City of San José

San José/Santa Clara Water Pollution
Control Plant Master Plan

TASK NO. 5
PROJECT MEMORANDUM NO. 1
LIQUIDS TREATMENT ALTERNATIVES

FINAL DRAFT
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CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

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GLOSSARY OF ACRONYMS AND TERMS

AB	Assembly Bill
AC	Acre
ACH	Air Changes per Hour
AD	Air Drying
ADAF	Average Day Annual Flow (Average daily flow or loading for an annual period)
ADC	Alternative Daily Cover
ADMMF	Average Day Maximum Month Flow (Peak month for each year)
ADMML	Average Day Maximum Month Load
ADWF	Average Dry Weather Flow (Average of daily influent flow occurring between May - October)
ADWIF	Average Dry Weather Influent Flow (Average of five consecutive weekday flows occurring between June - October)
ADWL	Average Dry Weather Load
AES	Advanced Energy Storage
ANSI	American National Standards Institute
ARWTF	Advanced Recycled Water Treatment Facility
BAAQMD	Bay Area Air Quality Management District
BAB2E	Bay Area Biosolids to Energy
BACWA	Bay Area Clean Water Association
BAF	Biological Aerated Filter
BC	Brown and Caldwell
BCDC	Bay Conservation and Development Commission
BNR	Biological Nutrient Removal
BNR1	Formerly Secondary Facilities
BNR2	Formerly Nitrification Facilities
BOD	Biochemical Oxygen Demand
BTUs	British Thermal Units

CAG	Community Advisory Group
CAL OSHA	California Occupational Safety and Health Administration
CAMBI	Vendor name for a pre-processing technology
CARB	California Air Resources Board
CCB	Chlorine Contact Basin
CEC	Contaminant of Emerging Concern
CEC	California Energy Commission
CEPT	Chemically Enhanced Primary Treatment
CEQA	California Environmental Quality Act
CFM	Cubic feet per minute
CH_4	Methane
CH_3SH	Methyl mercaptan
CIP	Capital Improvement Program
City	City of San José
CL	Covered Lagoons
CO	Catalytic Oxidation
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalence
CSI	California Solar Incentive
DAFT	Dissolved Air Flotation Thickener
DO	Dissolved Oxygen
DG	Digester Gas
DPH	Department of Public Health
D/T	Dilutions to threshold
EBOS	Emergency Basin Overflow Structure
EDCs	Endocrine Disrupting Compounds
EEC	Environmental Engineering and Contracting, Inc.
e.g.	For example
EIR	Environmental Impact Report

ELAC	Engineering, Legal, and Administrative Costs
EPA	United States Environmental Protection Agency
EQ	Equalization
ESD	Environmental Services Department
etc	etcetera
Fe_2O_3	Ferric Oxide
Fe_2S_3	Ferric Sulfide
FIPS	Filter Influent Pump Station
FOG	Fats, Oils, and Grease
fps	foot per second
FRP	Fiberglass Reinforced Plastic
FWS	Food Waste Separation
GC/SCD	Gas Chromatograph/Sulfur Chemiluminescence Detector
GHG	Greenhouse Gas Emissions
gpd/ft^2	Gallons per Day per Square Foot
GWP	Global Warming Potential
H_2S	Hydrogen Sulfide
H_2SO_4	Sulfuric Acid
HOCl	Hypochlorous Acid
HP	Harvest Power
HRT	Hydraulic Residence Time
HVAC	Heating Ventilation and Air Conditioning
HW	Headworks
IMLR	Internal Mixed Liquor Return
IWA	International Water Association
ISCST3	Industrial Source Complex Short-Term 3
ITC	Investment Tax Credit
JEPA	Joint Exercise of Power Authority
L	Liter

LFG	Landfill Gas
LHV	Lower Heating Value
MAD	Mesophilic Anaerobic Digestion
MBR	Membrane Bioreactor
MD	Mechanical Dewatering
MG	Million Gallons
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
MLE	Modified Ludzack - Ettinger
MLSS	Mixed Liquor Suspended Solids
MM	Million
MOP	Manual of Practice
MSW	Municipal Solid Waste
MW	Mega Watt
NAS	Nitrification with Anaerobic Selector
NBB	Nitrification Blower Building
NFPA	National Fire Protection Association
NG	Natural Gas
NH_3	Ammonia
N_2O	Nitrous Oxide
NPDES	National Pollutant Discharge Elimination System
OCMP	Odor Control Master Plan
O&M	Operations and Maintenance
ORP	Oxidation-Reduction Potential
OUR	Oxygen Uptake Rate
PE	Primary Effluent
PEPS	Primary Effluent Pump Station
PG&E	Pacific Gas and Electric
PHWWF	Peak Hour Wet Weather Flow (Peak hour flow resulting from a rainfall event)

PM	Project Memorandum
PMP	Plant Master Plan
PPA	Power Purchase Agreement
ppbv	Parts per billion by volume
PPCD	Pounds per capita per day
ppmv	Parts per million by volume
PPP	Public-Private Partnerships
PS	Primary Sludge
PV	Photovoltaic
QA/QC	Quality Assurance/Quality Control
RAS	Return Activated Sludge
RO	Reverse Osmosis
RPS	Renewable Portfolio Standard
ROAP	Regional Odor Assessment Program
RSPS	Raw Sewage Pump Station
SBB	Secondary Blower Building
SBR	Sequencing Batch Reactor
SBWR	South Bay Water Recycling
SC	Santa Clara
SCAQMD	South Coast Air Quality Management District
SCR	Selective Catalytic Reduction
SGIP	Self-Generation Incentive Program
SJ	San Jose
sf	Square Feet
SOM	Skidmore, Owings, and Merrill
SOTE	Standard Oxygen Transfer Efficiency
SRT	Solids Residence Time
SS	Suspended Solids
SSPS	Settled Sewage Pump Station

SVI	Sludge Volume Index
TAD	Thermophilic Anaerobic Digestion
TAG	Technical Advisory Group
TBL	Triple Bottom Line
TM	Technical memorandum
TN	Total Nitrogen (organic & inorganic forms which are ammonia, nitrates, nitrite)
TSS	Total Suspended Solids
TWAS	Thickened Waste Activated Sludge
UV	Ultraviolet
VFDs	Variable Frequency Drives
VOC	Volatile Organic Compound
VSL	Volatile Solids Loading
WAS	Waste Activated Sludge
WEF	Water Environment Federation
WPCP	Water Pollution Control Plant
WWTP	Wastewater Treatment Plant

LIQUIDS TREATMENT ALTERNATIVES

1.0 INTRODUCTION/SUMMARY

1.1 Introduction

The purpose of this project memorandum (PM) is to summarize the proposed liquid treatment alternatives for the San José/Santa Clara Water Pollution Control Plant (WPCP and Plant used interchangeably) for the WPCP Project Master Plan (PMP). This PM compares the full and reliable capacities of the different treatment processes developed in PM 3.5, with the projected flows and loads developed in PM 3.8 to determine future capacity needs. The alternatives presented in this PM illustrate the different options available to meet the capacity needs.

The initial wide range of alternatives was narrowed down through a screening and selection process to the alternatives presented in this PM. These alternatives were assessed from a conceptual perspective for their engineering feasibility, cost, and land-use requirements. This assessment will allow City staff to compare the alternatives, and make a selection that will be carried forward for further detailed analysis.

1.2 Summary

The elements of the recommended implementation plan include the following:

- Maintain both raw and primary effluent flow equalization to accommodate peak flows through the treatment plant. Expand the raw equalization basin from 8 MG to 10 MG.
- Expand Headworks 2 to a capacity of 400 million gallons per day (mgd), and decommission Headworks 1.
- Perform structural and mechanical rehabilitation of the East Primaries, including a detailed hydraulic evaluation to better accommodate peak flows.
- Decommission the West Primaries.
- Install iron salt dosing facilities at EBOS and the East Primaries to chemically enhance the precipitation of solids.
- Install a primary sludge/waste activated sludge (WAS) fine screening facility.
- Connect the aeration headers of the two secondary treatment plants, BNR1 and BNR2.
- Connect the BNR2 secondary clarifiers with BNR 1.

