,606,504	18,902,948	2,381,362	5,867,960	$29,233,276
Per Unit Costs	$ / Accounts	$ / CCF	$ / CCF	$ / lbs B.O.D	$ / lbs TSS	$ / lbs Nit	$ / lbs O/G	
	$0.00 *fixed*	$0.34	$1.21	$0.37	$0.23	$0.42	$0.08	
Per Unit Costs including Pumping	$0.00		$1.55	$0.37	$0.23	$0.42	$0.08	

USER RATE CALCULATION

				76811355.45						
					$ 39,213,008					
					$ 0.19					
RESIDENTIAL		**Number of Accounts**	**Pumping**	**Flow (CCF)**	**BOD (lbs)**	**TSS (lbs)**	**NIT (lbs)**	**O/G (lbs)**		
BASIC MULTI-FAMILY DWELLING UNIT	Actual annual			2,003,266	2,843,071	3,236,726	384,908	787,312		
flat charge per month	Actual monthly	20,677		166,939	236,923	269,727	32,076	65,609		**Check: Rate X Acc**
	Monthly units			8.07	11.46	13.05	1.55	3.17	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 9.76	$ 4.24	$ 2.95	$ 0.65	$ 0.25	$17.84	**$ 4,427,180**
BASIC SINGLE FAMILY DWELLING UNIT	Actual annual			4,718,349	6,696,365	7,623,554	906,585	1,854,378		
flat charge per month	Actual monthly	43,952		393,196	558,030	635,296	75,549	154,532		
	Monthly units			8.95	12.70	14.45	1.72	3.52	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 10.81	$ 4.70	$ 3.27	$ 0.72	$ 0.27	$19.77	**$ 10,427,463**
BASIC MULTI-FAMILY DWELLING - PUMPING	Actual annual			642,060	911,224	1,037,393	123,366	252,339		
flat charge per month	Actual monthly	6,627		53,505	75,935	86,449	10,280	21,028		
	Monthly units			8.07	11.46	13.05	1.55	3.17	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 12.51	$ 4.24	$ 2.95	$ 0.65	$ 0.25	$20.60	**$ 1,638,359**
BASIC SINGLE FAMILY DWELLING - PUMPING	Actual annual			1,776,866	2,521,760	2,870,926	341,407	698,333		
flat charge per month	Actual monthly	16,552		148,072	210,147	239,244	28,451	58,194		
	Monthly units			8.95	12.70	14.45	1.72	3.52	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 13.87	$ 4.70	$ 3.27	$ 0.72	$ 0.27	$22.83	**$ 4,534,065**
COMMERCIAL		**Number of Accounts**	**Pumping**	**Flow (CCF)**	**BOD (lbs)**	**TSS (lbs)**	**NIT (lbs)**	**O/G (lbs)**		
BASIC COMMERCIAL (FLAT RATE)	Actual annual			7,671	10,886	12,394	1,196	4,067		
flat charge per month	Actual monthly	71		639	907	1,033	100	339		
	Monthly units			8.95	12.70	14.45	1.40	4.74	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 10.81	$ 4.70	$ 3.27	$ 0.58	$ 0.37	$19.73	**$ 16,918**
BASIC COMMERCIAL - PUMPING (FLAT RATE)	Actual annual			1,380	1,958	2,229	215	732		
flat charge per month	Actual monthly	13		115	163	186	18	61		
	Monthly units			8.95	12.70	14.45	1.40	4.74	**Calculated Monthly Charge**	
	Charge per month	$0.00		$ 13.87	$ 4.70	$ 3.27	$ 0.58	$ 0.37	$22.79	**$ 3,515**
COMMERCIAL		**Number of Accounts**	**Pumping**	**Flow (CCF)**	**BOD (lbs)**	**TSS (lbs)**	**NIT (lbs)**	**O/G (lbs)**		
				110,578	103,473	96,575	17,246	58,635		
DEPARTMENT & RETAIL STORES	Billing unit (ccf) and load (mg	354		1	150	140	25	85		
charge per unit sewer flow	Qtty per unit			748	0.94	0.87	0.16	0.53	**Calculated Unit Charge**	
	Charge per month			$ 1.21	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$1.86	**$ 205,508**
				178,725	278,737	211,840	27,874	95,885		
HOTELS & MOTELS	Billing unit (ccf) and load (mg	37		1	250	190	25	86		
	Qtty per unit			748	1.56	1.19	0.16	0.54	**Calculated Unit Charge**	
	Charge per month			$ 1.21	$ 0.58	$ 0.27	$ 0.07	$ 0.04	$2.16	**$ 386,135**
				35,234	32,970	31,651	6,770	27,475		
LAUNDROMATS	Billing unit (ccf) and load (mg	27		1	150	144	31	125		
	Qtty per unit			748	0.94	0.90	0.19	0.78	**Calculated Unit Charge**	
	Charge per month			$ 1.21	$ 0.35	$ 0.20	$ 0.08	$ 0.06	$1.90	**$ 66,893**
				6,265	17,589	15,869	1,204	4,378		
LAUNDRIES	Billing unit (ccf) and load (mg	3		1	450	406	31	112		
	Qtty per unit			748	2.81	2.53	0.19	0.70	**Calculated Unit Charge**	
	Charge per month			$ 1.21	$ 1.04	$ 0.57	$ 0.08	$ 0.05	$2.96	**$ 18,515**
				54,232	270,653	168,143	10,420	28,757		
MARKETS	Billing unit (ccf) and load (mg	87		1	800	497	31	85		
	Qtty per unit			748	4.99	3.10	0.19	0.53	**Calculated Unit Charge**	
	Charge per month			$ 1.21	$ 1.85	$ 0.70	$ 0.08	$ 0.04	$3.88	**$ 210,350**
				2,832	14,136	14,083	544	1,113		

MORTUARIES	Billing unit (ccf) and load (mg	6		1	800	797	31	63				
	Qtty per unit			748	4.99	4.97	0.19	0.39	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 1.85	$ 1.13	$ 0.08	$ 0.03	$4.29	**$**	**12,156**	
				110,572	89,672	49,664	17,245	58,632				
PROFESSIONAL OFFICES	Billing unit (ccf) and load (mg	267		1	130	72	25	85				
	Qtty per unit			748	0.81	0.45	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.30	$ 0.10	$ 0.07	$ 0.04	$1.72	**$**	**189,769**	
				66,986	83,576	136,646	12,871	297,947				
REPAIR SHOPS & SERVICE STATIONS	Billing unit (ccf) and load (mg	181		1	200	327	31	713				
	Qtty per unit			748	1.25	2.04	0.19	4.45	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.46	$ 0.46	$ 0.08	$ 0.34	$2.56	**$**	**171,266**	
				145,665	908,707	523,415	57,418	228,085				
RESTAURANTS	Billing unit (ccf) and load (mg	256		1	1,000	576	63	251				
	Qtty per unit			748	6.24	3.59	0.39	1.57	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 2.31	$ 0.81	$ 0.16	$ 0.12	$4.62	**$**	**672,476**	
				1,173,702	1,098,289	1,025,070	183,048	622,364				
OTHER COMMERCIAL	Billing unit (ccf) and load (mg	1,847		1	150	140	25	85				
	Qtty per unit			748	0.94	0.87	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$1.86	**$**	**2,181,305**	
				163,129	228,972	203,531	25,441	64,112				
HOSPITAL	Billing unit (ccf) and load (mg	36		1	225	200	25	63				
	Qtty per unit			748	1.40	1.25	0.16	0.39	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.52	$ 0.28	$ 0.07	$ 0.03	$2.11	**$**	**343,514**	
				74,250	92,639	88,007	11,580	39,371				
CHURCHES & HALLS	Billing unit (ccf) and load (mg	154		1	200	190	25	85				
	Qtty per unit			748	1.25	1.19	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.46	$ 0.27	$ 0.07	$ 0.04	$2.04	**$**	**151,808**	
				149,285	107,098	91,266	23,282	12,107				
SCHOOLS "B"	Billing unit (ccf) and load (mg	104		1.0	115	98	25	13				
	Qtty per unit			748	0.72	0.61	0.16	0.08	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.27	$ 0.14	$ 0.07	$ 0.01	$1.68	**$**	**251,326**	
				101,133	94,635	87,064	15,773	53,627				
OTHER COMMERCIAL "A" [(1)]	Billing unit (ccf) and load (mg	61		1.0	150	138	25	85				
	Qtty per unit			748	0.94	0.86	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.35	$ 0.19	$ 0.07	$ 0.04	$1.86	**$**	**187,669**	
				93,842	87,813	83,129	14,635	49,760				
OTHER COMMERCIAL "B" [(1)]	Billing unit (ccf) and load (mg	238		1.0	150	142	25	85				
	Qtty per unit			748	0.94	0.89	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.21	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$1.86	**$**	**174,669**	

[(1)] Other Commercial "A" is assumed to be 60% of a unit of CCF and Other Commercial "B" is assumed to be 30% of a unit of CCF

COMMERCIAL		**Accounts**	**Pumping**	**Flow (CCF)**	**BOD (lbs)**	**TSS (lbs)**	**NIT (lbs)**	**O/G (lbs)**			
				41,533	38,864	36,273	6,477	22,023			
DEPARTMENT & RETAIL STORES - PUMPING	Billing unit (ccf) and load (mg	87		1	150	140	25	85			
charge per unit sewer flow	Qtty per unit			748	0.94	0.87	0.16	0.53	**Calculated Unit Charge**		
	Charge per month			$ 1.55	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$2.20	**$**	**91,381**
				14,946	23,310	17,715	2,331	8,019			
HOTELS & MOTELS - PUMPING	Billing unit (ccf) and load (mg	8		1	250	190	25	86			
	Qtty per unit			748	1.56	1.19	0.16	0.54	**Calculated Unit Charge**		
	Charge per month			$ 1.55	$ 0.58	$ 0.27	$ 0.07	$ 0.04	$2.50	**$**	**37,399**
				13,885	12,993	12,473	2,668	10,828			
LAUNDROMATS - PUMPING	Billing unit (ccf) and load (mg	8		1	150	144	31	125			
	Qtty per unit			748	0.94	0.90	0.19	0.78	**Calculated Unit Charge**		
	Charge per month			$ 1.55	$ 0.35	$ 0.20	$ 0.08	$ 0.06	$2.24	**$**	**31,107**
				75	211	190	14	52			
LAUNDRIES - PUMPING	Billing unit (ccf) and load (mg	1		1	450	406	31	112			
	Qtty per unit			748	2.81	2.53	0.19	0.70	**Calculated Unit Charge**		
	Charge per month			$ 1.55	$ 1.04	$ 0.57	$ 0.08	$ 0.05	$3.30	**$**	**248**
				20,396	101,787	63,235	3,919	10,815			
MARKETS - PUMPING	Billing unit (ccf) and load (mg	19		1	800	497	31	85			
	Qtty per unit			748	4.99	3.10	0.19	0.53	**Calculated Unit Charge**		
	Charge per month			$ 1.55	$ 1.85	$ 0.70	$ 0.08	$ 0.04	$4.22	**$**	**86,078**
				114	568	566	22	45			

MORTUARIES - PUMPING	Billing unit (ccf) and load (mg	1		1	800	797	31	63				
	Qtty per unit			748	4.99	4.97	0.19	0.39	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 1.85	$ 1.13	$ 0.08	$ 0.03	$4.63	**$**	**527**	
				50,005	40,553	22,460	7,799	26,515				
PROFESSIONAL OFFICES - PUMPING	Billing unit (ccf) and load (mg	26		1	130	72	25	85				
	Qtty per unit			748	0.81	0.45	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.30	$ 0.10	$ 0.07	$ 0.04	$2.06	**$**	**102,909**	
				14,528	18,126	29,636	2,791	64,619				
REPAIR SHOPS & SERVICE STATIONS - PUMPING	Billing unit (ccf) and load (mg	34		1	200	327	31	713				
	Qtty per unit			748	1.25	2.04	0.19	4.45	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.46	$ 0.46	$ 0.08	$ 0.34	$2.90	**$**	**42,109**	
				65,293	407,321	234,617	25,737	102,238				
RESTAURANTS - PUMPING	Billing unit (ccf) and load (mg	62		1	1,000	576	63	251				
	Qtty per unit			748	6.24	3.59	0.39	1.57	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 2.31	$ 0.81	$ 0.16	$ 0.12	$4.96	**$**	**323,746**	
				148,622	139,073	129,801	23,179	78,808				
OTHER COMMERCIAL - PUMPING	Billing unit (ccf) and load (mg	273		1	150	140	25	85				
	Qtty per unit			748	0.94	0.87	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$2.20	**$**	**327,001**	
				9,984	14,014	12,457	1,557	3,924				
HOSPITAL - PUMPING	Billing unit (ccf) and load (mg	5		1	225	200	25	63				
	Qtty per unit			748	1.40	1.25	0.16	0.39	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.52	$ 0.28	$ 0.07	$ 0.03	$2.45	**$**	**24,436**	
				8,896	11,100	10,545	1,387	4,717				
CHURCHES & HALLS - PUMPING	Billing unit (ccf) and load (mg	21		1	200	190	25	85				
	Qtty per unit			748	1.25	1.19	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.46	$ 0.27	$ 0.07	$ 0.04	$2.39	**$**	**21,229**	
				15,122	10,849	9,245	2,358	1,226				
SCHOOLS "B" - PUMPING	Billing unit (ccf) and load (mg	31		1.0	115	98	25	13				
	Qtty per unit			748	0.72	0.61	0.16	0.08	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.27	$ 0.14	$ 0.07	$ 0.01	$2.03	**$**	**30,627**	
				17,835	16,689	15,354	2,782	9,457				
OTHER COMMERCIAL "A" - PUMPING	Billing unit (ccf) and load (mg	9		1.0	150	138	25	85				
	Qtty per unit			748	0.94	0.86	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.35	$ 0.19	$ 0.07	$ 0.04	$2.20	**$**	**39,191**	
				14,183	13,272	12,564	2,212	7,521				
OTHER COMMERCIAL "B" - PUMPING	Billing unit (ccf) and load (mg	44		1.0	150	142	25	85				
	Qtty per unit			748	0.94	0.89	0.16	0.53	**Calculated Unit Charge**			
	Charge per month		$	1.55	$ 0.35	$ 0.20	$ 0.07	$ 0.04	$ 2.20	**$**	**31,247**	

		per gallon	per mg/L BOD	per lbs TSS	per lbs Nit	per lbs O/G
Existing Unit Cost	95,994	$ 0.0010	$ 0.18	$ 0.21	?	$ 0.56
		$ 0.76				

	Accounts	**Pumping**	**Flow (CCF)**	**BOD (lbs)**	**TSS (lbs)**	**NIT (lbs)**	**O/G (lbs)**			
SPECIAL USERS	Corona College Heights		15,044	34,771	17,174	2,891	2,628			
Billing unit (ccf) and load (mg/l)			1	371	183	31	28			
Qtty per unit			748	2.31	1.14	0.19	0.17	**Calculated Unit Charge**		
Charge per month		$	1.21	$ 0.86	$ 0.26	$ 0.08	$ 0.01	$2.42	**$**	**36,345**
		$	0.76	$ 0.41	$ 0.23		$ 0.10	$1.50		
	J.C. Grease Buyers		366	348	217	70	14			
Billing unit (ccf) and load (mg/l)			1	153	95	31	6			
Qtty per unit			748	0.95	0.59	0.19	0.04	**Calculated Unit Charge**		
Charge per month		$	1.21	$ 0.35	$ 0.13	$ 0.08	$ 0.00	$1.78	**$**	**651**
		$	0.76	$ 0.17	$ 0.12		$ 0.02	$1.07		
	La Sierra University		36,554	113,675	140,925	7,023	10,490			
Billing unit (ccf) and load (mg/l)			1	499	618	31	46			
Qtty per unit			748	3.11	3.86	0.19	0.29	**Calculated Unit Charge**		
Charge per month		$	1.21	$ 1.15	$ 0.87	$ 0.08	$ 0.02	$3.33	**$**	**121,893**
		$	0.76	$ 0.55	$ 0.79		$ 0.16	$2.26		

	Pepsi Bottling Group		172,121		413,929		41,876		33,071		7,516	
Billing unit (ccf) and load (mg/l)			1		386		39		31		7	
Qtty per unit			748		2.40		0.24		0.19		0.04	**Calculated Unit Charge**
Charge per month		$	1.21	$	0.89	$	0.06	$	0.08	$	0.00	$2.24 **$** **385,026**
		$	0.76	$	0.43	$	0.05			$	0.02	$1.26
	Prudential Overall Supply		29,771		102,982		21,172		5,720		16,715	
Billing unit (ccf) and load (mg/l)			1		555		114		31		90	
Qtty per unit			748		3.46		0.71		0.19		0.56	**Calculated Unit Charge**
Charge per month		$	1.21	$	1.28	$	0.16	$	0.08	$	0.04	$2.77 **$** **82,562**
		$	0.76	$	0.62	$	0.15			$	0.31	$1.83
	Ralphs Grocery Company		108,236		528,016		154,624		20,797		67,521	
Billing unit (ccf) and load (mg/l)			1		782		229		31		100	
Qtty per unit			748		4.88		1.43		0.19		0.62	**Calculated Unit Charge**
Charge per month		$	1.21	$	1.81	$	0.32	$	0.08	$	0.05	$3.47 **$** **375,126**
		$	0.76	$	0.87	$	0.29			$	0.35	$2.27
	Stremicks Heritage Foods		53,872		277,089		72,255		10,351		37,976	
Billing unit (ccf) and load (mg/l)			1		825		215		31		113	
Qtty per unit			748		5.14		1.34		0.19		0.70	**Calculated Unit Charge**
Charge per month		$	1.21	$	1.90	$	0.30	$	0.08	$	0.05	$3.55 **$** **191,268**
		$	0.76	$	0.94	$	0.28			$	0.40	$2.37
	Swiss Dairy		16,279	$	166,950.13	$	29,652.94	$	3,127.78		14,014	
Billing unit (ccf) and load (mg/l)			1		1,644		292		31		138	
Qtty per unit			748		10.26		1.82		0.19		0.86	**Calculated Unit Charge**
Charge per month		$	1.21	$	3.80	$	0.41	$	0.08	$	0.07	$5.56 **$** **90,566**
		$	0.76	$	1.87	$	0.38			$	0.48	$3.49
	Tri-City Linen Supply		58,366		156,383		73,185		11,214		66,995	
Billing unit (ccf) and load (mg/l)			1		430		201		31		184	
Qtty per unit			748		2.68		1.25		0.19		1.15	**Calculated Unit Charge**
Charge per month		$	1.21	$	0.99	$	0.28	$	0.08	$	0.09	$2.65 **$** **154,842**
		$	0.76	$	0.49	$	0.26			$	0.65	$2.16
	Triple H Foods, Inc.		39,481		258,490		26,354		7,586		5,665	
Billing unit (ccf) and load (mg/l)			1		1,050		107		31		23	
Qtty per unit			748		6.55		0.67		0.19		0.14	**Calculated Unit Charge**
Charge per month		$	1.21	$	2.42	$	0.15	$	0.08	$	0.01	$3.87 **$** **152,947**
		$	0.76	$	1.19	$	0.14			$	0.08	$2.17
	Windsor Foods		58,546		210,921		109,204		11,249		48,211	
Billing unit (ccf) and load (mg/l)			1		578		299		31		132	
Qtty per unit			748		3.60		1.87		0.19		0.82	**Calculated Unit Charge**
Charge per month		$	1.21	$	1.33	$	0.42	$	0.08	$	0.06	$ 3.11 **$** **181,961**
		$	0.76	$	0.66	$	0.39			$	0.46	$ 2.27

LIST OF PROJECTED USER RATES AND CONNECTION FEES

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

HANDOUT 6: Example - Revised Connection Fees

User Rate Categories	Existing Fees	Proposed Fees FY 2007/08	Proposed Fees FY 2007/08 (Treatment Only)
Residential Sewer Rates			
Residence on Septic System	$ -	$ -	$ -
Basic Multi-Family Dwelling Unit	$ 2,563	$ 3,134	$ 1,621
Basic Single Family Dwelling Unit	$ 2,684	$ 3,472	$ 1,796
Basic Single Family Dwelling - Pumping	$ 2,684	$ 3,472	$ 1,796
Basic Multi-Family Dwelling Units - Pumping	$ 2,563	$ 3,134	$ 1,621
Commercial Sewer Rates			
Basic Commercial (Flat Rate)	N/A	$ 3,472	$ 1,796
Basic Commercial - Pumping (Flat Rate)	N/A	$ 3,472	$ 1,796
Commercial Rate Structure			
Department & Retail Stores	$ 9,333	$ 8,472	$ 3,914
Hotels & Motels	$ 40,920	$ 157,693	$ 82,320
Laundromats	N/A	$ 35,726	$ 16,521
Laundries	N/A	$ 81,492	$ 48,944
Markets	$ 4,667	$ 40,256	$ 26,632
Mortuaries	$ 3,639	$ 32,853	$ 21,943
Professional Offices	$ 7,000	$ 10,552	$ 4,633
Repair Shops & Service Stations	$ 700	$ 11,675	$ 5,954
Restaurants	$ 1,167	$ 43,300	$ 29,568
Other Commercial	$ 4,305	$ 17,258	$ 7,972
Hospitals	$ 9,333	$ 142,988	$ 73,076
Churches & Halls	$ 2,333	$ 14,600	$ 7,261
Schools "A"	N/A	N/A	N/A
Schools "B"	$ 2,971	$ 35,846	$ 15,450
Other Commercial "A"	N/A	$ 45,267	$ 20,901
Other Commercial "B"	N/A	$ 10,721	$ 4,955
Commercial Rate Structure - Pumping			
Department & Retail Stores	$ 9,333	$ 12,898	$ 5,958
Hotels & Motels	$ 40,920	$ 60,285	$ 31,470
Laundromats	N/A	$ 46,261	$ 21,392
Laundries	N/A	$ 2,931	$ 1,761
Markets	$ 4,667	$ 70,967	$ 46,949
Mortuaries	$ 3,639	$ 6,602	$ 4,409
Professional Offices	$ 7,000	$ 49,670	$ 21,809
Repair Shops & Service Stations	$ 700	$ 13,534	$ 6,902
Restaurants	$ 1,167	$ 80,566	$ 55,015
Other Commercial	$ 4,305	$ 14,793	$ 6,834
Hospitals	$ 9,333	$ 67,824	$ 34,662
Churches & Halls	$ 2,333	$ 12,828	$ 6,380
Schools "A"	N/A	N/A	N/A
Schools "B"	$ 2,971	$ 11,969	$ 5,159
Other Commercial "A"	N/A	$ 51,890	$ 23,959
Other Commercial "B"	N/A	$ 8,699	$ 4,021

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

HANDOUT 5: Revised Summary of Rates

Full CIP Scenario

User Rate Categories	Existing Monthly Rate	Proposed Monthly Rate FY 2008/09	Proposed Monthly Rate FY 2009/2010 (15%)	Proposed Monthly Rate FY 2010/2011 (17%)	Proposed Monthly Rate FY 2011/2012 (14.5%)	Proposed Monthly Rate FY 2012/2013 (5.44%)	Proposed Monthly Rate FY 2013/2014 (0%)	Proposed Monthly Rate FY 2014/2015 (0.7%)	Proposed Monthly Rate FY 2015/2016 (2.3%)	Proposed Monthly Rate FY 2016/2017 (2.22%)	Proposed Monthly Rate FY 2017/2018 (1.92%)	Proposed Monthly Rate FY 2018/2019 (1.35%)	Proposed Monthly Rate FY 2019/2020 (1.3%)	Proposed Monthly Rate FY 2020/2021 (1.61%)	Proposed Monthly Rate FY 2021/2022 (2.59%)	Proposed Monthly Rate FY 2022/2023 (2.72%)	Proposed Monthly Rate FY 2023/2024 (1.69%)	Proposed Monthly Rate FY 2024/2025 (2%)
Residential Sewer Rates																		
Residence on Septic System	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Basic Multi-Family Dwelling Unit	$ 12.29	$17.84	$ 20.52	$ 24.01	$ 27.49	$ 28.98	$ 28.98	$ 29.19	$ 29.86	$ 30.52	$ 31.11	$ 31.53	$ 31.94	$ 32.45	$ 33.29	$ 34.19	$ 34.77	$ 35.47
Basic Single Family Dwelling Unit	$ 13.05	$19.77	$ 22.74	$ 26.60	$ 30.46	$ 32.11	$ 32.11	$ 32.34	$ 33.08	$ 33.82	$ 34.47	$ 34.93	$ 35.39	$ 35.96	$ 36.89	$ 37.89	$ 38.53	$ 39.30
Basic Single Family Dwelling - Pumping	$ 14.97	$22.83	$ 26.25	$ 30.71	$ 35.17	$ 37.08	$ 37.08	$ 37.34	$ 38.20	$ 39.05	$ 39.80	$ 40.33	$ 40.86	$ 41.52	$ 42.59	$ 43.75	$ 44.49	$ 45.38
Basic Multi-Family Dwelling Units - Pumping	$ 14.21	$20.60	$ 23.69	$ 27.72	$ 31.74	$ 33.47	$ 33.47	$ 33.70	$ 34.47	$ 35.24	$ 35.92	$ 36.40	$ 36.87	$ 37.47	$ 38.44	$ 39.48	$ 40.15	$ 40.95
Commercial Sewer Rates																		
Basic Commercial (Flat Rate)	$ 13.05	$19.73	$ 22.69	$ 26.55	$ 30.40	$ 32.05	$ 32.05	$ 32.28	$ 33.02	$ 33.75	$ 34.40	$ 34.86	$ 35.31	$ 35.88	$ 36.81	$ 37.81	$ 38.45	$ 39.22
Basic Commercial - Pumping (Flat Rate)	$ 14.97	$22.79	$ 26.21	$ 30.66	$ 35.11	$ 37.02	$ 37.02	$ 37.28	$ 38.13	$ 38.98	$ 39.73	$ 40.26	$ 40.79	$ 41.44	$ 42.52	$ 43.67	$ 44.41	$ 45.30

User Rate Categories	Existing Monthly Rate	Proposed Monthly Rate FY 2008/09	Proposed Monthly Rate FY 2009/2010 (15%)	Proposed Monthly Rate FY 2010/2011 (17%)	Proposed Monthly Rate FY 2011/2012 (14.5%)	Proposed Monthly Rate FY 2012/2013 (5.44%)	Proposed Monthly Rate FY 2013/2014 (0%)	Proposed Monthly Rate FY 2014/2015 (0.7%)	Proposed Monthly Rate FY 2015/2016 (2.3%)	Proposed Monthly Rate FY 2016/2017 (2.22%)	Proposed Monthly Rate FY 2017/2018 (1.92%)	Proposed Monthly Rate FY 2018/2019 (1.35%)	Proposed Monthly Rate FY 2019/2020 (1.3%)	Proposed Monthly Rate FY 2020/2021 (1.61%)	Proposed Monthly Rate FY 2021/2022 (2.59%)	Proposed Monthly Rate FY 2022/2023 (2.72%)	Proposed Monthly Rate FY 2023/2024 (1.69%)	Proposed Monthly Rate FY 2024/2025 (2%)
Commercial Rate Structure - Non-Pumping (per CCF)		Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF
Department & Retail Stores	$ 1.06	$ 1.41	$ 1.62	$ 1.90	$ 2.18	$ 2.29	$ 2.29	$ 2.31	$ 2.36	$ 2.42	$ 2.46	$ 2.50	$ 2.53	$ 2.57	$ 2.64	$ 2.71	$ 2.75	$ 2.81
Hotels & Motels	$ 1.23	$ 1.69	$ 1.94	$ 2.27	$ 2.60	$ 2.74	$ 2.74	$ 2.76	$ 2.82	$ 2.88	$ 2.94	$ 2.98	$ 3.02	$ 3.06	$ 3.14	$ 3.23	$ 3.28	$ 3.35
Laundromats	$ 1.06	$ 1.71	$ 1.97	$ 2.30	$ 2.63	$ 2.78	$ 2.78	$ 2.80	$ 2.86	$ 2.92	$ 2.98	$ 3.02	$ 3.06	$ 3.11	$ 3.19	$ 3.27	$ 3.33	$ 3.40
Laundries	$ 1.86	$ 2.66	$ 3.06	$ 3.58	$ 4.10	$ 4.32	$ 4.32	$ 4.35	$ 4.45	$ 4.55	$ 4.64	$ 4.70	$ 4.76	$ 4.84	$ 4.96	$ 5.10	$ 5.18	$ 5.29
Markets	$ 2.42	$ 3.49	$ 4.01	$ 4.70	$ 5.38	$ 5.67	$ 5.67	$ 5.71	$ 5.84	$ 5.97	$ 6.09	$ 6.17	$ 6.25	$ 6.35	$ 6.51	$ 6.69	$ 6.80	$ 6.94
Mortuaries	$ 2.43	$ 1.89	$ 2.17	$ 2.54	$ 2.91	$ 3.07	$ 3.07	$ 3.09	$ 3.16	$ 3.23	$ 3.29	$ 3.34	$ 3.38	$ 3.43	$ 3.52	$ 3.62	$ 3.68	$ 3.75
Professional Offices	$ 0.95	$ 1.17	$ 1.34	$ 1.57	$ 1.80	$ 1.90	$ 1.90	$ 1.91	$ 1.95	$ 2.00	$ 2.03	$ 2.06	$ 2.09	$ 2.12	$ 2.18	$ 2.24	$ 2.27	$ 2.32
Repair Shops & Service Stations	$ 1.54	$ 2.30	$ 2.65	$ 3.10	$ 3.55	$ 3.74	$ 3.74	$ 3.76	$ 3.85	$ 3.94	$ 4.01	$ 4.07	$ 4.12	$ 4.18	$ 4.29	$ 4.41	$ 4.48	$ 4.57
Restaurants	$ 2.53	$ 3.74	$ 4.30	$ 5.03	$ 5.76	$ 6.07	$ 6.07	$ 6.12	$ 6.26	$ 6.40	$ 6.52	$ 6.61	$ 6.69	$ 6.80	$ 6.98	$ 7.17	$ 7.29	$ 7.43
Other Commercial	$ 1.06	$ 1.67	$ 1.92	$ 2.25	$ 2.58	$ 2.72	$ 2.72	$ 2.74	$ 2.80	$ 2.86	$ 2.92	$ 2.96	$ 2.99	$ 3.04	$ 3.12	$ 3.21	$ 3.26	$ 3.32
Hospitals	$ 1.21	$ 1.77	$ 2.03	$ 2.38	$ 2.73	$ 2.87	$ 2.87	$ 2.89	$ 2.96	$ 3.03	$ 3.08	$ 3.13	$ 3.17	$ 3.22	$ 3.30	$ 3.39	$ 3.45	$ 3.52
Churches & Halls	$ 0.99	$ 0.90	$ 1.03	$ 1.21	$ 1.39	$ 1.46	$ 1.46	$ 1.47	$ 1.51	$ 1.54	$ 1.57	$ 1.59	$ 1.61	$ 1.64	$ 1.68	$ 1.72	$ 1.75	$ 1.79
Schools "B"	$ 0.41	$ 0.51	$ 0.58	$ 0.68	$ 0.78	$ 0.82	$ 0.82	$ 0.83	$ 0.85	$ 0.86	$ 0.88	$ 0.89	$ 0.90	$ 0.92	$ 0.94	$ 0.97	$ 0.98	$ 1.00
Other Commercial "A"	$ 0.67	$ 1.11	$ 1.28	$ 1.50	$ 1.72	$ 1.81	$ 1.81	$ 1.82	$ 1.86	$ 1.90	$ 1.94	$ 1.97	$ 1.99	$ 2.02	$ 2.08	$ 2.13	$ 2.17	$ 2.21
Other Commercial "B"	$ 0.33	$ 0.56	$ 0.64	$ 0.75	$ 0.86	$ 0.91	$ 0.91	$ 0.91	$ 0.93	$ 0.96	$ 0.97	$ 0.99	$ 1.00	$ 1.02	$ 1.04	$ 1.07	$ 1.09	$ 1.11

Commercial Rate Structure - Pumping (per CCF)		Rate zer Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF	Rate per Unit CCF
Department & Retail Stores	$ 1.24	$ 1.67	$ 1.92	$ 2.25	$ 2.58	$ 2.72	$ 2.72	$ 2.74	$ 2.80	$ 2.86	$ 2.92	$ 2.95	$ 2.99	$ 3.04	$ 3.12	$ 3.20	$ 3.26	$ 3.32
Hotels & Motels	$ 1.41	$ 1.95	$ 2.24	$ 2.63	$ 3.01	$ 3.17	$ 3.17	$ 3.19	$ 3.27	$ 3.34	$ 3.40	$ 3.45	$ 3.49	$ 3.55	$ 3.64	$ 3.74	$ 3.80	$ 3.88
Laundromats	$ 1.25	$ 2.02	$ 2.32	$ 2.71	$ 3.11	$ 3.28	$ 3.28	$ 3.30	$ 3.37	$ 3.45	$ 3.51	$ 3.56	$ 3.61	$ 3.67	$ 3.76	$ 3.86	$ 3.93	$ 4.01
Laundries	$ 2.04	$ 2.97	$ 3.41	$ 3.99	$ 4.57	$ 4.82	$ 4.82	$ 4.85	$ 4.96	$ 5.08	$ 5.17	$ 5.24	$ 5.31	$ 5.40	$ 5.54	$ 5.69	$ 5.78	$ 5.90
Markets	$ 2.62	$ 3.80	$ 4.37	$ 5.11	$ 5.85	$ 6.17	$ 6.17	$ 6.21	$ 6.36	$ 6.50	$ 6.62	$ 6.71	$ 6.80	$ 6.91	$ 7.09	$ 7.28	$ 7.40	$ 7.55
Mortuaries	$ 2.61	$ 2.04	$ 2.34	$ 2.74	$ 3.14	$ 3.31	$ 3.31	$ 3.33	$ 3.41	$ 3.49	$ 3.55	$ 3.60	$ 3.65	$ 3.71	$ 3.80	$ 3.91	$ 3.97	$ 4.05
Professional Offices	$ 1.14	$ 1.40	$ 1.61	$ 1.88	$ 2.16	$ 2.27	$ 2.27	$ 2.29	$ 2.34	$ 2.39	$ 2.44	$ 2.47	$ 2.50	$ 2.55	$ 2.61	$ 2.68	$ 2.73	$ 2.78
Repair Shops & Service Stations	$ 1.73	$ 2.61	$ 3.00	$ 3.51	$ 4.02	$ 4.24	$ 4.24	$ 4.27	$ 4.37	$ 4.46	$ 4.55	$ 4.61	$ 4.67	$ 4.74	$ 4.87	$ 5.00	$ 5.08	$ 5.19
Restaurants	$ 2.71	$ 4.02	$ 4.62	$ 5.40	$ 6.19	$ 6.52	$ 6.52	$ 6.57	$ 6.72	$ 6.87	$ 7.00	$ 7.10	$ 7.19	$ 7.30	$ 7.49	$ 7.70	$ 7.83	$ 7.98
Other Commercial	$ 1.24	$ 1.98	$ 2.28	$ 2.66	$ 3.05	$ 3.22	$ 3.22	$ 3.24	$ 3.31	$ 3.39	$ 3.45	$ 3.50	$ 3.54	$ 3.60	$ 3.69	$ 3.79	$ 3.86	$ 3.94
Hospitals	$ 1.40	$ 2.06	$ 2.36	$ 2.77	$ 3.17	$ 3.34	$ 3.34	$ 3.36	$ 3.44	$ 3.52	$ 3.58	$ 3.63	$ 3.68	$ 3.74	$ 3.84	$ 3.94	$ 4.01	$ 4.09
Churches & Halls	$ 1.14	$ 1.05	$ 1.21	$ 1.41	$ 1.62	$ 1.71	$ 1.71	$ 1.72	$ 1.76	$ 1.80	$ 1.83	$ 1.86	$ 1.88	$ 1.91	$ 1.96	$ 2.01	$ 2.05	$ 2.09
Schools "B"	$ 0.49	$ 0.61	$ 0.70	$ 0.82	$ 0.94	$ 0.99	$ 0.99	$ 0.99	$ 1.02	$ 1.04	$ 1.06	$ 1.07	$ 1.09	$ 1.10	$ 1.13	$ 1.16	$ 1.18	$ 1.21
Other Commercial "A"	$ 0.78	$ 1.32	$ 1.52	$ 1.77	$ 2.03	$ 2.14	$ 2.14	$ 2.16	$ 2.21	$ 2.26	$ 2.30	$ 2.33	$ 2.36	$ 2.40	$ 2.46	$ 2.53	$ 2.57	$ 2.62
Other Commercial "B"	$ 0.39	$ 0.66	$ 0.76	$ 0.89	$ 1.02	$ 1.07	$ 1.07	$ 1.08	$ 1.11	$ 1.13	$ 1.15	$ 1.17	$ 1.18	$ 1.20	$ 1.23	$ 1.27	$ 1.29	$ 1.31

Appendix C

USER RATE AND CONNECTION FEE COMPARISON

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Sewer User Rates Comparison

User Rate Categories	Rank Proposed Riverside [1]	City of Riverside Monthly Rate Proposed [2]	City of Riverside Monthly Rate Existing	Other Cities/Agencies Monthly Rate WMWD	EMWD	Corona	San Bernadino	IEUA-Ontario	Redlands	Rialto	YVWD	Colton	EVMWD
Residential Sewer Rates													
Basic Multi-Family Dwelling Unit	3	$ 17.84	$ 12.29	$ 26.99	$ 22.01	$ 37.34	$ 33.21	$ 14.81	$ 11.44	$ 25.97	$ 28.02	$ 28.51	$ 29.24
Basic Single Family Dwelling Unit	4	$ 19.77	$ 13.05	$ 38.55	$ 24.39	$ 37.34	$ 17.95	$ 17.70	$ 15.24	$ 25.97	$ 31.39	$ 32.78	$ 39.00

Commercial Rate Structure - Non-Pumping (per CCF)	Rank Proposed Riverside [1]	City of Riverside Monthly Rate Proposed Riverside [2]	City of Riverside Monthly Rate Existing Riverside [2]	Other Cities/Agencies Monthly Rate [3] WMWD	EMWD	Corona	San Bernadino	IEUA-Ontario	Redlands [4]	Rialto	YVWD	Colton	EVMWD
Department & Retail Stores	2	$ 1.41	$ 1.06	$ 2.58	$ 1.98	$ 5.30	$ 2.10	$ 1.44	$ 2.20	$ 2.83	$ 1.63	$ 1.10	$ 3.91
Hotels & Motels	4	$ 1.69	$ 1.23	$ 2.64	$ 2.11	$ 1.14	$ 2.17	$ 1.53	$ 2.20	$ 3.33	$ 2.11	$ 1.10	$ 4.10
Laundromats	5	$ 1.71	$ 1.06	$ 3.05	$ 2.35	$ 0.15	$ 1.50	$ 1.70	$ 2.20	$ 2.83	$ 1.78	$ 1.10	$ 3.91
Laundries	4	$ 2.66	$ 1.86	$ 3.05	$ 2.68	$ 0.11	$ 2.05	$ 1.94	$ 3.04	$ 3.33	$ 3.43	$ 2.67	$ 3.91
Markets	8	$ 3.49	$ 2.42	$ 3.05	$ 2.96	$ 3.42	$ 2.08	$ 2.15	$ 3.04	$ 4.25	$ 6.95	$ 2.67	$ 5.13
Mortuaries	6	$ 1.89	$ 2.43	$ 1.49	$ 1.52	$ 1.04	$ 1.18	$ 1.10	$ 3.04	$ 4.25	$ 3.40	$ 2.67	$ 5.13
Professional Offices	2	$ 1.17	$ 0.95	$ 2.30	$ 1.74	$ 9.60	$ 1.69	$ 1.26	$ 1.32	$ 2.83	$ 1.20	$ 0.68	$ 3.91
Repair Shops & Service Stations	3	$ 2.30	$ 1.54	$ 3.05	$ 2.47	$ 11.54	$ 1.58	$ 1.79	$ 3.04	$ 3.33	$ 2.55	$ 2.67	$ 5.13
Restaurants	8	$ 3.74	$ 2.53	$ 2.74	$ 2.82	$ 3.02	$ 2.21	$ 2.04	$ 3.04	$ 4.25	$ 6.25	$ 2.67	$ 5.13
Other Commercial	2	$ 1.67	$ 1.06	$ 3.05	$ 2.34	$ 3.33	$ 2.08	$ 1.70	$ 2.20	$ 3.33	$ 3.01	$ 1.10	$ 4.10
Hospitals	4	$ 1.77	$ 1.21	$ 2.85	$ 2.26	$ 4.33	$ 1.18	$ 1.64	$ 2.20	$ 2.83	$ 1.98	$ 1.10	$ 3.91
Churches & Halls	2	$ 0.90	$ 0.99	$ 1.49	$ 1.17	$ 1.05	$ 0.96	$ 0.85	$ 2.20	$ 2.83	$ 1.47	$ 1.10	$ 4.10
Schools "B"	1	$ 0.51	$ 0.41	$ 1.02	$ 0.77	$ 1.08	$ 0.95	$ 0.56	$ 1.32	$ 2.83	$ 0.55	$ 0.68	$ 3.91
Other Commercial "A"	2	$ 1.11	$ 0.67	$ 2.03	$ 1.56	$ 1.14	$ 2.04	$ 1.13	$ 2.20	$ 3.33	$ 2.01	$ 1.10	$ 4.10
Other Commercial "B"	1	$ 0.56	$ 0.33	$ 1.02	$ 0.78	$ 1.20	$ 2.04	$ 0.57	$ 2.20	$ 3.33	$ 1.00	$ 1.10	$ 4.10

Footnotes:

(1) Ranking from lowest to highest, 1 being lowest among the 11 cities/agencies, and 11 being the highest among the 11 cities/agencies.

