City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 2: SUMMARY OF PLANNING STUDIES

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

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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.