- Convert remaining aeration basins from coarse bubble to fine bubble diffusion.
- Keep monitoring flows and loads and the possible development of total nitrogen discharge regulations. Transition the secondary treatment process either to nitrification with anaerobic selector (NAS) in response to increases only in flow and load. However, if total nitrogen discharge regulations are implemented, transition the secondary treatment process to either NAS with an additional denitrification step, modified Ludzack-Ettinger (MLE), or step-feed with internal mixed liquor return (IMLR), all of which requiring a tertiary filtration step.
- Monitor the research developments in side-stream ammonia treatment processes, such as DEMON®, and consider implementing these once the more concentrated ammonia-rich recycle stream from the mechanized solids treatment processes is introduced to the treatment plant.
- Construct a new 12 million gallons (MG) primary effluent equalization basin to lower the ammonia loading peaks to the secondary process.
- To combat nuisance foaming in the secondary treatment system, perform a detailed assessment of the modifications required to allow surface wasting from the aeration basins, and compare them to the possible introduction of surface wasting installations in the mixed liquor channels to the secondary clarifiers, or in the RAS tanks prior to return to the aeration basins.
- Field verify the results from the hydraulic evaluation of the aeration basins through the secondary clarifiers. The hydraulic evaluation shows a minimal operational freeboard exists for the three secondary treatment modes proposed to meet a TN < 8 mg/L future regulation, namely NAS (with additional denitrification), MLE, and Step Feed with IMLR.
- Maintain the current filtration facilities in the interim, and monitor the performance benefit of refurbishing one of the filters. This outcome will help decide the benefits of refurbishing all or only some of the remaining filters. Meanwhile, conduct pilot testing on candidate replacement filter technologies.
- The analyses show a life-cycle benefit to 1) maintaining chlorination disinfection but transitioning to onsite hypochlorite generation or 2) transitioning to UV disinfection. However, this selection should be made in consort with a selection of advanced oxidation process (AOP) for reducing CECs. Since there is much uncertainty around the AOP best suited to reducing CECs, the current hypochlorite mode of disinfection should continue pending the outcome of further research.

Detailed descriptions of these projects, along with implementation timelines and planning level project cost estimates, are provided in PM 6.1 CIP Implementation. The costs provided in this PM are for comparison of alternatives only, and should not be used for CIP planning.

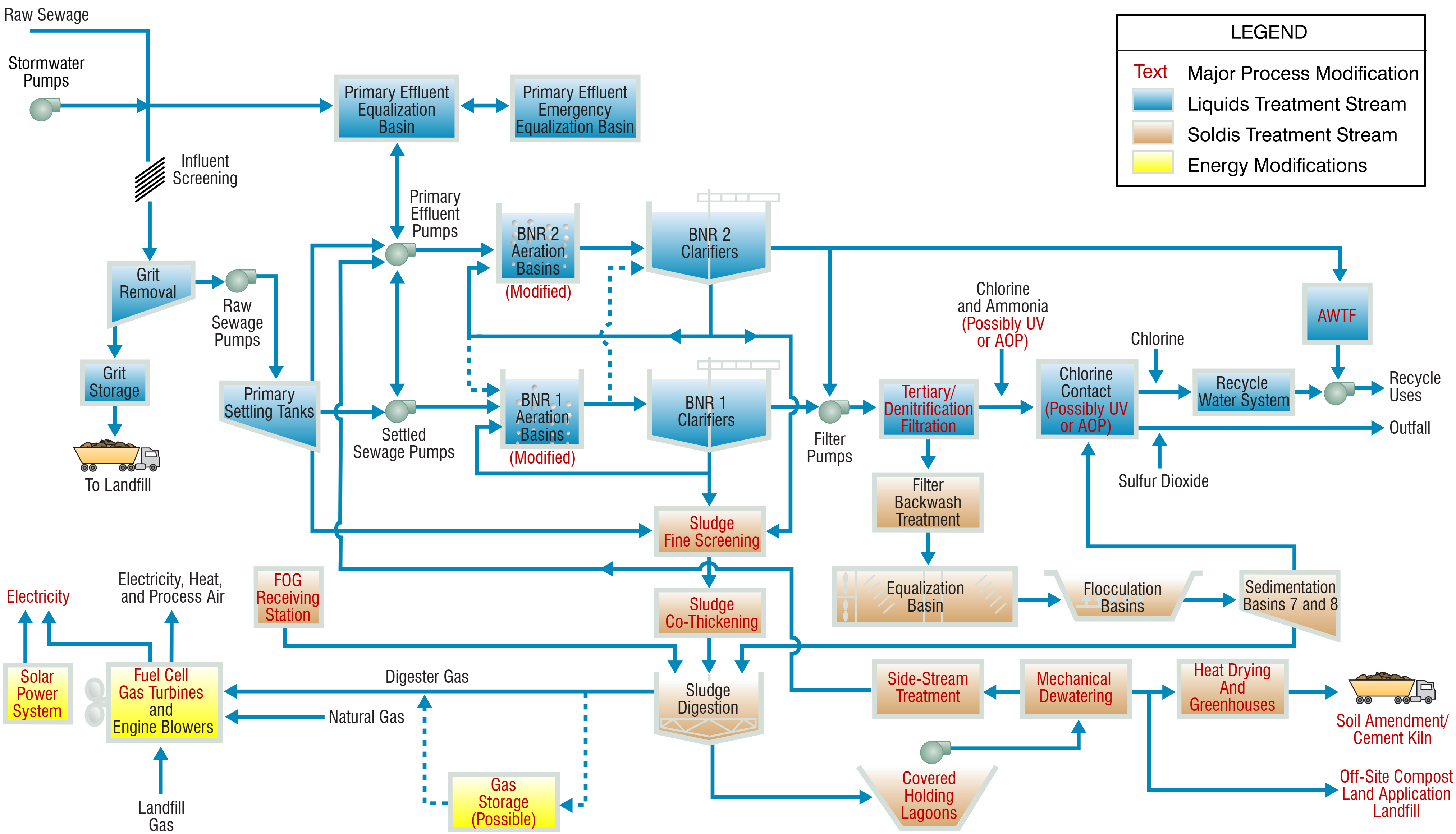
The modifications to the plant are shown on the following updated simplified process flow schematic, entitled “Future WPCP Process Flow Schematic.”

1.3 Liquids Treatment Brainstorm Process

In developing the liquids alternatives, the following process was followed:

1. Reviewed existing facilities and challenges through the following meetings and workshops:
    a. Brainstorm workshop at the WPCP on June 8, 2008.
    b. Project Team Brainstorming meeting at the Carollo offices on September 8, 2008.
    c. Technical Advisory Group (TAG) Workshop at the WPCP on November 13-14, 2008.
    d. Community Advisory Group (CAG) Public Meeting at the WPCP on May 16, 2009.
    e. Project Team Brainstorming meeting at the Brown and Caldwell (BC) offices on July 1, 2009.
    f. Liquids Treatment Alternatives Workshop at the WPCP on August 4, 2009.
    g. TAG Workshop at the WPCP on September 30-October 1, 2009.
2. Individual treatment process considerations.
3. Review of linkages and integration of process recommendations.
4. Screened using “Fatal Flaw” criteria (see Table 1), i.e., retained/eliminated conceptual liquids treatment alternatives according to pre-defined pass/fail criteria.

Table 1	“Fatal Flaw” (Pass/Fail) Technical Screening Criteria San José/Santa Clara Water Pollution Control Plant Master Plan City of San José
•	Feasible at large-scale facility.
•	Cannot significantly expand current process footprint.
•	Cannot reduce system reliability.
•	Must have the ability to meet future regulatory requirements.
•	Must be able to mitigate odor impacts.
•	Available buffer must be able to mitigate aesthetic impacts.



FUTURE WPCP PROCESS FLOW SCHEMATIC
SAN JOSE/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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1.4 Site Specific Considerations

In developing the liquids treatment alternatives, the following were identified as site specific considerations at the August 4, 2009, workshop.

- The plant should have no capacity problems.
- Influent flows will exceed Bay disposal capacity.
- Equalization of peak flows.
- The function of existing facilities needs to be maximized.
- Facilities are aging.
- WPCP is currently a two-plant operation - would a single plant operation be possible?
- Determine the footprint required for liquid and biosolids processing.
- Important for the plant aesthetically to be a good neighbor.
- Consider the impact of sea level rise.

1.5 Master Plan Layout Guidance

Some general principles apply with respect to plant layouts of alternatives. The most important of these are the following:

- Process requirements take priority over support facilities.
- Process areas take precedence over support facilities in site layout considerations.
- Big-plant hydraulics govern.
- Accommodate piping and support system corridors.

1.6 2040 Projected Wastewater Flow Rates

Historical plant influent data were analyzed to project future flows and loads. The procedure is described in detail in PM 3.8 Projected Wastewater Flows and Characteristics. A summary of the 2040 projected flows from that PM is presented in Table 2. These projected flow rates are used as the basis for planning for the liquid treatment alternatives discussed in this PM.