(2) Proposed City of Riverside Rate is based on the rate scenario that meets bond covenant requirements.

(3) Sewer Rates for the commercial categories are based on the individual city's $/ccf (100 cubic feet) rate, unless noted otherwise.
City of San Bernadino has a $3 monthly fee added to the $/ccf rate, the surcharge was added to calculate an average $/ccf rate.
Yucaipa Valley Water District (YVWD) and Western Municipal Water District (WMWD) Sewer User rates are based on $/1000 gal. A conversion to CCF of water used was calculated to compare with City of Riverside rate.
IEUA-Ontario and Rialto sewer rates are based on $/edu, and were converted to $/ccf of water used.
City of Corona has a monthly flat rate for specific different commercial categories. A $/ccf rate based on water used was converted to compare with City of Riverside sewer rate. City of Corona did not have some of the commercial categories used for City of Riverside. For those cases, professional judgement was used to determine what water meter size the category would most likely use and that information was applied to the respective rate as provided by the City of Corona.

(4) City of Redlands has three different rates for each low, med and high strength users. To make the conversion, each Riverside category was assigned either low, medium or high strength.

City of Riverside

WASTEWATER FINANCIAL ANALYSIS

Sewer Connection Fees Comparison

User Rate Categories	Rank Proposed Riverside [1]	City of Riverside Connection Fee		Other Cities/Agencies Connection Fee									
		Proposed [2]	Existing	WMWD	EMWD	Corona	San Bernadino	IEUA-Ontario	Redlands	Rialto	YVWD	Colton	EVMWD
Residential Sewer Rates													
Basic Multi-Family Dwelling Unit	5	$ 3,134.00	$ 2,563	$ 4,500.00	$ 4,185.00	$ 2,716.80	$ 2,471.95	$ 4,016.13	$ 3,360.00	$ 2,170.00	$ 7,433.00	$ 2,800.00	$ 4,014.00
Basic Single Family Dwelling Unit	4	$ 3,472.00	$ 2,684	$ 4,500.00	$ 4,185.00	$ 3,397.00	$ 3,500.00	$ 4,450.00	$ 4,200.00	$ 2,170.00	$ 7,433.00	$ 2,800.00	$ 6,690.00
Commercial Rate Structure - Non-Pumping (per CCF)	Rank Proposed Riverside [1]	City of Riverside Connection Fee		Other Cities/Agencies Connection Fee[3]									
		Proposed [2]	Existing	WMWD [4]	EMWD [5]	Corona [6]	San Bernadino [7]	IEUA-Ontario [8]	Redlands [9]	Rialto [3] [10]	YVWD [11]	Colton [12]	EVMWD [3] [10]
Department & Retail Stores (40,000 sqft)	2	$ 8,472.00	$ 9,333.33	$ 13,628.97	$ 15,286.64	$ 9,523.46	$ 10,474.12	$ 16,254.61	$ 17,414.80	$ 33,440.00	$ 27,150.68	$ 5,047.77	$ 441,085.20
Hotels & Motels (120 rooms)	5	$ 157,693.00	$ 40,920.00	$ 203,902.50	$ 237,664.76	$ 142,480.02	$ 156,702.85	$ 252,714.02	$ 260,542.09	$ 144,240.00	$ 422,117.60	$ 75,519.45	$ 379,563.60
Laundromats	3	$ 35,726.00	NA	$ 48,469.26	$ 54,409.30	$ 33,868.65	$ 37,249.53	$ 57,854.57	$ 61,932.95	NA	$ 96,636.64	$ 17,951.58	NA
Laundries	5	$ 81,492.00	NA	$ 66,080.43	$ 84,602.83	$ 46,174.72	$ 50,784.04	$ 89,960.00	$ 84,436.11	NA	$ 150,263.53	$ 24,474.23	NA
Markets (20,000 sqft)	9	$ 40,256.00	$ 4,666.67	$ 22,878.77	$ 32,366.96	$ 15,986.89	$ 17,582.75	$ 34,416.48	$ 29,233.98	$ 34,360.00	$ 57,487.12	$ 8,473.62	$ 141,052.00
Mortuaries (15,598 sqft)	4	$ 32,853.00	$ 3,639.47	$ 36,662.31	$ 54,409.32	$ 25,618.36	$ 28,175.66	$ 57,854.59	$ 46,846.29	$ 191,628.99	$ 96,636.67	$ 13,578.63	$ 73,451.01
Professional Offices (30,000 sqft)	2	$ 10,552.00	$ 7,000.00	$ 20,220.04	$ 22,230.51	$ 14,129.06	$ 15,539.47	$ 23,638.17	$ 25,836.71	$ 46,530.00	$ 39,483.72	$ 7,488.90	$ 151,889.70
Repair Shops & Service Stations (3,000 sqft)	5	$ 11,675.00	$ 700.00	$ 13,673.77	$ 16,149.46	$ 9,554.76	$ 10,508.55	$ 17,172.07	$ 17,472.04	$ 2,835.00	$ 28,683.14	$ 5,064.36	$ 7,640.64
Restaurants (5,000 sqft) [13]	8	$ 43,300.00	$ 1,166.67	$ 23,277.13	$ 34,863.70	$ 16,265.25	$ 17,888.90	$ 37,071.31	$ 29,742.99	$ 65,920.00	$ 61,921.59	$ 8,621.16	$ 167,484.00
Other Commercial (18,449 sqft)	4	$ 17,258.00	$ 4,304.84	$ 23,444.51	$ 26,296.02	$ 16,382.21	$ 18,017.54	$ 27,961.12	$ 29,956.88	$ 12,711.58	$ 46,704.50	$ 8,683.15	NA
Hospitals (40,000 sqft)	4	$ 142,988.00	$ 9,333.33	$ 178,390.71	$ 206,896.40	$ 124,653.26	$ 137,096.56	$ 219,997.37	$ 227,943.69	NA	$ 367,469.77	$ 66,070.63	NA
Churches & Halls (10,000 sqft)	2	$ 14,600.00	$ 2,333.33	$ 36,404.05	$ 41,842.21	$ 25,437.89	$ 27,977.18	$ 44,491.71	$ 46,516.28	NA	$ 74,316.16	$ 13,482.98	$ 12,537.10
Schools "B" (12,732 sqft)	1	$ 35,846.00	$ 2,971.00	$ 159,215.30	$ 175,229.33	$ 111,254.15	$ 122,359.91	$ 186,325.10	$ 203,441.77	NA	$ 311,225.72	$ 58,968.63	NA
Other Commercial "A"	3	$ 45,267.00	NA	$ 92,304.02	$ 103,488.09	$ 64,498.86	$ 70,937.35	$ 110,041.10	$ 117,944.02	$ 12,711.58	$ 183,805.74	$ 34,186.67	NA
Other Commercial "B"	1	$ 10,721.00	NA	$ 43,664.35	$ 48,995.34	$ 30,511.14	$ 33,556.86	$ 52,097.79	$ 55,793.33	$ 12,711.58	$ 87,020.88	$ 16,171.98	NA

Footnotes:

(1) Ranking from lowest to highest, 1 being lowest among the 11 cities/agencies that values are listed for, and 11 being the highest among the 11 cities/agencies that values are listed for.
(2) City of Riverside Connection fee is based on the information presented at the meeting on August 24, 2007.
(3) Connection fees for most Cities/Agencies are either flow based or per EDU; Only the Cities of Rialto and Elsinore Valley Municipal Water District (EVMWD) are based on square footage. There are no equivalent conversions for some categories. Therefore fees were not calculated for those categories
(4) Based on $16.20 per gpd.
(5) Based on $4185 per EDU
(6) Based on $11.32 per gpd
(7) Based on $12.45 per gpd
(8) Based on $4450 per EDU
(9) Based on $20.70 per gpd.
(10) NA: Does not have equilvalent conversion to Riverside fee structure
(11) Based on $7433 per EDU
(12) The average daily flow was used to calculate the connection fees for City of Colton, instead of the max. anticipated discharge flow that the City requires.
(13) Restaurants: For cities/agencies that based the fee on the number of seats, an estimated average of 150 seats were used to calculate the fee.

H:\Client\Riversid_SAO\7472A.00\Financial Plan\[UserRates+ConnectionFees 2nd submittal.xls]Connection Fees

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 11: FINANCIAL PLAN AND USER RATES AND FEES
CHAPTER 3: MASTER PLAN MANAGER™ HELP MENU

FINAL
February 2008

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City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

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Chapter 3

MASTER PLAN MANAGER™ HELP MENU

3.1 PURPOSE

The City of Riverside (City) is in the process of completing their Wastewater Collection and Treatment Facilities Integrated Master Plan (2006-2025) (Integrated Master Plan). One of the deliverables is the Master Plan Manager™ (MPM™) software application that has been used in the development of the Integrated Master Plan. MPM™ contains a Help Menu that can be used by staff in the future as questions arise about the operation of MPM™. In addition to a tutorial session, the purpose of this chapter is to provide some basic guidelines for using the Help Menu.

3.2 CONCLUSIONS

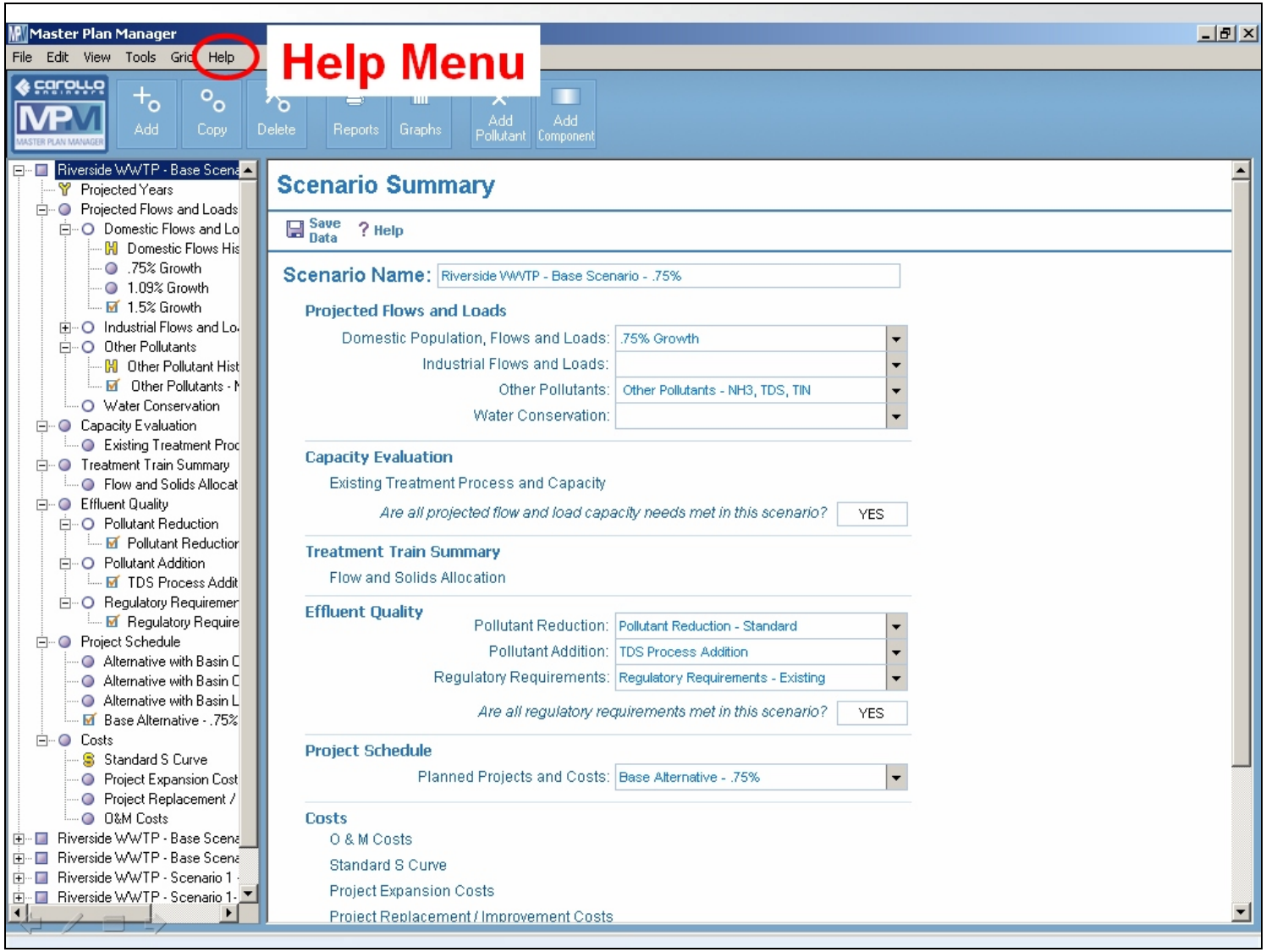
The MPM™ Help Menu will aid the City in the use of MPM™ and help provide information for questions that might arise. The complete Help Menu is provided in Appendix A for further detail.

3.3 GENERAL FUNCTIONALITY AND USE

MPM™'s Help Menu is located at the very top left-hand corner as part of the toolbar, as shown in Figure 3.1. When the user clicks on Help, they have three choices: About Master Plan Manager™, Contents, and Index. If the user clicks About Master Plan Manager™, the version number and logo are displayed as shown in Figure 3.2.

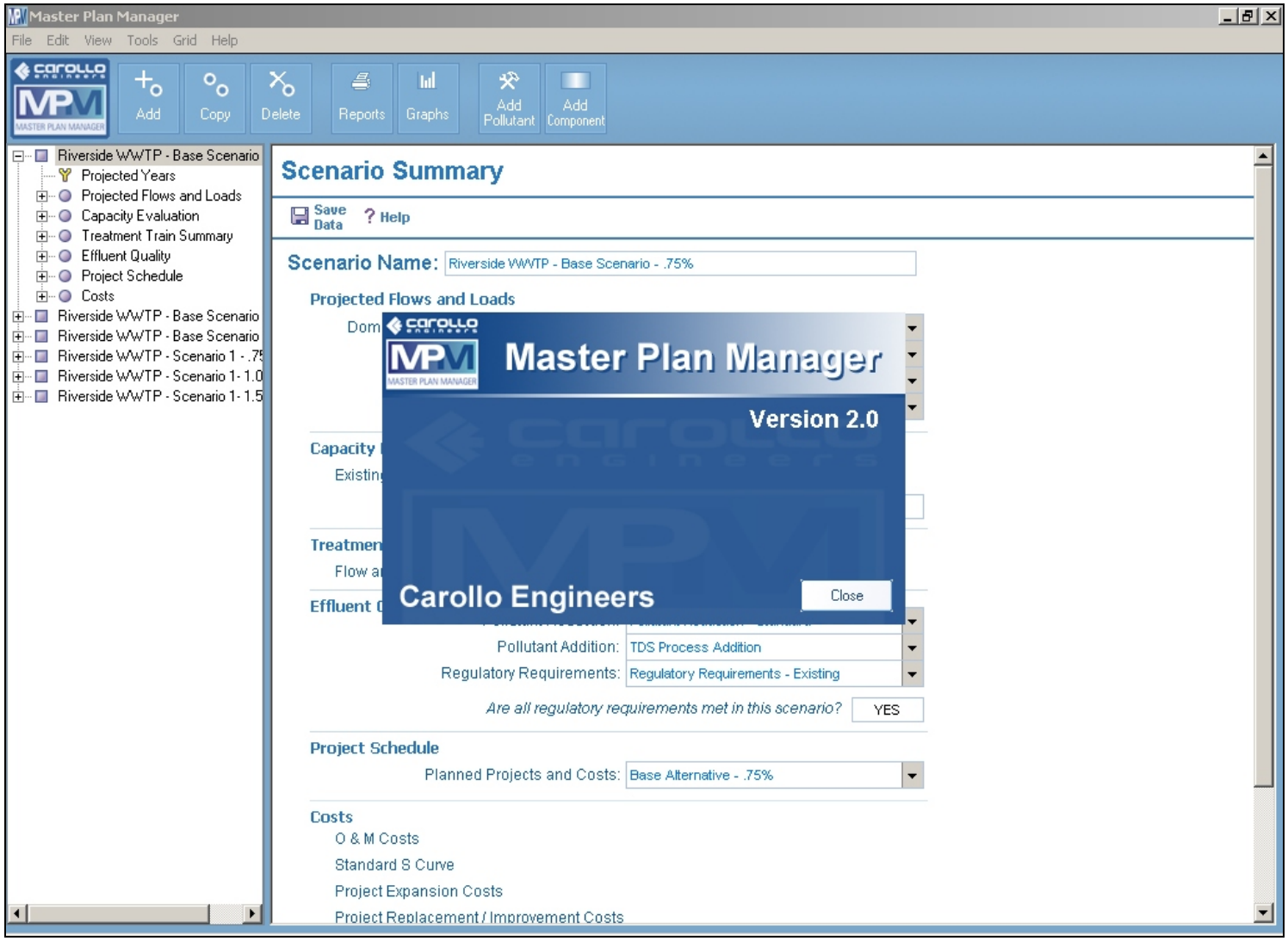
If the user clicks Content, the screen as shown in Figure 3.3 is displayed. There are three tabs on the Help Menu: Contents, Index, and Search. Under Contents, there are several options:

- Welcome to MPM™ 2.0.
- Getting Started.
- Overview.
- Data.
- Toolbars.
- Major Components.
- Pollutants.
- Database.
- Reports.
- Graphs.



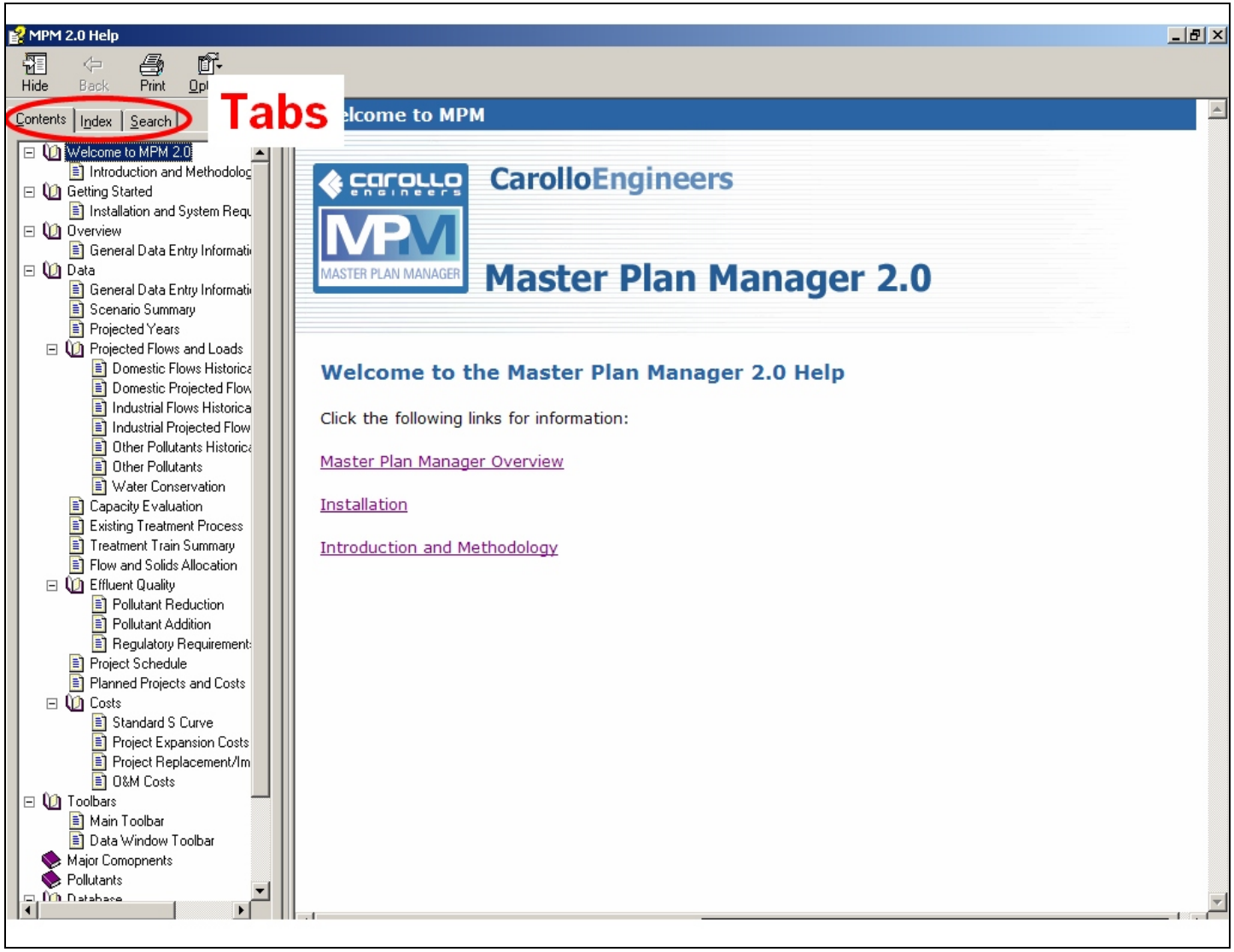
MASTER PLAN MANAGER™ OVERVIEW

FIGURE 3.1



HELP MENU - ABOUT MASTER PLAN MANAGER™

FIGURE 3.2



HELP MENU - CONTENTS

FIGURE 3.3

Welcome to MPM™ provides basic introductory and methodology information to the user. The Getting Started section provides specific information about how to install MPM™ and the requirements for the user's computer in order to support the MPM™ application. The Overview section discusses general data entry.

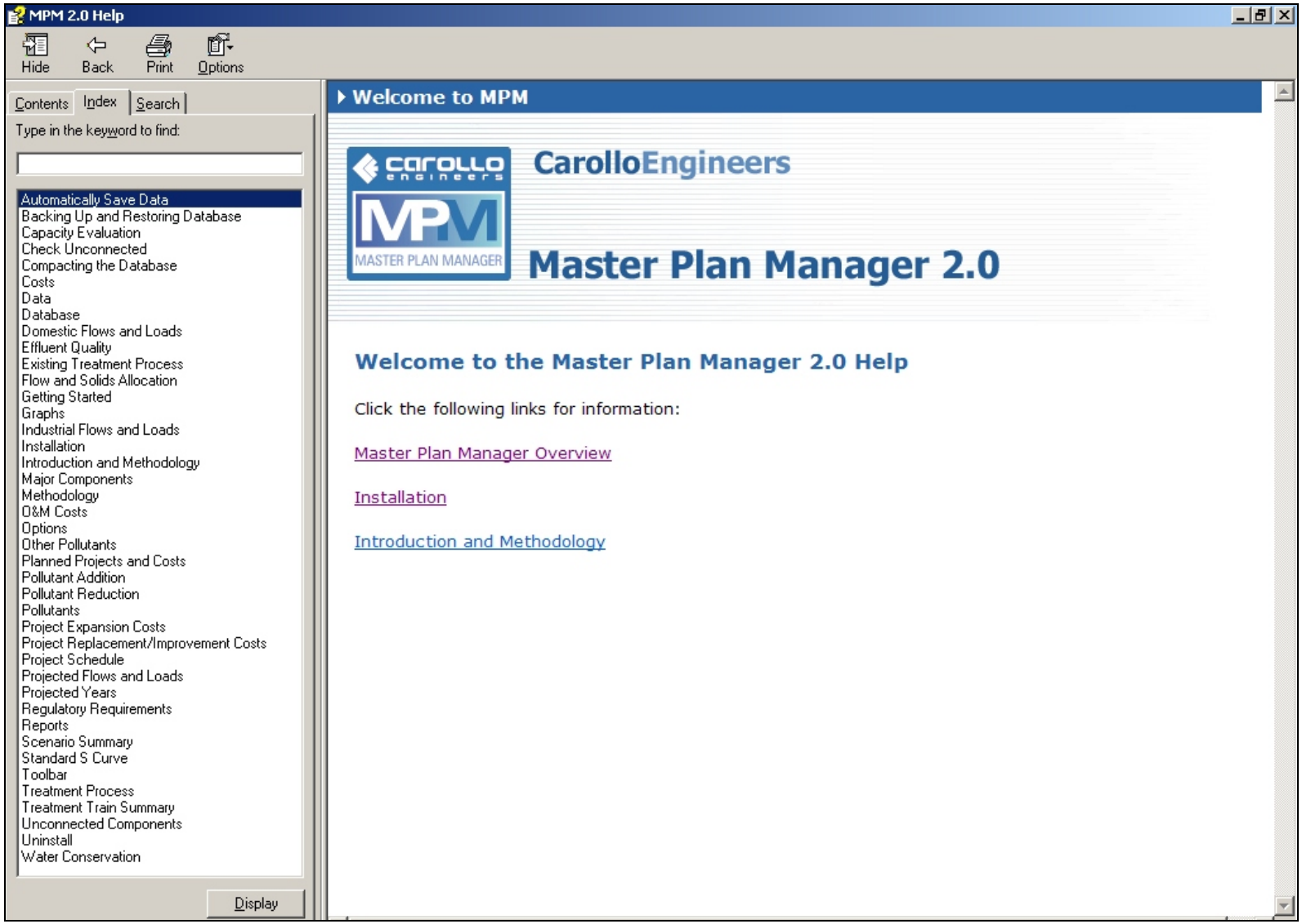
The Data section provides the detailed functionality information specific to each screen of the software and how data is connected, which data is required, and how the user can make modifications. The Data section has specific information listed for the screens:

- General Data Entry.
- Scenario Summary.
- Projected Years.
- Projected Flows and Loads:
  - Domestic Flows and Loads (projected and historical).
  - Industrial Flows and Loads (projected and historical).
  - Other Pollutants (projected and historical).
  - Water Conservation.
- Capacity Evaluation.
- Existing Treatment Process.
- Treatment Train Summary.
- Flow and Solids Allocation.
- Effluent Quality:
  - Pollutant Reduction.
  - Pollutant Addition.
  - Regulatory Requirements.
- Project Schedule.
- Planned Projects and Costs.
- Costs:
  - Standard S-Curve.
  - Project Expansion Costs.
  - Project Replacement/Improvement Costs.
  - O&M Costs.

The Toolbars section provides the user with information on the various toolbars in MPM™. The Major Components and Pollutants sections discuss those topics, respectively. The

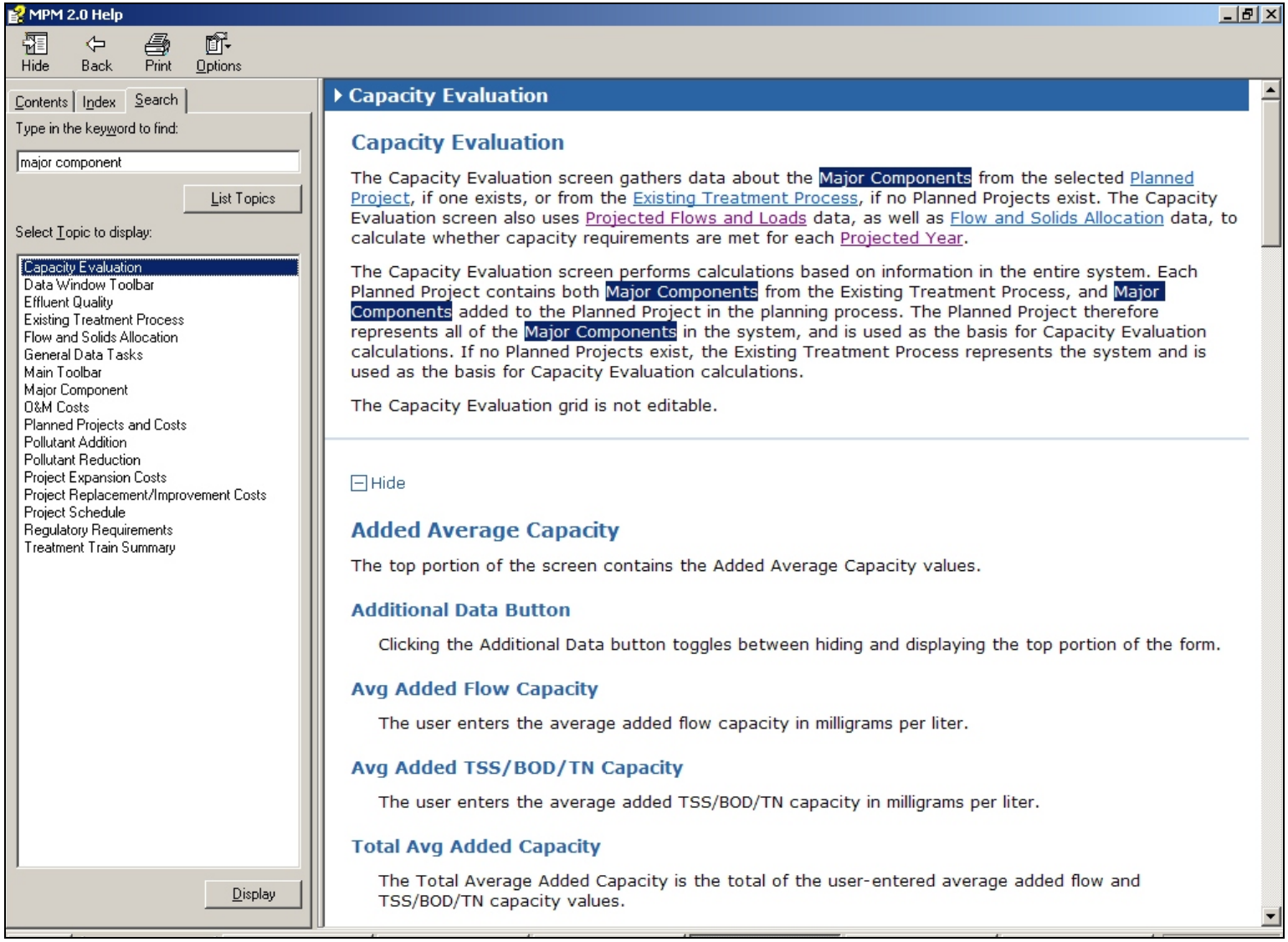
Database portion provides database-specific information. The Reports and Graphs sections explain MPM™'s functionality for developing reports and graphs.

If the user selects the Index tab, a list of topics is displayed, and the user can display information by topic, as shown in Figure 3.4. The user can also select the Search tab, type in a word, and MPM™ will display the topics associated with that word that the user can then display, as shown in Figure 3.5.



HELP MENU - INDEX

FIGURE 3.4



HELP MENU - SEARCH

FIGURE 3.5

Appendix A

MPM™ HELP MENU

WELCOME TO MPM 2.0 - INTRODUCTION AND METHODOLOGY

Introduction

The master planning process involves developing wastewater flow and pollutant load projections, often based on population, for the desired planning time frame. These projections are then compared with existing facilities or those that are in the midst of construction in order to determine where and when treatment capacity needs will be greater than the available capacity. Projections are also compared with existing and future regulatory requirements to determine when and for which constituents the projected effluent quality will exceed National Pollutant Discharge Elimination System (NPDES) permit limits. Once a complete scenario is developed, the impact to the Capital Improvement Program (CIP), in terms of costs and the implementation schedule, must be calculated. When multiple scenarios have been developed, their outputs and impacts can be compared against one another to determine the sensitivity of the system to a range of parameters. This sensitivity analysis allows an agency to understand a variety of options to ensure that they make intelligent, informed decisions.

The traditional approach to master planning is such that different projection options or combinations of options, for example, five percent residential growth or a new effluent limit for mercury, need to be evaluated for treatment capacity and effluent quality in individual scenarios. If a change is made to any of the inputs, the entire scenario must be reconfigured to correctly determine its impacts. Developing each scenario is a time and labor intensive process, as is performing a sensitivity analysis on the results.

By using a dynamic and analytical computer software model for the master planning process, instead of the "paper" approach, many more options, and thus scenarios, can be quickly and easily developed. The impacts from any changes or additions can be seen immediately, in real time, including the effects on the CIP implementation schedule. Sensitivity analyses can be developed in a fraction

of the time, putting the power to make well informed decisions in the agency's hands sooner, while at the same time increasing the number of potential scenarios the agency can effectively screen. Ultimately, this interactive modeling approach can help agencies make better strategic decisions.

Methodology

A software application called the Master Plan Manager™ (MPM) has been developed to more quickly and accurately model the master planning process. The MPM computerizes and automates the master plan process by incorporating historical and projected flows and loads for domestic, industrial, and nontraditional pollutants; water conservation measures; treatment processes and capacities; pollutant reduction; regulatory requirements; planned projects and costs; and operations and maintenance (O&M) costs. These data are used to develop flow and load projections, perform capacity evaluations, determine effluent quality, develop project schedules, and develop overall costs. The MPM can produce numerous "what-if" scenarios in order to develop a sensitivity analysis.

GETTING STARTED - INSTALLATION AND SYSTEM REQUIREMENTS

How to Install MPM

1. Insert the MPM CD-ROM into the CD-ROM drive.

2. The MPM installation program will start automatically. If it does not, press the Start button on the task bar, select Run, type **X:setup** (where **X** is the letter of your CD-ROM drive), and click the OK button.

3. Follow the instructions on each installation screen, allowing the computer to reboot as necessary during installation.

You must have Administrator privileges to install MPM on Windows NT, 2000, and XP.

Upgrading from a Previous Version

Upgrading to Version 2.0 from MPM Version 1.0 will not affect data you have entered into MPM. The existing data will remain unchanged; the data will be preserved as it existed just prior to the installation of MPM version 2.0.

After installation, start MPM as follows:

- Click the Start button on the task bar
- Click Programs
- Click Carollo Engineers > MPM 2.0 > MPM 2.0

System Requirements

- Intel® Pentium® 90 MHz or faster (or the minimum required by the operating system, whichever is higher)
- Microsoft® Windows 98 Second Edition, Windows Millennium Edition, Windows NT 4.0 with Service Pack 6.0a or later, Windows 2000, or Windows XP Professional or Home Edition
- 32MB of RAM (96MB or higher recommended, or the minimum required by the operating system, whichever is higher)
- 170MB of available hard-disk space (150MB for .NET Framework, plus 20MB for MPM)
- 800 x 600 or higher-resolution display with at least 256 colors
- Internet Explorer 5.01 or later (click to download Internet Explorer 7 from Microsoft)

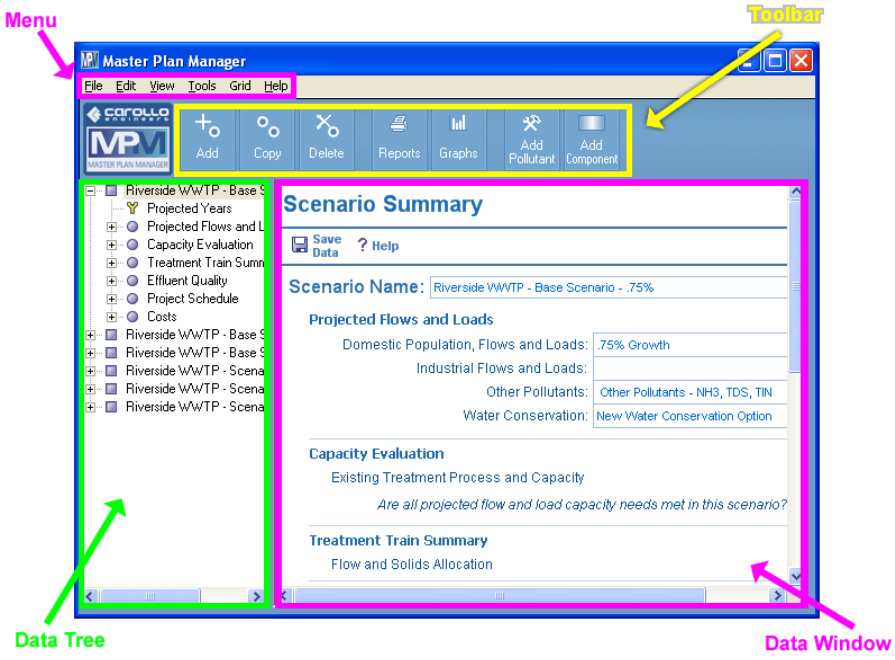
OVERVIEW OF MPM

The MPM screen is divided into three areas:

1. Menu and Toolbar. The Menu and Toolbar allow the user to add, copy, and delete Data Tree items, as well as creating reports and graphs.

2. Data Tree. The Data Tree is used to navigate through the application. Clicking on an item in the tree to displays the data associated with that item in the Data Window.

3. Data Window. The Data Window displays data for the currently selected item in the Data Tree.



General Data Entry Information

Adding Grid Rows

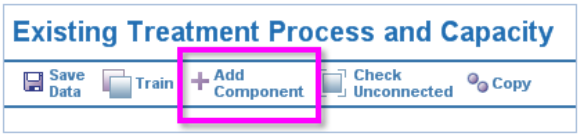
Rows can be manually added to grids by clicking the "Add Row" button at the top of the Data Window.

Rows can be added in this way to the following Data screens:

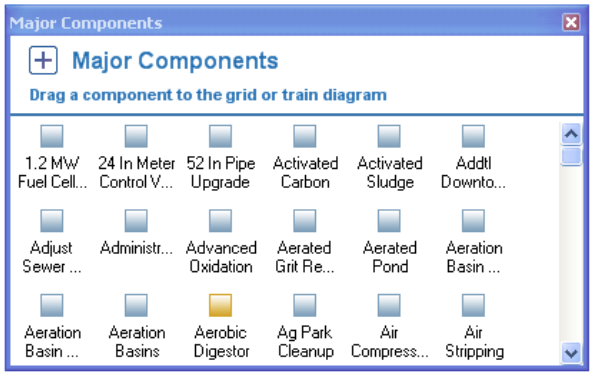
- Domestic Flows and Loads - Historical Data
- Industrial Flows and Loads - Historical Data
- Industrial Flows and Loads
- Other Pollutants - Historical Data
- Existing Treatment Process
- Planned Projects and Costs

Adding Grid Rows to Existing Treatment Process and Planned Projects Grids

To add a row to the Existing Treatment Process or Planned Projects grids, click the Add Component button in the toolbar at the top of the Data Window.



The Major Component box will become visible. Drag a component from the Major Component box and drop it into the grid, or into the train diagram. Both liquid and solid train components appear in the Major Component box. The solid train components are yellow. The liquid train components will appear blue in the Treatment Process train, and purple in the Planned Projects train.

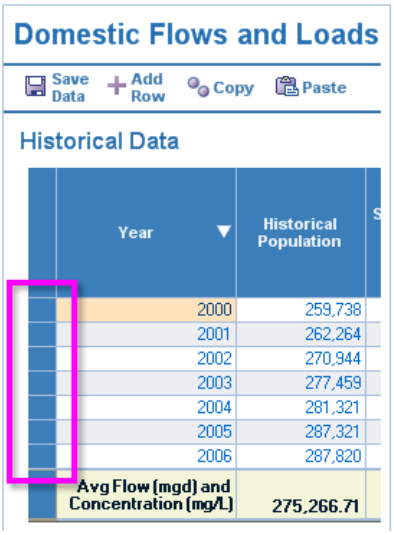


Dragging a component from the Major Components box creates a version of that component in the grid or train. The component itself remains in the Major Components box so that it can be added repeatedly to the grid or train.

A component can appear only once in any section of the Treatment Process train. For example, the "Filters" component can appear only once in section A of the train, once in section B, and so on. A component can appear multiple times in the same train section in the Planned Projects train, but the multiple versions will serve as added capacity to the original component. See Planned Projects for more information on added-capacity components.

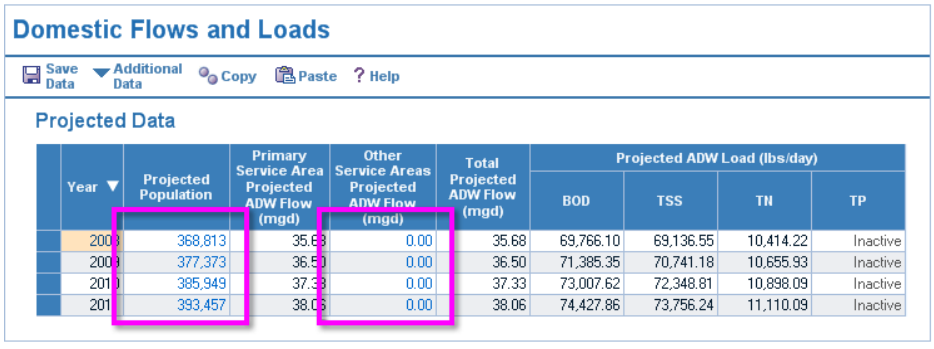
Deleting Grid Rows

To delete a grid row, use the mouse to click the left-most column in the grid (the blue column) of the row you wish to delete, and press the Delete key on the keyboard.

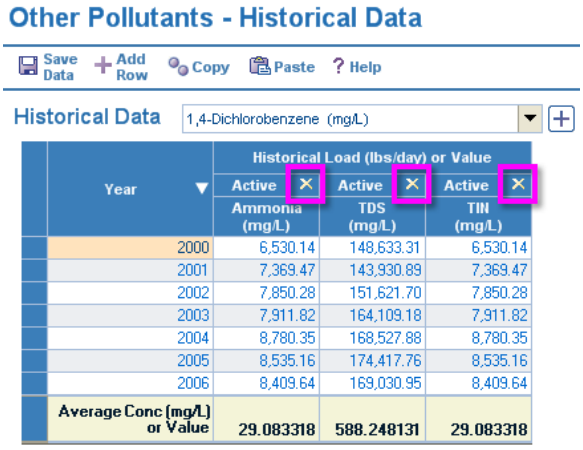


Editable Data

Data in blue text is editable, as shown in the image below. Data in black text is not editable.



Deleting Pollutants from Other Pollutant Grids

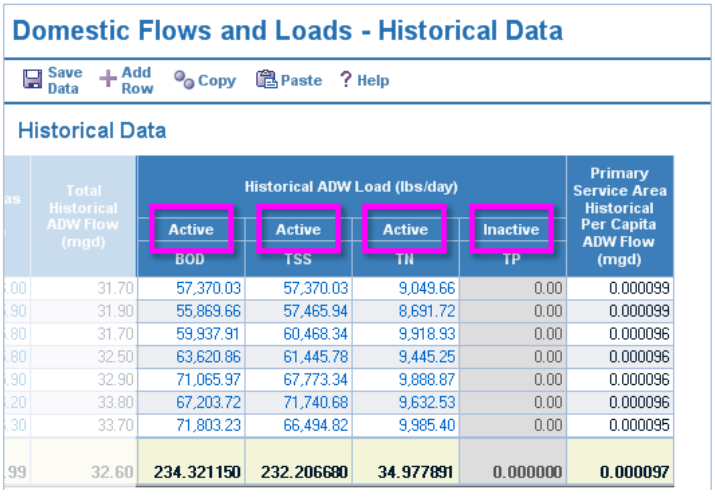


To delete a pollutant from the grid, click the "x" in the column heading of that pollutant.

Making Pollutants Active or Inactive

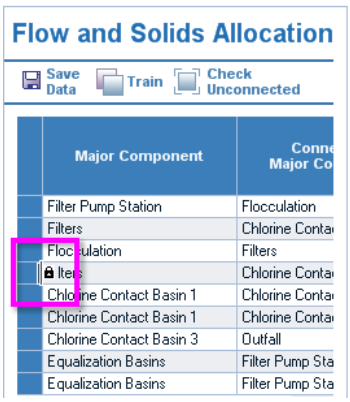
Click the word "Active" in the pollutant's column heading to make that pollutant inactive. The heading will change to "Inactive" and the column will be grayed out. Click the heading again to make the pollutant active. When a Domestic pollutant is inactive, it will not contribute to the values in the Projected Flows and Loads screen, and its values will not be used in any system calculations. Pollutants can be made active/inactive in the following screens:

- Domestic Flows and Loads - Historical Data
- Industrial Flows and Loads
- Other Pollutants - Historical Data
- Other Pollutants

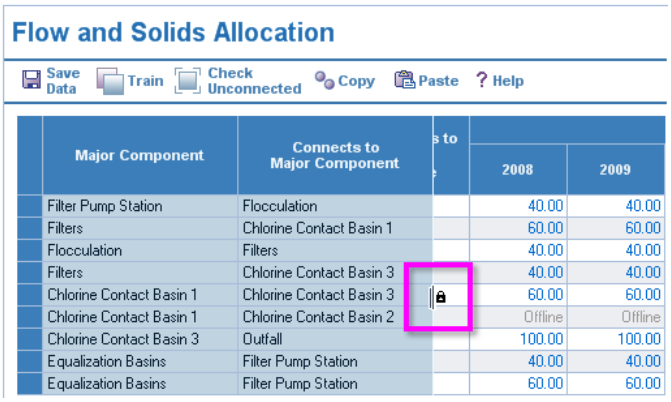


Setting a pollutant's values to zero will also effectively remove it from system calculations, since the pollutant's contribution will be zero. The advantage of making the pollutant inactive is that its values are retained (not set to zero) so that they will be available if the pollutant is again made active.

Locking Columns in Grids



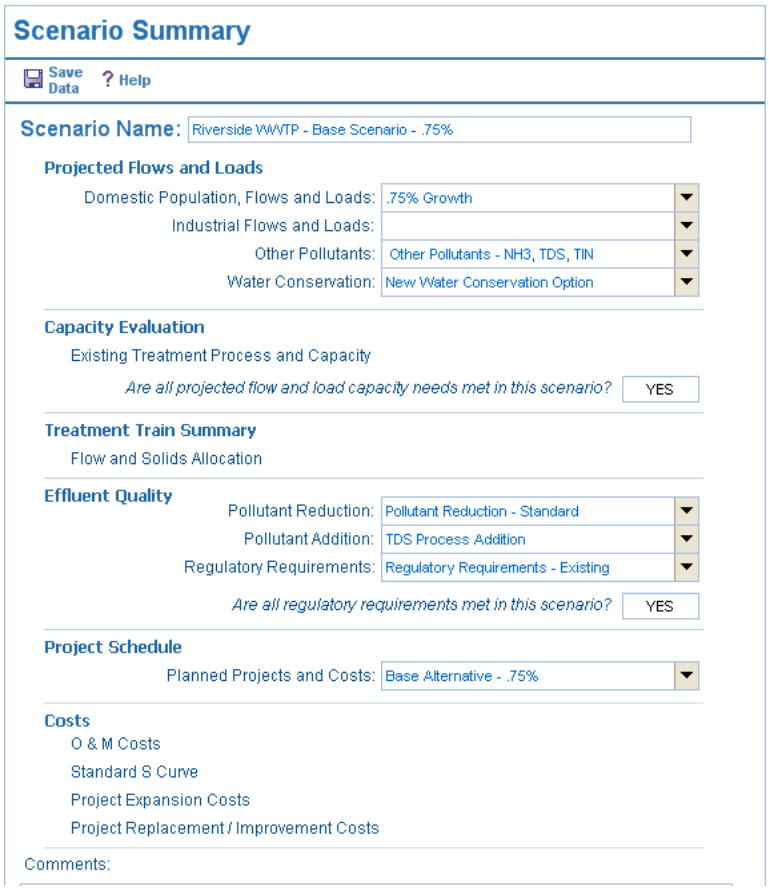
Columns in the grids can be locked so that when the grid data is scrolled, the locked columns remain visible and do not scroll out of view. Columns can be locked by holding the mouse over the left-most blue column until a small lock appears, as shown in the first image (right).



Once the lock appears, hold down the left mouse button and drag the lock to the right over the columns to be locked, as shown in the second image (left). Release the mouse button to lock the columns.

DATA

Scenario Summary



When MPM opens, the Scenario Summary screen is displayed. The Scenario Summary screen provides an overview of the system and allows users to make selections relating to the system.

System Selections

Calculations made by the system are based on the selections made in the Scenario Summary screen. For instance, the values in Projected Flows and Loads are calculated based on the selections made in the four drop-down boxes in that section. Capacity Evaluation uses Projected Flows and Loads, along with Flow and Solids Allocation, and the selected Planned Project to calculate whether capacity needs have been met. Effluent Quality uses those same values, along with Pollutant Reduction, Pollutant Addition, and Regulatory Requirements, to calculate whether regulatory requirements have been met.

The user can select items from the drop-down lists for Projected Flows and Loads, Effluent Quality, and Planned Projects and Costs. Whenever a new selection is made, that selection becomes the active selection for the system, and all values are recalculated. In this way, a user can test various combinations of selections to quickly determine whether requirements are met for the system.

Scenario Name

Edit the name of the Scenario Summary in the Scenario Name box. The new name will be displayed in the Data Tree when the data is saved.

Data Window Toolbar

Use the Save Data button in the toolbar at the top of the Scenario Summary screen to save any edited data, including drop-down list selections.

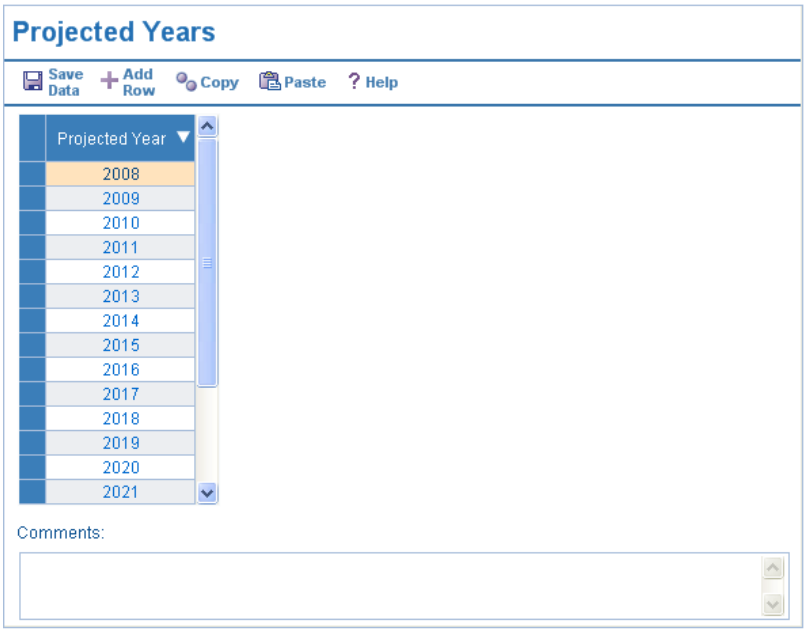
Links to Data Screens

Click on any item to display data for that item. For instance, click on Projected Flows and Loads to display the flows and loads data, or click on Pollutant Reduction to display the data for the selected Pollutant Reduction item.

Projected Years

The Projected Years screen displays the years for the planning period. The year values are editable, and rows can be added to and deleted from the grid.

Projected Years need not be consecutive.



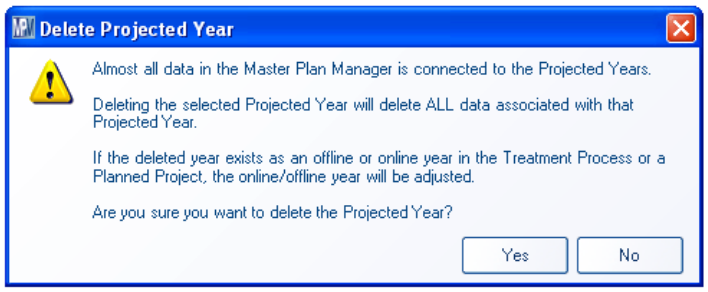
Projected Years as Basis for Data

Almost all data in MPM is connected to the Projected Years. Without Projected Years, many data screens will not be displayed.

Deleting Projected Years

Care should be taken when deleting years from the grid because all data for that year will also be deleted. The deleted year will no longer exist in the system. The message shown in the image below will be displayed whenever a Projected Year is to be deleted.

Also, when a year is deleted, data in the Treatment Process and Planned Projects grids will be modified so that all of the online and offline years in those grids fit within the range of the existing Projected Years. For instance, suppose a Treatment Process component goes offline in 2027, and the Projected Years grid contains years from 2008 to 2027. If the year 2027 is deleted from the Projected Years grid, the Treatment Process grid will be modified so that the component goes offline in 2026, rather than 2027, because 2027 no longer exists.



Editing Projected Years

The Treatment Process and Planned Projects grids will be modified if editing a year causes the overall year range to change. For instance, suppose the years 2010, 2015, and 2020 exist in the Projected Years grid, and a Planned Projects component comes online in 2010, which is the earliest Projected Year. If the year 2010 is changed to 2012 in the Projected Years grid, the Planned Projects grid will be modified so that the component comes online in 2012, because that is the now the earliest Projected Year.

Projected Flows and Loads

The Projected Flows and Loads screen displays the flows and loads for the system. The data in the grid is not directly editable, but is gathered from the supporting data screens that exist below the Projected Flows and Loads item in the Data Tree.

Options and Peaking Factors

The top portion of the screen contains the selected Projected Flows and Loads options and the Peaking Factors.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Options

Calculated values in the Projected Flows and Loads grid are based on the selected Domestic, Industrial, Other Pollutant, and Water Conservation options. The user can change which of those options are used by the system by selecting items from the drop-down lists in the top portion of this screen.

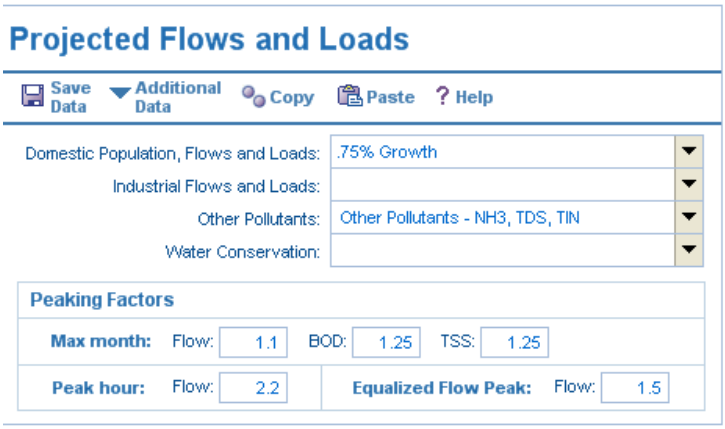
Whenever a new selection is made, that selection becomes the active selection for the entire system, and the values in the Projected Flows and Loads grid (as well as the entire system) are recalculated.

Peaking Factors

The user can enter the following peaking factors:

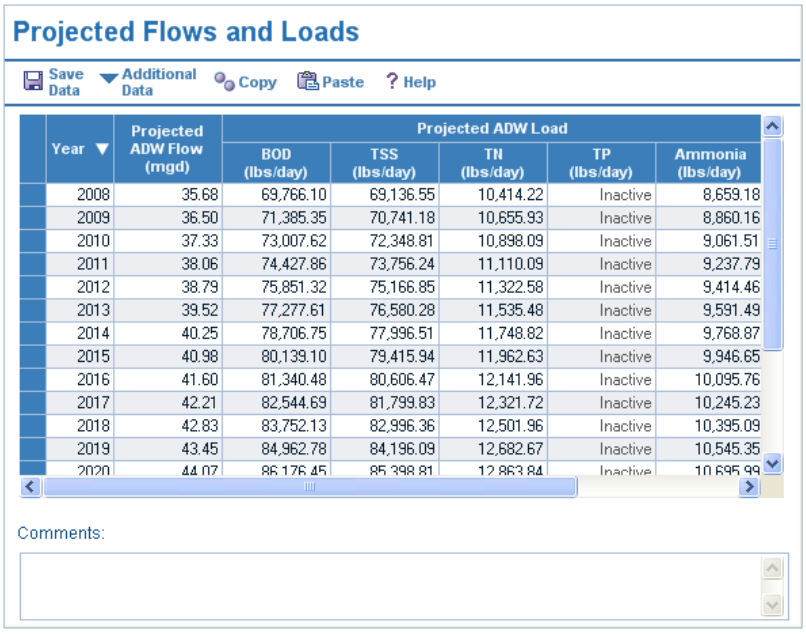
- Max month flow, max month BOD, and max month TSS
- Peak hour flow
- Equalized flow peak

The peaking factors are used in the Capacity Evaluation screen to calculate the peaking projected flows and loads values.



Projected Flows and Loads Data

The bottom portion of the screen contains the Projected Flows and Loads data.



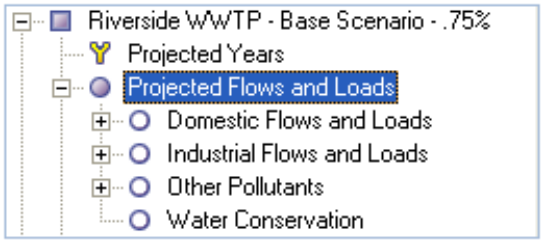
Year	Projected ADW Flow (mgd)	Projected ADW Load				
		BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)	Ammonia (lbs/day)
2008	35.68	69,766.10	69,136.55	10,414.22	Inactive	8,659.18
2009	36.50	71,385.35	70,741.18	10,655.93	Inactive	8,860.16
2010	37.33	73,007.62	72,348.81	10,898.09	Inactive	9,061.51
2011	38.06	74,427.86	73,756.24	11,110.09	Inactive	9,237.79
2012	38.79	75,851.32	75,166.85	11,322.58	Inactive	9,414.46
2013	39.52	77,277.61	76,580.28	11,535.48	Inactive	9,591.49
2014	40.25	78,706.75	77,996.51	11,748.82	Inactive	9,768.87
2015	40.98	80,139.10	79,415.94	11,962.63	Inactive	9,946.65
2016	41.60	81,340.48	80,606.47	12,141.96	Inactive	10,095.76
2017	42.21	82,544.69	81,799.83	12,321.72	Inactive	10,245.23
2018	42.83	83,752.13	82,996.36	12,501.96	Inactive	10,395.09
2019	43.45	84,962.78	84,196.09	12,682.67	Inactive	10,545.35
2020	44.07	86,176.45	85,398.81	12,863.84	Inactive	10,695.99

Year

The Year column contains the years that exist in the Projected Years screen.

Projected Average Dry Weather Flow

The Projected Average Dry Weather (ADW) Flow column is made up of values from the Domestic Flows and Loads, Industrial Flows and Loads, and Water Conservation screens, which appear beneath Projected Flows and Loads in the Data Tree.



Equation: The values in the Projected ADW Flow column are calculated by adding the Total Projected ADW Flow from the Domestic Flows and Loads screen to the Projected ADW Flow from the Industrial Flows and Loads screen, and multiplying the values by the Water Conservation percentage.

Projected ADW Load Columns

Equation: The Projected ADW Load values for BOD, TSS, TN, and TP are calculated by adding those columns from the Domestic Flows and Loads screen to the Industrial Flows and Loads screen, and modifying the result by the Water Conservation percentage (only when that percentage is 100%).

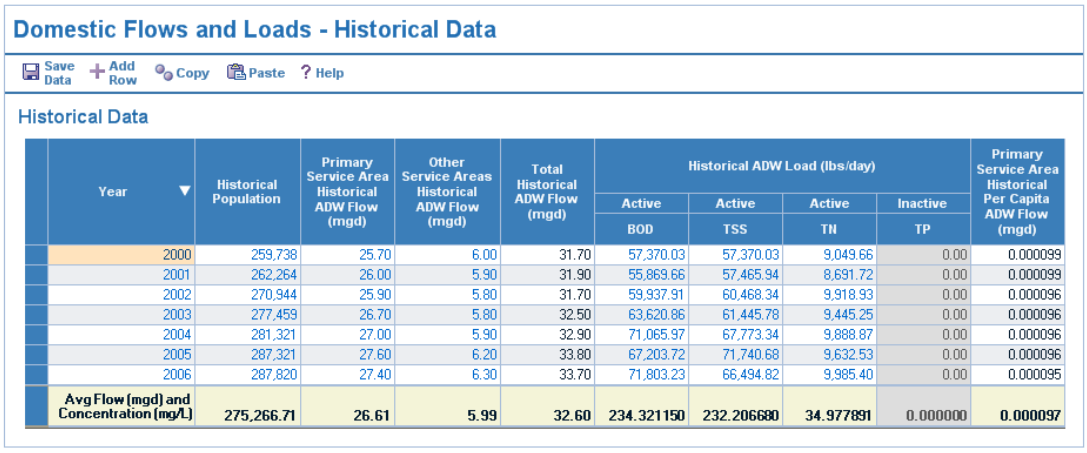
Equation: The Projected ADW Load values for all other pollutants are obtained from the pollutant columns in the Other Pollutants Projected Data screen, Pollutant TDS is multiplied by the TDS Conservation percentage on the Water Conservation screen. The load values are then modified by the Water Conservation percentage (only when that percentage is 100%).

The Load values are not modified by the water conservation percentage unless that percentage is 100%. When the water conservation percentage is 100%, the load becomes zero because there is no flow. If the Water Conservation is any percentage other than 100%, the load values are not modified by water conservation.

Domestic Flows and Loads - Historical Data

The Domestic Flows and Loads - Historical Data screen allows the user to enter values that will serve as the basis for the Domestic Projected Flows and Loads screen.

The pollutants in the grid are limited to BOD, TSS, TN, and TP. Additional pollutants can be added in the Other Pollutants and Other Pollutants - Historical Data screens.



Domestic Flows and Loads - Historical Data

Save Data | Add Row | Copy | Paste | Help

Historical Data

Year	Historical Population	Primary Service Area Historical ADW Flow (mgd)	Other Service Areas Historical ADW Flow (mgd)	Total Historical ADW Flow (mgd)	Historical ADW Load (lbs/day)				Primary Service Area Historical Per Capita ADW Flow (mgd)
					Active BOD	Active TSS	Active TN	Inactive TP	
2000	259,738	25.70	6.00	31.70	57,370.03	57,370.03	9,049.66	0.00	0.000099
2001	262,264	26.00	5.90	31.90	55,869.66	57,465.94	8,691.72	0.00	0.000099
2002	270,944	25.90	5.80	31.70	59,937.91	60,468.34	9,918.93	0.00	0.000096
2003	277,459	26.70	5.80	32.50	63,620.86	61,445.78	9,445.25	0.00	0.000096
2004	281,321	27.00	5.90	32.90	71,065.97	67,773.34	9,888.87	0.00	0.000096
2005	287,321	27.60	6.20	33.80	67,203.72	71,740.68	9,632.53	0.00	0.000096
2006	287,820	27.40	6.30	33.70	71,803.23	66,494.82	9,985.40	0.00	0.000095
Avg Flow (mgd) and Concentration (mg/L)	275,266.71	26.61	5.99	32.60	234.321150	232.206680	34.977891	0.000000	0.000097

Year

The user enters years into the Year column. The years must be historical; that is, each year must be less than the current calendar year.

Historical Population

The user enters the historical population for each year in the Historical Population column.

Primary Service Area Historical ADW Flow

The user enters values into the Primary Service Area (PSA) Historical ADW Flow column in millions of gallons per day.

Other Service Areas Historical ADW Flow

The Other Service Areas (OSA) Projected ADW Flow is entered by the user in millions of gallons per day.

Total Historical ADW Flow

The Total Historical ADW Flow column is calculated by adding the PSA Historical ADW Flow to the OSA Historical ADW Flow.

Historical ADW Load

Each Historical ADW Load value is calculated by multiplying the corresponding Historical ADW Concentration by the Total Historical ADW Flow by a conversion factor of 8.3454.

Primary Service Area Historical Per Capita ADW Flow

Each PSA Historical Per Capita ADW Flow value is calculated by dividing each PSA Historical ADW Flow value by the Historical Population value.

Average Flow and Concentration

The bottom row of the grid contains the average values for each column.

The average values for the Historical Population column, the PSA, OSA and Total Historical ADW Flow columns, and the PSA Historical Per Capita ADW Flow column are calculated by adding the values in each column and dividing by the number of years.

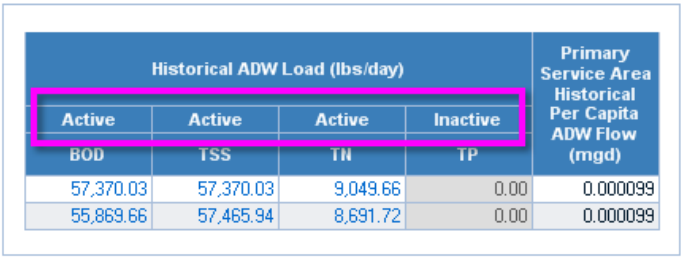
The average concentration values for the Historical ADW Load columns (BOD, TSS, TN, TP) are calculated by first dividing the Load value in each row by the Total Historical ADW Flow value in that row, and then summing the resulting

values for each row and dividing by the number of years. The result is also divided by a conversion factor of 8.3454.

Making Pollutants Active or Inactive

Click the word "Active" in the pollutant's column heading to make that pollutant inactive. The heading will change to "Inactive" and the column will be grayed out. Click the heading again to make the pollutant active. When a Domestic pollutant is inactive, it will not contribute to the values in the Projected Flows and Loads screen, and its values will not be used in any system calculations.

Setting a pollutant's values to zero will also effectively remove it from system calculations, since the pollutant's contribution will be zero. The advantage of making the pollutant inactive is that its values are retained (not set to zero) so that they will be available if the pollutant is again made active.



Historical ADW Load (lbs/day)				Primary Service Area Historical Per Capita ADW Flow (mgd)
Active	Active	Active	Inactive	
BOD	TSS	TN	TP	
57,370.03	57,370.03	9,049.66	0.00	0.000099
55,869.66	57,465.94	8,691.72	0.00	0.000099

Domestic Flows and Loads

The Domestic Flows and Loads screen displays the domestic flows and loads for the system. The values in the Total Projected ADW Flow column and the Projected ADW Load columns are added to the values in the Industrial Projected Flows and Loads screen to determine the values in the Projected Flows and Loads screen.

The pollutants in the grid are limited to BOD, TSS, TN, and TP. Additional pollutants can be added in the Other Pollutants and Other Pollutants - Historical Data screens.

Name, Selected, Historical Data

The top portion of the screen contains the Name, the Selected check box, and Historical data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

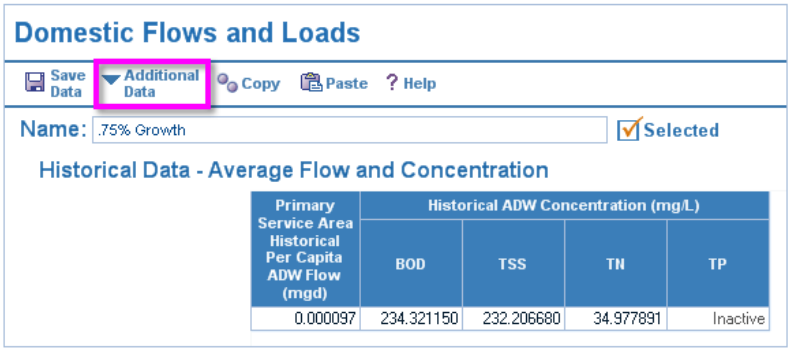
The user enters the name of the projected Domestic Flows and Loads option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the projected Domestic Flows and Loads option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Domestic Flows and Loads option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Domestic Flows and Loads option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

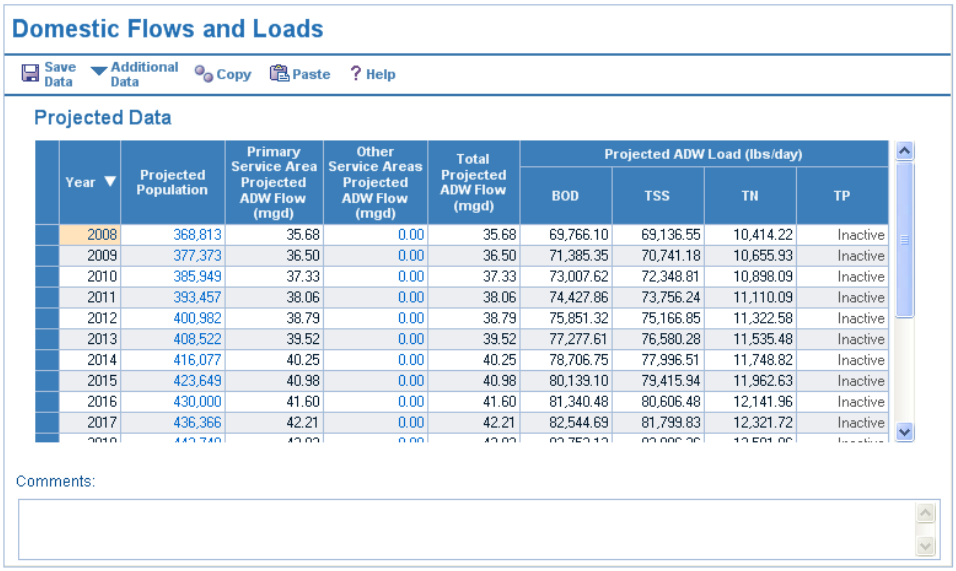
Historical Data

The average flow and concentration values from the Domestic Flows and Loads - Historical Data screen are displayed in the Historical Data grid.



Projected Data

The bottom portion of the screen contains the Domestic projected flows and loads data.



Year

The Year column contains the years that exist in the Projected Years screen.

Projected Population

The user enters the estimated population for each year in the Projected Population column.

Primary Service Area Projected ADW Flow

The Primary Service Area (PSA) Projected ADW Flow column is calculated by multiplying the Average PSA Historical Per Capita ADW Flow (from the Domestic historical data grid) by the Projected Population.

Other Service Areas Projected ADW Flow

The Other Service Areas (OSA) Projected ADW Flow is entered by the user in millions of gallons per day.

Total Projected ADW Flow

The Total Projected ADW Flow column is calculated by adding the PSA Projected ADW Flow to the OSA Projected ADW Flow.

Projected ADW Load

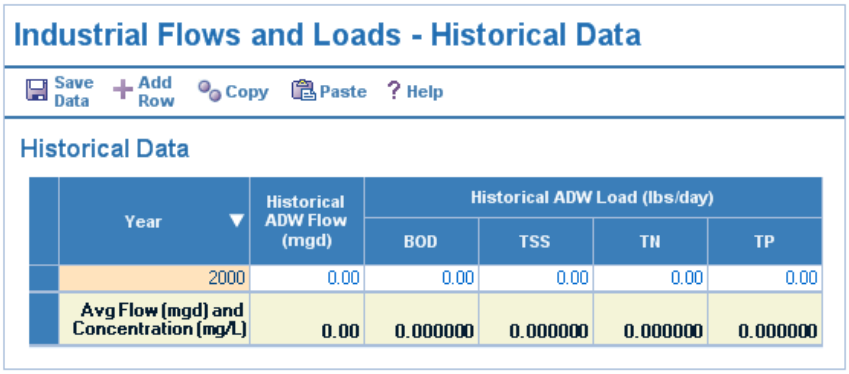
Each Projected ADW Load value is calculated by multiplying the corresponding Historical ADW Concentration (from the Domestic historical data grid) by the Total Projected ADW Flow by a conversion factor of 8.3454.

A pollutant is set to Active or Inactive in the Domestic Flows and Loads - Historical Data screen.

Industrial Flows and Loads - Historical Data

The Industrial Flows and Loads - Historical Data screen allows users to enter historical Industrial values. The historical values are for informational purposes only and are not used when calculating the projected Industrial Flows and Loads or any other values.

The pollutants in the grid are limited to BOD, TSS, TN, and TP. Additional pollutants can be added in the Other Pollutants and Other Pollutants - Historical Data screens.



Year

The user enters years into the Year column. The years must be historical; that is, each year must be less than the current calendar year.

Historical ADW Flow

The values in the Historical ADW Flow column are entered by the user in millions of gallons per day.

Historical ADW Load

The values in the Historical ADW Load columns are entered by the user in pounds per day.

Average Flow and Concentration

The bottom row of the grid contains the average values for each column.

The average value for the Historical ADW Flow column is calculated by adding the values in the column and dividing by the number of years.

The average concentration values for the Historical ADW Load columns (BOD, TSS, TN, TP) are calculated by first dividing the Load value in each row by the Historical ADW Flow value in that row, and then summing the resulting values for each row and dividing by the number of years. The result is also divided by a conversion factor of 8.3454.

Industrial Flows and Loads

The Industrial Flows and Loads screen displays the industrial flows and loads for the system. The values in the Projected ADW Flow column and the Projected ADW Load columns are added to the values in the Domestic Projected Flows and Loads screen to determine the values in the Projected Flows and Loads screen.

The pollutants in the grid are limited to BOD, TSS, TN, and TP. Additional pollutants can be added in the Other Pollutants and Other Pollutants - Historical Data screens.

Name, Selected, Historical Data

The top portion of the screen contains the Name, the Selected check box, and Historical data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

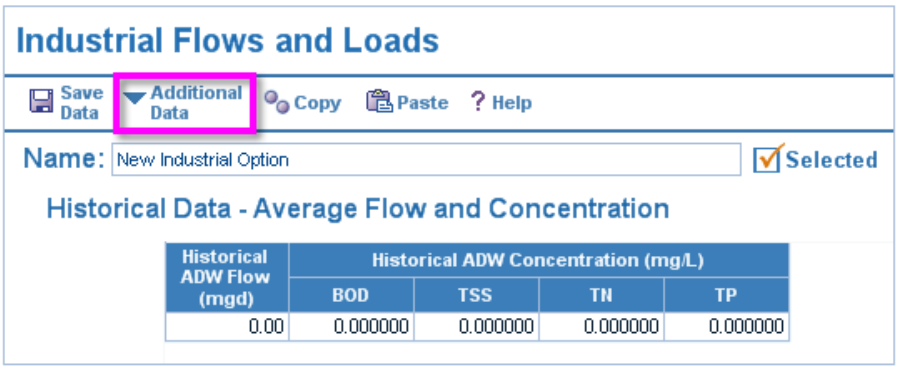
The user enters the name of the projected Industrial Flows and Loads option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the projected Industrial Flows and Loads option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Industrial Flows and Loads option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Industrial Flows and Loads option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

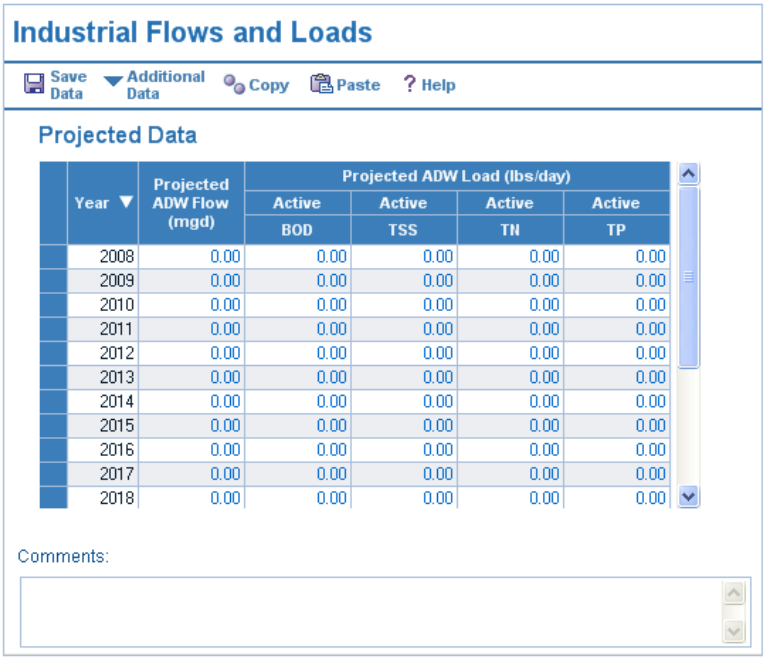
Historical Data

The average flow and concentration values from the Industrial Flows and Loads - Historical Data screen are displayed in the Historical Data grid.



Projected Data

The bottom portion of the screen contains the Industrial projected flows and loads data.



Year

The Year column contains the years that exist in the Projected Years screen.

Projected ADW Flow

The values in the Projected ADW Flow column are entered by the user in millions of gallons per day.

Projected ADW Load

The values in the Projected ADW Load columns are entered by the user in pounds per day.

Making Pollutants Active or Inactive

Click the word "Active" in the pollutant's column heading to make that pollutant inactive. The heading will change to "Inactive" and the column will be grayed out. Click the heading again to make the pollutant active. When an Industrial pollutant is inactive, it will not contribute to the values in the Projected Flows and Loads

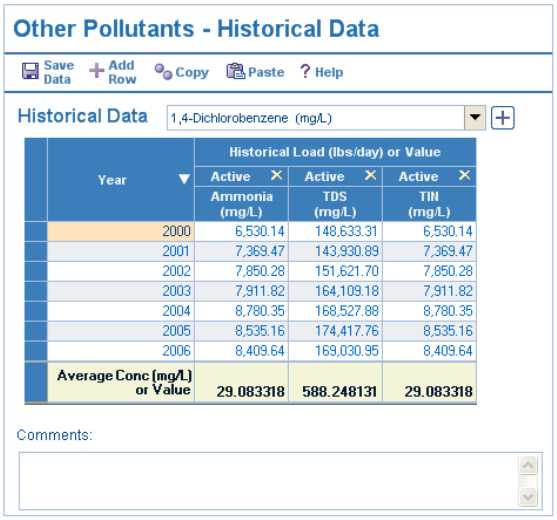
screen, and its values will not be used in any system calculations.

Setting a pollutant's values to zero will also effectively remove it from system calculations, since the pollutant's contribution will be zero. The advantage of making the pollutant inactive is that its values are retained (not set to zero) so that they will be available if the pollutant is again made active.

Other Pollutants - Historical Data

The Other Pollutants - Historical Data screen allows the user to create historical other pollutants and enter their values.

The historical values are for informational purposes only - they are not used in system calculations or to calculate projected Other Pollutants values.



Year

The user enters years into the Year column. The years must be historical; that is, each year must be less than the current calendar year.

Historical Load or Value

The values in the Historical Load columns are entered by the user in the units for that pollutant. For example, Ammonia would be entered in pounds per day, while Turbidity would be entered in NTU.

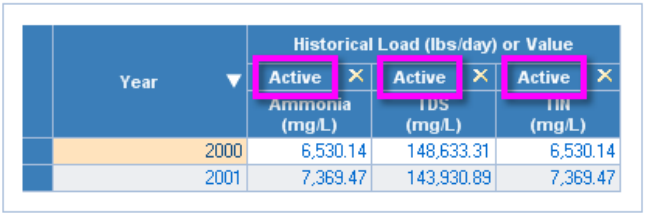
Average Concentration or Value

The bottom row of the grid contains the average values for each column.

The average concentration values for pollutants with units in pounds per day are calculated by first dividing the Load value in each row by a flow value, and then summing the resulting values for each row and dividing by the number of years. The result is also divided by a conversion factor of 8.3454. The flow that is used is the Average Flow value from the bottom row of the Total Historical ADW Flow value column in the Domestic Flows and Load - Historical Data and Industrial Flows and Load - Historical Data screen.
The average values for pollutants with units other than pounds per day are calculated by adding the values in each column and dividing by the number of years.

Making Pollutants Active or Inactive

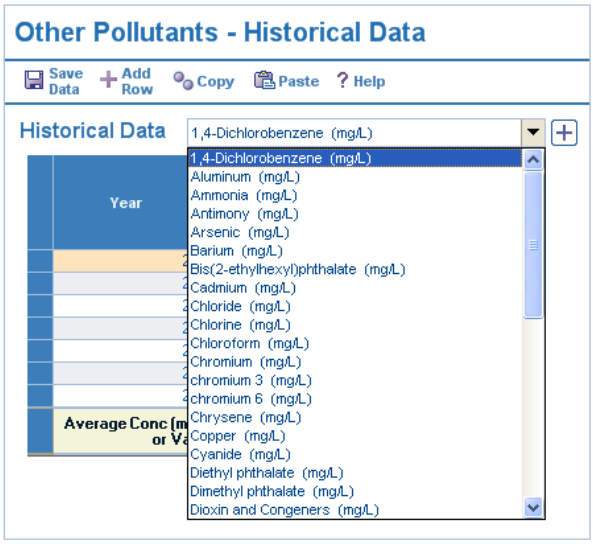
Click the word "Active" in the pollutant's column heading to make that pollutant inactive. The heading will change to "Inactive" and the column will be grayed out. Click the heading again to make the pollutant active.



	Year	Historical Load (lbs/day) or Value		
		Active ✕ Ammonia (mg/L)	Active ✕ TDS (mg/L)	Active ✕ TIN (mg/L)
	2000	6,530.14	148,633.31	6,530.14
	2001	7,369.47	143,930.89	7,369.47

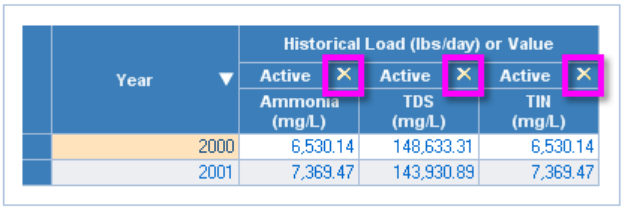
Adding a Pollutant to the Grid

To add a pollutant to the grid, select a pollutant from the drop-down list, and click the + button.



Deleting a Pollutant from the Grid

To delete a pollutant from the grid, click the "x" in the column heading of that pollutant.



Other Pollutants

The Other Pollutants screen displays the flows and loads for pollutants that are not BOD, TP, TN, or TP. The values that are calculated for the Projected Load or Value columns are also used in the Projected Flows and Loads screen.

Name, Selected, Historical Data

The top portion of the screen contains the Name, the Selected check box, and Historical data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

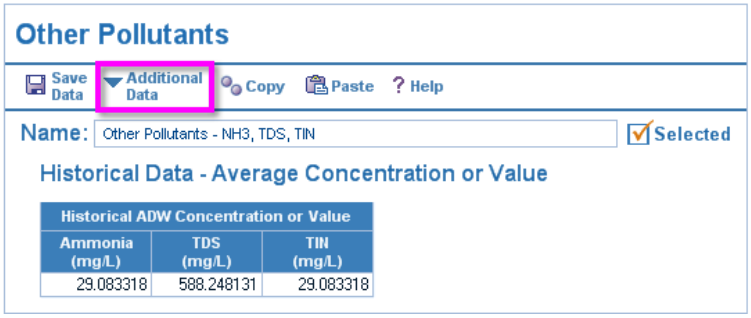
The user enters the name of the projected Other Pollutants option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the projected Other Pollutants option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Other Pollutants option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Other Pollutants option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

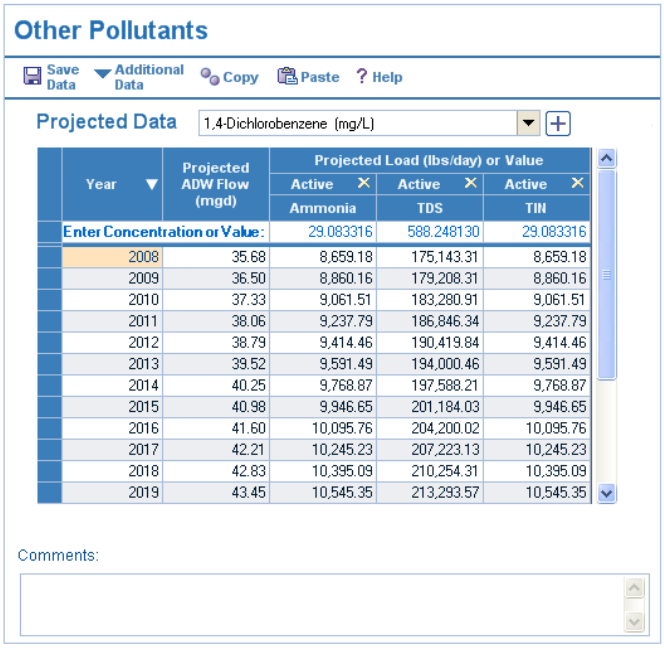
Historical Data

The average concentrations or values from the Other Pollutants - Historical Data screen are displayed in the Historical Data grid.