Table 2 2040 Projected Wastewater Flow Rates
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Type	ADAF	ADWIF	ADMMF	PHWWF
Plant Master Plan Flow Rate	~180	~190	~200	~455

Further description of the procedure followed to derive these flows is provided in Appendix A.

1.7 Regulatory Considerations

The liquids treatment processes collectively need to produce effluent streams that comply with the WPCP NPDES permit for Bay discharge, and Title 22 requirements for unrestricted reuse. These requirements are presented in detail in PM 4.1 Existing Regulatory Requirements.

The liquids treatment alternatives assessment needs to be responsive not only to these current regulatory requirements, but also to anticipated likely future regulatory modifications. A number of key regulations were identified and are shown in the following Table 3, along with the anticipated future limits.

Table 3 Regulatory Forecast
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Constituent	Current Requirement	Anticipated Future Requirement
Ammonia	3 / 8 mg-N/L(1)	1 mg-N/L
Total Nitrogen	None	8 mg-N/L(2), or 3 mg-N/L (Limit of Technology)
Cu Ni Hg	12 / 18 µg/L 25 / 34 µg/L 0.012 / 2.1 µg/L	Incremental decreases
Endocrine Disrupting Compounds (EDCs) and other Contaminants of Emerging Concern (CECs)	None	Monitoring, < 1 ng/L

Notes:
(1) Monthly Average/Daily Maximum.
(2) Bruce Wolfe, an Executive Officer at the San Francisco Bay Regional Water Quality Control Board (Oakland, CA), and member of the PMP Technical Advisory Group (TAG) indicated this change in regulatory requirements is likely three permit cycles into the future, i.e., approximately 15 years out.

1.8 Planning Triggers

Six categories of potential triggers for PMP projects include the following:

1. **Condition (Rehabilitation/Replacement)** – A *condition trigger* is assigned if the process or facility has reached the end of its economic useful life. This trigger is established based on the need to maintain that process or facility as operationally sufficient to meet mission critical reliability and performance requirements.

2. **Regulatory Requirement** – A *regulatory trigger* is assigned when the need is driven by local, state or national regulatory requirements.

3. **Economic Benefit** – An *economic benefit trigger* is assigned when a positive reduction in life-cycle costs (considering capital and O&M) can be achieved.

4. **Improved Performance Benefit** – An improved *performance benefit trigger* is assigned when there is a benefit in improved operations and maintenance performance related to overall reliability and/or reduced operational and safety-related risks.

5. **Increased Flows/Loads** – An *increased flow and load trigger* is assigned when the need is based on an increase in capacity to accommodate increases in flows or loads into the Plant.

6. **Policy Decision** – The *policy trigger* is assigned when the reason is based on a management and/or political decision from the policy-makers.

2.0 HYDRAULIC ANALYSIS

2.1 Major Master Planning Decisions

The major master planning decisions to be made for the hydraulics component of the liquids treatment system are the following:

- How the system should accommodate a 2040 peak hour wet weather (PHWWF) of 455 mgd.

2.2 Peak Flow Handling Analysis

The master plan PHWWF is shown as 455 mgd in Table 2. However, from the capacity evaluation (PM 3.5 Capacity Rating of Existing Facilities) the headworks (Headworks 1 and Headworks 2 facilities combined) has a capacity of 400 mgd, the east primary clarifiers have a capacity of 330 mgd, the secondary treatment system can accommodate a peak flow of 355 mgd, and the filtration and disinfection systems can accommodate peak flows of 300 mgd.

Flow equalization is required to bring the peak flows down to flow rates that can be accommodated in the downstream treatment processes. Two flow equalization alternatives were evaluated:

- **Alternative 1** partially equalizes the raw influent flow to lower the PHWWF from 455 mgd to 400 mgd, which benefits the headworks and primary clarifiers. The primary effluent is further equalized to 355 mgd to match the PHWWF capacity of the secondary treatment system.

- **Alternative 2** has no raw equalization, i.e., the full 455 mgd would have to be accommodated through headworks and primary treatment. Primary effluent equalization would have to be expanded to lower the 455 mgd PHWWF to the 355 mgd capacity of the secondary treatment system.

In both of these alternatives, the filtration and disinfection facilities would be bypassed at flows higher than their 300 mgd capacities. During these peak flow events, the secondary effluent flows, which would be bypassed around filtration would be considered similar in quality to that of the filtered effluent. Similarly, the flows which bypass the disinfection facilities could be effectively disinfected during these peak flow events in the discharge slough upstream of the effluent compliance monitoring point.

Details of the comparison are provided in Appendix B, indicating that not using raw equalization (Alternative 2) costs approximately $22 million (39 percent) more than using raw equalization (Alternative 1). Based on this analysis, it is recommended that raw equalization be maintained, and that the existing bypass capabilities from Headworks 2 to BNR2 be utilized in PHWWF management.

This conclusion was corroborated by the TAG during the October 1, 2009 TAG workshop where the TAG members concluded that: "Keep raw equalization, unless there is an overriding benefit from the land use plan." In addition, the equalization of primary effluent would have a beneficial impact on equalizing the ammonia loading to the secondary treatment process, which is discussed further in the secondary treatment section.

The recommended routing of peak flows through the headworks and primary treatment to secondary treatment is shown schematically on Figure 1.

Some modifications would be required to the existing raw equalization basin, such as increasing the capacity, and providing a liner. Condition (rehabilitation/replacement) is the primary trigger for this improvement, and economic benefit the secondary trigger. It is anticipated that this improvement would be implemented at the same time as the Headworks 2 expansion project.

3.0 RAW INFLUENT THROUGH PRIMARY TREATMENT

3.1 Major Master Planning Decisions

The major master planning process decisions to be made for the treatment system from raw influent through primary treatment are the following:

- Whether Headworks 1 should be phased out, and the timing of that.
- The extent of the upgrades required for the east primary clarifiers (e.g., include seismic upgrade, or not).
- The future of the west primary clarifiers.
- How best to incorporate fine screening into the treatment train.