Projected Data

The bottom portion of the screen contains the Other Pollutants projected flows and loads data.



Enter Concentration or Value

The user enters values in the "Enter Concentration or Value" row in the units of the pollutant. Pollutants such as Ammonia are in milligrams per liter, so the value entered for Ammonia in this row is in milligrams per liter. Pollutants that use other units (such as Turbidity), would have their values entered in those units.

Year

The Year column contains the years that exist in the Projected Years screen.

Projected ADW Flow

The Projected ADW Flow column is made up of values from the Domestic Flows and Loads and Industrial Flows and Loads.

The values in the Projected ADW Flow column are calculated by adding the Total Projected ADW Flow from the Domestic Flows and Loads screen to the Projected ADW Flow from the Industrial Flows and Loads screen.

These are the same values found in the Projected Flows and Loads screen, except that here, in the Other Pollutants screen, the values are not modified by the Water Conservation percentages.

Projected Load or Value

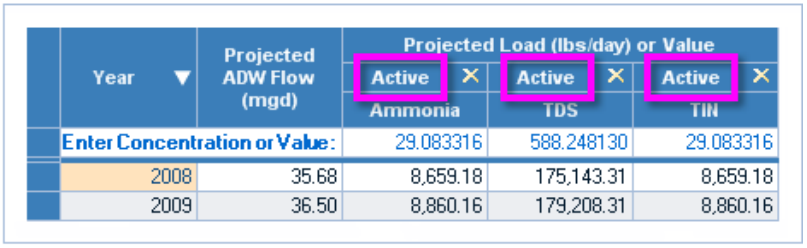
For pollutants with units of milligrams per liter (such as Ammonia), the Projected Load value is calculated by multiplying the user-entered Concentration by the Projected ADW Flow, and then by a conversion factor of 8.3454.

For pollutants with units other than milligrams per liter (such as Turbidity), each row in the Projected Value column contains the same value that is entered by the user in the "Enter Concentration or Value" row.

Making Pollutants Active or Inactive

Click the word "Active" in the pollutant's column heading to make that pollutant inactive. The heading will change to "Inactive" and the column will be grayed out. Click the heading again to make the pollutant active. When a pollutant is inactive, it will not contribute to the values in the Projected Flows and Loads screen, and its values will not be used in any system calculations.

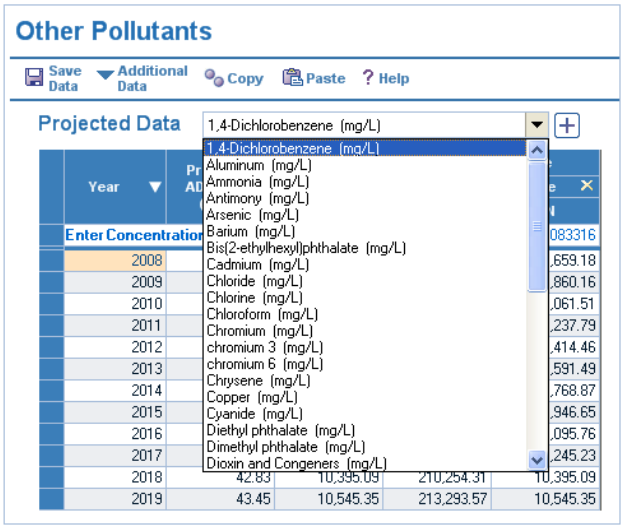
Setting a pollutant's values to zero will also effectively remove it from system calculations, since the pollutant's contribution will be zero. The advantage of making the pollutant inactive is that its values are retained (not set to zero) so that they will be available if the pollutant is again made active.



Year	Projected ADW Flow (mgd)	Projected Load (lbs/day) or Value		
		Active ✕ Ammonia	Active ✕ TDS	Active ✕ TIN
Enter Concentration or Value:		29.083316	588.248130	29.083316
2008	35.68	8,659.18	175,143.31	8,659.18
2009	36.50	8,860.16	179,208.31	8,860.16

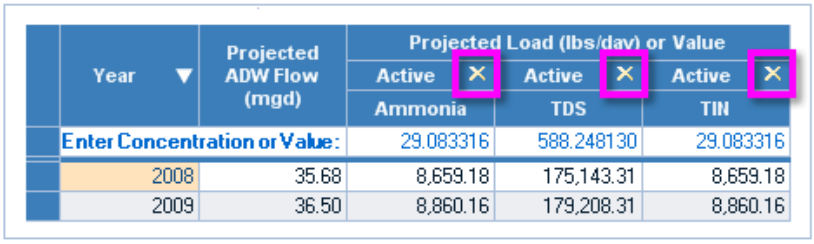
Adding a Pollutant to the Grid

To add a pollutant to the grid, select a pollutant from the drop-down list, and click the **+** button.



Deleting a Pollutant from the Grid

To delete a pollutant from the grid, click the "x" in the column heading of that pollutant.



Water Conservation

The Water Conservation screen displays the percentage of water and TDS that will be conserved. The values in the grid are in percentages, so that entering a value of 50.00 means 50.00 percent.

The percentages in the grid are used in calculations in the Projected Flows and Loads screen and the Effluent Quality screen.

Name, Selected

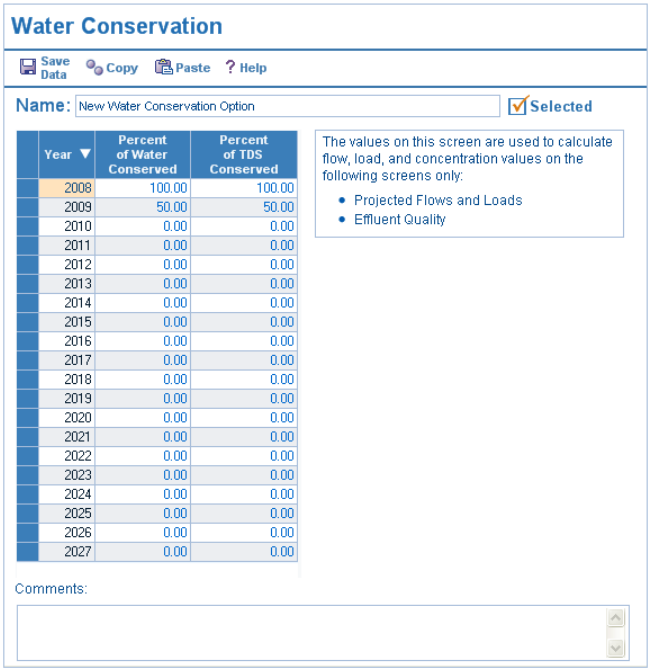
The top portion of the screen contains the Name, and the Selected check box.

Name

The user enters the name of the Water Conservation option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the Water Conservation option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Water Conservation option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Water Conservation option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.



Year

The Year column contains the years that exist in the Projected Years screen.

Effect of Conservation on Projected Flows and Loads

TDS Conservation

The Projected ADW Load values for TDS in the Projected Flows and Loads screen are reduced by the percentage in the "Percent of TDS Conserved" column. No other values in the Projected Flows and Loads screen are affected by the TDS Conservation percentage.

Water Conservation

The Projected ADW Flow values in the Projected Flows and Loads screen are reduced by the percentage in the "Percent of Water Conserved" column. The Projected ADW Load values are reduced only when the Water Conservation percentage is 100%.

The image below shows values from a portion of the Projected Flows and Loads screen when the Water Conservation values are all set to zero.

Year ▼	Projected ADW Flow (mgd)	Projected ADW Load				
		BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)	Ammonia (lbs/day)
2008	35.68	69,766.10	69,136.55	10,414.22	Inactive	8,659.18
2009	36.50	71,385.35	70,741.18	10,655.93	Inactive	8,860.16

The image below shows values from a portion of the Projected Flows and Loads screen when the Water Conservation values are 100.00% for 2008, and 50.00% for 2009. The Projected ADW Flow value for 2008 is zero because 100% of the water is conserved, while the value for 2009 is reduced by 50% because the Water Conservation value is 50.00% in 2009.

The Projected ADW Load columns in the Projected Flows and Loads grid are affected by the values in the Water Conservation grid only when water conservation is 100.00%. When all water is conserved, the load values are all

zero. However, when the water conservation percentage is anything other than 100.00%, the load values are unaffected.

Year ▼	Projected ADW Flow (mgd)	Projected ADW Load				
		BOD (lbs/day)	TSS (lbs/day)	TN (lbs/day)	TP (lbs/day)	Ammonia (lbs/day)
2008	0.00	0.00	0.00	0.00	Inactive	0.00
2009	18.25	71,385.35	70,741.18	10,655.93	Inactive	8,860.16

Effect of Conservation on Effluent Quality

The Effluent Quality screen uses the values from the Projected Flows and Load screen, including changes to flows and loads due to water and TDS conservation.

Capacity Evaluation

The Capacity Evaluation screen gathers data about the Major Components from the selected Planned Project, if one exists, and from the Existing Treatment Process. The Capacity Evaluation screen also uses Projected Flows and Loads data, as well as Flow and Solids Allocation data, to calculate whether capacity requirements are met for each Projected Year.

The Capacity Evaluation screen performs calculations based on information in the entire system. Each Planned Project contains both Major Components from the Existing Treatment Process, and Major Components added to the Planned Project in the planning process. The Planned Project therefore represents all of the Major Components in the system, and is used as the basis for Capacity Evaluation calculations. If no Planned Projects exist, the Existing Treatment Process represents the system and is used as the basis for Capacity Evaluation calculations.

The Capacity Evaluation grid is not editable.

Added Average Capacity

The top portion of the screen contains the Added Average Capacity values.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Avg Added Flow Capacity

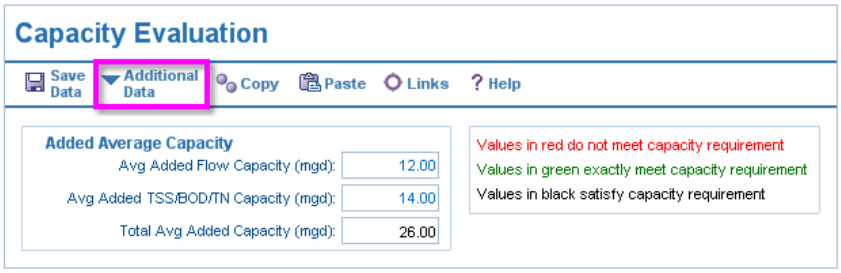
The user enters the average added flow capacity in million gallons per day.

Avg Added TSS/BOD/TN Capacity

The user enters the average added TSS/BOD/TN capacity in million gallons per day.

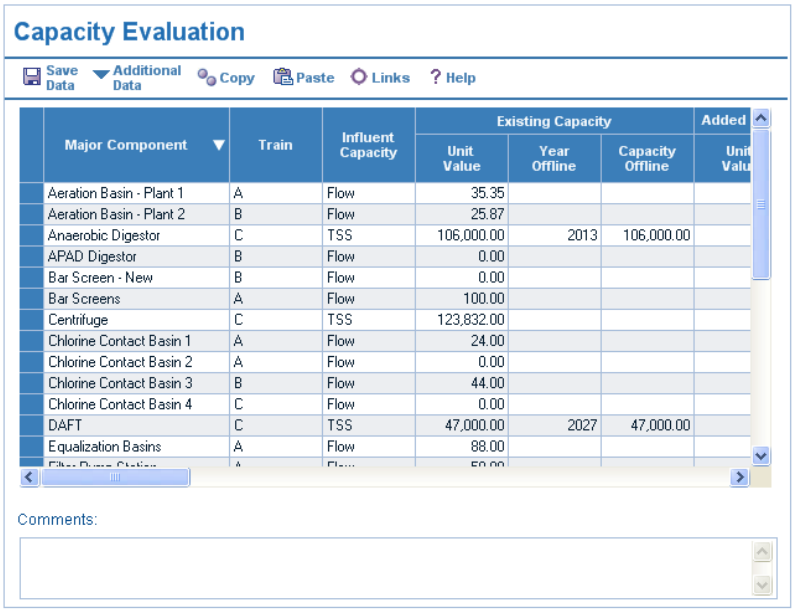
Total Avg Added Capacity

The Total Average Added Capacity is the total of the user-entered average added flow and TSS/BOD/TN capacity values.



Capacity Evaluation Data

The bottom portion of the screen contains the Capacity Evaluation data.



Major Component

The Major Components from the selected Planned Projects option are used to populate the Major Component column. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Train

The train that each Major Component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Influent Capacity

The Capacity Type for each Major Component. The Capacity Type for all Major Components is displayed in the Major Component window.

Existing Capacity - Unit Value

The existing capacity of the Major Component. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist.

Existing Capacity - Year Offline

The year the existing Major Component goes offline and is no longer available to the system. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist.

Existing Capacity - Capacity Offline

The amount of capacity that goes offline in the year offline. Any portion (or all) of the capacity can go offline. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist.

Added Capacity - Unit Value

The added capacity of the Major Component. This value always comes from the Planned Projects screen.

This value can act as additional capacity to an existing Treatment Process Major Component, or it can be additional capacity

Added Capacity - Capacity Units

The Capacity Unit for each Major Component. The Capacity Unit for each Major Component is displayed in the Major Component window.

Added Capacity - Unit Value

The added capacity for the Major Component from the "Added Capacity - Unit Value" column broken down by year. If the added capacity occurs in multiple years, each capacity will be listed separately in this column.

Added Capacity by Year - Year(s) Online

The years the added capacity comes online. This data always comes from the Planned Projects screen. If the added capacity comes online in multiple years, each year will be listed separately in this column.

Averaging Period

The Averaging Period for each Major Component is the Capacity Basis for that component as shown in the Major Component window.

Peaking Factor

The Peaking Factor value is a user-entered value that is entered into the top portion of the Projected Flows and Loads screen, specific to each Major Component.

The Peaking Factors are as follows:

- Max month flow, max month BOD, and max month TSS
- Peak hour flow
- Equalized flow peak

The projected flows and loads are multiplied by the peaking factor in the Capacity Evaluation screen.

Requirements Met

The capacity of each Major Component is compared with the values in the Peaking Projected Flows and Loads column for each year. If the capacity (both existing and added) of the Major Component is sufficient to handle the projected flow or load, the requirements have been met, and the Requirements Met column will contain "YES." If the projected flow or load exceeds the capacity of the Major Component, the Requirements Met column will contain "NO."

Peaking Projected Flows and Loads

The Peaking Projected Flows and Loads are displayed for each year and for each Major Component. The value is calculated as follows:

Equation: Projected Flow or Load x Peaking Factor x Major Component Flow Percentage.

The flow and load values, along with the peaking factor, come from the Projected Flows and Loads screen. The flow percentage for each Major Component comes from the Flow and Solids Allocation screen.

The values in the column are color-coded for ease in identifying whether the projected flow or load exceeds the capacity. A value displayed in red text indicates that the flow or load exceeds the capacity of the Major Component in that year. A value in green indicates that the flow or load is the same value as the available capacity, and a value in black indicates that the capacity is sufficient to handle the flow or load for that year.

If a Major Component is offline, the word "Offline" will appear in the column instead of a numerical value.

Existing Treatment Process

The Existing Treatment Process represents the Major Components as they currently exist. The existing treatment process is created by adding Major Components to the grid or train, entering data for those components, and creating connections in the train.

The Treatment Process stands on its own as the model for the existing system, but its real purpose is to serve as the basis for Planned Project options that can

be created to modify the system in future years. When a Planned Project is created, it starts off with all of the existing treatment process components and connections. The Planned Project can then be modified by adding Planned Project components to model the treatment processes in future years.

When there are no Planned Projects, the Existing Treatment Process serves as the treatment system upon which calculations are based. System calculations (such as those for Capacity Evaluation and Effluent Quality) are based on the components and data that appear in the Existing Treatment Process.

When Planned Projects exist, system calculations are no longer based on the Existing Treatment Process, but are based on the components and data in the selected Planned Project. Although the Existing Treatment Process is no longer used as the basis for those calculations, it is still used as the starting point for newly-created Planned Projects.

In addition, whenever a change is made to a component or connection in the Existing Treatment Process screen, that change is automatically included in all the Planned Projects in the Scenario. For example, if a connection is created between two components in the Treatment Process train, that connection will also be created automatically in all the Planned Projects in the Scenario. However, if a connection is deleted in the Treatment Process train, that connection will NOT be deleted from any of the Planned Projects. The Treatment Process only adds information to the Planned Projects; it never deletes it. Any changes made in the Planned Projects will have no effect on any data in the Treatment Process screen.

General Data Operations

Adding Grid Rows. Click the Add Component button to display a small major components box. A row is added to the grid by dragging a component from the major components box and dropping it into the grid or train. When a component

is dropped into the train, it is automatically added to the grid, and the "Included in Treatment" check box is checked. When a component is dropped into the grid, it is not automatically added to the train, and its "Included in Treatment" check box is not checked. Checking the "Included in Treatment" checkbox causes the component to appear in the train. Unchecking the checkbox removes the component from the train.

Deleting Grid Rows. When a row is deleted from the grid, that component is deleted from the train. The component and all of its data will be deleted when the data is saved.

Major Components. Components are added to the treatment process by clicking the Add Component button and dragging components from the major components box and dropping them into the grid or train.

Train. The components that are marked as "Included in Treatment" in the grid will appear in the treatment train. Click the Train button in the toolbar to display/hide the train diagram.

Component Connections. Creating connections between the components creates the flow through the treatment train. To create a connection, check the Connect check box, click a component, and then click another component. The connection will be created between the two components. If a third component is then clicked, a connection will be created from the second component to the third component. To then create a connection between two other components, four and five, click a blank spot on the train to remove the highlight from the third component, and click component four to highlight it, and then click component five to create the connection.

Removing or Deleting Components. To remove a component from the treatment train, click on it in the train and press the Delete button. The component will be removed from the train; it will remain in the grid, but its "Included in Treatment"

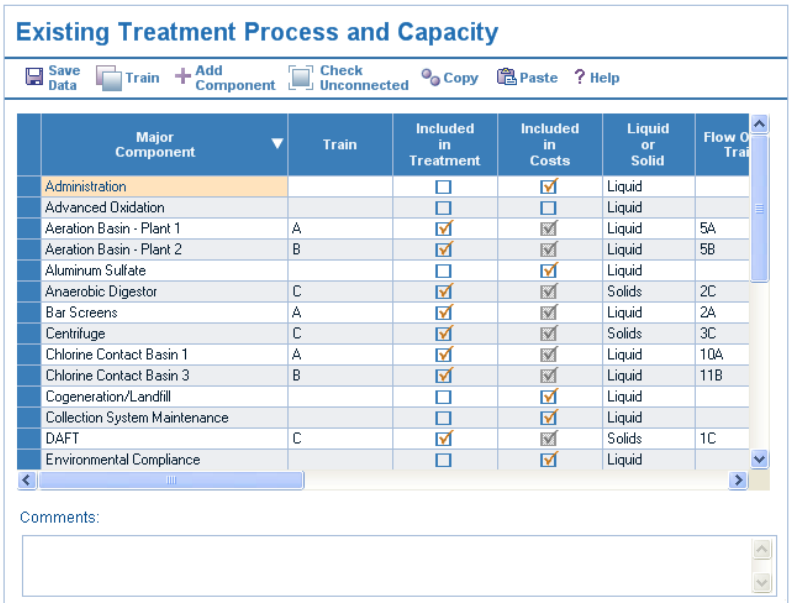
check box will be unchecked. A component can also be removed from the train by unchecking its "Included in Treatment" check box in the grid.

When a component is removed from treatment via the methods described above, that component, along with its data, remains in the grid. To delete the component completely, rather than just removing it from treatment, delete its row from the grid. Deleting the grid row will delete the component from the grid and the train, and all of its data will be deleted when the Treatment Process data is saved.

Liquids and Solids. The train is separated into a liquids train and a solids train. Click the Liquids button to view the liquids train, and the Solids button to view the solids train.

Check Unconnected. In order for the flow to travel through all components, the components must be connected to each other. If a component has no connections, it will not be included in the flow. Click the Check Unconnected button to display a list of the unconnected components.

If a Planned Project exists, it does not matter to the system whether or not unconnected Treatment Process components exist. Because the system performs calculations based on the selected Planned Project, if one exists, unconnected Treatment Process components will have no effect on those calculations, if a Planned Project exists.



Major Component

Each Major Component is added to the grid by dragging and dropping from the small major components box accessed by clicking the Add Component button. There can be only one component of the same type in each lettered section of the train. For example, there can be only one Filters component in train section A, one Filters component in train section B, and so on.

Train

The Train column displays the letter of the train section in which the Major Component appears.

Included in Treatment

Check the Included in Treatment check box to include the component in the treatment train. Uncheck the box to remove the components from the train. When the Included in Treatment box is checked the Included in Costs box is automatically checked.

Included in Costs

Some components, such as administration or maintenance, do not appear in the treatment train, but are included in the system because they have associated costs. To include a component only for cost purposes, leave the Included in Treatment box unchecked, and check the Included in Costs box. The component will not appear in the train, but will appear in the O&M Costs screen.

Liquid or Solid

The value in the Liquid or Solid column denotes the component as a Liquids or Solids component. Liquids components appear in the Liquids train, and Solids components appear in the Solids train. Click the Liquids button and the Solids button to view the train diagrams.

Flow Order Train

The Flow Order Train column contains the flow order of each component. The flow order is based on the connections between the components. Each component is numbered in succession based on the connection coming into it from the previous component. Components that have no connections have no Flow Order Train value.

Influent Capacity

The Capacity Type for all Major Components is displayed in the Major Component window.

Existing Capacity

The user enters the capacity of the component in the units that appear in the Capacity Units column.

Capacity Units

The capacity unit for each Major Component is displayed in the Major Component window.

Averaging Period

The Averaging Period for each Major Component is the Capacity Basis for that component as shown in the Major Component window.

Design Criteria

The user enters design criteria such as width, volume, or surface area.

Design Criteria Units

The user enters the units for the Design Criteria column.

Number of Units

The user enters the number of units that comprise the component. This is a numeric value only.

Year Offline

The user enters the year the existing Major Component goes offline and is no longer available to the system. A component may be scheduled to be retired in a certain year, or to go offline because it is being replaced by a Planned Project component.

The user must also enter a value in the Capacity Offline column. If the value in the Capacity Offline is less than the value in the Existing Capacity column, the component only partially goes offline, and still contributes to the system.

Capacity Offline

The amount of capacity that goes offline in the year offline. Any portion (or all) of the capacity can go offline.

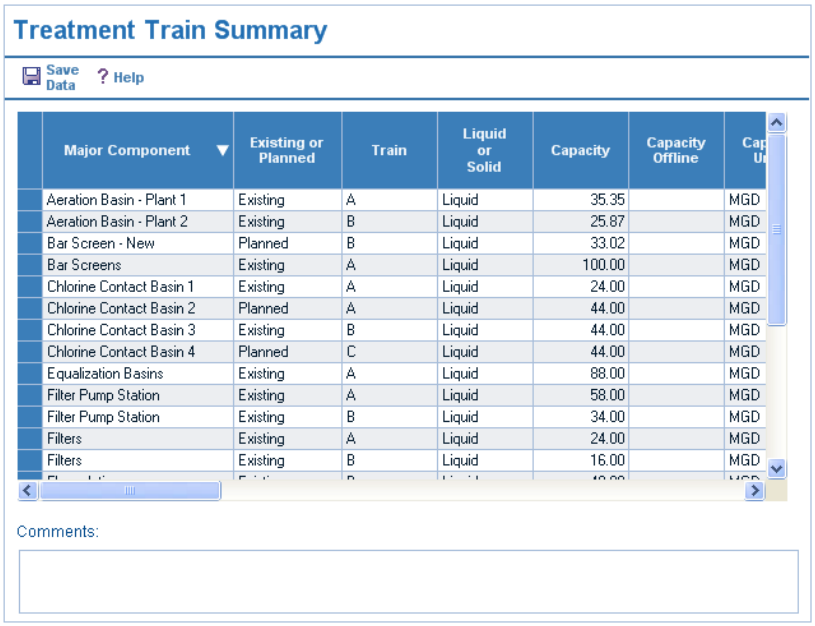
If there is no value in the Year Offline column, the component will be treated as being fully online. In order for the offline capacity value to have any effect, there must be a value in the Year Offline column. If a value exists in the Year Offline column, the Capacity Offline value must be greater than zero, and less than or equal to the value in the Existing Capacity column.

Treatment Train Summary

The Treatment Train Summary screen is a summary, by Major Component and projected year, of the flows through the system. The values in the Flows columns represent the flows through the Major Components (unlike the values in the Flow and Solids Allocation screen, which represent the percentage of the flows through the connections). A value of 40.00 means that 40% of the flow travels through that component.

Only the components in the liquid train are displayed in the Treatment Train Summary grid; the solids are not included.

The Treatment Train Summary grid is not editable.



Treatment Train Summary

Save Data | Help

Major Component	Existing or Planned	Train	Liquid or Solid	Capacity	Capacity Offline	Cap U
Aeration Basin - Plant 1	Existing	A	Liquid	35.35		MGD
Aeration Basin - Plant 2	Existing	B	Liquid	25.87		MGD
Bar Screen - New	Planned	B	Liquid	33.02		MGD
Bar Screens	Existing	A	Liquid	100.00		MGD
Chlorine Contact Basin 1	Existing	A	Liquid	24.00		MGD
Chlorine Contact Basin 2	Planned	A	Liquid	44.00		MGD
Chlorine Contact Basin 3	Existing	B	Liquid	44.00		MGD
Chlorine Contact Basin 4	Planned	C	Liquid	44.00		MGD
Equalization Basins	Existing	A	Liquid	88.00		MGD
Filter Pump Station	Existing	A	Liquid	58.00		MGD
Filter Pump Station	Existing	B	Liquid	34.00		MGD
Filters	Existing	A	Liquid	24.00		MGD
Filters	Existing	B	Liquid	16.00		MGD

Comments:

Major Component

The Major Components from the selected Planned Projects option are used to populate the Major Component column. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Existing or Planned

The "Existing or Planned" column displays whether the Major Component is an existing or planned component. The data comes entirely from the selected Planned Project option, if one exists. The term "Existing" refers to the existing components in the Planned Project, while the term "Planned" refers to the planned components in the Planned Project.

Each Planned Project contains both existing and planned Major Components. Although the "existing" components are originally derived from the Existing Treatment Process train diagram, each Planned Project has its own versions of those existing components, with its own connections, which may differ from the original connections in the Existing Treatment Process train diagram. The

connections between existing and planned components in the Planned Project train diagram are the ones used in this screen.

The connections in the Existing Treatment Process are not used in this screen unless there are no Planned Projects. If there are no Planned Projects, the data for this screen comes solely from the Existing Treatment Process, and there will be no planned components. So, the term "Existing" refers to existing components in the Planned Project diagram, unless there are no Planned Projects.

Train

The train that each Major Component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Liquid or Solid

The Liquids train or the Solids train.

Capacity

The capacity of the existing or planned Major Component. The capacity for an existing component always comes from the Existing Treatment Process screen because that is the only screen where existing capacity is entered. That capacity is used in the Planned Projects screen, but it originates in the Existing Treatment Process screen.

Capacity Offline

The amount of capacity that goes offline in the year the component goes offline. This data always comes from the Existing Treatment Process screen because only existing components can go offline.

Capacity Units

The Capacity Unit for each Major Component. The Capacity Unit for all Major Components is displayed in the Major Component window.

Year Online

The year the planned component goes online. This data always comes from the Planned Project because only planned components can have a go online year value.

Year Offline

The year the component goes offline. This data always comes from the Existing Treatment Process screen because only existing components can go offline.

Flows

The values in the Flows columns represent the flows for each Major Component in each projected year. Unlike the flow percentages in the Flow and Solids Allocation screen, which represent the flows through the connections, the flows in the Treatment Train Summary grid represent the flows through the components.

A value of 40.00 means that 40% of the flow travels through the component.

If a connection is offline (or not yet online) for any year, the value in that grid cell will be "Offline."

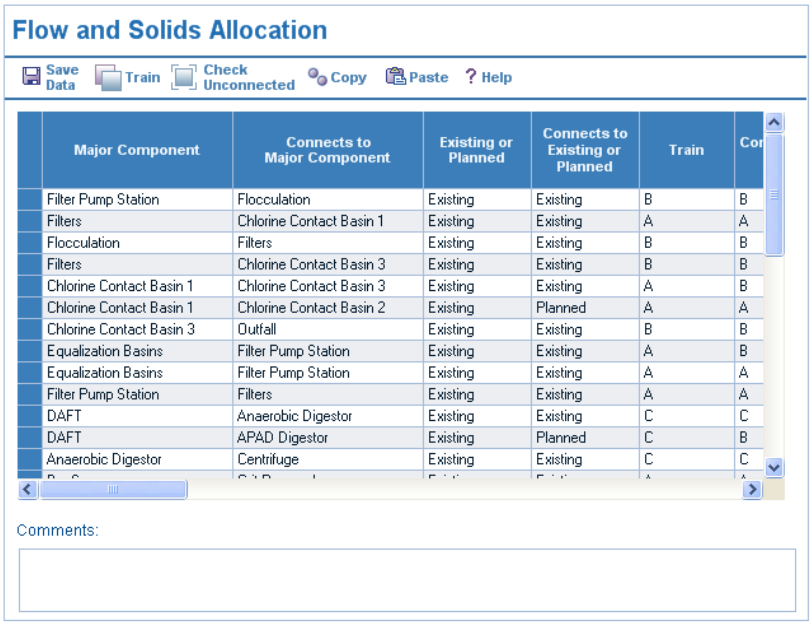
Flow and Solids Allocation

The Flow and Solids Allocation screen allows the user to enter the flow percentages for the connections between Major Components. A value in the Flow Allocation Percentage column represents the percentage of flow traveling through the connection between two components. The value is always entered for the connection, and not for the component itself. Although the percentage of

flow through the component may be the same as the percentage of flow through the connection, the value represents the percentage of flow through the connection, and not the percentage of flow through the component.

The percentage of flows in the train diagram are calculated based on the percentage of flows traveling through each connection. The Capacity Evaluation and Effluent Quality screens use the percentage of flows at the component to perform their calculations. If any component has a zero flow, the value for that component will be zero in the Capacity Evaluation screen. Also, that component will have no effect on the Effluent Quality calculations, as it will be unable to contribute to pollutant reduction or addition due to its zero flow.

Entering 40.00 means that 40% of the total projected flow for that projected year travels through that connection.



Major Component

The Major Components from the selected Planned Projects option are used to populate the Major Component column. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Connects to Major Component

Each Major Component must be connected to another Major Component in order to become part of the flow through the system. The "Connects to Major Components" column lists which component the Major Component is connected to. All of the components and their connections come from the selected Planned Projects option. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Existing or Planned

The "Existing or Planned" column displays whether the Major Component is an existing or planned component. The data comes entirely from the selected Planned Project option, if one exists. The term "Existing" refers to the existing components in the Planned Project, while the term "Planned" refers to the planned components in the Planned Project.

Each Planned Project contains both existing and planned Major Components. Although the "existing" components are originally derived from the Existing Treatment Process train diagram, each Planned Project has its own versions of those existing components, with its own connections, which may differ from the original connections in the Existing Treatment Process train diagram. The connections between the Planned Project's existing and planned components are the ones used in this screen.

The connections in the Existing Treatment Process are not used in this screen unless there are no Planned Projects. If there are no Planned Projects, the data for this screen comes solely from the Existing Treatment Process, and there will

be no planned components. In that case, the term "Existing" refers to the components in the Existing Treatment Process screen.

So, the term "Existing" refers to existing components in the Planned Project diagram, unless there are no Planned Projects.

Connects to Existing or Planned

The "Connects to Existing or Planned" column displays whether the component that the Major Component is connected to is an existing or planned component. The same logic applies for this column as for the "Existing or Planned" column, above, in that all of the data comes from the Planned Project option, if one exists.

Train

The train that each Major Component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Connects to Train

The train that connected component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Liquid or Solid

The Liquids train or the Solids train.

Capacity

The capacity of the existing or planned Major Component. The capacity for an existing component always comes from the Existing Treatment Process screen because that is the only screen where existing capacity is entered. That capacity is used in the Planned Projects screen, but it originates in the Existing Treatment Process screen.

Capacity Offline

The amount of capacity that goes offline in the year the component goes offline. This data always comes from the Existing Treatment Process screen because only existing components can go offline.

Capacity Units

The Capacity Unit for each Major Component. The Capacity Unit for all Major Components is displayed in the Major Component window.

Year Online

The year the Major Component goes online. This data always comes from the Planned Project because only Planned Project components can go online. Existing Treatment Process components are always online unless they go offline; they cannot go online in a certain year - they can only go offline.

Year Offline

The year the existing Major Component goes offline and is no longer available to the system. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist. This is because only Existing Treatment Process components can go offline. Planned Project components can **be** offline, but that is only because they are not yet online - they cannot **go** offline once they are online.

Connects to Year Online

The year the connected planned component goes online. This data always comes from the Planned Project because only planned components can go online.

Connects to Year Offline

The year the connected component goes offline. This data always comes from the Existing Treatment Process screen because only existing components can go offline.

Flow Allocation Percentage

The Flow Allocation Percentage is entered by the user, and represents the percentage of flow traveling through the connection between the Major Component and the component it is connected to. Although the percentage of flow through the connection may be the same as the flow through the component, the value represents the percentage of flow through the connection, and not the percentage of flow through the component.

The percentage of flows in the train diagram are calculated based on the percentage of flows traveling through each connection. The Capacity Evaluation and Effluent Quality screens use the percentage of flows at the component to perform their calculations. If any component has a zero flow, the percentage of value for that component will be zero in the Capacity Evaluation screen. Also, that component will have no effect on the Effluent Quality calculations, as it will be unable to contribute to pollutant reduction or addition due to its zero flow.

Entering a value of 40.00 means that 40% of the flow travels through the connection.

If a connection is offline (or not yet online) for any year, the value in that grid cell will be automatically set to "Offline."

Effluent Quality

The Effluent Quality screen gathers data about the Major Components from the selected Planned Project, if one exists, or from the Existing Treatment Process, if no Planned Projects exist. The Effluent Quality screen also uses Projected Flows

and Loads data, Flow and Solids Allocation data, as well as Pollutant Reduction data, Pollutant Addition data, and Regulatory Requirements data, to calculate the effluent quality for each Projected Year.

The Effluent Quality grid is not editable.

Selected Pollutant Options

The top portion of the screen contains the selected options for Pollutant Reduction, Pollutant Addition, and Regulatory Requirements.

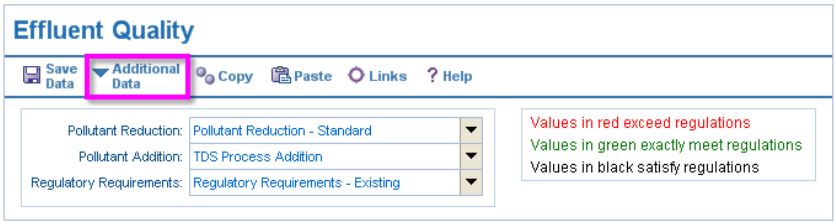
Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Selected Options

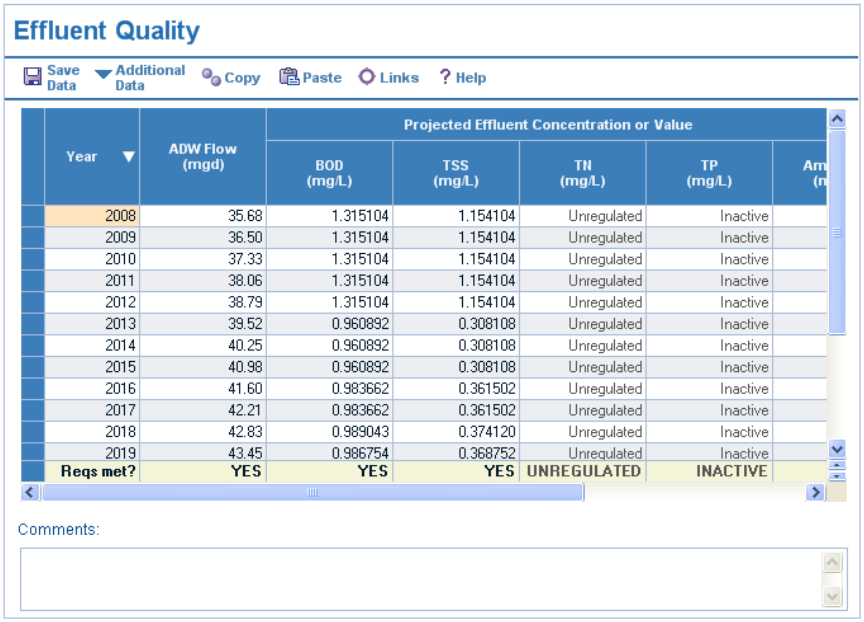
Calculated values in the Effluent Quality grid are based in part on the selected Pollutant Reduction, Pollutant Addition, and Regulatory Requirements options. The user can change which of those options are used in the Effluent Quality calculations by selecting items from the drop-down lists in the top portion of this screen.

Whenever a new selection is made, that selection becomes the active selection for the entire system, and the values in the Effluent Quality grid (as well as the entire system) are recalculated. The user can test various combinations of options to quickly determine whether Effluent Quality requirements are met for the system for those options.



Effluent Quality Data

The bottom portion of the screen contains the Effluent Quality data.



Year	ADW Flow (mgd)	Projected Effluent Concentration or Value				
		BOD (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)	Am (n
2008	35.68	1.315104	1.154104	Unregulated	Inactive	
2009	36.50	1.315104	1.154104	Unregulated	Inactive	
2010	37.33	1.315104	1.154104	Unregulated	Inactive	
2011	38.06	1.315104	1.154104	Unregulated	Inactive	
2012	38.79	1.315104	1.154104	Unregulated	Inactive	
2013	39.52	0.960892	0.308108	Unregulated	Inactive	
2014	40.25	0.960892	0.308108	Unregulated	Inactive	
2015	40.98	0.960892	0.308108	Unregulated	Inactive	
2016	41.60	0.983662	0.361502	Unregulated	Inactive	
2017	42.21	0.983662	0.361502	Unregulated	Inactive	
2018	42.83	0.989043	0.374120	Unregulated	Inactive	
2019	43.45	0.986754	0.368752	Unregulated	Inactive	
Reqs met?	YES	YES	YES	UNREGULATED	INACTIVE	

Year

The Year column contains the years that exist in the Projected Years screen.

ADW Flow

The values in the ADW Flow column are the same values that appear in the Projected ADW Flow column in the Projected Flows and Loads screen.

Projected Effluent Concentration or Value

Effluent concentrations or values are calculated for each Major Component as follows:

Equation: Projected ADW Load x (100 - Pollutant Reduction Percentage) x Major Component Flow Percentage

The value is then combined with values from all other Major Components and converted from pounds per day to milligrams per liter by dividing by the Projected ADW Flow and dividing by 8.3454.

Finally, the Pollutant Addition values are added.

- The Projected ADW Load comes from the Projected ADW Load columns in the Projected Flows and Loads screen
- The Pollutant Reduction Percentage comes from the Major Component Pollutant Reduction Percentage columns in the Pollutant Reduction screen.
- The Major Component Flow Percentage values come from the Flow Allocation Percentage columns in the Flow and Solids Allocation screen
- The Projected ADW Flow comes from the Projected ADW Flow column in the Projected Flows and Loads screen
- The Pollutant Addition values come from the Major Component Pollutant Addition Increase column in the Pollutant Addition screen.

Each value in the "Projected Effluent Concentration or Value" columns is compared to the pollutant's regulatory requirement from the Regulatory Requirements screen. The value is displayed in red text if it exceeds the regulatory requirement, black text if it exactly meets the requirement, and green text if it satisfies the requirement.

Requirements Met

The Requirements Met row displays "YES" when every value in the column satisfies or exactly meets the regulatory requirement, and "NO" when any value in the column exceeds the requirement.

The Requirements Met row will display "INACTIVE" when BOD, TSS, TN, or TP is marked as inactive in both the Domestic Flows and Loads - Historical Data and the Industrial Flows and Loads screens, or when the pollutant is marked as inactive in the Other Pollutants screen.

The Requirements Met row will display "UNREGULATED" when the pollutant is unregulated in the Regulatory Requirements screen.

Pollutant Reduction

The Pollutant Reduction screen allows the user to enter pollutant reduction percentages for each Major Component and pollutant in the system. Those percentages are used in the Projected Effluent Concentration or Value columns in the Effluent Quality screen.

MPM does not allow pollutant reduction for components in the solids train, so only the liquid components are displayed in the Pollutant Reduction grid.

Name, Selected, Options

The top portion of the screen contains the Name, Selected check box, and the selected options.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

The user enters the name of the Pollutant Reduction option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the Pollutant Reduction option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Pollutant Reduction option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Pollutant Reduction option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

Selected Options

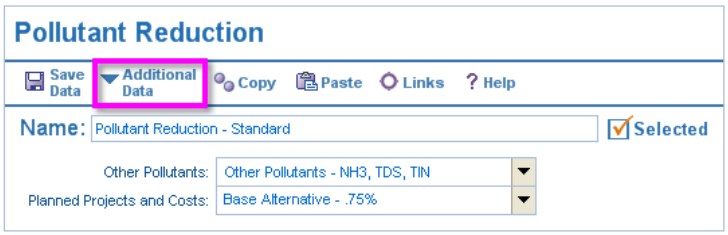
The BOD, TSS, TN, and TP will always appear in the Pollutant Reduction grid, but the additional pollutants come from the Other Pollutants screen. Changing the selected Other Pollutants option in the drop-down list will load the additional pollutants for that option into the grid.

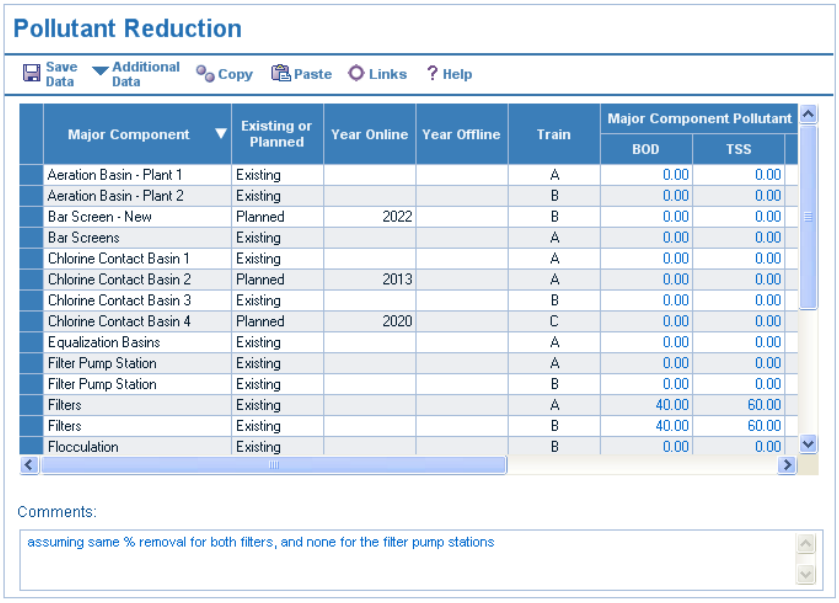
Each Other Pollutants option has its own values for the additional pollutants. This means that when changing the selected Other Pollutants option, the pollutant reduction values for the additional pollutants for that option will be loaded into the grid, but the BOD, TSS, TN and TP values will remain unchanged because they are shared by all of the Other Pollutants options.

The Major Components that are listed in the Pollutant Reduction grid come from the Planned Projects screen. Changing the selected Planned Projects option in the drop-down list will load the Major Components into the grid for that Planned Project.

Each Planned Project has its own pollutant reduction values for BOD, TSS, TN, and TP as well as all the additional pollutants. This means that changing the selected Planned Projects option will cause the entire grid to be reloaded with the pollutant reduction values from the selected Planned Project.

Whenever a new selection is made, that selection becomes the active selection for the entire system. The data for that option is loaded into the Pollutant Reduction grid, and the system values are recalculated.





Major Component

The Major Components from the selected Planned Projects option are used to populate the Major Component column. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Existing or Planned

The "Existing or Planned" column displays whether the Major Component is an existing or planned component. The data comes entirely from the selected Planned Project option, if one exists. The term "Existing" refers to the existing components in the Planned Project, while the term "Planned" refers to the planned components in the Planned Project.

Each Planned Project contains both existing and planned Major Components. Although the "existing" components are originally derived from the Existing Treatment Process train diagram, each Planned Project has its own versions of those existing components, with its own connections, which may differ from the original connections in the Existing Treatment Process train diagram. The connections between the Planned Project's existing and planned components are the ones used in this screen.

The connections in the Existing Treatment Process are not used in this screen unless there are no Planned Projects. If there are no Planned Projects, the data for this screen comes solely from the Existing Treatment Process, and there will be no planned components. In that case, the term "Existing" refers to the components in the Existing Treatment Process screen.

So, the term "Existing" refers to existing components in the Planned Project diagram, unless there are no Planned Projects.

Year Online

The year the Major Component goes online. This data always comes from the Planned Project because only Planned Project components can go online. Existing Treatment Process components are always online unless they go offline; they cannot go online in a certain year - they can only go offline.

Year Offline

The year the existing Major Component goes offline and is no longer available to the system. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist. This is because only Existing Treatment Process components can go offline. Planned Project components can be offline, but that is only because they are not yet online - they cannot go offline once they are online.

Train

The train that each Major Component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Major Component Pollutant Reduction Percentage

The percentage of the pollutant load that will be removed as flow travels through the Major Component.

Entering a value of 40.00 means that 40% of the pollutant load will be removed.

Pollutant Addition

The Pollutant Addition screen allows the user to enter pollutant addition values for each Major Component and pollutant in the system. Those concentrations are used in the Projected Effluent Concentration or Value columns in the Effluent Quality screen.

MPM does not allow pollutant addition for components in the solids train, so only the liquid components are displayed in the Pollutant Reduction grid.

Name, Selected, Options

The top portion of the screen contains the Name, Selected check box, and the selected options.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

The user enters the name of the Pollutant Addition option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the Pollutant Addition option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Pollutant Addition option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Pollutant Addition option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

Selected Options

The BOD, TSS, TN, and TP will always appear in the Pollutant Addition grid, but the additional pollutants come from the Other Pollutants screen. Changing the selected Other Pollutants option in the drop-down list will load the additional pollutants for that option into the grid.

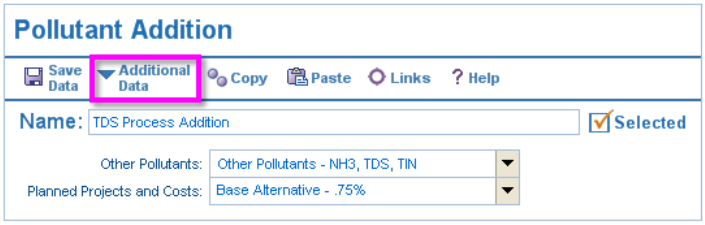
Each Other Pollutants option has its own values for the additional pollutants. This means that when changing the selected Other Pollutants option, the pollutant

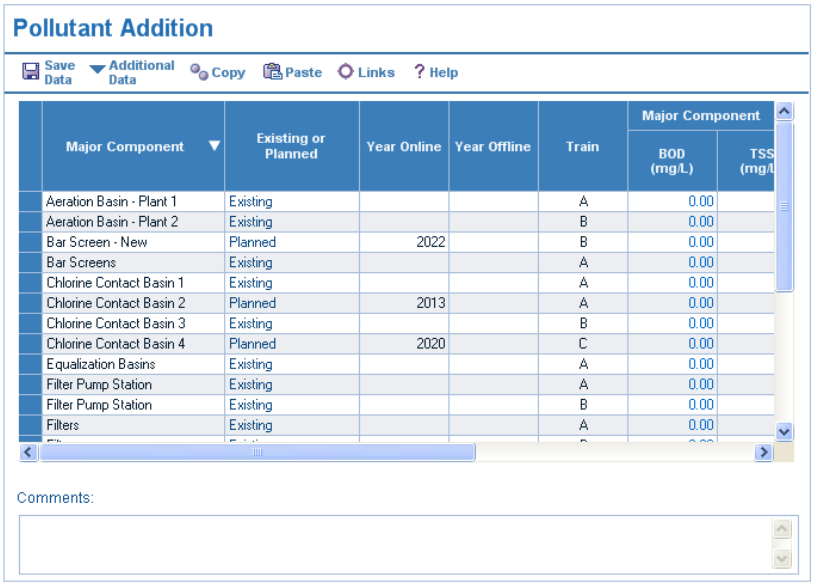
addition values for the additional pollutants for that option will be loaded into the grid, but the BOD, TSS, TN and TP values will remain unchanged because they are shared by all of the Other Pollutants options.

The Major Components that are listed in the Pollutant Addition grid come from the Planned Projects screen. Changing the selected Planned Projects option in the drop-down list will load the Major Components into the grid for that Planned Project.

Each Planned Project has its own pollutant addition values for BOD, TSS, TN, and TP as well as all the additional pollutants. This means that changing the selected Planned Projects option will cause the entire grid to be reloaded with the pollutant addition values from the selected Planned Project.

Whenever a new selection is made, that selection becomes the active selection for the entire system. The data for that option is loaded into the Pollutant Addition grid, and the system values are recalculated.





Major Component

The Major Components from the selected Planned Projects option are used to populate the Major Component column. If no Planned Projects exist, the Major Components from the Existing Treatment Process are used.

Existing or Planned

The "Existing or Planned" column displays whether the Major Component is an existing or planned component. The data comes entirely from the selected Planned Project option, if one exists. The term "Existing" refers to the existing components in the Planned Project, while the term "Planned" refers to the planned components in the Planned Project.

Each Planned Project contains both existing and planned Major Components. Although the "existing" components are originally derived from the Existing Treatment Process train diagram, each Planned Project has its own versions of those existing components, with its own connections, which may differ from the original connections in the Existing Treatment Process train diagram. The connections between the Planned Project's existing and planned components are

the ones used in this screen.

The connections in the Existing Treatment Process are not used in this screen unless there are no Planned Projects. If there are no Planned Projects, the data for this screen comes solely from the Existing Treatment Process, and there will be no planned components. In that case, the term "Existing" refers to the components in the Existing Treatment Process screen.

So, the term "Existing" refers to existing components in the Planned Project diagram, unless there are no Planned Projects.

Year Online

The year the Major Component goes online. This data always comes from the Planned Project because only Planned Project components can go online. Existing Treatment Process components are always online unless they go offline; they cannot go online in a certain year - they can only go offline.

Year Offline

The year the existing Major Component goes offline and is no longer available to the system. This value always comes from the Existing Treatment Process screen, regardless of whether or not Planned Projects exist. This is because only Existing Treatment Process components can go offline. Planned Project components can **be** offline, but that is only because they are not yet online - they cannot **go** offline once they are online.

Train

The train that each Major Component is in (from the Planned Projects train, or the Existing Treatment Process train, if no Planned Projects exist).

Major Component Pollutant Addition Increase

The amount or concentration that will be added to the BOD, TSS, TN, TP or additional pollutant in the Projected Effluent Concentration or Value column in the Effluent Quality screen.

Regulatory Requirements

The Regulatory Requirements screen allows the user to enter National Pollutant Discharge Elimination System (NPDES) effluent quality requirements for the pollutants in the system. These values will be used by the Effluent Quality screen when determining if the effluent concentration values satisfy regulatory requirements.

Name, Selected, Options

The top portion of the screen contains the Name, Selected check box, and the selected options.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

The user enters the name of the Regulatory Requirements option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the Regulatory Requirements option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Regulatory Requirements option the currently selected one. Once the data is saved, the check box cannot be

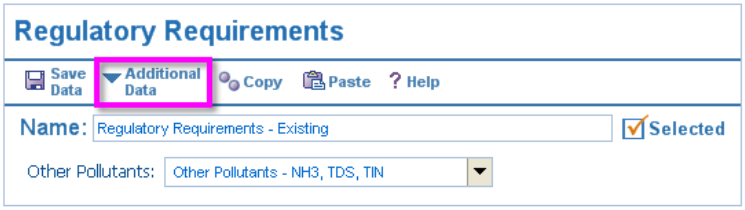
unchecked. To make a different Regulatory Requirements option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

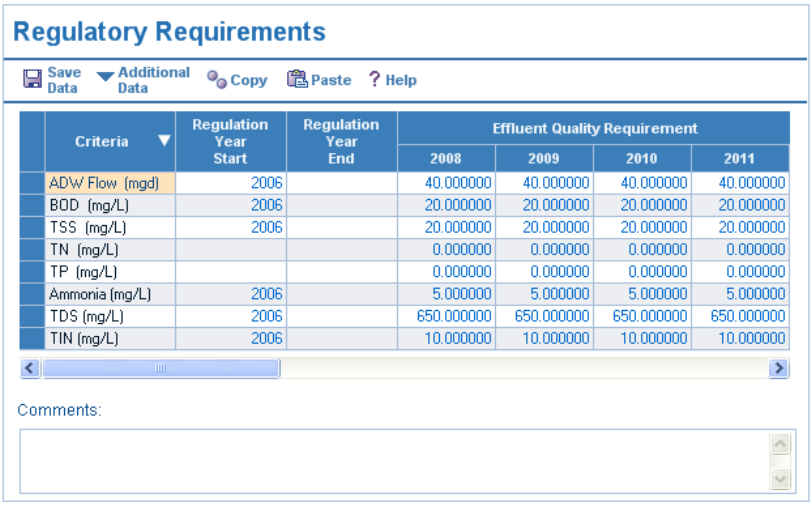
Selected Option

The BOD, TSS, TN, and TP will always appear in the Regulatory Requirements grid, but the additional pollutants come from the Other Pollutants screen. Changing the selected Other Pollutants option in the drop-down list will load the additional pollutants for that option into the grid.

Each Other Pollutants option has its own values for the additional pollutants. This means that when changing the selected Other Pollutants option, the regulatory requirement values for the additional pollutants for that option will be loaded into the grid, but the BOD, TSS, TN, and TP values will remain unchanged because they are shared by all of the Other Pollutants options.

Whenever a new selection is made, that selection becomes the active selection for the entire system. The data for that option is loaded into the Regulatory Requirements grid, and the system values are recalculated.





Regulatory Requirements

Save Data | Additional Data | Copy | Paste | Help

Criteria	Regulation Year Start	Regulation Year End	Effluent Quality Requirement			
			2008	2009	2010	2011
ADW Flow (mgd)	2006		40.000000	40.000000	40.000000	40.000000
BOD (mg/L)	2006		20.000000	20.000000	20.000000	20.000000
TSS (mg/L)	2006		20.000000	20.000000	20.000000	20.000000
TN (mg/L)			0.000000	0.000000	0.000000	0.000000
TP (mg/L)			0.000000	0.000000	0.000000	0.000000
Ammonia (mg/L)	2006		5.000000	5.000000	5.000000	5.000000
TDS (mg/L)	2006		650.000000	650.000000	650.000000	650.000000
TIN (mg/L)	2006		10.000000	10.000000	10.000000	10.000000

Comments:

Criteria

The Criteria column will always contain ADW Flow, BOD, TSS, TN, and TP. If an Other Pollutants option exists, the Criteria column will also contain the pollutants from the selected Other Pollutants option. Changing the selected Other Pollutants option in the drop-down list will cause the Regulatory Requirements grid to reload Major Components in the grid to change to match the components that exist in the Planned Projects screen.

Each Planned Project has its own pollutant addition values for BOD, TSS, TN, and TP as well as all the additional pollutants. This means that changing the selected Planned Projects option will cause the entire grid to be reloaded with the pollutant addition values from the selected Planned Project.

Whenever a new selection is made, that selection becomes the active selection for the entire system. The data for that option is loaded into the Pollutant Addition grid, and the system values are recalculated.

Regulation Year Start

The year in which the regulation of the pollutant will begin. If this value is left blank, the pollutant will be unregulated in the Effluent Quality screen.

The value must be a four-digit year.

Regulation Year End

The year in which the regulation of the pollutant will end. If a year is entered in this column, a year must also be entered in the Regulation Year Start column.

The value must be a four-digit year.

Effluent Quality Requirement

The NPDES regulatory requirement for the item in the Criteria column, in the units that appear in the Criteria column.

Project Schedule

The Project Schedule screen displays the scheduling information for the currently selected Planned Project. Each planned Major Component in the Planned Project that is included in treatment or included in costs (or both) will be displayed in the Project Schedule grid.

The Project Schedule grid is not editable.

Selected Option

The top portion of the screen contains the Planned Projects selected option.

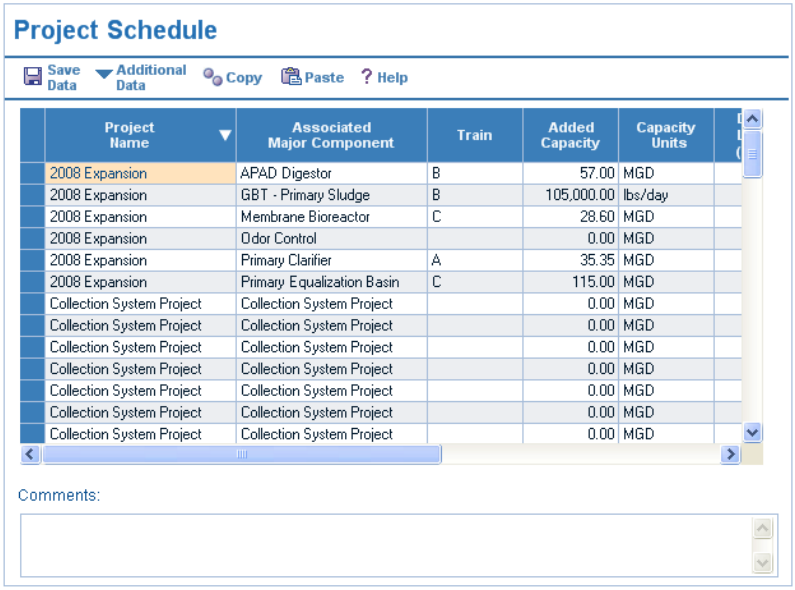
Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Selected Planned Project Option

The Project Names and Associated Major Components that are listed in the Project Schedule grid come from the Planned Projects screen. Changing the selected Planned Projects option in the drop-down list will load the Project Names and Associated Major Components into the grid for that Planned Project.

Whenever a new selection is made, that selection becomes the active selection for the entire system. The data for that option is loaded into the Project Schedule grid, and the system values are recalculated.



Associated Major Component

The Associated Major Component comes from the selected Planned Projects grid. Only those planned Major Components that are included in treatment or included in costs (or both) will be included in the Project Schedule grid.

Train

Data for the Train data comes from the Train column in the selected Planned Projects grid.

Added Capacity

Data for the Added Capacity column comes from the Capacity column in the selected Planned Projects grid.

Capacity Units

Data for the Capacity Units column comes from the Capacity Units column in the selected Planned Projects grid.

Design Length

Data for the Design Length column comes from the Design Length column in the selected Planned Projects grid.

Construction Length

Data for the Construction Length column comes from the Construction Length column in the selected Planned Projects grid.

Year Design Starts

The Year Design Starts is the year during which the design process should begin so that the project will be completed by the scheduled year online.

The Year Design Starts is calculated as follows:

Equation: Year Online - Design Length - Construction length

Year Construction Starts

The Year Construction Starts is the year during which the construction process should begin so that the project will be completed by the scheduled year online.

The Year Construction Starts is calculated as follows:

Equation: Year Online - Construction Length

Year Online

Data for the Year Online column comes from the Year Online column in the selected Planned Projects grid.

Planned Projects and Costs

The Planned Projects and Costs screen represents the configuration of major components for the years in the planning period. The planned components are created by adding Major Components to the grid or train, entering data for those components, and creating connections in the train. Multiple Planned Project options can be created to determine the effects of various component configurations.

When a Planned Project is created, it starts off with all of the existing treatment process components and connections as a basis upon which to build. Whenever a change is made to a component or connection in the Existing Treatment Process screen, that change is automatically included in all the Planned Projects in the Scenario.

When there are no Planned Projects, the Existing Treatment Process serves as the treatment system upon which calculations are based. System calculations (such as those for Capacity Evaluation and Effluent Quality) are based on the components and data that appear in the Existing Treatment Process.

When Planned Projects exist, system calculations are no longer based on the Existing Treatment Process, but are based on the components and data in the selected Planned Project. Although the Existing Treatment Process is no longer used as the basis for those calculations, it is still used as the starting point for newly-created Planned Projects.

In addition, whenever a change is made to a component or connection in the Existing Treatment Process screen, that change is automatically included in all the Planned Projects in the Scenario. For example, if a connection is created between two components in the Treatment Process train, that connection will also be created automatically in all the Planned Projects in the Scenario. However, if a connection is deleted in the Treatment Process train, that connection will NOT be deleted from any of the Planned Projects. The Treatment Process only adds information to the Planned Projects; it never deletes it. Any changes made in the Planned Projects will have no effect on any data in the Treatment Process screen.

General Data Operations

Adding Grid Rows. Click the Add Component button to display a small major components box. A row is added to the grid by dragging a component from the major components box and dropping it into the grid or train. When a component is dropped into the train, it is automatically added to the grid, and the "Included in Treatment" check box is checked. When a component is dropped into the grid, it is not automatically added to the train, and its "Included in Treatment" check box is not checked. Checking the "Included in Treatment" checkbox causes the component to appear in the train. Unchecking the checkbox removes the component from the train. See the Adds Capacity column, below, for a description of added-capacity components

Deleting Grid Rows. When a row is deleted from the grid, that component is deleted from the train. The component and all of its data will be deleted when the data is saved.

Major Components. Components are added to the planned project by clicking the Add Component button and dragging components from the major components box and dropping them into the grid or train.

Train. The components that are marked as "Included in Treatment" in the grid will appear in the treatment train. Click the Train button in the toolbar to display/hide the train diagram. Click the year to the left of the Liquids button to display and select from the list of Projected Years. Years in blue indicate a change in component connection or Year Online for that year.

Component Connections. Creating connections between the components creates the flow through the treatment train. To create a connection, check the Connect check box, click a component, and then click another component. The connection will be created between the two components. If a third component is then clicked, a connection will be created from the second component to the third component. To then create a connection between two other components, four and five, click a blank spot on the train to remove the highlight from the third component, and click component four to highlight it, and then click component five to create the connection.

Removing or Deleting Components. To remove a component from the treatment train, click on it in the train and press the Delete button. The component will be removed from the train; it will remain in the grid, but its "Included in Treatment" check box will be unchecked. A component can also be removed from the train by unchecking its "Included in Treatment" check box in the grid.

When a component is removed from treatment via the methods described above, that component, along with its data, remains in the grid. To delete the component

complete, rather than just removing it from treatment, delete its row from the grid. Deleting the grid row will delete the component from the grid and the train, and all of its data will be deleted when the Planned Projects data is saved.

Liquids and Solids. The train is separated into a liquids train and a solids train. Click the Liquids button to view the liquids train, and the Solids button to view the solids train.

Check Unconnected. In order for the flow to travel through all components, the components must be connected to each other. If a component has no connections, it will not be included in the flow. Click the Check Unconnected button to display a list of the unconnected components. If there are any unconnected components, the Capacity Evaluation and Effluent Quality calculations cannot be performed, and the data for those screens will not be displayed.

Name, Selected, ELAC, ENR, Total Included Project Costs

The top portion of the screen contains the Name, the Selected check box, the ELAC factor, ENR values, and the Total Included Project Costs.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Name

The user enters the name of the projected Planned Projects option in the Name box. This name will be used in the Data Tree, in the selection drop-down lists in the Scenario Summary form, and in reports and graphs.

Selected Check Box

The Selected check box denotes whether the projected Planned Projects option is the one that is currently used by the system in calculations. When the box is unchecked, checking it will make the Planned Projects option the currently selected one. Once the data is saved, the check box cannot be unchecked. To make a different Planned Projects option the selected one, click on that option in the Data Tree, and click its Selected box in the Data Window, or visit the Scenario Summary screen to set the selections.

ELAC Factor

The ELAC Factor modifies the Total Project Cost values by multiplying it by the value entered into the ELAC Factor box.

ENR Values

The Engineering News Record (ENR) index values allow costs estimated in previous years to be adjusted to the current year. The ENR index represents the costs of construction from year to year. The Original ENR Value represents the ENR index for the year in which the costs were determined. The Current ENR Value represents the ENR index for the current year. The equation for adjusting the costs to the current year is as follows:

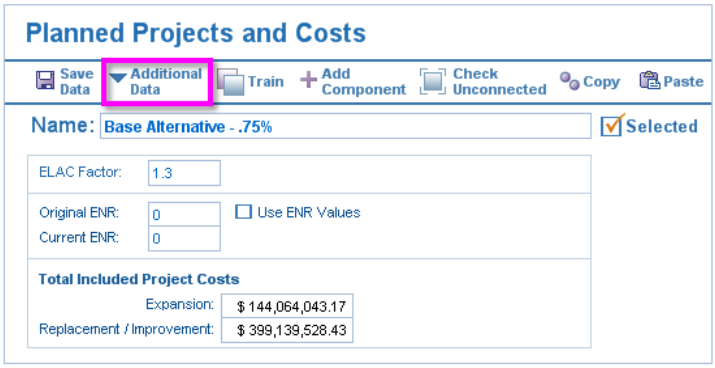
Equation: Current Cost = Original Cost x Current ENR Value / Original ENR Value

To apply the ENR values, check the "Use ENR Values" check box, and enter the Original ENR Value and the Current ENR Value.

When the "Use ENR Values" box is checked, the data in the Estimated Construction Cost column are not editable.

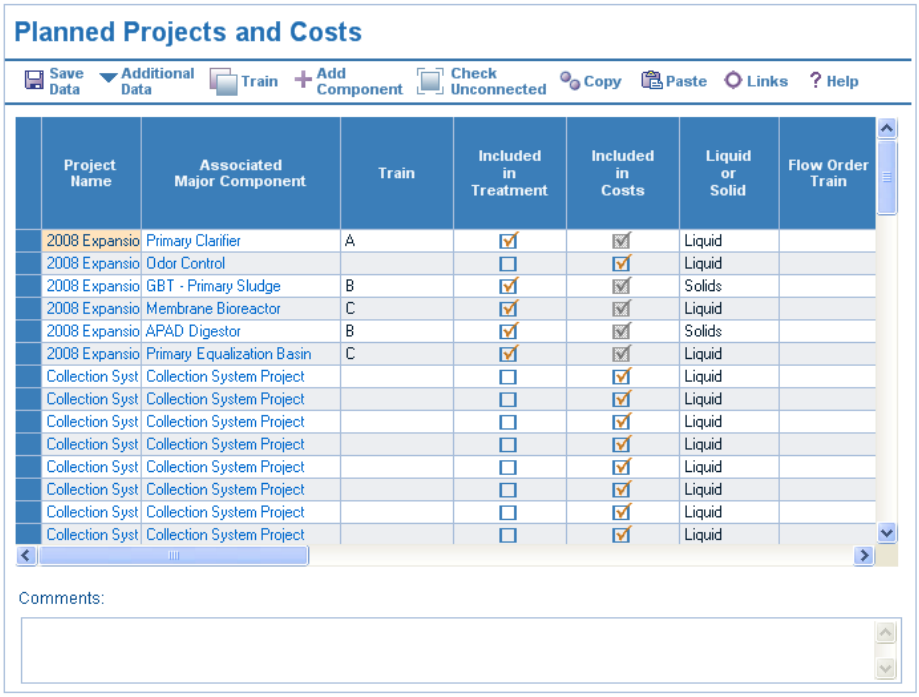
Total Included Project Costs

The Total Project Cost for all Major Components is split into Expansion and Replacement/Improvement portions based on the percentages in the "Percentage of Project Costs Allocated to Expansion" column and the "Percentage of Project Costs Allocated to Replacement or Improvement" column. The totals for each of those portions appears in the Expansion and Replacement/Improvement boxes.



Planned Projects Data

The bottom portion of the screen contains data for the Planned Projects.



Project Name

The user enters a Project Name for each row in the grid.

Associated Major Component

Each Major Component is added to the grid by dragging and dropping from the small major components box accessed by clicking the Add Component button.

There can be multiple components of the same type in each lettered section of the train, but only one of them will be visible in the train. The other components in the train will be invisible, and they will only contribute capacity to the visible component. For example, if a Membrane Bioreactor exists in train section C, and another Membrane Bioreactor is dropped into section C, the newly-dropped Membrane Bioreactor will become invisible, and will become a capacity contributor to the visible Membrane Bioreactor. Any other Membrane Bioreactors dropped into section C will also become invisible capacity contributors. The invisible component cannot have any connections, as it does not stand on its own, but is only a contributor to another component.

When a component is a capacity contributor, the word "Yes" will appear in the Adds Capacity column.

Train

The Train column displays the letter of the train section in which the Major Component appears.

Included in Treatment

Check the Included in Treatment check box to include the component in the treatment train. Uncheck the box to remove the components from the train. When

the Included in Treatment box is checked the Included in Costs box is automatically checked.

Included in Costs

Some components, such as administration or maintenance, do not appear in the treatment train, but are included in the system because they have associated costs. To include a component only for cost purposes, leave the Included in Treatment box unchecked, and check the Included in Costs box. The component will not appear in the train, but will appear in the O&M Costs screen.

Liquid or Solid

The value in the Liquid or Solid column denotes the component as a Liquids or Solids component. Liquids components appear in the Liquids train, and Solids components appear in the Solids train. Click the Liquids button and the Solids button to view the train diagrams.

Flow Order Train

The Flow Order Train column contains the flow order of each component. The flow order is based on the connections between the components. Each component is numbered in succession based on the connection coming into it from the previous component. Components that have no connections have no Flow Order Train value.

Reason

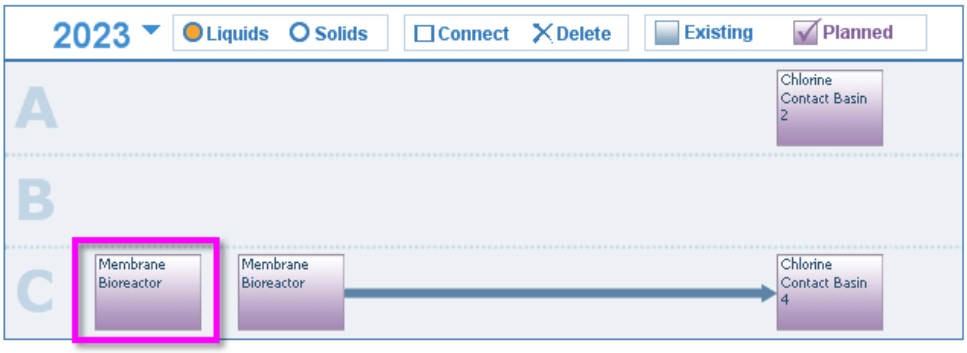
The user selects a reason for the existence of the project from a predefined list of reasons.

Adds Capacity

There can be multiple components of the same type in each lettered section of the train, but only one of them will be visible in the train. The other components in the train will be invisible, and they will only contribute capacity to the visible component. For example, if a Membrane Bioreactor exists in train section C, and another Membrane Bioreactor is dropped into section C, the newly-dropped Membrane Bioreactor will become invisible, and will become a capacity contributor to the visible Membrane Bioreactor. Any other Membrane Bioreactors dropped into section C will also become invisible capacity contributors. The invisible component cannot have any connections, as it does not stand on its own, but is only a contributor to another component.

When a component is a capacity contributor, the word "Yes" will appear in the Adds Capacity column.

The invisible components can be revealed by unchecking the Existing check box, so that only the Planned check box is checked. The Membrane Bioreactor circled in pink, below, is an added-capacity component. It contributes capacity to the other Membrane Bioreactor in section C of the train.



Capacity

The Capacity Type for each Major Component. The Capacity Type for all Major Components is displayed in the Major Component window.

Capacity Type

The Capacity Type for each Major Component. The Capacity Type for all Major Components is displayed in the Major Component window.

Capacity Units

The capacity unit for each Major Component. The capacity unit for each Major Component is displayed in the Major Component window.

Design Length

The user enters the length of time the design process will take, in whole years.

Construction Length

The user enters the length of time the construction process will take, in whole years.

Year Online

The user enters the year the major component will come online.

Estimated Construction Cost

The user enters the estimated cost of construction for the project. The Estimated Construction Cost column is not editable when the Use ENR Values check box is checked. To edit the values, uncheck the Use ENR Values check box.

Total Project Cost

The Total Project Cost is the Estimated Construction Cost modified by the ELAC Factor and the ENR values.

Percentage of Project Costs Allocated To Expansion

The user enters the percentage of the total costs that are applicable to expansion costs. Enter values as percentages, so that entering 50.00 represents 50%. The Expansion percentage plus the Replacement/Improvement percentage must total 100%.

Percentage of Project Costs Allocated To Replacement or Improvement

The user enters the percentage of the total costs that are applicable to replacement or improvement costs. Enter values as percentages, so that entering 50.00 represents 50%. The Expansion percentage plus the Replacement/Improvement percentage must total 100%.

Number of Units

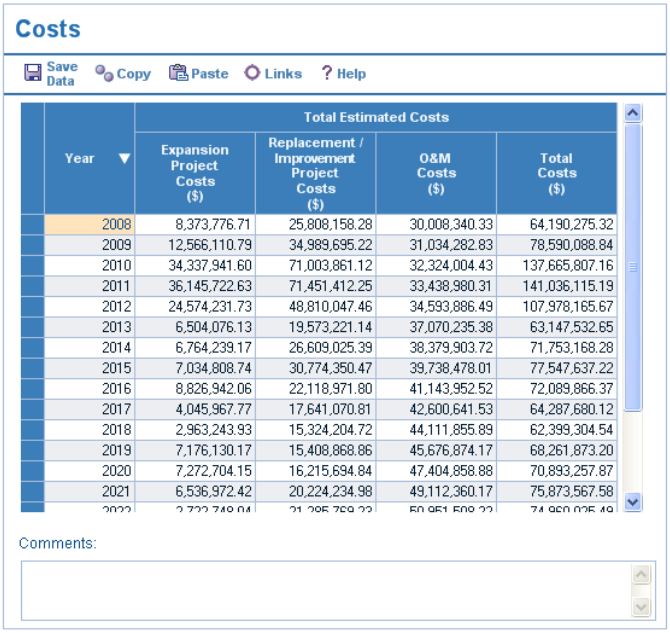
The user enters the number of units that comprise the component. This is a numeric value only.

Comments

The user enters comments for each project/major component row in the grid.

Costs

The Costs screen displays the total costs from the Project Expansion Costs, Project Replacement/Improvement Costs, and O&M Costs screens



Costs

Save Data | Copy | Paste | Links | Help

	Year	Total Estimated Costs			
		Expansion Project Costs ($)	Replacement / Improvement Project Costs ($)	O&M Costs ($)	Total Costs ($)
	2008	8,373,776.71	25,808,158.28	30,008,340.33	64,190,275.32
	2009	12,566,110.79	34,989,695.22	31,034,282.83	78,590,088.84
	2010	34,337,941.60	71,003,861.12	32,324,004.43	137,665,807.16
	2011	36,145,722.63	71,451,412.25	33,438,980.31	141,036,115.19
	2012	24,574,231.73	48,810,047.46	34,593,886.49	107,978,165.67
	2013	6,504,076.13	19,573,221.14	37,070,235.38	63,147,532.65
	2014	6,764,239.17	26,609,025.39	38,379,903.72	71,753,168.28
	2015	7,034,808.74	30,774,350.47	39,738,478.01	77,547,637.22
	2016	8,826,942.06	22,118,971.80	41,143,952.52	72,089,866.37
	2017	4,045,967.77	17,641,070.81	42,600,641.53	64,287,680.12
	2018	2,963,243.93	15,324,204.72	44,111,855.89	62,399,304.54
	2019	7,176,130.17	15,408,868.86	45,676,874.17	68,261,873.20
	2020	7,272,704.15	16,215,694.84	47,404,858.88	70,893,257.87
	2021	6,536,972.42	20,224,234.98	49,112,360.17	75,873,567.58
	2022	2,722,748.04	21,285,769.23	50,951,508.22	74,960,025.49

Comments:

Year

The Year column contains the years that exist in the Projected Years screen.

Expansion Project Costs

The costs for each year from the Project Expansion Costs screen.

Replacement/Improvement Project Costs

The costs for each year from the Project Replacement/Improvement Costs screen.

O&M Costs

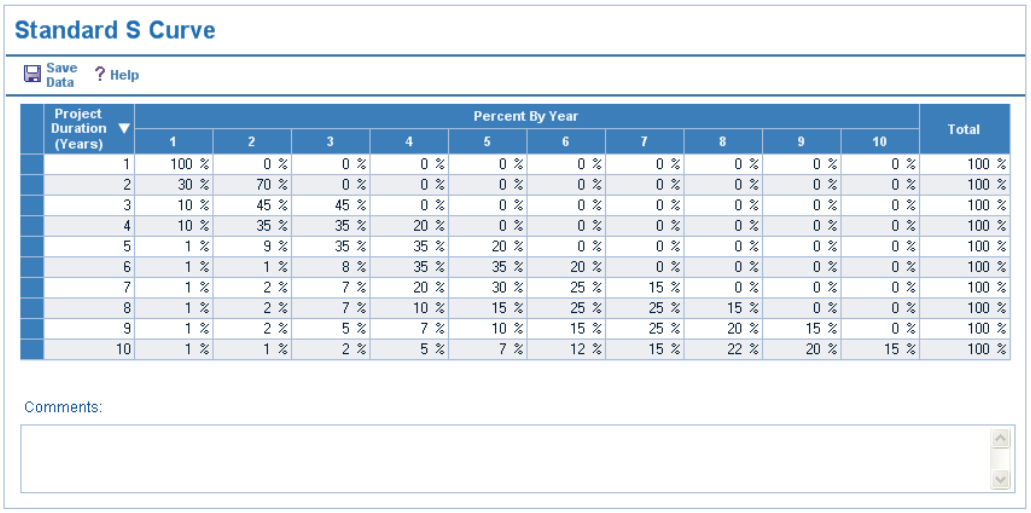
The costs for each year from the O&M Costs screen.

Total Costs

The total costs for each year.

Standard S Curve

The percentages in the Standard S Curve grid are used to calculate the yearly costs in the Project Expansion Costs and Project Replacement/Improvement Costs screens.



Standard S Curve

Save Data | Help

Project Duration (Years)	Percent By Year										Total
	1	2	3	4	5	6	7	8	9	10	
1	100 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %
2	30 %	70 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %
3	10 %	45 %	45 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %
4	10 %	35 %	35 %	20 %	0 %	0 %	0 %	0 %	0 %	0 %	100 %
5	1 %	9 %	35 %	35 %	20 %	0 %	0 %	0 %	0 %	0 %	100 %
6	1 %	1 %	8 %	35 %	35 %	20 %	0 %	0 %	0 %	0 %	100 %
7	1 %	2 %	7 %	20 %	30 %	25 %	15 %	0 %	0 %	0 %	100 %
8	1 %	2 %	7 %	10 %	15 %	25 %	25 %	15 %	0 %	0 %	100 %
9	1 %	2 %	5 %	7 %	10 %	15 %	25 %	20 %	15 %	0 %	100 %
10	1 %	1 %	2 %	5 %	7 %	12 %	15 %	22 %	20 %	15 %	100 %

Comments:

Example Calculation

The image below shows a portion of the Project Expansion Costs grid. The cost for 2008 for a project with a total cost of $210,583.10 (the first row in the grid) is calculated as follows:

Find the percentages in the Project Duration column in the Standard S Curve grid for a project that lasts three years. The percentages are 10%, 45%, and 45%.

The total project cost is $210,583.10, so the cost for the first year is $210,583.10 x 10% = $21,058.31; the cost for the second year is $210,583.10 x 45% = $94,762.40; and the cost for the third year is $210,583.10 x 45% = $94,762.40.

The projects starts in 2006 and ends in 2008, making 2008 the third year. So the cost in 2008 is $94,762.40.

(For the purposes of determining project schedules and costs, a year starts in January and ends in December, so that the first year of the project is the entire

year of 2006, the second year is 2007, and the third year is 2008, so that the project is ready to go online at the beginning of 2009).

Project Name	Major Component Name	Start Date (Year)	Year Online	Project Duration (Years)	Total Expansion Project Cost ($)	Expansion Project Cost By Year	
						2008	2009
Misc CIP	Addtl Downtown Manholes	2006	2009	3	210,583.10	94,762.40	0.00
Misc CIP	Adjust Sewer Manholes on Bla	2006	2009	3	5,717.40	2,572.83	0.00
2008 Expansion	APAD Digestor	2008	2013	5	5,112,660.11	51,126.60	460,139.41

Project Duration

The length of the project, in years.

Percent by Year

The percentage of the total project cost that is applied to each year of the project.

Total

The total of the percentages in the "Percent by Year" column.

Project Expansion Costs

The Project Expansion Costs screen displays the expansion-related project cost data from the selected Planned Projects option. Each Major Component in the Planned Project that is included in treatment or included in costs (or both) will be displayed in the Project Expansion Costs grid.

The data in the Project Expansion Costs grid is not editable.

Project Cost Escalation

The top portion of the screen contains the Project Cost Escalation data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Project Cost Escalation

Project cost escalation allows inflation to be taken into account when calculating costs. By including the effects of inflation, cost escalation provides a more realistic estimate of future year costs.

The basis for the cost escalation is the year entered into the "Costs are in what year's dollars" box. The cost for each project year is escalated based on that cost year. The costs for the first five project year are escalated using the percentage entered into the "Escalation rate for first 5 years" box. Subsequent project year costs are escalated using the percentage entered into the "Escalation rate for subsequent years" box.

To escalate the existing costs, check the "Escalate Costs to Corresponding Year" check box, and enter the escalation year and the escalation percentages.

The equations for applying cost escalation are as follows:

For the case where the Escalation Cost Year + 5 <= Project Year:

Equation: Future Cost = Original Cost x (1 + Escalation PercentageA/100) (Project Year - Escalation Cost Year)

For the case where the Escalation Cost Year + 5 > Project Year:

Equation: Future Cost = Original Cost x (1 + Escalation PercentageA/100) ^{5} x (1 + Escalation PercentageB/100) (Project Year - Escalation Cost Year - 5)

Where

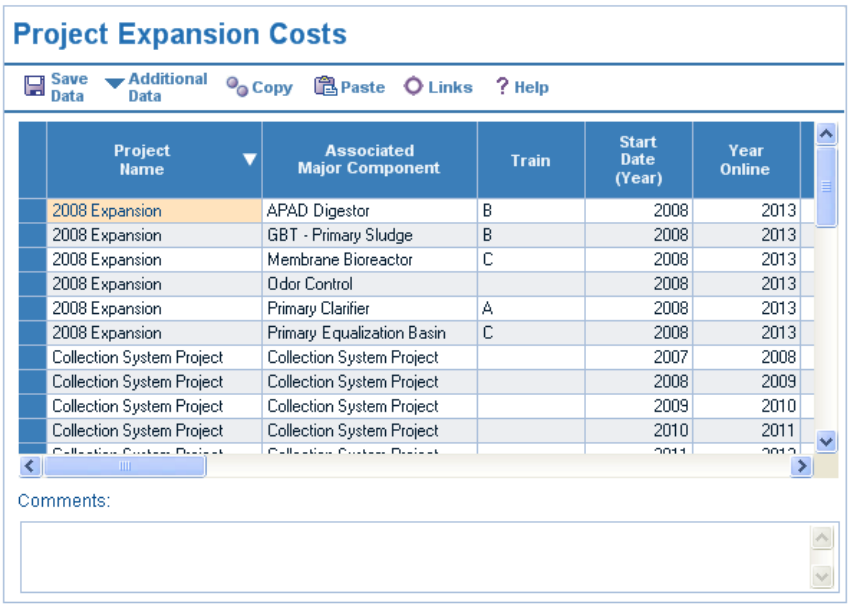
- the Escalation Cost Year is the year in the "Costs are in what year's dollars" box
- the Escalation PercentageA is the escalation rate for the first 5 years
- the Escalation PercentageB is the escalation rate for subsequent years

For example, a 2007 cost of $94,762.40 escalated to 2008 dollars would be $100,448.14:

$$\$94{,}762.40 \times (1 + 6/100)^{(2008 - 2007)} = \$100{,}448.14$$

while a 2007 cost of $4,673,292.35 escalated to 2014 dollars would be $6,764,239.17:

$$\$4{,}673{,}292.35 \times (1 + 6/100)^{5} \times (1 + 4/100)^{(2014 - 2007 - 5)} = \$6{,}764{,}239.17$$



Project Name

The Project Name comes from the Project Name column in the Planned Projects screen.