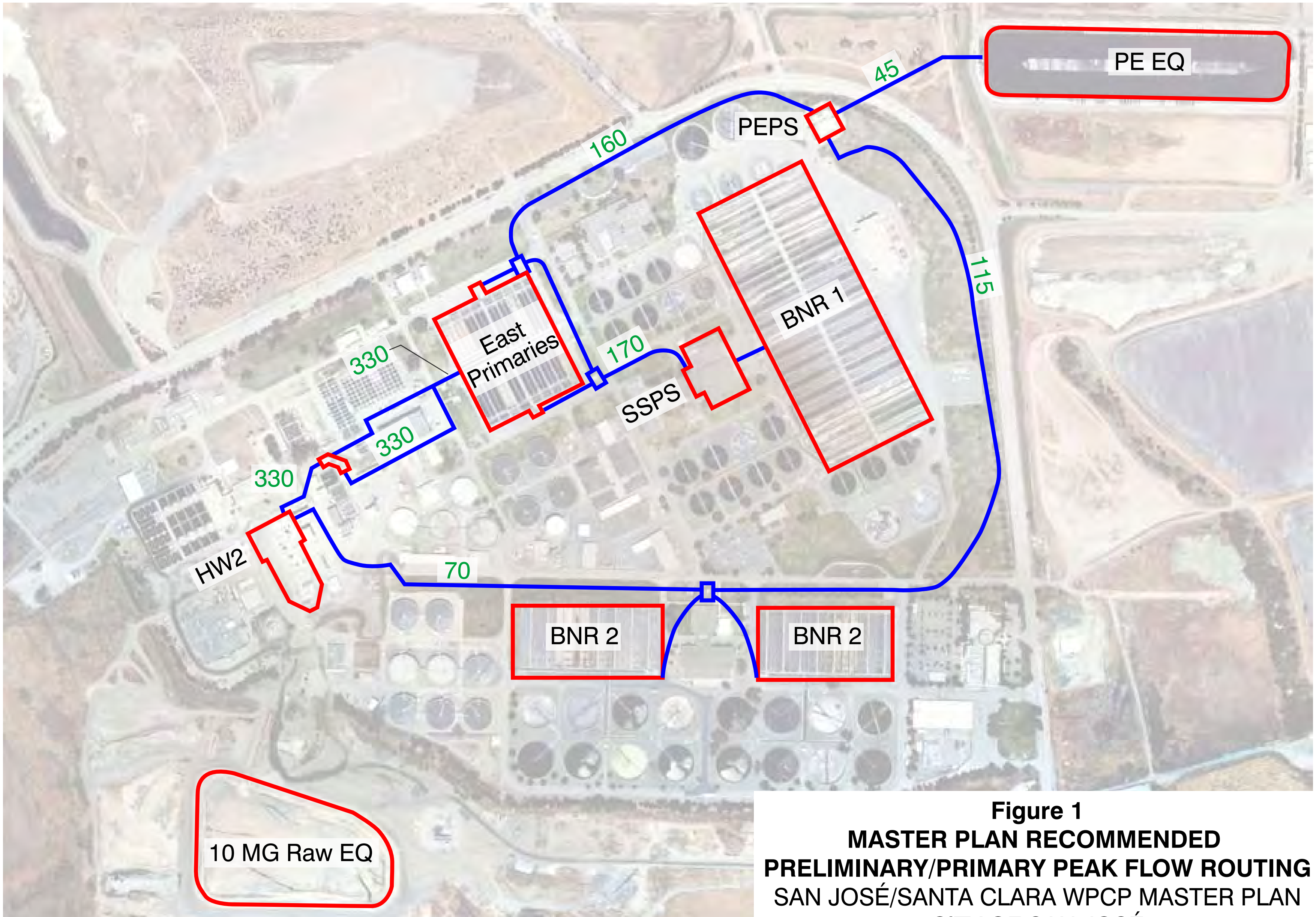

Figure 1
MASTER PLAN RECOMMENDED
PRELIMINARY/PRIMARY PEAK FLOW ROUTING
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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3.2 Headworks Analysis

Headworks 1 and 2 have design capacities of 240 mgd and 160 mgd, respectively, with a combined capacity of 400 mgd. However, Headworks 1, built in the mid 1950s and early 1960s, would require extensive repair and rehabilitation to remain as an operating facility. The master plan for the headworks complex needs to include a decision on the future of Headworks 1, namely whether it should be rehabilitated, or whether to expand the capacity of Headworks 2 to 400 mgd instead, and to decommission Headworks 1.

An extensive evaluation of the Headworks 1 facilities was performed in the Headworks Condition Assessment Project (Carollo Engineers, 2010), which determined that it would be more feasible to expand the capacity of Headworks 2, and to decommission Headworks 1. Key excerpts from that assessment are presented in Appendix C, and can be summarized as follows:

- A detailed condition assessment of Headworks No. 1 mechanical, structural, and electrical and instrumentation components confirmed that most components are functional, but deteriorating due to age and the corrosive nature of the headworks environment.
- The cost comparison of the two alternatives accounted for the relative timing of expenditures, renewal efforts that would need to be repeated over the study period, and the differences in annual O&M costs.
- Expanding Headworks No. 2 was shown to be approximately 20% less expensive than maintaining Headworks No. 1.
- Added benefits of expanding Headworks No. 2 include improved performance benefits to downstream treatment processes, improved seismic performance, improved reliability, and improved safety for operators.

The Headworks 2 expansion will entail constructing a duplication of the existing infrastructure (3 bar screens, 3 vortex grit basins, and 3 pumps, 80 mgd each). Even though this is a duplication of the existing infrastructure, it would increase the capacity from 160 mgd to 400 mgd because operational redundancy is already included in the existing infrastructure, and would not need to be repeated. Odor control infrastructure would be installed over the existing Headworks 2 and over the supporting infrastructure as part of the expansion project.

A schematic of the expanded Headworks 2 is shown in Figure 2.

Condition (rehabilitation/replacement) is the primary trigger for this expansion, and improved performance benefit the secondary trigger. This expansion is scheduled for completion by 2021± to avoid a major refurbishment that will otherwise be required for Headworks 1.

LEGEND
Expanded Headworks #2

Figure 2
EXPANDED HEADWORKS 2
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

3.3 Primary Clarifier Analysis

The primary treatment process consists of two sets of primary clarifiers, namely the West Primaries and the East Primaries. The West Primaries were constructed in the mid 1950s, with the most recent renovation in the 1990s. In addition to their age and condition, they are hydraulically limited to a peak flow of 50 mgd. The East Primaries, constructed in phases through the 1960s and 1970s, have a hydraulic (and process) capacity of 330 mgd, which results in a combined primary clarifier peak flow capacity of 380 mgd.

The hydraulic analysis presented earlier showed how influent peak flows to the plant could be equalized to 400 mgd, which could be accommodated through the headworks. The flow routing assessment also showed how a portion of the flow from the headworks could bypass primary treatment directly to the BNR2 secondary treatment system. BNR2 would likely be operational during the wet season and could therefore provide the necessary treatment. If not operational, the basins could provide storage capacity for the bypassed flows.

Because of this bypass capability, the primary treatment system could potentially be simplified to consist only of the East Primaries. The West Primaries could be decommissioned, therefore, for the following reasons:

- The East Primaries have sufficient treatment capacity to accommodate maximum month flows.
- Under peak flow conditions, the primary treatment process could be partially bypassed without negatively impacting the wastewater treatment process because a major component of the wastewater would be comprised of stormwater runoff, and not residential wastewater.
- Both the West and East Primaries require significant upgrades, consisting of structural rehabilitation and corrosion-prevention measures. Even if the cost of upgrading the West Primaries were incurred, with a capacity of only 50 mgd, bypassing at least 20 mgd during peak flow events would still be required. Replacing the West Primaries with a new 70 mgd facility is estimated to cost $18 million±.
- Odor control is planned for implementation during upgrades to the primaries. This would be a major cost saving if it were not implemented at the West Primaries.

Based on all these limitations, it is recommended that the West Primaries be phased out.

Improvements to the East Primaries would be implemented in phases over a 10-year period. During that implementation period, the West Primaries would continue to be utilized as each quadrant of the East Primaries is taken offline for rehabilitation. The West Primaries would then be decommissioned once all four quadrants of the East Primaries have been rehabilitated.

Part of the rehabilitation of the East Primaries would include a more detailed hydraulic evaluation to determine the modifications necessary to improve flow accommodation, and possibly increase the hydraulic capacity. Provisions for chemical addition should also be included as part of the rehabilitation efforts.

The addition of iron salts and polymer to influent wastewater is commonly used in the industry to chemically enhance the precipitation of solids. This increased removal in the primary treatment phase not only decreases the organic load on the secondary treatment process, but also increases the amount of primary settled sludge, which increases the feedstock to the digesters resulting in increased gas production. Iron salts are also very effective in binding and precipitating phosphorus, which prevents the phosphorus from forming struvite depositions, which are a costly O&M issue in digesters.

Additionally, iron salts will reduce the future costs for the plant to draw off and treat foul air as well as to minimize the corrosive impacts of H2S generation.

Condition (rehabilitation/replacement) is the primary trigger for this improvement, and improved performance benefit the secondary trigger.

3.4 Fine Screening Analysis

The plant currently has 5/8-inch opening coarse screens at Headworks 1 and Headworks 2. While these screens remove the majority of the coarse material from the influent stream, a significant quantity of material still passes through to the various treatment processes. Plant staff has reported that significant maintenance time is required to remove this material from various downstream process equipment.

Fine screening, with 5 to 6 millimeter (mm) (approximately 1/4-inch) openings, would improve materials removal significantly. The best location in the treatment process for fine screening is dictated by the intended goal. For example, the City of Roseville implemented fine screening of its secondary effluent to improve performance of their continuous backwash filters, and improve final effluent quality. The City of Atlanta implemented fine screening of their headworks effluent to reduce the maintenance requirements in their treatment process, but also to improve the quality of their Class A solids.

Fine screening was evaluated from a planning level perspective for three potential streams at the WPCP: 1) the influent stream (following coarse screening), 2) primary effluent, and 3) the primary sludge and waste activated sludge (WAS) streams.

Details of the evaluation are provided in Appendix D, and can be summarized as follows:

- Influent Stream Screening. While fine screening of the influent stream will reduce the maintenance effort required in all the downstream processes, it will require the construction of a sizeable facility which would require significant odor control and would add a substantial materials handling step to the overall treatment process.

- Primary Effluent Stream Screening. While primary effluent screening is expected to improve the efficiency of the secondary treatment process, it is currently only utilized to protect the membranes in membrane bioreactors (MBRs), to screen out snails following trickling filters, and on a very small scale outside the US, either in lieu of primary treatment, or in the pilot stages of development. In addition, since the primary settled sludge, which is treated further in the solids treatment processes, would not have been fine screened the potential benefit to the downstream solids treatment processes would be missed. The final biosolids product, therefore, would also not benefit from this screening step.
- Primary Sludge/WAS Screening. Fine screening of the primary sludge and WAS streams will benefit the solids treatment processes, although it will not have any benefits for the liquid treatment processes. One of its major benefits would be a final biosolids product that will be of a much higher quality (essentially free of nuisance materials), which would potentially increase its market value and disposition options.