Associated Major Component

The Associated Major Component comes from the selected Planned Projects grid. Only those planned Major Components that are included in treatment or included in costs (or both) will be included in the Project Expansion Costs grid.

Train

Data for the Train column comes from the Train column in the selected Planned Projects grid.

Start Date

The Start Date is the year during which the design process should begin so that the project will be completed by the scheduled year online.

The Start Date is calculated as follows:

Equation: Year Online - Project Duration

Year Online

Data for the Year Online column comes from the Year Online column in the selected Planned Projects grid.

Project Duration

The Project Duration is the length of time it will take to complete the design and construction of the project.

The Project Duration is calculated as follows:

Equation: Design Length + Construction Length

(The Design Length and Construction Length come from the Planned Projects grid.)

Total Expansion Project Cost

The total of the expansion portion of the project cost, from the Planned Projects screen, modified by ENR and cost escalation, if used.

Expansion Project Cost by Year

The expansion project costs are broken down by year in the Expansion Project Cost by Year columns based on the percentages in the Standard S Curve screen.

For example, the cost for year 2008 for a project with a total cost of $210,583.10 (the first row in the grid below) is calculated as follows:

Find the percentages in the Standard S Curve grid (the second image, below) for a project that lasts three years. The percentages are 10%, 45%, and 45%.

The total project cost is $210,583.10, so the cost for the first year is $210,583.10 x 10% = $21,058.31;
the cost for the second year is $210,583.10 x 45% = $94,762.40; and
the cost for the third year is $210,583.10 x 45% = $94,762.40.

The project starts in 2006 and ends in 2008, making 2008 the third year. So the cost in 2008 is $94,762.40.

(For the purposes of determining project schedules and costs, a year starts in January and ends in December, so that the first year of the project is the entire year of 2006, the second year is 2007, and the third year is 2008, so that the project is ready to go online at the beginning of 2009).

Project Name	Major Component Name	Start Date (Year)	Year Online	Project Duration (Years)	Total Expansion Project Cost ($)	Expansion Project Cost By Year	
						2008	2009
Misc CIP	Addtl Downtown Manholes	2006	2009	3	210,583.10	94,762.40	0.00
Misc CIP	Adjust Sewer Manholes on Bla	2006	2009	3	5,717.40	2,572.83	0.00
2008 Expansion	APAD Digestor	2008	2013	5	5,112,660.11	51,126.60	460,139.41

The image below shows a portion of the Standard S Curve grid.

Project Duration (Years)	Percent By Year		
	1	2	3
1	100 %	0 %	0 %
2	30 %	70 %	0 %
3	10 %	45 %	45 %
4	10 %	35 %	35 %
5	1 %	9 %	35 %

Project Replacement/Improvement Costs

Project Cost Escalation

The top portion of the screen contains the Project Cost Escalation data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

Project Cost Escalation

Project cost escalation allows inflation to be taken into account when calculating costs. By including the effects of inflation, cost escalation provides a more realistic estimate of future year costs.

The basis for the cost escalation is the year entered into the "Costs are in what year's dollars" box. The cost for each project year is escalated based on that cost year. The costs for the first five project year are escalated using the percentage entered into the "Escalation rate for first 5 years" box. Subsequent project year costs are escalated using the percentage entered into the "Escalation rate for subsequent years" box.

To escalate the existing costs, check the "Escalate Costs to Corresponding Year" check box, and enter the escalation year and the escalation percentages.

The equations for applying cost escalation are as follows:

For the case where the Escalation Cost Year + 5 <= Project Year:

Equation: Future Cost = Original Cost x (1 + Escalation PercentageA/100) (Project Year - Escalation Cost Year)

For the case where the Escalation Cost Year + 5 > Project Year:

Equation: Future Cost = Original Cost x $(1 + \text{Escalation PercentageA}/100)^{5}$ x $(1 + \text{Escalation PercentageB}/100)^{(\text{Project Year - Escalation Cost Year - 5})}$

Where

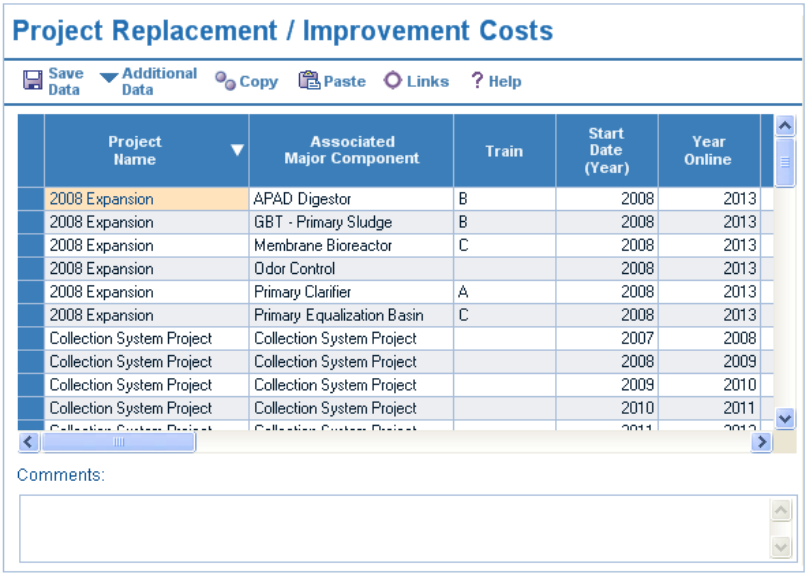
- the Escalation Cost Year is the year in the "Costs are in what year's dollars" box
- the Escalation PercentageA is the escalation rate for the first 5 years
- the Escalation PercentageB is the escalation rate for subsequent years

For example, a 2007 cost of $94,762.40 escalated to 2008 dollars would be $100,448.14:

$94,762.40 x $(1 + 6/100)^{(2008 - 2007)}$ = $100,448.14

while a 2007 cost of $4,673,292.35 escalated to 2014 dollars would be $6,764,239.17:

$4,673,292.35 x $(1 + 6/100)^{5}$ x $(1 + 4/100)^{(2014 - 2007 - 5)}$ = $6,764,239.17



Project Name	Associated Major Component	Train	Start Date (Year)	Year Online
2008 Expansion	APAD Digestor	B	2008	2013
2008 Expansion	GBT - Primary Sludge	B	2008	2013
2008 Expansion	Membrane Bioreactor	C	2008	2013
2008 Expansion	Odor Control		2008	2013
2008 Expansion	Primary Clarifier	A	2008	2013
2008 Expansion	Primary Equalization Basin	C	2008	2013
Collection System Project	Collection System Project		2007	2008
Collection System Project	Collection System Project		2008	2009
Collection System Project	Collection System Project		2009	2010
Collection System Project	Collection System Project		2010	2011

Project Name

The Project Name comes from the Project Name column in the Planned Projects screen.

Associated Major Component

The Associated Major Component comes from the selected Planned Projects grid. Only those planned Major Components that are included in treatment or included in costs (or both) will be included in the Project Replacement/Improvement Costs grid.

Train

Data for the Train column comes from the Train column in the selected Planned Projects grid.

Start Date

The Start Date is the year during which the design process should begin so that the project will be completed by the scheduled year online.

The Start Date is calculated as follows:

Equation: Year Online - Project Duration

Year Online

Data for the Year Online column comes from the Year Online column in the selected Planned Projects grid.

Project Duration

The Project Duration is the length of time it will take to complete the design and construction of the project.

The Project Duration is calculated as follows:

Equation: Design Length + Construction Length

(The Design Length and Construction Length come from the Planned Projects grid.)

Total Replacement/Improvement Project Cost

The total of the replacement/improvement portion of the project cost, from the Planned Projects screen, modified by ENR and cost escalation, if used.

Replacement/Improvement Project Cost by Year

The replacement/improvement project costs are broken down by year in the Replacement/Improvement Project Cost by Year columns based on the percentages in the Standard S Curve screen.

For example, the cost for year 2008 for a project with a total cost of $13,199,999.80 (the first row in the grid below is calculated as follows):

Find the percentages in the Standard S Curve grid (the second image, below) for a project that lasts four years. The percentages are 10%, 35%, 35%, and 20%.

The total project cost is $13,199,999.80, so the cost for the first year is $13,199,999.80 x 10% = $1,319,999.98;
the cost for the second year is $13,199,999.80 x 35% = $4,619,999.93;
the cost for the third year is $13,199,999.80 x 35% = $4,619,999.93; and
the cost for the fourth year is $13,199,999.80 x 20% = $2,639,999.96.

The project starts in 2008 and ends in 2011, making 2008 the first year. So the cost in 2008 is $1,319,999.98.

(For the purposes of determining project schedules and costs, a year starts in January and ends in December, so that the first year of the project is the entire year of 2008, the second year is 2009, the third year is 2010, and the fourth year is 2011, so that the project is ready to go online at the beginning of 2012).

	Project Name	Major Component Name	Start Date (Year)	Year Online	Project Duration (Years)	Total Replacement / Improvement Project Cost ($)	Replacement /Improvement Project Cost By Year ($)			
							2008	2009	2010	2011
	Rehab	1.2 MW Fuel Cell and Power S	2008	2012	4	13,199,999.80	1,319,999.98	4,619,999.93	4,619,999.93	2,639,9
	Rehab	24 In Meter Control Valve	2007	2009	2	499,999.50	349,999.65	0.00	0.00	
	Rehab	52 In Pipe Upgrade	2007	2009	2	99,999.90	69,999.93	0.00	0.00	

The image below shows a portion of the Standard S Curve grid.

	Project Duration (Years)				
		1	2	3	4
	1	100 %	0 %	0 %	0 %
	2	30 %	70 %	0 %	0 %
	3	10 %	45 %	45 %	0 %
	4	10 %	35 %	35 %	20 %
	5	1 %	9 %	35 %	35 %

O&M Costs

The O&M Costs screen allows the user to enter maintenance and operations costs for each Major Component, as well as labor and disposal costs, for each year in the planning period. Each Major Component appears in the grid only for those years when that component is online.

Editing the Data

The data in the left-hand grid is not editable. The data in the right-hand grid is editable only when both the ENR Values check box and the Project Cost Escalation check box are unchecked. When either of those check boxes is checked, the data is not editable.

ENR Values, Project Cost Escalation

The top portion of the screen contains the ENR Values and the Project Cost Escalation data.

Additional Data Button

Clicking the Additional Data button toggles between hiding and displaying the top portion of the form.

ENR Values

The Engineering News Record (ENR) index values allow costs estimated in previous years to be adjusted to the current year. The ENR index represents the costs of construction from year to year. The Original ENR Value represents the ENR index for the year in which the costs were determined. The Current ENR Value represents the ENR index for the current year. The equation for adjusting the costs to the current year is as follows:

Equation: Current Cost = Original Cost x Current ENR Value / Original ENR Value

To apply the ENR values, check the "Use ENR Values" check box, and enter the Original ENR Value and the Current ENR Value.

Project Cost Escalation

Project cost escalation allows inflation to be taken into account when calculating future costs. By including the effects of inflation, cost escalation provides a more realistic estimate of future year costs.

The basis for the cost escalation is the year entered into the "Costs are in what year's dollars" box. The cost for each project year is escalated based on that cost year. The costs for the first five project year are escalated using the percentage entered into the "Escalation rate for first 5 years" box. Subsequent project year costs are escalated using the percentage entered into the "Escalation rate for subsequent years" box.

To escalate the existing costs, check the "Escalate Costs to Corresponding Year" check box, and enter the escalation year and the escalation percentages.

The equations for applying cost escalation are as follows:

For the case where the Escalation Cost Year + 5 <= Project Year:

Equation: Future Cost = Original Cost x (1 + Escalation PercentageA/100) (Project Year - Escalation Cost Year)

For the case where the Escalation Cost Year + 5 > Project Year:

Equation: Future Cost = Original Cost x (1 + Escalation PercentageA/100) ^{5} x (1 + Escalation PercentageB/100) (Project Year - Escalation Cost Year - 5)

Where

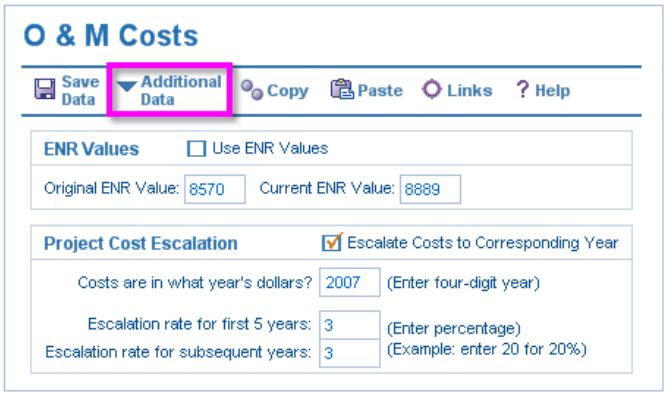
- the Escalation Cost Year is the year in the "Costs are in what year's dollars" box
- the Escalation PercentageA is the escalation rate for the first 5 years
- the Escalation PercentageB is the escalation rate for subsequent years

For example, a 2007 cost of $94,762.40 escalated to 2008 dollars would be $100,448.14:

$$\$94{,}762.40 \times (1 + 6/100)^{(2008 - 2007)} = \$100{,}448.14$$

while a 2007 cost of $4,673,292.35 escalated to 2014 dollars would be $6,764,239.17:

$$\$4{,}673{,}292.35 \times (1 + 6/100)^{5} \times (1 + 4/100)^{(2014 - 2007 - 5)} = \$6{,}764{,}239.17$$



Year

The Year column contains the years that exist in the Projected Years screen.

Total O&M Annual Costs

The total costs for each year, as detailed in the right-hand grid.

Major Component Name

The Major Component comes from the selected Planned Projects grid (or from the Existing Treatment Process grid if no Planned Projects exist). Only those Major Components that are included in treatment or included in costs (or both) will be included in the O&M Costs grid. Each component appears in the grid only for those years during which it is online. If the component is offline, it will not appear in the grid.

Train

Data for the Train column comes from the Train column in the selected Planned Projects grid (or from the Existing Treatment Process grid if no Planned Projects exist).

Operating Cost

The yearly cost of operations for the Major Component.

Maintenance Cost

The yearly cost of maintenance for the Major Component.

Total Estimated O&M Costs

The operating cost plus the maintenance cost.

Labor Cost

The labor cost for all Major Components during the year.

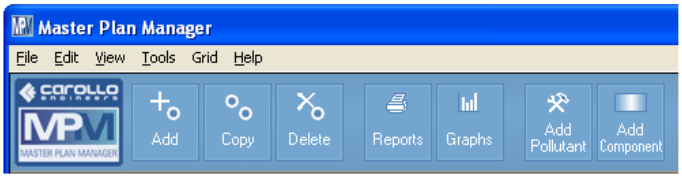
Disposal Cost

The disposal cost for all Major Components during the year.

TOOLBARS

Main Toolbar

The main toolbar for the MPM application appears at the top of the MPM window. The buttons in the main toolbar perform operations in the Data Tree, and allow access to other areas in the application, such as reports and graphs.

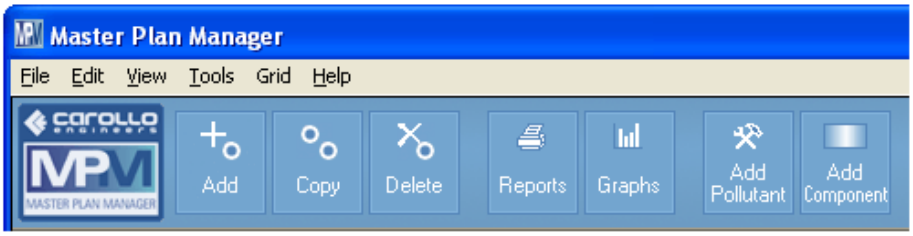


Data Window Toolbar

Each data window has a toolbar at the top. The buttons in the toolbar operate for that Data Window only.

Main Toolbar

The main toolbar for the MPM application appears at the top of the MPM window. The buttons in the main toolbar perform operations in the Data Tree, and allow access to other areas in the application, such as reports and graphs.



See Data Window toolbar for information on the toolbar that exists in each Data Window.

Add

The Add button adds a new item to the Data Tree. The type of item that is added is dependent upon which item is selected in the Data Tree. For instance, if a Scenario is the selected tree item, clicking the Add button will add a new Scenario to the tree. If one of the Other Pollutants items is selected, a new Other Pollutants option will be added to the tree. The types of items that can be added to the tree are as follows:

- Scenario
- Domestic, Industrial, Other Pollutant, and Water Conservation options
- Pollutant Reduction, Pollutant Addition, and Regulatory Requirements options
- Planned Projects options

The Add button is dimmed (inoperable) when the selected tree item cannot be added to the tree. When the Projected Years item is selected in the tree, for example, the Add button is inoperable because there can be only one Projected Years item in each Scenario.

Copy

The Copy button copies the currently selected Data Tree item. The Copy button will be dimmed (inoperable) when the selected tree item cannot be copied. For instance, because there can be only one Capacity Evaluation per Scenario, that item cannot be copied. The items in the tree that can be copied are as follows:

- Scenario
- Domestic, Industrial, Other Pollutant, and Water Conservation options
- Pollutant Reduction, Pollutant Addition, and Regulatory Requirements options
- Planned Projects options

Delete

The Delete button deletes the currently selected Data Tree item. The Delete button will be dimmed (inoperable) when the selected tree item cannot be deleted. For instance, because Capacity Evaluation must exist in every Scenario, it cannot be deleted. The items in the tree that can be deleted are as follows:

- Scenario
- Domestic, Industrial, Other Pollutant, and Water Conservation options
- Pollutant Reduction, Pollutant Addition, and Regulatory Requirements options
- Planned Projects options

Reports

Click the Reports button to display, print, and save reports.

Graphs

Click the Graphs button to display, print, and save graphs.

Add Pollutant

Click the Add Pollutant button to add, edit, or delete pollutants.

Add Component

Click the Add Component button to add, edit, or delete major components.

Data Window Toolbar

Each Data Window has a toolbar at the top. The buttons in the toolbar operate for that Data Window only. Each Data Windows contains only those toolbar buttons that are required for that Data Window. For instance, the Projected Years screen contains only the Save, Add Row, Copy, Paste, and Help buttons.

See the main toolbar for information on the toolbar that appears in MPM's main window.

Save Data

Saves the changes made to the data in the Data Window. (See Options for automatically saving data.)

Additional Data

Some Data Windows have information at the top of the screen that can be hidden to provide more viewing area for the data grid. Clicking the Additional Data button toggles between displaying and hiding that additional information.

Add Row

Click the Add Row button to add a row to the grid.

Train

The Existing Treatment Process and the Planned Projects and Costs screens each have a train diagram that displays the major components that are included in treatment. Clicking the Train button toggles between displaying and hiding the train diagram.

Add Component

The Existing Treatment Process and the Planned Projects and Costs screens each have a train diagram that displays the major components that are included in treatment. Clicking the Add Component button adds a Major Component to the grid or train diagram.

Check Unconnected

When the system calculations are performed, the Major Components in the train diagrams are examined to determine how the components are connected to each other. If any component exists that is not connected to another component, the Capacity Evaluation and Effluent Quality calculations cannot be performed.

To determine if unconnected components exist, the Check Unconnected button is available in the Existing Treatment Process, Planned Projects and Costs, and Flow and Solids Allocation screens.

Existing Treatment Process

When pressing the Check Unconnected component button in the Existing Treatment Process screen, MPM will display unconnected components for that Existing Treatment Process. If Planned Projects exist, then it doesn't matter if there are unconnected components in the Existing Treatment Process train diagram, because the system no longer uses the Treatment Process component connections as the basis for calculations in the system. Once a Planned Project exists, the system's calculations are based on the Planned Project components and connections.

Planned Projects

When pressing the Check Unconnected component button in the Planned Projects screen, MPM will display unconnected components for that Planned Project.

Flow and Solids Allocation

When pressing the Check Unconnected component button in the Flow and Solids Allocation screen, MPM will check the selected Planned Project for unconnected components. (The selected Planned Project is the one in the data tree with the check mark.) The components in the selected Planned Project serve as the basis for any system calculations involving components and connections, and its components are the ones that are used in other data grids that contain components (such as Capacity Evaluation, Flow and Solids Allocation, and Pollutant Reduction).

If there are no Planned Projects, then the components in the Existing Treatment Process are used as the basis for the system. In this case, pressing the Check Unconnected component button in the Flow and Solids Allocation screen checks the Existing Treatment Process for unconnected components.

Copy

The Copy button can be used to copy highlighted data from a grid or text box. To copy data, highlight it, and click the Copy button.

Data can also be copied using the keyboard keys by holding down the Ctrl key and pressing the C key.

Paste

The Copy button can be used to paste data into an editable grid or text box. To paste data, first copy it, as described above, and then highlight the area in the grid or text box that will receive the text, and click the paste button.

Data can also be pasted using the keyboard keys by holding down the Ctrl key and pressing the V key.

Links

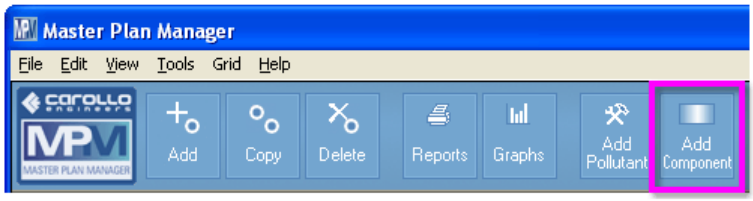
Some Data Windows (such as Effluent Quality) have a Links button. Hovering over the Links button with the mouse displays links to related Data Windows. This is an alternative to clicking on the items in the Data Tree.

Help

Click the Help button to open this help file.

MAJOR COMPONENTS

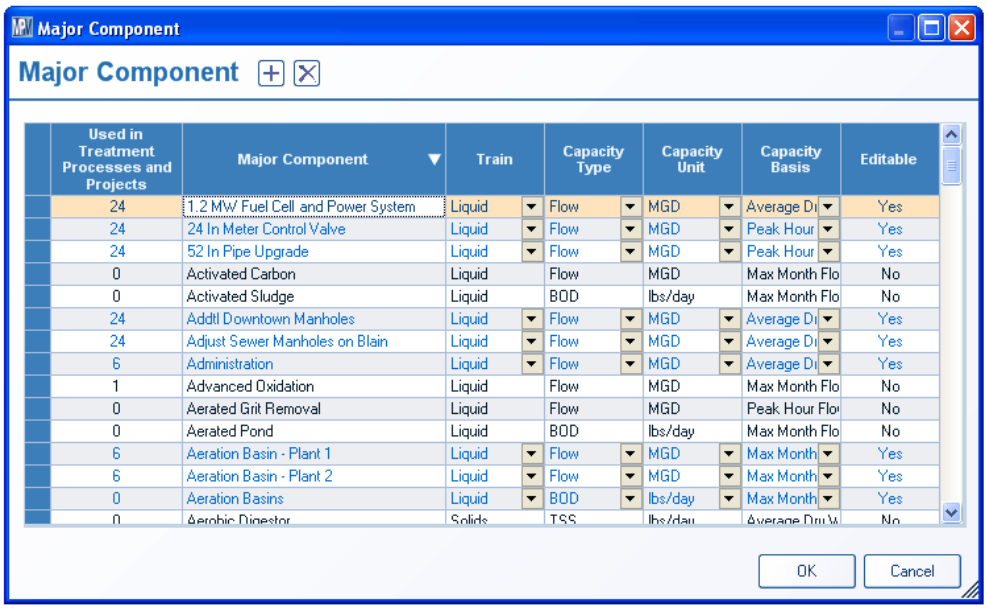
Open the Major Component window by clicking the Add Component button in the toolbar.



Major Components

The Major Components window is used to add, edit, and delete Major Components. The components that appear in the Major Components window are the same components that appear in the smaller major components box in the Existing Treatment Process and Planned Projects screens. Any changes made to the components in this larger Major Components window will show up in the smaller major components window. The difference between the two windows is that this one allows the user to add, edit, and delete components, which the smaller window is used only to add components to the Treatment Process and Planned Projects trains.

MPM contains both built-in major components and user-created major components that are used throughout the system. The built-in major components are part of the system and cannot be edited or deleted. New major components can be created for use in the system, and those major components can be edited and deleted. User-created major components are displayed in blue text and display "Yes" in the Editable column, while built-in major components are displayed in black text, and display "No" in the Editable column.



Used in Treatment Processes and Projects

The "Used in Treatment Processes and Projects" column displays the number of times the major component is used in Treatment Processes and Planned Projects in all Scenarios in the system.

Editable Column

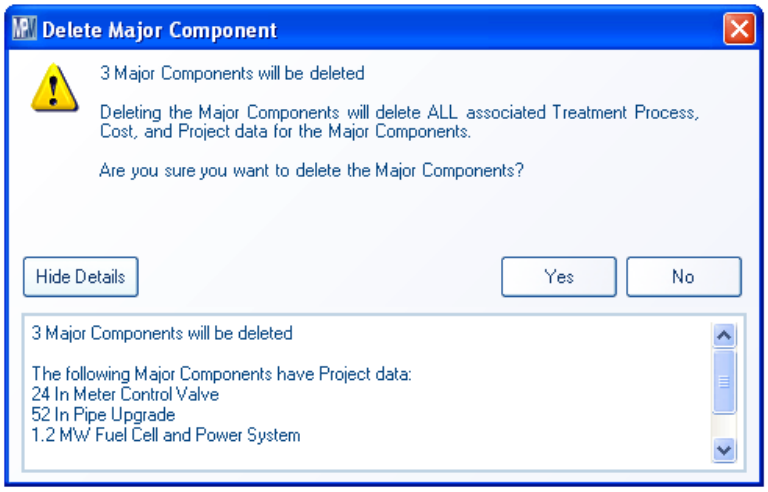
The Editable column displays whether or not the major component is editable by the user. Non-editable major components cannot be edited or deleted.

Adding a Major Component to the System

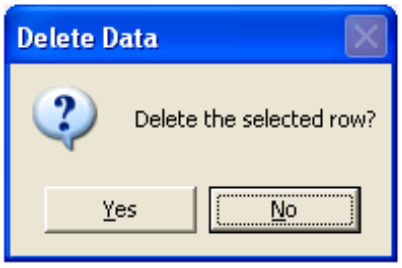
To add a Major Component to the system, click the **+** button to create a new row in the grid. Change the name of the new major component and make a selection in the Train, Capacity Type, Capacity Unit, and Capacity Basis columns. The Major Component is now available to be used in any Scenario by adding it to the Existing Treatment Process grid or the Planned Projects and Costs grid.

Deleting a Major Component from the System

To delete a major component from the system, highlight the major component(s) to be deleted by clicking on them in the grid, and click the X button at the top of the window. (The button will be visible only when user-created major components are highlighted.) If any of those major components are used in the Treatment Processes, Planned Projects, or Costs of any Scenario, a message box will be displayed that lists those major components, allowing the user to see which major components are currently being used, and to confirm that they should be deleted.



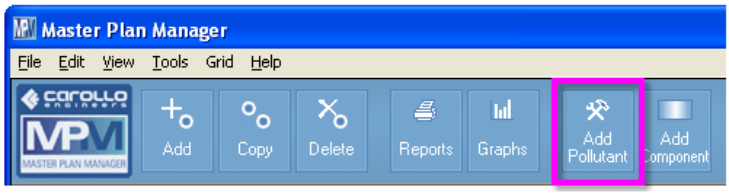
If the major component to be deleted is not currently used in any Scenario in the system, the following message box will be displayed:



POLLUTANTS

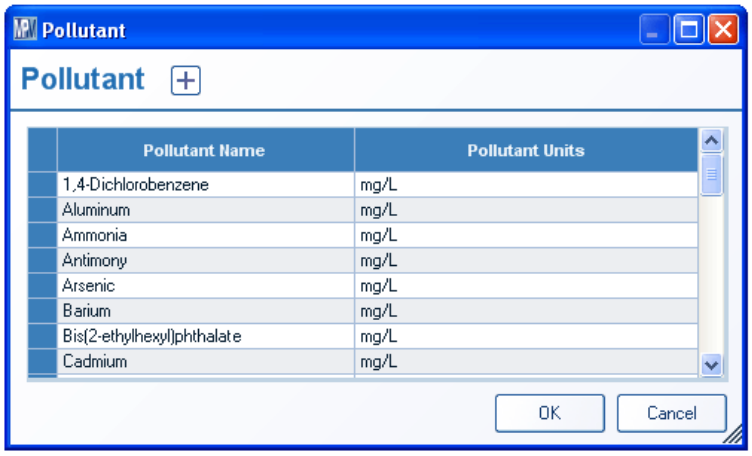
Opening the Pollutant Window

Open the Pollutant window by clicking the Add Pollutant button in the toolbar.



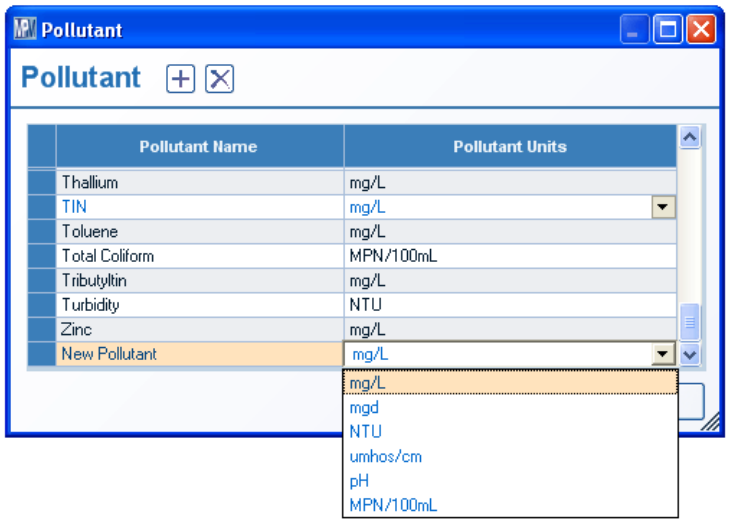
Pollutants

MPM contains both built-in pollutants and user-created pollutants that are used throughout the system. The built-in pollutants are part of the system and cannot be edited or deleted. New pollutants can be created for use in the system, and those pollutants can be edited and deleted. User-created pollutants are displayed in blue text, while built-in pollutants are displayed in black text.



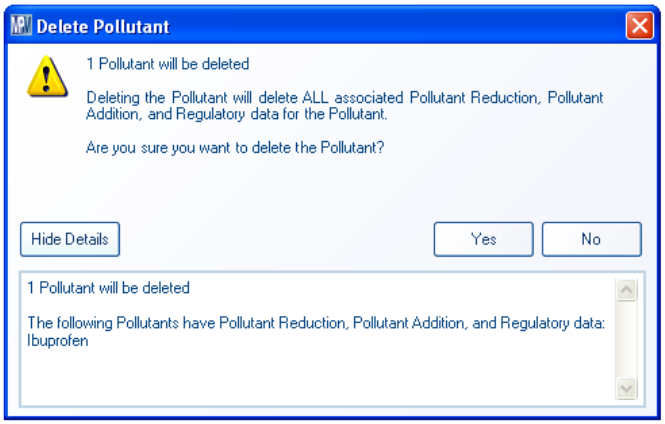
Adding a Pollutant to the System

To add a pollutant to the system, click the **+** button to create a new row in the grid. Change the name of the new pollutant and make a selection in the Pollutant Units column. The pollutant is now available to be used in any Scenario, by adding it to the Other Pollutants grid, or the Other Pollutants - Historical Data grid.

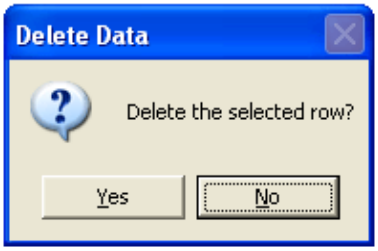


Deleting a Pollutant from the System

To delete a pollutant from the system, highlight the pollutant(s) to be deleted by clicking on them in the grid, and click the X button at the top of the window. (The button will be visible only when user-created pollutants are highlighted.) If any of those pollutants have Pollutant Reduction, Addition, or Regulatory data in any Scenario, a message box will be displayed that lists those pollutants. If any of the pollutants are used only in Other Pollutants Historical data, which will also be noted in the message. (Pollutants used only in Other Pollutants Historical data have no Pollutant Reduction, Addition, or Regulatory data.) Displaying the pollutants in the message box allows the user see which pollutants are currently being used, and to confirm that they should be deleted by the system.



If the pollutant to be deleted is not currently used in any Scenario in the system, the following message box will be displayed:



DATABASE

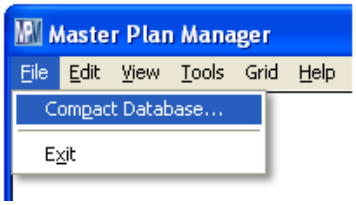
All data for MPM is stored in the database. The database file resides in the MPM folder and is named MPM.mdb. Every time data is added, deleted, or edited, that data is saved to the MPM database.

To protect data, the database should be compacted and backed up from time to time.

Compacting the Database

Opening the Compact Database Window

Open the Compact Database window by clicking File on the menu and selecting Compact Database.



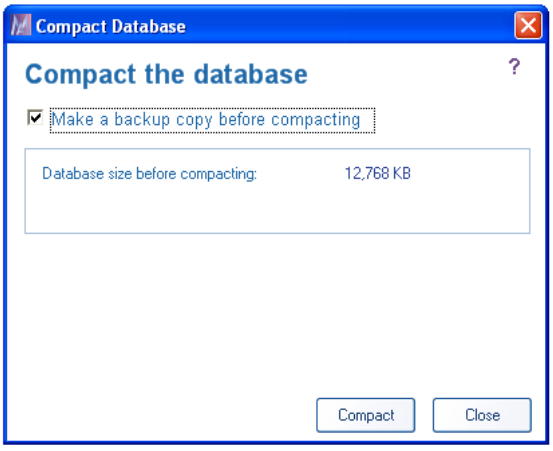
The Purpose of Compacting a Database

Over time, the database grows in size as data is created and modified. The database may become fragmented, leading to poor performance and possible

data loss. Compacting the database will decrease its size, eliminate fragmentation, improve performance, and reduce the chance for data loss. A database should be compacted from time to time, particularly after large amounts of data have been deleted from the database. Compacting after deleting large amounts of data is useful because the database does not automatically shrink in size when data is deleted from it, but retains the empty space where the data used to be. The empty space can be removed only by compacting the database.

Making a Backup of the Database File Before Compacting

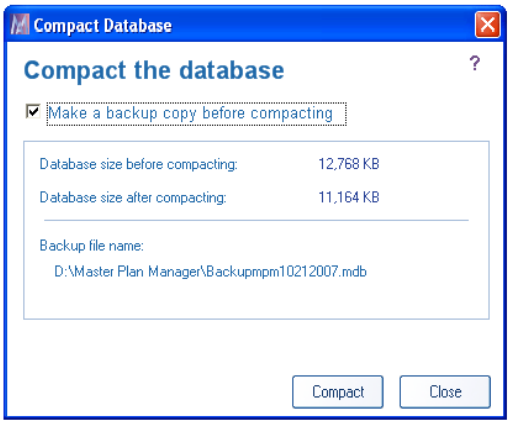
The "Make a backup copy before compacting" check box is checked by default whenever the Compact Database window is opened. When the box is checked, a copy of the database is made automatically before the compacting process begins. A backup copy should always be made because, although it is unlikely, the compacting process may fail, leaving the database unusable and all data in the database permanently lost. (Data loss is likely to occur if, for instance, a power failure occurs during the compacting process.) If compaction fails, the backup copy of the database can be renamed to "MPM.mdb" and opened in the MPM application.



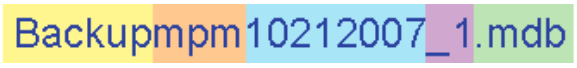
Compacting a Database

Click the **Compact** button to compact the database. Compacting will take as little as a few seconds for small databases, or up to a minute or more for very large databases.

After compacting, the window shows the database size before and after compacting, along with the name of the backup file.



The name of the backup file (Backupmpm10212007_1.mdb, in this example) takes the following form:



- the word "Backup"
- the compacted file name ("mpm")
- the date in the form mmddyyyy ("10212007")
- incremental number, if necessary ("_1")
- the file extension (".mdb")

Backing Up and Restoring Data

Why Backing Up Data is Important

The MPM database should be backed up regularly to storage medium (such as a CD-ROM or network drive) to minimize data loss in the event of a hard drive

failure or database corruption. The databases can be lost due to hard drive failure or unintentional deleting of a database or a folder that contains a database. A database can become corrupted due to a power failure during operation of MPM or, occasionally, simply through data entry and deletion. Once a database becomes corrupted, it is not always possible to retrieve its data and the data may be lost forever. Because of the possibility of corruption, it is important to back up the database at regular intervals. A backup copy of a database can be used to restore data as it existed at the time of the backup.

How to Back Up Data to a Storage Medium

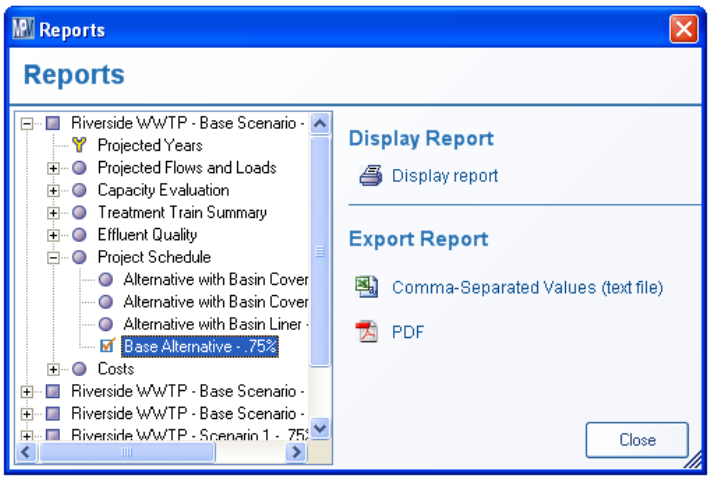
To transfer a database to a storage medium, copy the MPM.mdb file from the MPM application folder to the storage medium. The backup database can be renamed to signify the date and time it was backed up. For instance, the MPM.mdb file could be renamed MPM_Nov_2007_Backup.mdb.

Restoring Data from a Storage Medium

To restore a backed-up database into MPM, close MPM if it is open, and copy the database from the storage medium back into the MPM application folder, and rename it, if necessary, back to MPM.mdb. (If there is already a file named MPM.mdb in the MPM folder, rename it to something else, like MPM1.mdb, so that the backup file can then be named MPM.mdb.) Make sure that the database file is not read-only. Open MPM to view the data.

REPORTS

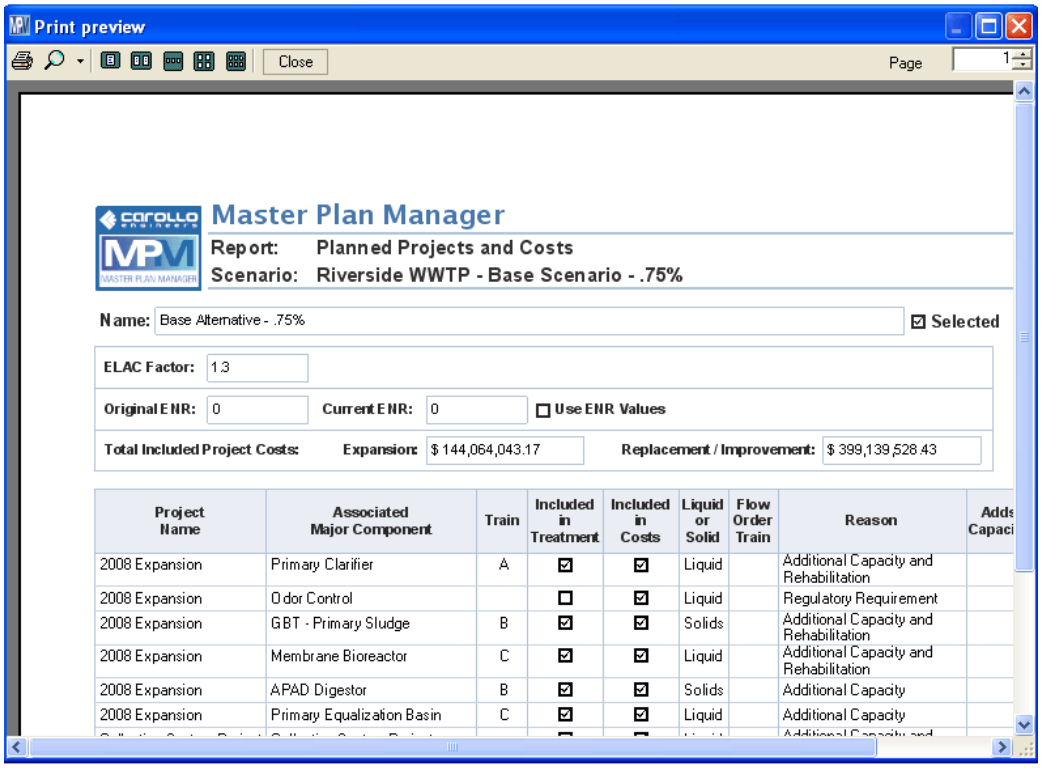
The Reports window provides the ability to display, save, and print reports.