Conceptual layouts and capital cost estimates were developed for influent flow and primary sludge/WAS fine screening, and are provided in Appendix D. The cost of a fine screening facility for the full influent stream was estimated at almost $50± million, while a primary sludge/WAS fine screening facility was estimated at approximately $8± million. Due to this large capital cost difference, in combination with avoiding the O&M efforts associated with the substantial materials handling resulting from fine screening of the full influent stream, screening of the primary sludge/WAS is recommended. The proposed location of this facility is shown on Figure 3.

This project has primarily a policy decision trigger, since the final solids product would be of a much higher quality and therefore potentially easier to market as a useable product. The secondary trigger is improved performance benefit to the sludge handling facilities from the reduced maintenance effort. Therefore, even though this is not a critical facility, the timing of its implementation should be linked to the timing of transitioning to mechanical sludge dewatering.

4.0 SECONDARY TREATMENT

4.1 Short-Term Secondary Treatment Improvements

The secondary treatment process consists of two separate sets of aeration basins, each with dedicated secondary clarifiers and return activated sludge (RAS) and WAS pumping facilities. Originally these two plants were operated in series, i.e. primary effluent was fed to the first plant, called the Secondary Plant, where primarily BOD was removed. The effluent from the Secondary Plant was fed to the second plant, called the Nitrification Plant, where primarily nitrification took place.

Figure 3
RECOMMENDED LOCATION OF PRIMARY SLUDGE AND WAS FINE SCREENING FACILITY
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

The process has since been modified and optimized such that BOD removal, nitrification, and denitrification can all be achieved in both the Secondary and Nitrification Plants. The single-plant system (operating in series) had been converted to a dual-plant system (operating in parallel). The names of these two plants consequently changed from Secondary to BNR1, and Nitrification to BNR2, indicative of this major change in operational approach.

To further improve secondary treatment operations, two short-term improvements have been identified and recommended for early implementation.

4.1.1 Aeration Header Connections

A major component of the secondary treatment process is the introduction of large quantities of air into the wastewater. This effort exerts the single largest energy demand of the treatment plant, and any efforts to increase efficiency would have a significant impact on the overall energy demand. The aeration blowers for BNR1 are located in two (2) separate locations, connected by an air header: 1) secondary blower building (SBB), and 2) Building 40. BNR2 has its own blowers located in the nitrification blower building (NBB).

The blowers in these different locations are different in size and capacity. Therefore, as aeration demand fluctuates throughout the day in response to influent flow fluctuations, different combinations of blowers provide the best efficiency (and lowest energy) aeration to suit. However, since there is no connection between the BNR1 and BNR2 blowers, there are limits to the best efficiency points attainable within each system.

Furthermore, if the blower systems were connected, the engine-driven SBB blowers would allow digester gas to be used for all secondary treatment, which is consistent with the City's goal of using "green" energy. Such a connection would also improve operational flexibility.

Figure 4 presents a proposed aeration header pipe alignment that would connect SBB and Building 40 blowers to the NBB.

Economic benefit is the primary trigger for this new connection, since digester gas produced at the facility will potentially be used for all aeration, and aeration to both secondary treatment systems can be provided at improved efficiencies. The secondary trigger is improved performance due to the added operational flexibility that this provides.

4.1.2 BNR1-BNR2 Connection

In the secondary treatment system the mixed liquor generated in the aeration basins is sent to the clarifiers to separate into two components: the settled sludge and the clarified effluent. The effluent is sent to the tertiary treatment complex for polishing and disinfection before discharge, while most of the sludge is returned to the aeration basins for treatment of incoming wastewater. Therefore, the secondary clarifier capacity has a large impact on the overall capacity of the secondary treatment system.

Figure 4
AERATION HEADER PIPE ALIGNMENT FOR RECOMMENDED SHORT-TERM SECONDARY AERATION SYSTEM IMPROVEMENT
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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BNR1 has approximately 80 percent more aeration basin capacity than BNR2, but also approximately 15 percent less clarifier capacity than BNR2. Since BNR2 has a much higher aeration basin capacity, flows to the WPCP during the dry summer months are low enough to allow BNR2 to be taken out of service. BNR2 is then brought back online once the flows start increasing during the wet season. However, if more clarifiers were available to BNR1, this would allow BNR2 to stay out of service for a greater portion of the year, thereby decreasing the overall operating costs associated with the secondary treatment system.

An inter-connection between BNR1 and BNR2 would allow the BNR2 clarifiers to be used with the BNR1 system. The inter-connection would entail construction of pipelines that would carry mixed liquor from BNR1 to the BNR2 secondary clarifiers, and RAS from the BNR2 wet wells pumped back to the BNR1 RAS wet wells. Figure 5 presents proposed mixed liquor and RAS pipe alignments. Aside from the higher aeration basin capacity of BNR1 compared to BNR2, the BNR1 water surface elevation is approximately five (5) feet higher than BNR2, which would allow gravity flow of mixed liquor to BNR2. This configuration would add clarification capacity only to BNR1, and would be non-reversible.

Improved performance benefit is the primary trigger for this connection, since the BNR 2 secondary clarifiers would be available to the BNR 1 facility during low flow periods of the year. The secondary trigger is economic benefit, since this would allow BNR 1 to use the clarifiers that are in the best condition, thereby potentially delaying clarifier improvements.

4.1.3 Cost Estimate

Planning level cost estimates for the recommended short-term improvement projects are presented in Table 4. The cost presented for the BNR1-BNR2 connection represents the connection of all sixteen BNR2 clarifiers to BNR1. These cost estimates are representative of the two conceptual alignments presented in this section. Alternative configurations could possibly be developed during the pre-design phase of these projects.

Table 4 Summary of Planning Level Cost Estimates for Short-Term Improvements
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alternative	Project Cost(1)
Aeration Header Connection	$4 MM±
BNR1-BNR2 Connection (16 clarifiers)	$13 MM±

Note:
(1) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.