Display and Print Reports

To display a "print preview" version of a report, click on an item in the list on the left, and then click the printer image under the Display Report heading.

Once the report is displayed it can be printed by clicking the printer image at the top of the "print preview" window.



Export Reports - Comma-Separated Values File

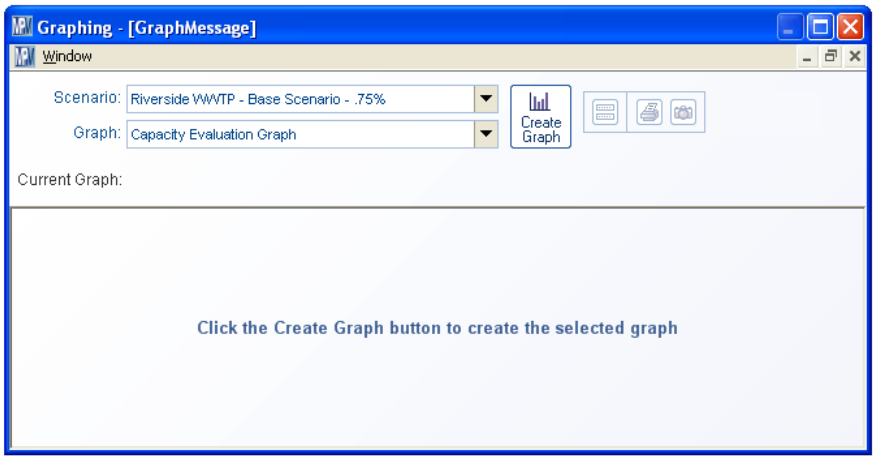
Data for each report can be exported to a file in Comma-Separated Values (CSV) format. CSV files can be opened in spreadsheet programs such as Excel or Calc.

Export Reports - PDF File

Data for each report can be exported to a file in Portable Document Format (PDF) format. PDF files can be opened in programs such as Adobe Reader.

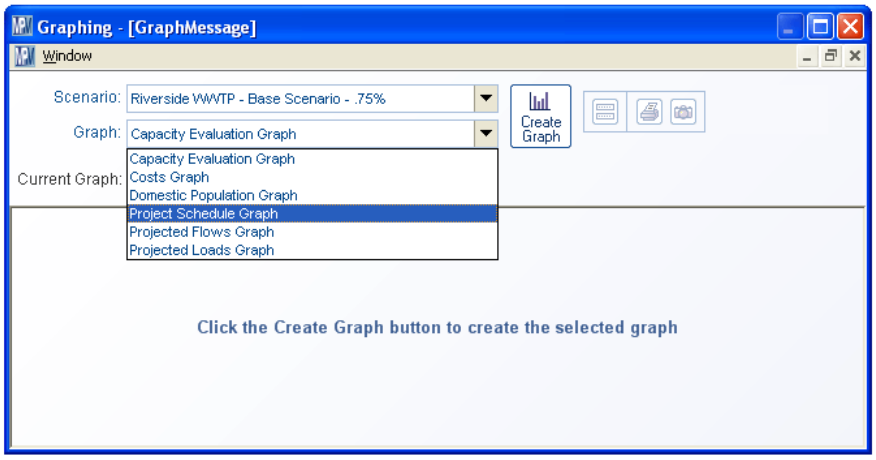
GRAPHS

The Graphs window provides the ability to display, save, and print graphs.



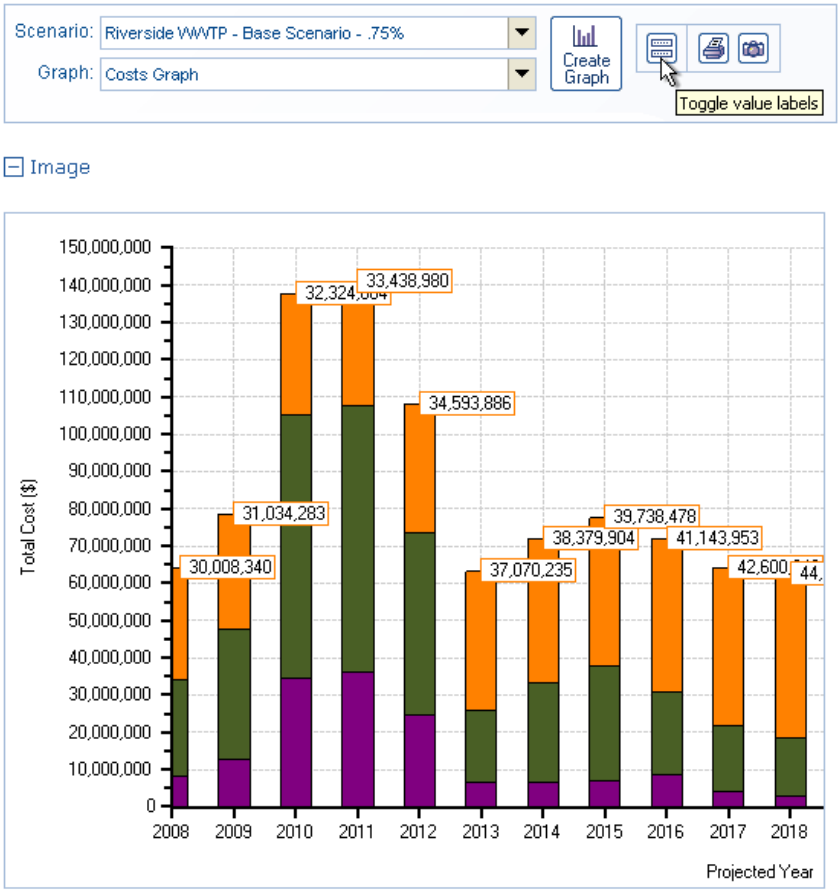
Display a Graph

To display a graph, select it from the drop-down list of available graphs and click the Create Graph button.



Display Labels

Click the labels button display labels on the graph, as shown below. Click the button again to hide the labels.



Print Graph

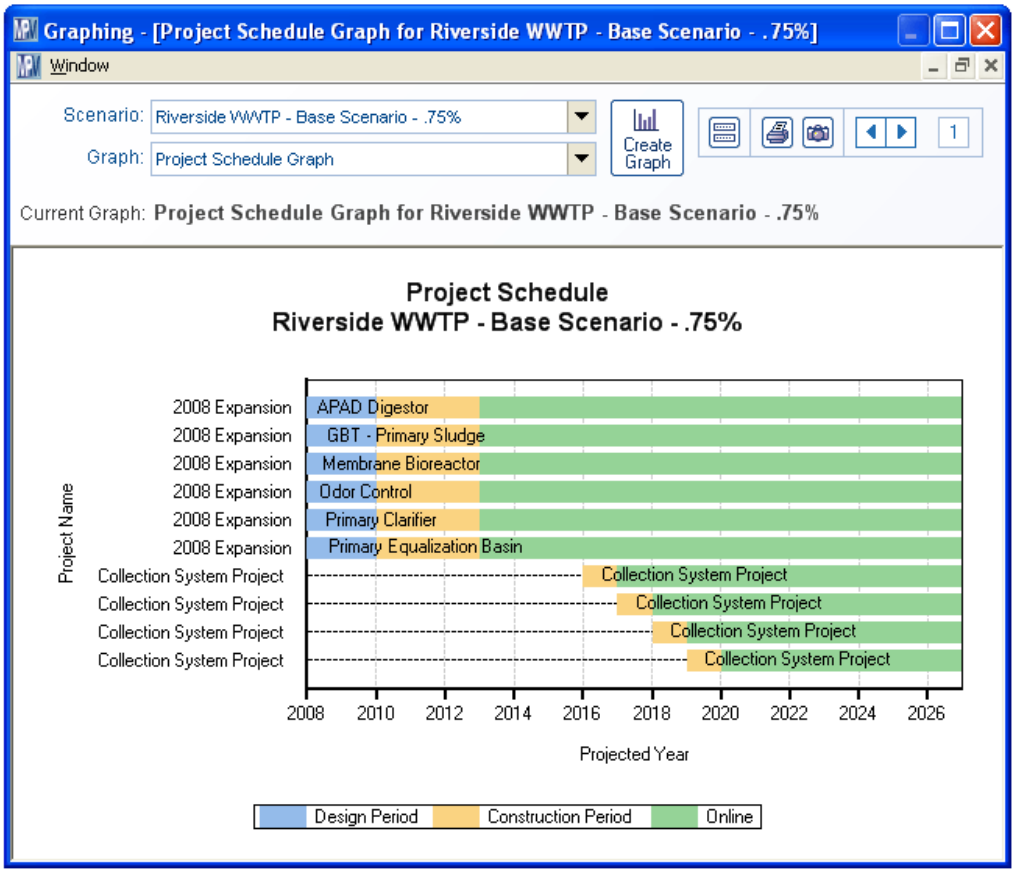
Click the printer button to print the graph

Save Graph Image

Click the camera button to save the graph to an image file.

Multi-Page Graphs

The Capacity Evaluation and Project Schedule graphs have multiple pages. To display each page, click the left and right page number arrows at the top of the graph window.


Graphing - [Project Schedule Graph for Riverside WWTP - Base Scenario - .75%]
Window
Scenario: Riverside WWTP - Base Scenario - .75%
Graph: Project Schedule Graph
Create Graph
Current Graph: Project Schedule Graph for Riverside WWTP - Base Scenario - .75%
Project Schedule
Riverside WWTP - Base Scenario - .75%
2008 Expansion APAD Digestor
2008 Expansion GBT - Primary Sludge
2008 Expansion Membrane Bioreactor
2008 Expansion Odor Control
2008 Expansion Primary Clarifier
2008 Expansion Primary Equalization Basin
Collection System Project Collection System Project
Collection System Project Collection System Project
Collection System Project Collection System Project
Collection System Project Collection System Project
Project Name
2008 2010 2012 2014 2016 2018 2020 2022 2024 2026
Projected Year
Design Period
Construction Period
Online

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 12: ASSET MANAGEMENT
CHAPTER 1: STRATEGIC VISION

FINAL
February 2008

10540 TALBERT AVENUE, SUITE 200 EAST • FOUNTAIN VALLEY, CALIFORNIA 92708 • (714) 593-5100 • FAX (714) 593-5101

City of Riverside

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Chapter 1

STRATEGIC VISION

1.1 PURPOSE

The purpose of this chapter is to describe and define the key components of asset management as they will be carried out in the Integrated Master Plan, and describe how the asset management data from the Maintenance Tactical Plan and the Integrated Master Plan can be integrated by the City of Riverside (City).

The City has developed a strategic vision for implementing asset management within their Regional Water Quality Control Plant (RWQCP). The City's stated goals, per the Maintenance Tactical Plan that was developed by the City in June of 2006, are to improve internal and external communication, improve infrastructure, increase the quality and quantity of reusable resources, and improve employee motivation, recognition, and opportunity for advancement. The intent of implementing asset management is to better support and achieve these goals in the vision and mission statements developed for the RWQCP. The City is therefore embarking on asset management, as both part of the Integrated Master Plan, as well as part of their Maintenance Tactical Plan.

1.2 CONCLUSIONS AND RECOMMENDATIONS

- The asset management component of the Integrated Master Plan will ensure that the proposed CIP includes existing facilities and supports the City's asset management initiative by providing initial data for SPL, a complete asset assessment/valuation database specifically designed for asset management, and a basic decision framework to more effectively manage the long term planning for the City's capital assets.

1.3 MAINTENANCE TACTICAL PLAN

The Maintenance Tactical Plan is intended to identify, focus, and optimize the RWQCP maintenance activities in pursuit of a proactive, rather than reactive, mode of operation, in order to support the asset management initiative. The goal is to focus on life cycle asset management, risk management, and capital equipment replacement. The Maintenance Tactical Plan will support asset management through a variety of avenues including the SPL Enterprise Asset and Work Management System, which involves the development of a Master Equipment List and subsequent data collection and population; availability of appropriate maintenance facilities, equipment, and tools; reorganization of maintenance (preventative, corrective, and predictive) planning and scheduling; more efficient purchasing and warehousing; training and qualification of maintenance personnel; and better control of maintenance activities.

1.4 ASSET MANAGEMENT IN THE INTEGRATED MASTER PLAN

The intent of the asset management component of the Integrated Master Plan is to provide repair/replacement recommendations for the existing facilities for the overall Capital Improvement Plan (CIP) that is produced as a result of the work completed in the Integrated Master Plan. This asset management component is also intended to support the asset management efforts undertaken as part of the Tactical Plan by providing initial asset data in the form of major asset inventory and classification, condition, and other assessment information including photographs, useful lives, and cost data. If desired, the City can use this information to populate their SPL system. Additionally, a preliminary decision framework will be established to select assets for inclusion of projects in the CIP. The specific asset management tasks within the Integrated Master Plan are as follows:

1. Define an asset.
2. Develop a major asset inventory and classification system.
3. Perform asset assessments on the identified major assets.
4. Develop replacement costs and other valuation data.
5. Populate all data in Carollo Engineer's (Carollo's) Water/Wastewater Asset Manager™ (WAM™) software application.
6. Develop specific recommendations for the CIP.

1.5 ASSET MANAGEMENT STRATEGY

There are several asset management definitions and components for both the Maintenance Tactical Plan and the Integrated Master Plan. Asset management involves defining an asset so an inventory may be created for an assessment that assigns condition values and collects data. Parameters developed from the assessment and estimated financial valuations are used to compile a CIP. Each component in this process is integral to the overall asset management strategy. This section describes the key definitions and components from both plans and how they may be integrated by the City.

Defining an "asset" determines the level at which the City's facilities will be managed. The Integrated Master Plan's "asset" is a major component and can be defined as a complete physical component of a facility that enables service to be provided, is critical to plant operation, and/or has a value greater than $25,000. Examples would include a pump, a major Electrical/Instrumentation and Controls (I&C) item such as a Motor Control Center (MCC) or flowmeters, a rapid mixer, or a Heating, Ventilation, and Air Conditioning (HVAC) system. It would not include a sample pump, valve actuator, or pump motor. This definition is fairly consistent with the SPL "assembly" level and is appropriate for managing capital assets. SPL further divides an "asset" into its respective components to effectively manage them at a maintenance and operations level.

The inventory component determines which items are major assets and is developed based on site layouts, flow schematics, existing knowledge of City facilities, and available SPL data from the City. Additions to the inventory are made based on assets identified in the field, and from Operations and Maintenance (O&M) staff knowledge. The inventory is classified based on processes within the facility. This inventory can be used to further develop and populate the asset list in SPL.

The asset assessments are used to develop specific parameters around which a framework can be developed and specific decisions can be made. These assessments involve data collection and the calculation of a variety of attributes, including condition and specific comments based on condition. These comments may include descriptions of corrosion, spalling, vibration, and noise; rankings for criticality, vulnerability, risk, and level of service; calculations for remaining useful life, evaluated remaining useful life, and economic remaining useful life; and documentation of installation year and original useful life. Digital photos taken of each asset also contribute to the assessment. Most of this data can be used to further populate SPL. WAM™ ranking systems can be converted to SPL ranking systems to make the data in the two different systems compatible and consistent.

The condition ranking system (1 to 5) in WAM™ is based on the percentage of the value of the asset that needs to be invested in order to return the asset to excellent condition. The condition rating within SPL can also be configured to be on a 1 to 5 scale and be based on the user-defined percentage of the asset that is new. This ability to configure the condition rating in SPL will allow for consistency with the ranking given in WAM™. Additionally, both WAM™ and SPL allow specific comments related to condition so the comment data within WAM™ can be easily transferred to SPL. Original useful lives are user defined in both WAM™ and SPL, which enables compatibility between the two systems. The remaining useful life is calculated using the same equation in both WAM™ and SPL to maintain consistency. Criticality in WAM™ is based on four components, for which each has been assigned a value, and the four values are added to develop one overall criticality score. SPL has four criticality ratings. The WAM™ scores can be divided into four groups, from low to high, and each grouping can be associated with one of the SPL ratings to ensure compatibility between the two applications.

Financial valuations are developed to accurately budget for the funds that will be required in the future, and to optimize decision making in terms of the tradeoffs between capital and O&M spending. Replacement value, repair cost, book value, annual and cumulative depreciation, evaluated value, current value, and estimated acquisition value are all developed as part of the asset management work within WAM™. Of these valuations, acquisition cost, book value, and cumulative depreciation are available within SPL and calculated in a similar manner to ensure consistency.

Based upon the assessment and financial information, a decision framework is developed in order to define parameters around which to make recommendations for the CIP. Assets with any or all of the following are included in the development of the CIP: high risk, poor

condition, low economic remaining useful life, and high cost. This component of the CIP will then be discussed with O&M staff to verify the validity for the inclusion of the assets.

City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 12: ASSET MANAGEMENT
CHAPTER 2: CONDITION ASSESSMENT

FINAL
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Chapter 2

CONDITION ASSESSMENT

2.1 PURPOSE

The purpose of this chapter is to describe the procedures that were undertaken to complete a condition assessment, and to present the resulting replacement and rehabilitation (R&R) recommendations of the key Regional Water Quality Control Plant (RWQCP) assets.

2.2 CONCLUSIONS AND RECOMMENDATIONS

The primary emphasis of the Asset Condition Assessment is to determine the condition of the aboveground assets at the RWQCP and to develop a list of potential R&R projects for the overall Capital Improvement Plan (CIP).

Recommendations related to these work elements are listed below:

- **Condition Assessment:**

  The RWQCP has been operating since the 1940s and main process components were built in each decade thereafter. Over the years, the plant has been well maintained; this fact is evident in the small number of Condition 4 and 5 assets identified during the assessment. Currently, the City of Riverside (City) is anticipating and making plans for the R&R needs of the Plant 1 primary clarifiers, the Plant 2 secondary clarifiers, and the reclaimed water pump station.

  To ensure accurate and timely identification of future R&R projects, it is recommended that condition assessments be conducted on a regular basis and that assts identified for the R&R projects be monitored and assessed prior to implementation of the project.

  Accordingly, it is recommended that assets in poor condition (Condition 4 or 5) be assessed annually, and a comprehensive assessment of all of the aboveground RWQCP assets be conducted every 3 to 5 years. New assets (installed within the past year) should be evaluated concurrent to the comprehensive assessment, to ensure that the required information (such as acquisition cost, manufacturer, and installation year) is correctly input into Water/Wastewater Asset Manager™ (WAM™).

  The assessments should be conducted by a team of individuals including O&M staff and engineering staff, and discipline specialists in electrical, mechanical, and structural engineering. Information collected during future condition assessments should mirror the work completed in this work. Digital photos of the assets should also be taken to document the existing condition of each asset.

- **Repair and Replacement Project Costs:**

  The condition assessment identified several R&R projects that are recommended for implementation within the next 10 years. Based on the information obtained in the condition assessment, 36 R&R projects have been identified for inclusion in the City's CIP. When reasonable, these R&R projects may be bundled with the planned projects from other sections of the master plan. Also, the R&R list may be modified according to the conclusions from other sections of the master plan. For example, it may be uneconomical to repair certain assets if the overall process is scheduled for replacement. Also, some of the assets on the R&R list are already on the plant's existing CIP. Currently, the assets from the primary clarification process are on both the existing list and the list from this report.

  It is recommended that the City confirm the estimated project costs during the course of the preliminary and/or final engineering that will precede implementation of any of the target R&R projects.

In support of the ongoing effort related to this Asset Management program, other recommendations developed during this effort are as follows:

- **Update of the Water/Wastewater Asset Manager™ Database:**

  In the future, it will be necessary to update the 2006 WAM™ database. For example, as new assets are added to the RWQCP through expansion and improvements, they will need to be included in the asset listing and corresponding R&R project list. It is recommended that updates of the WAM™ and associated changes to LOS goals be conducted every 5 years, coincident to the recommended 3-to 5-year comprehensive condition assessment.

WAM™ is a powerful and dynamic tool that can be used to easily identify assets that require attention. However, it is imperative that professional judgment be used when developing projects, as there are often factors that may influence projects that are not contained or cannot be captured within the WAM™ database.

2.3 BACKGROUND

A comprehensive condition assessment is critical to the City's vision for implementing asset management within the RWQCP. The condition assessment involves collection of data through review of existing reports, plans, bid tabulations and databases for the existing facilities at the RWQCP; interviews with RWQCP staff; and field inspections of key aboveground assets. Condition data and estimated replacement costs are then compiled into an electronic database using a computer-based asset management tool known as the Carollo Engineers (Carollo) WAM^{TM}, which is able to organize the data to develop a list of potential R&R projects for the RWQCP's existing assets. The results of this condition

assessment are detailed in this chapter and will be used in conjunction with the results from subsequent Master Plan tasks to develop the overall CIP.

The overall objective of the condition assessment is to meet the goals developed in Volume 12, Chapter 1 - Strategic Vision by creating an updated asset inventory, evaluating the aboveground assets, estimating appropriate replacement costs for each asset, and developing prioritized R&R recommendations of key RWQCP assets. This process includes gaining a thorough understanding of each asset's condition, risk, criticality, vulnerability, remaining useful life, and associated costs.

2.4 EXISTING FACILITY DESCRIPTION

The RWQCP serves the City of Riverside and several outlying communities. The plant became regional in 1978 when service was extended to the communities of Jurupa and Rubidoux. The RWQCP has a current sustained treatment capacity of 40 mgd (annual average flow) with a peak hydraulic capacity of 88 mgd. Flows through the plant are divided between two treatment trains, including Plant 1 (20 mgd) and Plant 2 (20 mgd). Each plant is equipped with aeration and sedimentation basins. Secondary effluent is combined downstream of the two plants before filtration. Filtration at the RWQCP consists of 16 dual media filters operating in parallel. Filtered effluent flows to Chlorine Contact Basins 1 and 3 and subsequently to the Santa Ana River. A site plan of the existing treatment facilities at the RWQCP is shown on Figure 2.1.

2.5 PROJECT APPROACH

2.5.1 Methodology Overview

The following is a brief overview of the methodology implemented for the condition assessment.

1. **Asset Management Visioning Workshop:**

   A Visioning Workshop was held with the City to determine the City's vision and guidelines for asset management, and to demonstrate how the WAM™ data could be integrated into the City's current SPL system.

2. **Asset Definition and Inventory Development:**

   An "asset" was defined and an inventory, or list, of the assets of the RWQCP was developed and classified by treatment process through a review of plant documents provided by the RWQCP and input from Operations and Maintenance (O&M) staff. An "asset" was defined as a complete physical component of a facility that enables service to be provided, is critical to plant operation, and/or has a value greater than $25,000.

KEY

1. Headworks
2. Biofilter
3. Primary Sedimentation Basins for Plant 1
4. Primary Sedimentation Basins for Plant 2
5. Secondary Sedimentation Basins - Plant 1 (Abandoned)
6. Secondary Sedimentation Basins - Plant 2
7. Chlorine Contact Basins
8. Chlorine Injection Structure (Abandoned)
9. Waste Backwash Lagoons
10. Tertiary Filters
11. Dissolved Air Flotation Thickeners
12. Digesters
13. Sludge Hopper Building
14. Caustic Soda Feed Pump Station (Abandoned)
15. Combined Aeration Basin Distribution Structure
16. Maintenance/Storage Building
17. Pump Station
18. RAS Distribution Structure
19. Primary Effluent Distribution Structure
20. Equalization Distribution Structure
21. Distribution Structure
22. Trickling Filter Effluent Metering Structure
23. Solids Metering Structure
24. Final Effluent Metering Structure
25. Dewatering Flow Metering and Sampling Structure
26. Distribution Box 2 (Abandoned)
27. Junction Box
28. Grit Storage (Abandoned)
29. Junction Structure
30. Parshall Flume
31. Transformer
32. Electrical Pad
33. Motor Control Center, Operations Lab and Pump Station
34. Boiler 1 and Pump Station 9
35. Dechlorination Building
36. Digester Control Building and Pump Station
37. Digester Control Building
38. New Blower Building
39. Sewer Line Maintenance Building
40. Bioassay Studies Building
41. Office Maintenance Building
42. Landscape Maintenance Storage Building
43. Indian Rocks Reserve Area
44. Storage
45. Sampling Station
46. Equalization Ponds
47. Aeration Basins Plant 2
48. Aeration Basins Plant 1
49. Secondary Sedimentation Basin, Plant 1
50. Cogeneration
51. Belt Press Building
52. Storage/Electrical Shop
53. Maintenance Building
54. Chemical Building
55. Backwash Storage Tank
56. Lab/Administration Building
57. Old Administration Building

Legend

- Headworks
- Primary Treatment Facilities
- Secondary Treatment Facilities
- Tertiary Treatment Facilities
- Disinfection
- Equalization Ponds
- Solids Handling Facilities
- Cogeneration Building
- Waste Lagoons
- Supporting Facilities

EXISTING SITE PLAN

FIGURE 2.1

carollo
Engineers...Working Wonders With Water™

20-Riverside2-08\Volume 1\2-F2.1-7472A00.cdr

3. **Software Customization:**

   Following development of the asset inventory, the WAM™ software tool was customized with an asset "tree" specific to the assets identified at the RWQCP.

4. **Asset Condition Assessment Approach:**

   This task included determination of the asset evaluation and condition ranking approach used during field inspection. Specific guidelines and condition ranking scales were developed for aboveground assets (including visual elements of belowground vaults) assets. The task also included establishment of an approach for determination of asset vulnerability, criticality, and risk.

5. **Facility Condition Assessment:**

   During this task information, risk, and condition data for each asset was collected, quantified, documented, and photographed through a field inspection. A Carollo team guided by a RWQCP staff member conducted the field inspection. The Carollo team included process, structural, mechanical, electrical, and instrumentation and control discipline specialists.

6. **Replacement Cost Development and Rationale:**

   Replacement cost data was developed for each asset. Estimates were developed based on information obtained from cost curves, recent bid tabulations, and recent Carollo asset management work conducted for other agencies. The level of accuracy of the cost estimates is consistent with that needed to make planning level decisions and other cost estimates throughout the Master Plan. The replacement cost data reflects total project costs including general conditions, contractor overhead and profit, engineering and legal, and a design contingency.

7. **Software Population:**

   Data collected during the facility inspection and replacement cost development tasks was entered into the customized WAM™ database.

8. **Development of Potential Repair and Replacement Projects:**

   Following data population, WAM™ was used to develop five separate lists of potential R&R projects. These lists were based on five different criteria: asset condition, risk, repair cost, evaluated remaining useful life, and economic remaining useful life. Based on specific criteria, key projects from each list were used to develop a single list of R&R projects. The developed list will be used in conjunction with the results from subsequent Master Plan tasks to develop a CIP for the RWQCP.

2.5.2 Condition Assessment

The condition assessment included a field evaluation of key assets by a multi-discipline engineering team licensed and experienced in the areas of civil/sanitary engineering, mechanical engineering, structural engineering, and electrical/instrumentation engineering.

The assessment team visited the RWQCP, inspected the major assets, and interviewed O&M personnel regarding the operation and maintenance history of the major facilities and assets.

The information gathered during the condition assessment provides a standardized record of the asset condition specific to each discipline. Data collected for each asset included, condition, installation year, and discipline specific data as applicable. In addition, other relevant information, such as recent performance history, and design and sizing criteria was gathered where available, and the existing condition of all assets was documented with digital photos. To standardize the process of determining an asset's condition, specific discipline-related questions were answered for each asset. Sample field sheets and discipline questions are presented in Appendix A. The assessment also included assigning criticality and vulnerability to each major asset, as well as useful life. Data from the assessment was organized for entry into the WAM™ database.

2.6 CONDITION ASSESSMENT RESULTS

2.6.1 Water/Wastewater Asset Manager™ Reports

Using the filtering capabilities for the selected criteria in the WAM™ software package, condition assessment data was translated into potential repair and rehabilitation projects. The main purpose behind generating the report was to better understand and determine true project needs at the plant. In addition, separate reports were created to prioritize the data for each criterion. The following sections detail each of the assessment data reports that were generated using the WAM™ software package. These reports/criterion are intended for use in prioritizing potential R&R projects at the plant. WAM™ reports were created for each of the following:

- Asset condition ranking.
- Asset risk.
- Economic remaining useful life.
- Evaluated remaining useful life.
- Asset replacement and repair cost.
- Summary report of assets that meet the five criteria listed above.

A photo of each asset is included in the WAM™ database. An electronic copy of the WAM™ software, specifically tailored to the RWQCP, will be provided separately to the City with this report.

2.6.1.1 Asset Condition

The ranking scale used in the condition assessment of each asset is shown in Table 2.1. Each asset was assigned a condition value based on the percentage of the value of the asset that was required to return each asset to essentially new condition (i.e., restored to original physical condition, useful life, etc.). This scale is an internationally accepted, industry-wide standard for designating asset condition. The condition ranking is related to the percentage of the value of an asset needed to repair/rehabilitate the asset to return it to its original condition. In the case where an asset was not accessible or was non-existent in the field, a ranking of 0 was assigned.

Table 2.1 Asset Condition Ranking Scale[(1)(2)]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Ranking	Description	Percentage of Asset Requiring Repair[(2)]
0	Non-Existent/Not Assessed	N/A
1	Very Good Condition	0%
2	Minor Defects	5%
3	Maintenance Required to Return to Accepted Level of Service	10 to 20%
4	Requires Rehabilitation	20 to 40%
5	Asset Unserviceable	>50%

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) "Percentage of asset requiring repair" is that percentage of the value of the asset needed to return the asset to a condition ranking of 1.

The repair percentages associated with each condition ranking are used to calculate the evaluated remaining useful life, evaluated value, and the necessary repair/rehabilitation costs to return the component to its original condition.

Each major asset (including junction and distribution boxes) was divided into three disciplines (as appropriate) and each discipline was assessed individually. The three disciplines were:

1. Mechanical/Electrical/Instrumentation/Piping.
2. Structural/Architectural.
3. Civil/Site Work.

Members of the field condition assessment team separately assigned a condition ranking for each discipline. The discipline-specific condition rankings were then compiled into the WAM™ software package and averaged by the software into one overall component condition ranking based on a cost-weighted basis.

Appendix B lists the assets that received the lowest overall condition rankings (i.e., assets in greatest need of replacement or rehabilitation based on condition). All assets with a condition ranking greater than 3 are included in the list, as assets with a condition greater than 3 are in fair to poor condition. The listing is sorted first by condition and then by risk. Condition assessment information for each asset at the RWQCP is included in the WAM™ database. For comparison, Figure 2.2 indicates the number of assets that received each condition ranking score.

2.6.1.2 Level of Service

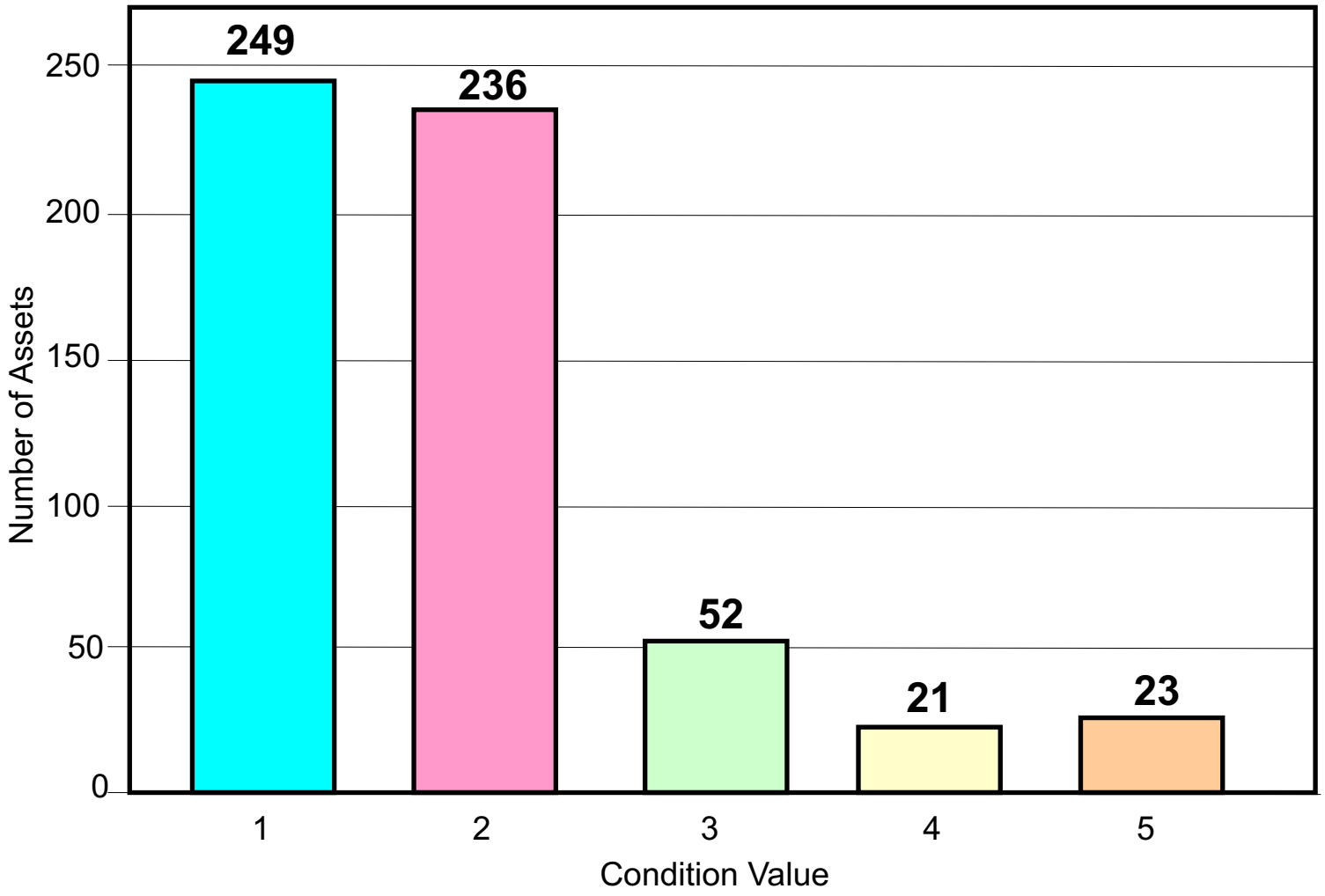
Level of Service (LOS) defines the target condition value desired for each asset. The ranking scale used to assign a LOS to each asset is the same as the condition scale shown in Table 2.1. Ideally, all assets would be a Condition/LOS of 1. Realistically, it is uneconomical to maintain all plant assets at a condition ranking of 1. Based on the City's internal goals for wastewater treatment, each asset was assigned a target LOS value of 2 (equivalent to an asset condition of 2; good condition). Although there are no specific reliability goals associated with the LOS rankings, an LOS value of 2 is considered reasonable for the City to meet its goals for wastewater treatment (i.e., if assets meet the LOS value of 2, and are therefore in good condition, it is expected that the City will meet its service goals).

The condition assessment was used to quantify any differences between the baseline level of service value and the current condition of each asset. If the current condition of the asset does not meet the designated LOS value, repairs will need to be made to improve the asset condition to meet the LOS goal. However, LOS goals for the assets can be modified based on the City's knowledge of the operations goals and maintenance history of individual assets. For example, if an asset will be replaced in the near future, the City may decide to decrease the LOS value for the existing asset. This would allow the condition of the existing asset to decrease slightly before it is replaced with a new asset, while preventing the expenditure of funds needed to maintain the existing asset in good condition (to meet the assigned LOS goal of 2). LOS is used to develop the repair costs in the WAM™ report.

2.6.1.3 Criticality

Criticality is defined as the relative overall consequence of asset failure. Criticality incorporates four main categories:

1. Public Health and Safety.
2. Effect on Customers.
3. Environmental Impacts.
4. Cost of Repair.



ASSESSMENTS RESULTS

FIGURE 2.2

Table 2.2 shows the criticality ranking scale used in the condition assessment of each asset. The criticality scoring for an asset (the sum of the individual categories) ranges from a possible high of 39 points (highly critical) to a possible low of 2 points (not critical). As can be seen in the table, each category is weighted differently; the categories with the highest criticality factors are Public Health and Safety and Environmental Impacts (ability to meet permit) because these two categories have the highest potential consequence, should an asset failure occur. Criticality is one of the two factors used to determine asset risk.

Table 2.2 Criticality Ranking Scale[(1)(2)]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Criticality Factor Description	Ranking
Public Health and Safety	
Multiple illness or injury	15
Illness of injury due to seasonal effects	10
Single illness or injury	5
No effect	0
Effect on Customers	
Major or repeat occurrence	8
Minor	4
No effect	0
Environmental Impacts	
Major	10
Minor	5
No effect	0
Cost of Repair	
More than $20,000	6
Between $5,000 and $20,000	4
Less than $5,000	2

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) An overall criticality is developed by summing the rankings of the four categories.

2.6.1.4 Vulnerability

Vulnerability is the probability or likelihood of asset failure. Failure can occur from physical failure, performance failure, or technological obsolescence. The vulnerability of an asset is inversely proportional to the evaluated remaining useful life, which is determined as part of the condition assessment. Table 2.3 presents the probability of failure associated with the vulnerability failure timeframe. Vulnerability is the second factor used to determine asset risk.

Table 2.3 Vulnerability Scale[1] Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Failure Timeframe	**Probability[2]**
1 year	0.9
2 years	0.7
3 years	0.4
4 to 5 years	0.2
6 to 10 years	0.1
11 to 20 years	0.05
21 to 50 years	0.02
51 to 100 years	0.01

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) Probability of failure within the first year of the failure timeframe.

2.6.1.5 Asset Risk

Risk is the mathematical product of the criticality score and the vulnerability probability. Risk is a relative number used to identify the assets, which have a high probability and/or consequence related to their failure to meet prescribed level of service goals. The equation used to determine the risk associated with an asset is as follows:

Risk = Criticality x Vulnerability

Risk provides information crucial to making more informed management decisions. For example, decisions must differentiate need and priority between replacing an asset with a high-risk value, or alternatively, choosing to implement an ongoing repair or maintenance strategy in lieu of replacement. Generally, assets with a high risk score should be higher on the priority list for capital improvements; however, there may be exceptions to this general rule. Table C.1 in Appendix C lists the top ranked assets that received the greatest risk scores at the RWQCP. For this report, the Appendix includes assets with a risk of 1.26 and greater. This cutoff was made based on the R&R rationale as outlined in Section 2.4.1.11. The risk assessment for every asset at the RWQCP is included in the WAM™ database.

2.6.1.6 Original and Remaining Useful Life

Original Useful Life is the number of years an asset is expected to be in service as a function of asset type (i.e., mechanical, structural, electrical, instrumentation and control) and Remaining Useful Life is the original useful life less the number of years an asset has been in service. Original useful life is used to develop the evaluated remaining useful life and economic remaining useful life. The original useful life values for different types of assets are presented in Table 2.4.

Table 2.4 Original Useful Life per Asset Type Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside	
Asset Type	**Original Useful Life**
Mechanical	20 years
Structural	50 years
Electrical	30 years
Instrumentation	15 years

Notes:
(1) The biofilters were assigned an original useful life of 10 years.
(2) Exceptions such as the one for the biofilters are made on a case-by-case basis.

2.6.1.7 Evaluated Remaining Useful Life

Evaluated Remaining Useful Life (ERUL) is based on the current condition of the asset and is the estimated remaining number of years until the physical failure of the asset. ERUL is often used in conjunction with Remaining Useful Life to better understand project needs. ERUL differs from remaining useful life because it incorporates the asset condition ranking. For example, the original useful life for structural components is listed as 50 years. If that asset is 49 years old, the remaining useful life will be only 1 year. However, in reality, if that asset is still in excellent condition, the "true" remaining life will be much more than 1 year.

ERUL is one method used to take into account the existing condition and ongoing maintenance work on the asset. WAM™ calculates the ERUL for each asset. The table in Appendix D lists the assets at the RWQCP with the lowest ERUL. These assets have an ERUL of less than 16 years; the cutoff point was selected according to the criteria stated in Section 2.4.1.11. The evaluated remaining useful life of every asset is included in the WAM™ database.

2.6.1.8 Economic Remaining Useful Life

The economic remaining useful life of an asset is the estimated period between the date of the condition assessment and the time when the asset degrades to a condition where repairing the asset ceases to be cost effective. It is important to keep in mind that the economic remaining useful life is only an estimate of the feasible operating period of an asset. Factors such as the operating environment, maintenance schedule, and other extraneous variables will influence the actual economic remaining useful life. For example, the economic remaining useful life of a newly purchased pump is equal to 20 years; however, the economic remaining useful life may continue to be 20 years, even several years after purchase if the pump is well maintained and run under low-stress conditions. Ultimately, if the pump continues to be well maintained, it may be feasible to run it for more than 20 years. The table in Appendix E lists assets with the lowest economic remaining useful life. The cutoff for the table in Appendix E is 6 years and less. This cutoff was based on the criteria stated in Section 2.3.1.11. The WAM™ database contains the economic remaining useful life data for all assets.

2.6.1.9 Replacement Value

For this project, replacement value is defined as the cost to replace the asset with a similar piece of equipment in August 2006 dollars.