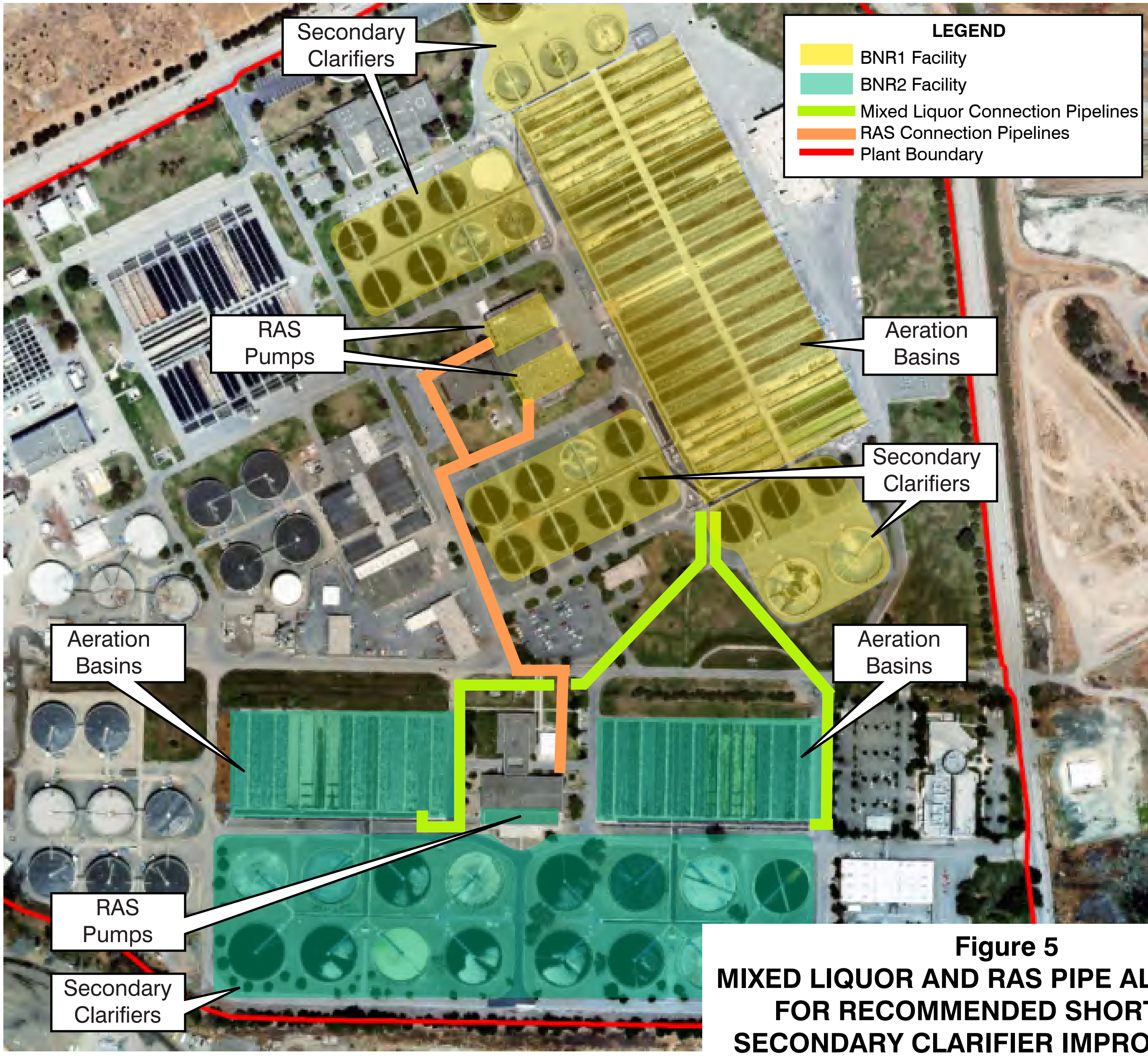

Figure 5
MIXED LIQUOR AND RAS PIPE ALIGNMENTS FOR RECOMMENDED SHORT-TERM SECONDARY CLARIFIER IMPROVEMENTS
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Due to their immediate benefits, these two projects should be considered for near-term implementation (next five to ten years).

4.2 Long-Term Secondary Treatment Improvements

The long-term planning for the secondary treatment system needs to consider not only the expected increase in wastewater flow, but also future effluent quality treatment objectives. Criteria were developed to select from several potential secondary treatment alternatives, which were evaluated in further detail. Planning level costs and footprint requirements were developed as part of that analysis.

4.2.1 Treatment Objectives

Based on the current and anticipated future effluent discharge regulations presented earlier, three treatment objectives were identified for secondary treatment:

- Ammonia: < 3 mg-N/L
- Total Nitrogen (TN): < 8 mg-N/L
- TN: < 3 mg-N/L

The first treatment objective (ammonia < 3 mg-N/L) represents the existing permit requirements. The second and third treatment objectives represent a future regulatory condition where TN removal would be required. A TN < 3 mg-N/L represents the approximate limit of technology for existing secondary processes. Based on discussions with the Regional Water Quality Control Board, these more stringent TN requirements are two to three permit cycles from implementation.

The TN limits are assumed to be regulated on an annual average basis. This is a typical monitoring requirement for plants that have a TN requirement. Annual average or seasonal is considered appropriate since receiving water eutrophication is not affected by short-term variations in effluent nitrogen.

4.2.2 Preliminary Screening Criteria

Secondary processes were screened out based on three criteria listed below:

- Make use of existing facilities (to minimize cost).
- Minimize external carbon source (e.g., methanol) use for TN removal.
- Proven at large scale.

Secondary treatment alternatives represent a place holder for both planning CIP budgets as well as land requirements. It may be that there are future developments in secondary treatment that would be more appropriate. Emerging technologies should continue to be evaluated by the City, and should be pilot tested where appropriate.

While the Regional Water Quality Control Board has indicated that phosphorus removal requirements are not anticipated for the WPCP (TAG, 2009), all of the alternatives retained after screening could accommodate future modifications to achieve phosphorus removal, should it ever become necessary.

4.2.3 Conclusions/Recommendations - Secondary Treatment Alternatives Analysis

The alternatives analysis identified four treatment technologies (which passed the preliminary screening criteria) that could address the identified treatment objectives:

- **Nitrification with Anaerobic Selector (NAS).** The NAS approach is a two-stage system consisting of an anaerobic zone followed by a larger aerobic zone. The volumes of these two zones are split into a one to three ratio. The secondary treatment system could transition to NAS once the current step-feed mode of operation is no longer able to meet the existing discharge regulations (ammonia < 3 mg/L). According to the flow and load projections, this should be expected around approximately the year 2026. However, if the discharge requirements were to become more stringent, NAS would need an additional denitrification treatment step, such as denitrification filters.
- **Modified Ludzack-Ettinger (MLE).** The MLE process is a two-stage system consisting of an anoxic and aerobic zone. There is an internal mixed liquor recycle (IMLR) stream that returns mixed liquor from the aerobic zone (nitrate rich) to the anoxic zone (carbon rich) to promote TN removal. An external carbon source can be added to the anoxic zone to promote additional TN removal.
- **4-Stage Bardenpho.** The first two stages of the 4-stage Bardenpho process are identical to the MLE process. A subsequent anoxic zone followed by an aerobic zone makes up the third and fourth stages of the process. An external carbon source is added to the second anoxic zone to promote additional TN removal.
- **Membrane Bioreactor (MBR).** The MBR process makes use of membranes (either ultrafilters or microfilters) for solid-liquid separation which eliminates the need for secondary clarification. The MBR process can be configured for TN removal in the MLE configuration or the 4-stage Bardenpho configuration. The process is not as efficient as the activated sludge counterparts for TN removal because of the high recycle rate that is required from the membranes (up to 400 percent of influent, compared to 25 to 100 percent for secondary clarification). External carbon source is added as needed.

A detailed process evaluation was performed, which comprised various combinations of these technologies, as detailed in Appendix E. Details of the process modeling needed for the evaluation are provided in Appendix F.

From this evaluation, the following conclusions were made:

- If the existing discharge regulations (ammonia < 3 mg/L) remain unchanged, the current step-feed mode of operation would be sufficient for some time into the future. According to the flow and load projections, the secondary process would need to be modified to NAS around the year 2026.
- To meet a TN < 8 mg/L, NAS (with denitrification filters) and MLE are the least expensive alternatives. Of these two alternatives, MLE would have a life-cycle cost of approximately seven (7) percent less than MLE, in spite of the requirement of an additional treatment step. However, the MLE approach would require significantly less methanol addition than NAS, which would be more in keeping with the WPCP 2040 Vision of minimizing chemical addition.
- A hybrid alternative that meets a TN < 8 mg/L (consisting of MLE and a 50 mgd MBR facility), has a much higher life-cycle cost, and is not considered feasible. In addition, construction of the first phase of the Advanced Water Treatment Facility (AWTF), which consists of microfiltration, reverse osmosis, and UV disinfection, is currently underway. It is a facility that the Santa Clara Valley Water District, in partnership with the City of San José, intends to operate at an initial capacity of 10 mgd, with the possibility to expand to 40 mgd. The construction of this membrane facility eliminates the need for MBR treated effluent. Should the subsequent phases of this membrane facility also be implemented, almost all of the projected water reuse flows will have been met, which would eliminate the driver for the MBR facility.

Regulatory requirement is the primary trigger for this improvement, i.e., TN <8 mg/L. If a future regulatory requirement is implemented, a limit of TN < 8 mg/L is more likely than a limit of TN < 3 mg/L. Increased flows is the secondary trigger, which would necessitate the transition from the current step-feed operation to NAS around 2026, at the current flow and load projections.

4.3 Additional Considerations for Secondary Processes

The impacts of the following aspects of the secondary treatment process warrant further discussion: 1) recycle streams, 2) waste minimization, 3) primary effluent flow and loading equalization, 4) nuisance foam control, 5) biological struvite control, and 6) secondary treatment system hydraulics. A more detailed discussion of each is provided in Appendix G.

- **Impact of Recycle Streams.** Recycle streams can impose a significant BOD, TSS, and ammonia load on secondary treatment. One way to mitigate the impact is to equalize the return stream, which would help avoid shock loads to the system. Another approach is to consider side-stream treatment, especially for nitrogen removal. The DEMON® process is an example of a side-stream nitrogen removal system that represents an emerging technology. The process is capable of up to 90 percent ammonia removal and consists of a sequencing batch reactor (SBR) designed for deammonification through pH and DO control. The deammonification process is comprised of two metabolic steps: 1) approximately half of the ammonia is oxidized to nitrite and 2) the remaining ammonia is anaerobically oxidized to nitrogen gas using nitrite. The deammonification process eliminates the need for an external organic carbon source and significantly reduces the process oxygen requirements when compared with conventional nitrification.

Both existing and developing side-stream treatment technologies should continue to be evaluated in the future to mitigate these impacts. This ammonia-rich recycle stream would be linked to the transition of a more mechanized biosolids dewatering process.

- **Impact of Waste Minimization.** Neither food waste separation (FWS) nor urine separation would have a significant impact on influent flow. FWS would have a significant impact on BOD and TSS loading. Urine separation would have the greatest impact on influent nitrogen, and a lesser impact on TSS. Both FWS and urine separation would reduce aeration requirements, while FWS would significantly reduce additional aeration basin requirements for the MLE scenario. However, the City is not considering FWS or urine separation at this time.

- **Primary Effluent Flow and Loading Equalization.** Currently, primary effluent is equalized on a daily basis in a 16 MG equalization basin to minimize the impact of diurnal loading to the secondary system. This allows for a more consistent loading pattern to the secondary system. Expanding this current practice to include ammonia load equalization would further contribute to the stable operation of the secondary process.

  The flow and ammonia equalization requirements were estimated for the 2010 and projected 2040 flows and loads. Based on the projected 2040 flows, the analysis showed the equalization basin would have to be increased from 16 MG to 23 MG to continue flow equalization, i.e. an increase of 7 MG. Based on the projected 2040 ammonia loadings, an equalization capacity of 28 MG would be required, i.e. an increase of 12 MG. Based on the added operational benefit of ammonia equalization, the construction of an additional 12 MG equalization basin is recommended. Improved performance benefit is the primary trigger for this improvement, with economic benefit the secondary trigger.

- **Nuisance Foam Control.** Nuisance foaming is a serious issue in the secondary treatment system, made worse by the plant’s transition to fine-bubble aeration because it generates more foam, and induces less mixing. While there are a number of ways to combat nuisance foaming, such as surface chlorination, anaerobic and anoxic selectors, SRT control, etc., the use of classifying selectors holds particular promise. They function as physical removal mechanisms by which foam-causing organisms, enriched into the solids in the foam, are systematically removed from the treatment system. Since these organisms are continually wasted, they are prevented from being trapped in the treatment system, and from accumulating to nuisance level concentrations.

The design of the aeration basins at the WPCP is fundamentally at the heart of the problem because underflow between compartments and the discharge to the clarifiers causes foam-causing organisms to be trapped throughout the reactors. It is recommended that a detailed assessment be conducted of the modifications required to allow surface wasting from the aeration basins, and to compare them to the possible introduction of surface wasting installations in the mixed liquor channels to the secondary clarifiers, or in the RAS tanks prior to return to the aeration basins. This assessment should be conducted within the next 5-year period.

- **Biological Struvite Control.** Struvite (ammonium magnesium phosphate) is a phosphate mineral that crystallizes into a hard white to brownish-white substance. It is particularly problematic in the anaerobic digestion system where ammonium and phosphate is released from the sludge, scaling on equipment and clogging pipelines. One approach to limiting struvite formation is to limit the amount of phosphorus contained in the waste activated sludge (WAS) from the secondary treatment system. This limits the amount of available phosphorus in the digesters, and reduces struvite formation. This can be done by introducing an oxygen-rich internal mixed liquor return (IMLR) stream from the aerated zone to the anoxic zone.

  The MLE process, proposed as one of the alternatives to meet a potential future TN < 8 mg/L limit, already utilizes IMLR, and is expected to limit phosphorus uptake. However, a modification to the current step-feed mode of operation was considered, and entails the addition of IMLR, although at a much lower flow rate than is required by the MLE process.

- **Nitrogen Removal.** Step-feed with an IMLR of greater than 150 percent results in a similar nitrogen removal performance as MLE with an IMLR of 400 percent. This shows that the introduction of IMLR into the step-feed process will meet the target TN at a much lower IMLR than required for the MLE process, which will significantly lower the associated energy costs.

- **Phosphorus Removal**. While an IMLR of 150 percent in the step-feed mode is sufficient to meet the TN requirement, it results in only approximately 10 percent reduction of phosphorus to the digester. To maximize the reduction of digester phosphorus loading, and offer an improvement over the MLE process, an IMLR of 300 percent would be recommended for the step-feed configuration. However, under these operating conditions, the difference in IMLR operating costs between the two processes would not be as dramatic.

  The capital cost for this treatment approach is expected to be very similar to MLE, since both approaches would require a similar addition of aeration basins. However, the smaller IMLR would result in a reduced O&M cost compared to MLE. Therefore, this treatment approach would have a life-cycle cost between NAS (with additional denitrification) and MLE. It would also have a regulatory requirement primary trigger, similar to the other secondary treatment process alternatives. However, its secondary trigger could be economic benefit due to the potential limiting of struvite formation.

- **Secondary Treatment System Hydraulics.** Two secondary treatment modes of operation are recommended for consideration to meet a possible future discharge regulation of TN < 8 mg/L, namely NAS (with additional denitrification), and MLE. A third treatment mode, namely Step Feed with IMLR, was also considered because of its potential to reduce struvite in the digesters, at a lower IMLR flow rate than required for MLE.

  While all three of these modes of operation have been shown to meet the target TN removal objective, additional analysis was required to verify their hydraulic capability of accommodating the PHWWF. The analysis shows a minimal freeboard exists in both the aeration basins and the secondary clarifiers for all these modes of operation under PHWWF conditions. However, these conclusions are based exclusively on hydraulic modeling results and it is imperative, therefore, that the results be field verified.

  Details of the assumptions which the hydraulic analysis was based on, and key results of the modeling effort, are provided in Appendix G.

5.0 FILTRATION

5.1 Major Master Planning Decisions

The major master planning decisions to be made for the filtration treatment system are the following:

- Whether all or only a portion of the secondary effluent stream requires filtration.
- Whether all or only a portion of the existing filters should be refurbished.
- Whether the existing filters should be abandoned altogether and replaced with an alternative technology.

5.2 Major Filtration Considerations

Some of the major considerations affecting filtration decisions can be summarized as follows:

- The WPCP treatment process is capable of maintaining a very consistent level of treatment in spite of wide diurnal flow fluctuations to the plant. Due to these fluctuations, there is some variability in the effluent TSS. Filtration of a portion of the effluent and blending with the unfiltered effluent will provide the WPCP some protection against this effluent TSS variability, and consistency in meeting discharge requirements.

- Possible future CEC regulations may require the filtration of all secondary effluent.

- Switching to UV disinfection would require the filtration of all of the secondary effluent. (See Appendix H.)

- A future discharge regulation of TN <8 mg/L would require full filtration with any of the three viable secondary treatment alternatives (NAS with denitrification, MLE, and Step-feed with IMLR).

- In future, should 100 percent of the final effluent go to reuse[1], this would require filtration for the entire stream.

- The existing filter complex needs significant refurbishment.[2]

- The NAS alternative would require an additional denitrification step, which could be combined with the prerequisite filtration in denitrification filters.

5.3 Conclusions/Recommendations - Filtration Alternatives Analysis

The WPCP currently filters a portion of the secondary effluent stream to reuse standards, and the remainder to the standards required for discharge to San Francisco Bay. The capability exists to partially bypass the filters and disinfect in the discharge slough, where it would be blended with the filtered and disinfected stream. This is the practice typically utilized during peak flow events.

Reuse in 2040 is expected to increase to 55 mgd, of which 20 mgd is assumed to be met with the new AWTF (10 mgd currently under construction, expected to expand at least to 20 mgd by 2040). Under this assumption, the remaining 35 mgd of projected reuse will be generated by the WPCP. Of the projected 2040 secondary effluent ADMMF of 200 mgd, 145 mgd will therefore have to be filtered (or partially filtered) for bay discharge.

Plant data have shown that the effluent TSS standard of 10 mg/L for bay discharge could potentially be met without filtration. However, due to variability in secondary effluent TSS concentration inherent to the wastewater treatment process, filtration of at least a portion of the secondary effluent stream should be provided to consistently meet the discharge

[1] City of San José Green Vision.
[2] Infrastructure Condition Assessment, CH2MHILL, May 2007 report.

regulations. While partial filtration could be implemented, there are a number of drivers for full filtration of the secondary effluent stream, namely:

- Future CEC regulations may require full filtration.
- The City's collimated beam tests, conducted in 2007, show that transitioning from hypochlorite to UV disinfection would require filtration of the full secondary effluent stream.
- A possible future discharge regulation of TN <8 mg/L would require full filtration of the effluent streams of all three viable secondary treatment alternatives, namely NAS with denitrification, MLE, and Step-feed with IMLR.
- In future, all final effluent may go to reuse, for which full filtration is a Title 22 requirement.