Replacement costs were developed for each of the key assets at the RWQCP based on Carollo's experience with infrastructure costs at similar wastewater facilities. Ultimate project costs at the time of construction are dependent on actual labor and material costs, actual site conditions, competitive market conditions, final project scope, final project schedule, and other factors. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

The level of accuracy for construction cost estimates varies depending on the level of detail to which the project has been defined. Feasibility studies and master plans represent the lowest level of accuracy, while pre-bid estimates (based on detailed plans and specifications) represent a higher level. The American Association of Cost Engineers has developed the following guidelines for developing project cost estimates:

Type of Estimate	Anticipated Accuracy
Order-of-Magnitude (Master Plans)	+50% to -30%
Budget Estimate (Pre-design Report)	+30% to -15%
Budget Estimate (Pre-design Report)	+15% to -5%

The opinions of cost presented in this report should be considered order-of-magnitude estimates, with an anticipated level of accuracy of +50 to -30 percent. The cost opinions for each of the listed assets represent August 2006 dollars consistent with the 20-city Engineering News-Record (ENR) value of 7723. Location factors were used to adjust the costs to the Los Angeles region, so the dollars are also consistent with the Los Angeles ENR value of 8570.

Base construction costs were adjusted to develop total project costs, and included the following:

- Contingency of 30 percent. This contingency represents undeveloped or unforeseen design details at the planning stage (i.e., master plans). Design for additional or required process equipment and structures that are known, but not yet defined, were also included. Costs for the maintenance or operations during construction were not included.
- General conditions estimate of 10 percent. This value includes all items contained within Division 01 of most project specifications including: mobilization/demobilization, contractor temporary facilities, contractor's field supervision, and bonds and insurance.
- Contractor overhead and profit of 15 percent. This value includes general contractor home office overheads and profit.

- Sales tax of 7.75 percent on 50 percent of the total direct cost plus the order of magnitude contingency.
- Bid market allowance of 15 percent. This value includes costs due to the volatile nature of the current bidding market throughout the United States and especially California.
- Engineering, Legal, Administrative, and Construction management costs (ELAC) of 30 percent. Legal and administrative costs reflect assistance with permitting and financing.

The costs developed herein are based on estimated total project costs, including all costs that may be required to complete the replacement project. Therefore, each cost was calculated as the sum of the construction, general conditions, contractor's costs, bid market allowance, sales tax, and ELAC. It is recognized that, depending on the project, total project costs may include items such as repaving or relocation of utilities. Such additional costs are difficult to predict in the absence of detailed engineering information. However, based on Carollo's experience, the presented planning level contingencies generally cover added cost elements such that the total project costs (i.e., the asset "replacement value") used to predict future expenditures are reflective of actual project costs. It is recommended that the RWQCP revise any estimated total project costs during the course of preliminary and/or final engineering projects that will precede implementation of any of the projects.

2.6.1.10 Repair Costs

Repair costs are defined as the cost required to return an asset to a specified level of service, in this case a LOS of 2. Repair costs were estimated by WAM™ as a percentage of the replacement cost based on the assessed condition. In the case of assets with a condition of 5, repair costs are equivalent to replacement costs. It should be noted that the developed repair costs represent relative numbers useful for prioritizing R&R projects. These costs are not intended to directly correlate to potential alternatives related to each asset. In some cases, it may be more practical not to repair specific assets, but rather to replace them when their various remaining useful lives expire. For these reasons, the repair costs identified herein for each asset should be revisited prior to implementing repair projects. Table F.1 in Appendix F lists the top ranked assets with the greatest repair cost evaluated as part of the condition assessment. Cost information for every asset at the RWQCP is included in the WAM™ database.

2.6.1.11 Repair and Replacement Rationale

The goal of creating the different tables was to bring attention to assets according to varying criteria. The cutoff points for each asset table were based on past experience and the current framework of this 20-year master plan. Accordingly, this report looks at R&R greater than $25,000 for the Repair Cost table and ERULs of less than 20 years for the ERUL table. It is assumed that most repair costs less than $25,000 will be covered by the

plant's annual maintenance budget. Since assets with an ERUL between 16 and 20 years were either Condition 2 or 3, and only assets with Condition 3.8 or greater are included in the Condition table), the ERUL table in Appendix D only includes assets with an ERUL of 16 years and less.

The remaining economic useful life table in Appendix F has a cutoff of 6 years and less. This cutoff captures the most critical assets (Conditions 4 and 5). Almost all assets with a greater economic remaining useful life have a condition ranking of 3 or better. The few Condition 4 assets above the 6-year threshold are included in the condition-ranking table, in Appendix B.

For the risk table in Appendix C, the cutoff is 1.26 and this number is based roughly on a criticality greater than 20 (moderate criticality) and an ERUL of less than 15 years (vulnerability = 1/ERUL). The ERUL of 15 years fits within the timeframe of the master plan and the criticality of 20 is a median value within the criticality range. It is expected that most assets below the 1.26 value have a low consequence and probability related to failure.

The final R&R list will have exceptions to the individual table cutoffs. For example, an asset with a high repair cost could also have a high ERUL. The high repair cost would warrant the asset's placement on the final list even though the ERUL is greater than 20 years. The final R&R list will have exceptions to the individual table cutoffs. For example, an asset with a high repair cost could also have a high ERUL. The high repair cost would warrant the asset's placement on the final list even though the ERUL is greater than 20 years. Conversely, an asset with a high risk rating but a low (good) condition rating may not be placed on the final list, even though the risk rating is high. Professional judgment may indicate that because of the good condition rating, it is not appropriate to place the asset on the list. However, it is suggested that in cases of exceptions, those assets should be carefully monitored.

WAM™ was used to filter and create the initial R&R list based on the above criteria. The reports based on the individual criterion were used to fine-tune the WAM™ generated R&R list. Based on professional judgment the WAM™ generated list was supplemented with items from the individual reports. The final R&R list is a combination of the initial WAM™ generated list and these additional items. This final list will aid the City in making economic planning decisions related to plant maintenance and operation, as well as capital decisions.

2.7 REPAIR AND REPLACEMENT PROJECT LIST

A list of potential R&R projects is detailed in Tables 2.5 and 2.6. Explanations for each R&R project are detailed in Table 2.7. Table 2.5 is a list of the assets compiled from the WAM™ program using the criteria discussed in Section 2.4.1.11, and Table 2.6 includes additional assets that were included based on professional judgment. The items in Table 2.7 have mechanical components that are in very poor condition. Since the structural components of these items are in good condition, they have a cost weighted condition ranking below the

cutoff value of 3. It was necessary to add these items to the R&R list because the mechanical components need rehabilitation or replacement. The total repair cost for the items in Table 2.5 is $14,093,000 and the total repair cost for the items in Table 2.6 is $2,446,000. The overall total repair cost is $16,539,000. Repair costs are only planning level estimates (anticipated accuracy of +50% to -30%), and specific repair costs should be more closely examined prior to implementation of a project.

Items can either be added or removed form the list in accordance to plant needs and expectations. This list is conditional and the final version will include input from RWQCP staff members. Once the City approves the list, it will be used in conjunction with subsequent Integrated Master Plan tasks to develop the overall CIP.

Tables 2.5, 2.6, and 2.7 show the recommended items for the final R&R list and their explanations. Although the primary goal of the assessment was to document the condition of the plant's assets and recommend the most critical for the R&R list, a few additional issues were documented during the assessment. These issues are related to the following:

- Tertiary - Influent Pump 1 (Filters 1-10).
- Tertiary - Influent Pump 2 (Filters 1-10).
- Tertiary - Influent Pump 3 (Filters 1-10).
- Old Administration Building.

The tertiary influent pumps are ranked a Condition 3. Although this ranking does not warrant the inclusion of these items with the other items in the R&R list, it is necessary to closely watch these items since they have a risk value of 1.26. Currently, some parts of the pumps are corroded and some of the seals are leaking. If proper maintenance is not performed, repair costs could escalate and equipment failure could occur. Consequently, these pumps have the potential of costing the plant a considerable amount of money if they are not closely monitored. The old administration building is also ranked a Condition 3. Even though the building is in relatively good condition, seismic bracing is required. Retrofitting the building with seismic upgrades has the potential of being a costly item, and therefore, the City might want to plan for the eventual upgrade of this structure.

Table 2.5 Preliminary List of Repair and Replacement Projects
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition[3]	Risk	Criticality	Replacement Value	Repair Cost[2][4]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
2	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
3	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
4	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
5	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
6	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
7	Electrical	Switchgear M (Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0
8	Electrical	Switchgear W (Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0
9	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0
10	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
11	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
12	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0
13	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
14	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
15	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
16	Primary	Primary Clarifier Structure Plant 1A	5	0.99	25	$1,745,000	$1,745,000	50	25	0
17	Primary	Primary Clarifier Structure Plant 1B	5	0.99	25	$1,818,000	$1,818,000	50	25	0

Table 2.5 Preliminary List of Repair and Replacement Projects
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition[3]	Risk	Criticality	Replacement Value	Repair Cost[2][4]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
18	Water Recycle	VFD for Recycle Pump 1	5	0.93	14	$73,000	$73,000	30	15	0
19	Primary	Pump Station 14	5	0.79	20	$198,000	$198,000	50	25	0
20	Primary	Distribution Box (Plant 1)	5	0.71	18	$147,000	$147,000	50	25	0
21	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
22	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
23	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
24	Water Recycle	Water Recycle Pump 6	4	1.01	14	$191,000	$50,000	20	14	4
25	Digestion	Pump Station 1	4	0.57	20	$233,000	$61,000	50	35	10
26	Buildings	Headquarters for Sewer Line Maintenance	4	0.17	6	$1,209,000	$318,000	50	35	10
						Total Repair Cost	**$14,093,000**			

Notes:
(1) Because of Title 22 requirements, all pumps will be replaced and relocated to Chlorine Contact Basin 2.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal and construction fees.
(3) Condition rankings are a cost weighted average of discipline-specific condition rankings, and where applicable the mechanical and structural rankings are shown in parentheses by an M or S, respectively.
(4) The overall total repair cost for the items in both Tables 2.5 and 2.6 is $16,539,000.

Table 2.6 Preliminary List of Repair and Replacement Projects - Additional Items
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition[3]	Risk	Criticality	Replacement Value	Repair Cost[2][4]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
27	Cogeneration	Cooling Tower (Gas Treatment Area)	3.8 (M - 4, S -1)	0.76	13	$299,000	$73,000	22.7	17	6
28	Digestion	Anaerobic Digester 4	2.6 (M - 4, S - 2)	0.40	16	$10,907,000	$832,000	43.1	40	18
29	Aeration	Blower Building 2	2.4 (M - 4, S - 2)	0.35	15	$3,413,000	$145,000	46.3	43	20
30	Primary	Primary Clarifier 2 (Plant 2)	2.4 (M - 5, S - 1)	0.58	25	$2,310,000	$303,000	45	43	21
31	Primary	Primary Clarifier 4 (Plant 2)	2.4 (M - 5, S - 1)	0.58	25	$2,310,000	$303,000	45	43	21
32	Disinfection	Chlorine Contact Basin 1	2.3 (M - 5, S - 2)	0.57	26	$1,526,000	$77,000	48.2	45	21
33	Equalization	Junction Box 9	2.3 (M - 5, S - 1)	0.41	18	$494,000	$56,000	45.7	44	22
34	Secondary	Clarifier 3 (Plant 2)	2.2 (M - 4, S - 1)	0.59	25	$2,533,000	$185,000	43.7	42	21
35	Secondary	Clarifier 2 (Plant 2)	2.1 (M - 4, S - 1)	0.58	25	$3,573,000	$236,000	44.3	43	21
36	Secondary	Clarifier 1 (Plant 2)	2.1 (M - 4, S - 1)	0.58	25	$3,573,000	$236,000	44.3	43	21
						Total Repair Cost	**$2,446,000**			

Notes:
(1) Because of Title 22 requirements, all pumps will be replaced and relocated to Chlorine Contact Basin 2.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal and construction fees.
(3) Condition rankings are a cost weighted average of discipline-specific condition rankings, and where applicable the mechanical and structural rankings are shown in parentheses by an M or S, respectively.
(4) The overall total repair cost for the items in both Tables 2.5 and 2.6 is $16,539,000.

Table 2.7 Preliminary List of Repair and Replacement Projects - Explanations
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Explanation
1	Primary	Primary Clarifier 5 (Plant 1A)	The clarifiers are outdated, in poor condition, and need to be replaced.
2	Primary	Primary Clarifier 6 (Plant 1A)	The clarifiers are outdated, in poor condition, and need to be replaced.
3	Primary	Primary Clarifier 7 (Plant 1A)	The clarifiers are outdated, in poor condition, and need to be replaced.
4	Primary	Primary Clarifier 8 (Plant 1A)	The clarifiers are outdated, in poor condition, and need to be replaced.
5	Primary	Primary Clarifier 9 (Plant 1B)	The clarifiers are outdated, in poor condition, and need to be replaced.
6	Primary	Primary Clarifier 10 (Plant 1B)	The clarifiers are outdated, in poor condition, and need to be replaced.
7	Electrical	Switchgear M (Plant 2)	The switchgear appears corroded and is over 25 years old.
8	Electrical	Switchgear W (Plant 2)	The switchgear appears corroded and is over 25 years old.
9	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	This MCC unit is scheduled for replacement with the Plant 1 primary clarifiers.
10	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	This MCC unit is scheduled for replacement with the Plant 1 primary clarifiers.
11	Primary	Sludge Pump 5	These pumps are old and will be replaced with the Plant 1 clarifiers.
12	Primary	Sludge Pump 6	These pumps are old and will be replaced with the Plant 1 clarifiers.
13	Primary	Sludge Pump 7	These pumps are old and will be replaced with the Plant 1 clarifiers.
14	Primary	Sludge Pump 8	These pumps are old and will be replaced with the Plant 1 clarifiers.
15	Primary	Sludge Pump 9	These pumps are old and will be replaced with the Plant 1 clarifiers.
16	Primary	Primary Clarifier Structure Plant 1A	The structure has concrete spalling, corroded structural elements, and is scheduled for replacement.

Table 2.7 Preliminary List of Repair and Replacement Projects - Explanations
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Explanation
17	Primary	Primary Clarifier Structure Plant 1B	The structure has concrete spalling, corroded structural elements, and is scheduled for replacement.
18	Water Recycle	VFD for Recycle Pump 1	This unit needs to be replaced.
19	Primary	Pump Station 14	The structure has concrete spalling, excessive corrosion, and is scheduled for replacement.
20	Primary	Distribution Box (Plant 1)	The structure has excessive spalling from corrosion.
21	Digestion	Waste Gas Burner	The exposed structural elements are corroded
22	Headworks	Biofilter 1	The media needs to be replaced.
23	Headworks	Biofilter 2	The media needs to be replaced.
24	Water Recycle(1)	Water Recycle Pump 6	The pump needs to be rebuilt because of excessive corrosion and a seal failure.
25	Digestion	Pump Station 1	The structure most likely requires a seismic retrofit.
26	Buildings	Headquarters for Sewer Line Maintenance	The tile roof is in need of repair, a seismic retrofit is required, and two trusses do not have wall anchorages.
27	Cogeneration	Cooling Tower (Gas Treatment Area)	The media needs replacement and the tower is leaking
28	Digestion	Anaerobic Digester 4	The mechanical elements of the asset are in fair to poor condition. The digester is leaking because the seal is in poor condition and a conduit is needed for wiring.
29	Aeration	Blower Building 2	Better ventilation is needed. The pipes and ducting are very corroded. The interior wall is not braced.

Table 2.7 Preliminary List of Repair and Replacement Projects - Explanations
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Explanation
30	Primary	Primary Clarifier 2 (Plant 2)	The bridge needs to be repainted and the feedwells are sagging.
31	Primary	Primary Clarifier 4 (Plant 2)	The bridge needs to be repainted and the feedwells are sagging.
32	Disinfection	Chlorine Contact Basin 1	The mechanical elements of the asset are in fair to poor condition. The gates do not work, the ladder needs replacement, and some instruments need replacement.
33	Equalization	Junction Box 9	The box has been temporarily “repaired” to pull electricity from another box.
34	Secondary	Clarifier 3 (Plant 2)	The mechanical elements of the asset are in fair to poor condition. The drive mechanism and feedwell need rehabilitation. The weir stiffeners are severely corroded.
35	Secondary	Clarifier 2 (Plant 2)	The mechanical elements of the asset are in fair to poor condition. New stiffeners are needed, the skim bar is bent, and the center well needs repair.
36	Secondary	Clarifier 1 (Plant 2)	The weir stiffeners are corroded.

Notes:
(1) Because of Title 22 requirements, all pumps will be replaced and relocated to Chlorine Contact Basin 2.

Appendix A

SAMPLE FIELD SHEETS

Facility / System Condition Assessment Form

Facility / System:	Treatment Plant	Current Year	
Process / Basin / Zone:	Sample Process	Current ENR	
Component / Subbasin / Subzone:	Sample Component		
Discipline:	Structural / Architectural		

Main Tab

Level of Service *	1	2	3	4	5	0			
Criticality									
Public Health & Safety	Multiple		Single		Seasonal		No Effect		
Environmental	Major			Minor			No Effect		
Cost of Repair	>$20			$5-$20			<$5		
Effect on Customers	Major			Minor			No Effect		
Vulnerability	1	2	3	5	10	20	50	100	150
Condition *	1		2		3		4	5	0

Annual Maintenance Cost
Installation Year
Original Useful Life
Date of Inspection
Assessed By
Photo #
Acquisition Cost
Replacement Value
Salvage Value

Component Information Tab

ID Number

Manufacturer/Model (nameplate info)

Comments

Spalling concrete?	Yes	No	N/A
Excessive corrosion to structure?	Yes	No	N/A
Excessive corrosion to members?	Yes	No	N/A
Corrosion coating intact and in place?	Yes	No	N/A
Paint in good condition?	Yes	No	N/A
Visible structural deformaties?	Yes	No	N/A
Foundation settling evident?	Yes	No	N/A
Major cracks?	Yes	No	N/A

*** Condition / Level of Service**

1 - Very Good

2 - Minor Defects

3 - Requires Significant Maintenance

4 - Requires Rehabilitation

5 - Requires Replacement (>50%)

0 - Non-Existent

Facility / System Condition Assessment Form

Facility / System:	Treatment Plant	Current Year	
Process / Basin / Zone:	Sample Process	Current ENR	
Component / Subbasin / Subzone:	Sample Component		
Discipline:	Mechanical / Electrical / Instrumentation / Piping		

Main Tab

Level of Service *	1	2	3	4	5	0				Annual Maintenance Cost
Criticality										Installation Year
Public Health & Safety	Multiple		Single		Seasonal		No Effect			Original Useful Life
Environmental	Major			Minor			No Effect			Date of Inspection
Cost of Repair	>$20			$5-$20			<$5			Assessed By
Effect on Customers	Major			Minor			No Effect			Photo #
Vulnerability	1	2	3	5	10	20	50	100	150	Acquisition Cost
Condition *	1		2		3	4		5	0	Replacement Value
										Salvage Value

Component Information Tab

ID Number

Manufacturer/Model (nameplate info)

Comments

*** Condition / Level of Service**

1 - Very Good

2 - Minor Defects

3 - Requires Significant Maintenance

4 - Requires Rehabilitation

5 - Requires Replacement (>50%)

0 - Non-Existent

Mechanical

Excessive vibration?	Yes	No	N/A
Excessive noise?	Yes	No	N/A
Excessive corrosion?	Yes	No	N/A
Excessive leaks?	Yes	No	N/A
Running hot?	Yes	No	N/A
Capable of running when inspected?	Yes	No	N/A
Support equipment functional?	Yes	No	N/A
Equipment or parts missing?	Yes	No	N/A
Parts for maintenance available?	Yes	No	N/A
Adequate for intended service?	Yes	No	N/A
Motor amps within rating?	Yes	No	N/A

Instrumentation

All critical indications functioning?	Yes	No	N/A
Alarms functional?	Yes	No	N/A
Equipment or parts missing?	Yes	No	N/A
Parts available for maintenance?	Yes	No	N/A

Electrical

Excessive corrosion?	Yes	No	N/A
Clean, well maintained contacts?	Yes	No	N/A
Parts available for maintenance?	Yes	No	N/A

Piping

Excessive corrosion?	Yes	No	N/A
Excessive leaks?	Yes	No	N/A
Paint in good condition?	Yes	No	N/A

Facility / System Condition Assessment Form

Facility / System:	Treatment Plant	Current Year	
Process / Basin / Zone:	Sample Process	Current ENR	
Component / Subbasin / Subzone:	Sample Component		
Discipline:	Civil / Sitework		

Main Tab

Level of Service *	1	2	3	4	5	0			
Criticality									
Public Health & Safety	Multiple		Single		Seasonal		No Effect		
Environmental	Major			Minor			No Effect		
Cost of Repair	>$20			$5-$20			<$5		
Effect on Customers	Major			Minor			No Effect		
Vulnerability	1	2	3	5	10	20	50	100	150
Condition *	1	2	3	4	5	0			

Annual Maintenance Cost
Installation Year
Original Useful Life
Date of Inspection
Assessed By
Photo #
Acquisition Cost
Replacement Value
Salvage Value

Component Information Tab

ID Number

Manufacturer/Model (nameplate info)

Comments

Sitework

Several potholes?	Yes	No	N/A
Excessive erosion?	Yes	No	N/A
Severe road degradation evident?	Yes	No	N/A
Functional ground cover?	Yes	No	N/A
Fencing adequate and well maintained?	Yes	No	N/A
Facilities adequately secured?	Yes	No	N/A
Space for expansion?	Yes	No	N/A

Civil

Presence of clay liner?	Yes	No	N/A
Excessive erosion on berm interior?	Yes	No	N/A
Excessive erosion on berm exterior?	Yes	No	N/A
Vegetation along berms?	Yes	No	N/A
Noticeable settlement of berms?	Yes	No	N/A
Presence of seepage on outer edge of berms?	Yes	No	N/A
Presence of burrow holes?	Yes	No	N/A
Presence of riprap or other erosion protection?	Yes	No	N/A
Adequate erosion protection?	Yes	No	N/A
Excessive algal blooms?	Yes	No	N/A
Adequate drainage?	Yes	No	N/A

*** Condition / Level of Service**

1 - Very Good

2 - Minor Defects

3 - Requires Significant Maintenance

4 - Requires Rehabilitation

5 - Requires Replacement (>50%)

0 - Non-Existent

Appendix B

SUMMARY OF ASSETS WITH THE LOWEST OVERALL CONDITION RANKING

Table B.1 Summary of Assets with the Lowest Overall Condition Rankings[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/Basin/ Zone	Major Component/Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
2	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
3	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
4	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
5	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
6	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
7	Electrical	Switchgear M (Transformer 3, Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0
8	Electrical	Switchgear W (Transformer 4, Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0
9	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0
10	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
11	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
12	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0
13	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
14	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
15	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
16	Primary	Primary Clarifier Structure Plant 1A	5	0.99	25	$1,745,000	$1,745,000	50	25	0

Table B.1 Summary of Assets with the Lowest Overall Condition Rankings[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/Basin/ Zone	Major Component/Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
17	Primary	Primary Clarifier Structure Plant 1B	5	0.99	25	$1,818,000	$1,818,000	50	25	0
18	Secondary	VFD for WAS 5 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
19	Secondary	VFD for WAS 6 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
20	Water Recycle	VFD for Recycle Pump 1	5	0.93	14	$73,000	$73,000	30	15	0
21	Primary	Pump Station 14	5	0.79	20	$198,000	$198,000	50	25	0
22	Primary	Distribution Box (Plant 1)	5	0.71	18	$147,000	$147,000	50	25	0
23	Primary	Steam Generator 2 (PS 4)	5	0.4	4	$485,000	$485,000	20	10	0
24	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
24	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
25	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
26	Electrical	Transformer T1 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
27	Electrical	Transformer T2 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
28	Electrical	Transformer T3 (Plant 2)	4	1.63	34	$38,000	$10,000	30	21	6
29	Electrical	Transformer T4 (Plant 2)	4	1.63	34	$38,000	$10,000	30	21	6
30	Primary	Primary MCC 4 (S, Plant 2)	4	1.29	18	$66,000	$17,000	20	14	4
31	Water Recycle	Water Recycle Pump 6	4	1.01	14	$191,000	$50,000	20	14	4
32	Cogeneration	Air Compressor 1 (Pump and Air Compressor Room)	4	0.93	13	$6,000	$1,600	20	14	4

Table B.1 Summary of Assets with the Lowest Overall Condition Rankings[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/Basin/ Zone	Major Component/Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
33	Water Recycle	VFD for Recycle Pump 2	4	0.67	14	$73,000	$19,000	30	21	6
34	Water Recycle	VFD for Recycle Pump 5	4	0.67	14	$33,000	$9,000	30	21	6
35	Water Recycle	VFD for Recycle Pump 6	4	0.67	14	$33,000	$9,000	30	21	6
36	Water Recycle	VFD for Recycle Pump 7	4	0.67	14	$33,000	$9,000	30	21	6
37	Secondary	Scum Pump 2 (Plant 2)	4	0.65	9	$65,000	$17,000	20	14	4
38	Digestion	Pump Station 1	4	0.57	20	$233,000	$61,000	50	35	10
39	Buildings	Field Maintenance Storage Building	4	0.43	15	$376,000	$99,000	50	35	10
40	Dewatering	Polymer Bulk Transfer Pump 1	4	0.29	4	$18,000	$5,000	20	14	4
41	Dewatering	Polymer Bulk Transfer Pump 2	4	0.29	4	$18,000	$5,000	20	14	4
42	Buildings	Headquarters for Sewer Line Maintenance	4	0.17	6	$1,209,000	$318,000	50	35	10
43	Primary	Ferric Sulfate System (Plant 1)	3.9	0.9	18	$49,000	$14,000	31.3	20	4
44	Cogeneration	Cooling Tower (Gas Treatment Area)	3.8	0.76	13	$299,000	$73,000	22.7	17	6

Notes:
(1) Assets are ordered first by condition and second by risk values.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal, and construction fees.

Appendix C

SUMMARY OF ASSETS WITH GREATEST RISK

Table C.1 Summary of Assets with Greatest Risk[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Disinfection	Effluent Analyzers	2	2.59	37	$208,000	$-	15	14	6.8
2	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0.1
3	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0.1
4	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0.1
5	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0.1
6	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0.1
7	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0.1
8	Electrical	Switchgear M (Transformer 3, Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0.1
9	Electrical	Switchgear W (Transformer 4, Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0.1
10	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
11	Disinfection	Sodium Bilsulfite Injector 1 (Basin 3)	2	1.94	37	$265,000	$-	20	19	9.1

Table C.1 Summary of Assets with Greatest Risk[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
12	Disinfection	Sodium Bilsulfite Injector 2 (Basin 3)	2	1.94	37	$265,000	$-	20	19	9.1
13	Disinfection	Sodium Hypo-Chlorite Injector 1 (Basin 3)	2	1.94	37	$265,000	$-	20	19	9.1
14	Disinfection	Sodium Hypo-Chlorite Injector 2 (Basin 3)	2	1.94	37	$265,000	$-	20	19	9.1
15	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
16	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
17	Disinfection	Sodium Bilsulfite Chemical Feed, North Unit	1	1.85	37	$15,000	$-	20	20	10
18	Disinfection	Sodium Bilsulfite Chemical Feed, South Unit	1	1.85	37	$15,000	$-	20	20	10
19	Disinfection	Sodium Hypo-Chlorite Injector 3	1	1.85	37	$265,000	$-	20	20	10
20	Disinfection	Sodium Hypo-Chlorite Injector 4	1	1.85	37	$265,000	$-	20	20	10
21	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0

Table C.1 Summary of Assets with Greatest Risk[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
22	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
23	Electrical	Transformer T1 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
24	Electrical	Transformer T2 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
25	Electrical	Transformer T3 (Plant 2)	4	1.63	34	$38,265	$10,059	30	21	6
26	Electrical	Transformer T4 (Plant 2)	4	1.63	34	$38,000	$10,000	30	21	6
27	Headworks	Headworks PLC	1	1.53	23	$26,000	$-	15	15	8
28	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
29	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0
30	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
31	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
32	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
33	Tertiary	Control Panel	2	1.47	21	$26,000	$-	15	14	7
34	Primary	Primary Influent Meter (Plant 2)	2	1.4	20	$26,000	$-	15	14	7
35	Disinfection	MCC at CCB 3	2	1.37	39	$66,000	$-	30	29	14

Table C.1 Summary of Assets with Greatest Risk[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
36	Disinfection	MCC at the Dechlorination Bldg	2	1.37	39	$66,000	$-	30	29	14
37	Electrical	Switchgear A (Plant 2)	3	1.34	34	$109,000	$12,000	30	25	10
38	Electrical	Switchgear B (Plant 2)	3	1.34	34	$109,000	$12,000	30	25	10
39	Primary	Primary MCC 4 (S, Plant 2)	4	1.29	18	$66,000	$17,000	20	14	4
40	Headworks	Jurupa/Rubidoux Metering	2	1.26	18	$26,000	$-	15	14	7
41	Headworks	Riverside/Hillside Influent Metering	2	1.26	18	$26,000	$-	15	14	7
42	Tertiary	Influent Pump 1 (Filters 1-10)	3	1.26	21	$612,000	$66,000	20	17	7
43	Tertiary	Influent Pump 2 (Filters 1-10)	3	1.26	21	$612,000	$66,000	20	17	7
44	Tertiary	Influent Pump 3 (Filters 1-10)	3	1.26	21	$612,000	$66,000	20	17	7

Notes:
(1) Assets are ordered by risk values.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal, and construction fees.

Appendix D

EVALUATED REMAINING USEFUL LIFE

Table D.1 Evaluated Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
2	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
3	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
4	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
5	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
6	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
7	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
8	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
9	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0
10	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
11	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
12	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0

Table D.1 Evaluated Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
13	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
14	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
15	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
16	Primary	Steam Generator 2 (PS 4)	5	0.4	4	$485,000	$485,000	20	10	0
17	Primary	Primary MCC 4 (S, Plant 2)	4	1.29	18	$66,000	$17,000	20	14	4
18	Water Recycle	Water Recycle Pump 6	4	1.01	14	$191,000	$50,000	20	14	4
19	Cogeneration	Air Compressor 1 (Pump and Air Compressor Room)	4	0.93	13	$6,000	$2,000	20	14	4
20	Secondary	Scum Pump 2 (Plant 2)	4	0.65	9	$65,000	$17,000	20	14	4
21	Dewatering	Polymer Bulk Transfer Pump 1	4	0.29	4	$18,000	$5,000	20	14	4
22	Dewatering	Polymer Bulk Transfer Pump 2	4	0.29	4	$18,000	$5,000	20	14	4
23	Disinfection	Effluent Analyzers	2	2.59	37	$208,000	$-	15	14	7
24	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
25	Tertiary	Control Panel	2	1.47	21	$26,000	$-	15	14	7

Table D.1 Evaluated Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
26	Primary	Primary Influent Meter (Plant 2)	2	1.4	20	$26,000	$-	15	14	7
27	Headworks	Jurupa/Rubidoux Metering	2	1.26	18	$26,000	$-	15	14	7
28	Headworks	Riverside/Hillside Influent Metering	2	1.26	18	$26,000	$-	15	14	7
29	Headworks	Headworks PLC	1	1.53	23	$26,000	$-	15	15	8
30	Secondary	WAS Flow Meter 1 (Plant 1, Pump Station 22)	1	1.2	18	$11,000	$-	15	15	8
31	Secondary	WAS Flow Meter 2 (Plant 2, Pump Station 16)	1	1.2	18	$11,000	$-	15	15	8
32	Cogeneration	Cogen Monitoring System	1	1.2	18	$132,000	$-	15	15	8
33	Outfall/Effluent Disposal	Effluent Metering	1	1.2	18	$26,000	$-	15	15	8
34	Cogeneration	Calorimeter	1	0.53	8	$2,000	$-	15	15	8
35	Electrical	Switchgear M (Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0
36	Electrical	Switchgear W (Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0

Table D.1 Evaluated Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
37	Secondary	VFD for WAS 5 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
38	Secondary	VFD for WAS 6 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
39	Water Recycle	VFD for Recycle Pump 1	5	0.93	14	$73,000	$73,000	30	15	0

Notes:
(1) Assets are ordered by first by Evaluated Remaining Useful Life and second by risk values.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal, and construction fees.

Appendix E

ECONOMIC REMAINING USEFUL LIFE

Table E.1 Economic Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
2	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
3	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
4	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
5	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
6	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
7	Electrical	Switchgear M (Transformer 3, Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0
8	Electrical	Switchgear W (Transformer 4, Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0
9	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0

Table E.1 Economic Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
10	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
11	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
12	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0
13	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
14	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
15	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
16	Secondary	VFD for WAS 5 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
17	Secondary	VFD for WAS 6 (Pump Station 6)	5	0.93	14	$14,000	$14,000	30	15	0
18	Water Recycle	VFD for Recycle Pump 1	5	0.93	14	$73,000	$73,000	30	15	0
19	Primary	Steam Generator 2 (PS 4)	5	0.4	4	$485,000	$485,000	20	10	0
20	Primary	Primary Clarifier Structure Plant 1A	5	0.99	25	$1,745,000	$1,745,000	50	25	0
21	Primary	Primary Clarifier Structure Plant 1B	5	0.99	25	$1,818,000	$1,818,000	50	25	0
22	Primary	Pump Station 14	5	0.79	20	$198,000	$198,000	50	25	0

Table E.1 Economic Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
23	Primary	Distribution Box (Plant 1)	5	0.71	18	$147,000	$147,000	50	25	0
24	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
25	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
26	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
27	Primary	Primary MCC 4 (S, Plant 2)	4	1.29	18	$66,000	$17,000	20	14	4
28	Water Recycle	Water Recycle Pump 6	4	1.01	14	$191,000	$50,000	20	14	4
29	Cogeneration	Air Compressor 1 (Pump and Air Compressor Room)	4	0.93	13	$6,000	$2,000	20	14	4
30	Secondary	Scum Pump 2 (Plant 2)	4	0.65	9	$65,000	$17,000	20	14	4
31	Dewatering	Polymer Bulk Transfer Pump 1	4	0.29	4	$18,000	$5,000	20	14	4
32	Dewatering	Polymer Bulk Transfer Pump 2	4	0.29	4	$18,000	$5,000	20	14	4
33	Primary	Ferric Sulfate System (Plant 1)	3.9	0.9	18	$49,000	$14,000	31	20	4
34	Cogeneration	Cooling Tower (Gas Treatment Area)	3.8	0.76	13	$299,000	$73,000	23	17	6

Table E.1 Economic Remaining Useful Life[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/ Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
35	Electrical	Transformer T1 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
36	Electrical	Transformer T2 (Plant 2)	4	1.63	34	$65,000	$17,000	30	21	6
37	Electrical	Transformer T3 (Plant 2)	4	1.63	34	$38,000	$10,000	30	21	6
38	Electrical	Transformer T4 (Plant 2)	4	1.63	34	$38,000	$10,000	30	21	6
39	Water Recycle	VFD for Recycle Pump 2	4	0.67	14	$73,000	$19,000	30	21	6
40	Water Recycle	VFD for Recycle Pump 5	4	0.67	14	$33,000	$10,000	30	21	6
41	Water Recycle	VFD for Recycle Pump 6	4	0.67	14	$33,000	$9,000	30	21	6
42	Water Recycle	VFD for Recycle Pump 7	4	0.67	14	$33,000	$9,000	30	21	6

Notes:
(1) Assets are ordered by first by Economic Remaining Useful Life and second by risk values.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal, and construction fees.

Appendix F

SUMMARY OF ASSETS WITH GREATEST REPAIR COSTS

Table F.1 Summary of Assets with Greatest Repair Costs[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
1	Primary	Primary Clarifier 9 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
2	Primary	Primary Clarifier 10 (Plant 1B)	5	2.48	25	$2,121,000	$2,121,000	20	10	0
3	Primary	Primary Clarifier Structure Plant 1B	5	0.99	25	$1,818,000	$1,818,000	50	25	0
4	Primary	Primary Clarifier Structure Plant 1A	5	0.99	25	$1,745,000	$1,745,000	50	25	0
5	Primary	Primary Clarifier 5 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
6	Primary	Primary Clarifier 6 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
7	Primary	Primary Clarifier 7 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
8	Primary	Primary Clarifier 8 (Plant 1A)	5	2.48	25	$1,018,000	$1,018,000	20	10	0
9	Digestion	Anaerobic Digester 4	2.6	0.40	16	$10,907,000	$832,000	43.1	40	18
10	Primary	Steam Generator 2 (PS 4)	5	0.4	4	$485,000	$485,000	20	10	0
11	Dewatering	Sludge Dewatering Building	3	0.14	6	$3,637,000	$394,000	50	42	17

Table F.1 Summary of Assets with Greatest Repair Costs[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
12	Buildings	Headquarters for Sewer Line Maintenance	4	0.17	6	$1,209,000	$318,000	50	35	10
13	Primary	Primary Clarifier 2 (Plant 2)	2.4	0.58	25	$2,310,000	$303,000	45	43	21
14	Primary	Primary Clarifier 4 (Plant 2)	2.4	0.58	25	$2,310,000	$303,000	45	43	21
15	Buildings	Van Buren Storage	3	0.14	6	$2,424,000	$263,000	50	42	17
16	Digestion	Waste Gas Burner	4	2.23	31	$954,000	$250,797	20	14	4
17	Secondary	Clarifier 2 (Plant 2)	2.1	0.58	25	$3,573,000	$236,000	44.3	43	21
18	Secondary	Clarifier 1 (Plant 2)	2.1	0.58	25	$3,573,000	$236,000	44.3	43	21
19	Primary	Pump Station 14	5	0.79	20	$198,000	$198,000	50	25	0
20	Secondary	Clarifier 3 (Plant 2)	2.2	0.59	25	$2,533,000	$185,000	43.7	42	21
21	Aeration	Blower 2 (Blower Bldg 2)	3	0.59	10	$1,439,000	$156,000	20	17	7
22	Aeration	Blower 3 (Blower Bldg 2)	3	0.59	10	$1,439,000	$156,000	20	17	7
23	Aeration	Blower 4 (Blower Bldg 2)	3	0.59	10	$1,439,000	$156,000	20	17	7
24	Primary	Distribution Box (Plant 1)	5	0.71	18	$147,000	$147,000	50	25	0

Table F.1 Summary of Assets with Greatest Repair Costs[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
25	Aeration	Blower Building 2	2.4	0.35	15	$3,413,000	$145,000	46.3	43	20
26	Buildings	Old Administration Building	3	0.14	6	$1,284,000	$139,000	50	42	17
27	Primary	Sludge Pump 5	5	1.49	15	$127,000	$127,000	20	10	0
28	Primary	Sludge Pump 6	5	1.49	15	$127,000	$127,000	20	10	0
29	Primary	Sludge Pump 7	5	1.49	15	$127,000	$127,000	20	10	0
30	Primary	Sludge Pump 8	5	1.49	15	$127,000	$127,000	20	10	0
31	Primary	Sludge Pump 9	5	1.49	15	$127,000	$127,000	20	10	0
32	Electrical	Switchgear M (Transformer 3, Plant 2)	5	2.25	34	$109,000	$109,000	30	15	0
33	Buildings	Maintenance Building	3	0.35	15	$973,000	$105,000	50	42	17
34	Buildings	Field Maintenance Storage Building	4	0.43	15	$376,000	$99,000	50	35	10
35	Headworks	Biofilter 1	4	1.86	13	$336,000	$88,000	10	7	2
36	Headworks	Biofilter 2	4	1.86	13	$336,000	$88,000	10	7	2
37	Disinfection	Chlorine Contact Basin 1	2.3	0.57	26	$1,526,000	$77,000	48.2	45	21
38	Cogeneration	Cooling Tower (Gas Treatment Area)	3.8	0.76	13	$299,000	$73,000	22.7	17	6

Table F.1 Summary of Assets with Greatest Repair Costs[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
39	Water Recycle	VFD for Recycle Pump 1	5	0.93	14	$73,000	$73,000	30	15	0
40	Thickening	DAF Thickener 1	2.1	0.42	16	$1,575,000	$68,000	39.2	38	19
41	Tertiary	Influent Pump 1 (Filters 1-10)	3	1.26	16	$612,000	$66,000	20	17	7
42	Tertiary	Influent Pump 2 (Filters 1-10)	3	1.26	16	$612,000	$66,000	20	17	7
43	Tertiary	Influent Pump 3 (Filters 1-10)	3	1.26	16	$612,000	$66,000	20	17	7
44	Primary	Primary MCC 1 (Plant 1A, Pump Station 12)	5	1.78	18	$66,000	$66,000	20	10	0
45	Primary	Primary MCC 2 (Plant 1B, Pumps Station 13)	5	1.78	18	$66,000	$66,000	20	10	0
46	Electrical	Switchgear W (Transformer 4, Plant 2)	5	2.25	34	$66,000	$66,000	30	15	0
47	Digestion	Pump Station 1	4	0.57	20	$233,000	$61,000	50	35	10
48	Equalization	Junction Box 9	2.3	0.41	18	$494,000	$56,000	46	44	22

Table F.1 Summary of Assets with Greatest Repair Costs[1]
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

No.	Treatment Process/ Basin/Zone	Major Component/ Subbasin/Subzone	Condition	Risk	Criticality	Replacement Value	Repair Cost[2]	Original Useful Life	Evaluated Remaining Useful Life	Economic Remaining Useful Life
49	Primary	Steam Generator 1 (Plant 1)	3	0.24	4	$485,000	$53,000	20	17	7
50	Water Recycle	Water Recycle Pump 6	4	1.01	14	$191,000	$50,000	20	14	4

Notes:
(1) Assets are ordered by first by repair costs and second by risk values.
(2) Repair costs are project costs that include a contingency, general conditions, contractor overhead, sales tax, bid market allowances, and engineering, legal, and construction fees.