Due to the age and condition of the existing tertiary filters, a significant investment would be required to refurbish and retain them for future use. In the interim, the existing filtration facilities should be maintained to allow the continued production of reuse water, and at a minimum, partial filtration of bay discharge. The refurbishment effort that is currently underway on one of the filters, which includes replacing the underdrain system and filtration media, should be used to ascertain whether refurbishment and continued use of the filters is feasible. If this full-scale demonstration is successful, a detailed evaluation for the refurbishment of the remainder of the filters should be completed.

In lieu of (or in combination with limited) refurbishment of the existing filters, new filters could be installed. A wide variety of alternate filter technologies are available, with new technologies continuing to be introduced to the market. The ultimate filtration objective will dictate which technology may be most appropriate for the plant.

Due to the variability in secondary effluent generated at every wastewater treatment plant, filtration characteristics can vary significantly. Therefore, it is appropriate to pilot any potential technology before full-scale implementation, especially in light of the vast amount of research ongoing in this field. Since the piloting effort would likely be conducted over a number of years, the existing filters would need to be maintained to allow 1) the continued production of Title 22 reuse water, and 2) the partial filtration of bay discharge effluent.

Planning level project costs are presented in Table 5, which indicate that refurbishment and continued use of the existing filters would be less costly than new tertiary filters or a combination of denitrification and tertiary filters. However, these should be used as placeholder costs only, since the outcome of future pilot testing may identify a potential lower cost filtration technology.

Notes:

1. 35 mgd is for reuse
2. 145 mgd is for bay discharge. This assumes an NAS process with a TN limit of 8 mg/L-N.

Figure 6
NEW 180 MGD
DENITRIFICATION PLUS TERTIARY FILTRATION FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Table 5	Representative Filtration Alternatives San José/Santa Clara Water Pollution Control Plant Master Plan City of San José
Alternative(1)	**Cost(2)**
Upgrade existing filter building	$50 million(3)
New tertiary filters	$65 million
New Tetra denitrification plus tertiary filters	$100 million

Notes:
(1) Sufficient for filtration of the full ADMMF, less 20 mgd secondary effluent routed directly to the AWTF.
(2) All costs are presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) From Infrastructure Condition Assessment Report, May 2007, CH2MHILL.

It is recommended that a large site footprint be set aside to accommodate a variety of possible ultimate filtration technologies (Figure 6). To ensure sufficient space is available for whichever technology is ultimately selected, the footprint associated with denitrification with tertiary filters(sufficient for the NAS secondary treatment alternative to meet a TN <8 mg/L limit) has been used as placeholder for site planning purposes.

Further details of the filtration alternatives analysis are presented in Appendix I.

Condition (rehabilitation/replacement) would be the primary trigger for replacing the existing filters, and the secondary trigger would be improved performance benefit.

6.0 DISINFECTION

6.1 Major Master Planning Decisions

The major master planning decisions to be made for the disinfection treatment system are the following:

- Whether the current hypochlorite mode of disinfection should be retained, or replaced with an alternative disinfection technology, such as UV (peak flows will continue to be disinfected with hypochlorite).
- Since the future of possible CEC regulations is uncertain, how best to make provisions to accommodate them in the disinfection system plan.

6.2 Major Disinfection Considerations

Some of the major considerations affecting disinfection decisions can be summarized as follows:

- Since UV is considered the most proven alternative disinfection technology at large-scale wastewater facilities, pasteurization and ozone were not considered further.

- Currently peak flows and filter bypass flows are not disinfected in the chlorine contact basins, where disinfection and contact times are carefully controlled. Instead, these flows are disinfected either at the filter influent pump station (FIPS) or in the artesian slough, where conditions are difficult to control and a consistent contact time is hard to achieve. As part of the PMP, plant staff set an objective to disinfect all flows in the contact basins, including PHWWF[3]. Therefore, in all disinfection alternatives presented in the evaluation below, peak flows would be chlorinated with sodium hypochlorite in the chlorine contact basins.

- The City has recently completed construction and commissioning of new disinfection facilities, thereby converting from gas chlorination to hypochlorite disinfection.

- Advanced oxidation is the only current alternative shown to be effective in the treatment of CECs.

6.3 Conclusions/Recommendations - Disinfection Alternatives Analysis

Life-cycle cost assessments were prepared for hypochlorite disinfection and UV disinfection, and included the following scenarios:

- Refurbishment of the existing facilities vs. constructing new facilities.

- For hypochlorite disinfection, continue purchasing hypochlorite vs. generating hypochlorite on site.

Details of the assessments are provided in Appendix J. Some of the key conclusions are the following:

Chlorination:

- The cost to refurbish the existing chlorine contact basins (CCBs), which would include adding one new CCB for peak flows, is approximately $15 million less than constructing all new CCBs.

- The addition of onsite hypochlorite generation facilities results in a lower life-cycle cost compared to purchased hypochlorite (see Tables 6 and 7). The payback period for these facilities would be between seven and ten years, depending on the increases in the purchase price of hypochlorite.

UV:

- It costs more to use the existing CCBs for UV disinfection than to construct new UV facilities because of the size constraints of the existing channels.

[3] Meeting with plant staff held on September 18, 2009.

Chlorination vs. UV:

- If the WPCP transitions to full filtration, the life-cycle cost comparison shows UV to be significantly less expensive than chlorination assuming purchased hypochlorite, but comparable to chlorination when using on-site hypochlorite generation facilities (Table 6).

Table 6 Disinfection Alternatives Life-Cycle Cost Comparison For Equivalent Levels of Filtration(1)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Disinfection Alternative	Total Present Worth Cost
Refurbish Existing Disinfection Facilities	
Hypochlorite On-site Generation(2)	$57 MM
Hypochlorite @$0.7745/gal(2)	$80 MM
Hypochlorite @$1.00/gal(2)	$91 MM
UV(3)	$60 MM
New Disinfection Facilities	
Hypochlorite On-site Generation(3)	$72 MM
Hypochlorite @$0.7745/gal(3)	$95 MM
Hypochlorite @$1.00/gal(3)	$106 MM
UV(3)	$54 MM

Notes:
(1) Costs do not include filtration since full filtration is common to both chlorination and UV disinfection.
(2) Includes the cost of one (1) new CCB to accommodate peak flows of 47 mgd.
(3) Includes the cost of two (2) new CCBs to accommodate peak flows of 155 mgd.

- If partial filtration is maintained for chlorination, the life-cycle cost comparison shows chlorination costs to be comparable to UV (requiring full filtration). However, onsite hypochlorite generation has a significantly lower life-cycle cost than both chlorination with purchased hypochlorite and UV (Table 7). In addition, research is on-going into the possible beneficial use of the hydrogen byproduct resulting from onsite hypochlorite generation, namely as the electron donor in biological denitrification processes.

Treatment of CECs:

Industrialization and advancement in human lifestyle have resulted in the increased presence of man-made, mostly refractory, organic compounds in the environment. Of these, the CECs include endocrine disrupting chemicals (EDCs) and pharmaceuticals, and personal care products. Most CECs are life-improving drugs and useful household

Table 7 Disinfection Alternatives Life-Cycle Cost Comparison For Non-Equivalent Levels of Filtration(1)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Disinfection Alternative	TOTAL Present Worth Cost
Refurbish Existing Disinfection Facilities	
Hypochlorite On-site Generation(4,7)	$82 MM
Hypochlorite @$0.7745/gal(4,7)	$105 MM
Hypochlorite @$1.00/gal(4,7)	$116 MM
UV(5,9)	$110 MM
New Disinfection Facilities	
Hypochlorite On-site Generation(5,8)	$110 MM
Hypochlorite @$0.7745/gal(5,8)	$133 MM
Hypochlorite @$1.00/gal(5,8)	$144 MM
UV(5,10)	$129 MM

Notes:
(1) Costs include partial filtration for chlorination, and full filtration for UV disinfection.
(2) All costs are presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) O&M costs are considered over the 30-year life cycle of the project, and amortized to present worth using a real interest rate of 2%.
(4) Includes the cost of one (1) new CCB to accommodate peak flows of 47 mgd.
(5) Includes the cost of two (2) new CCBs to accommodate peak flows of 155 mgd.
(6) All costs are rounded up to the nearest million.
(7) Assumes half of the existing filters will be refurbished for $25 million.
(8) Assumes new tertiary filters will be constructed for a flow of 100 mgd (half of the 2040 ADMMF of 200 mgd) for $38 million.
(9) Assumes all the existing filters will be refurbished for $50 million.
(10) Assumes new tertiary filters will be constructed for full 2040 ADMMF for $75 million.

products, such as anti-bacterial agents and flame retardants. Due to their wide-spread use and range of application, effective source control of these compounds is infeasible until less refractory substitutes are developed. These compounds are discharged into the wastewater stream, and since conventional wastewater treatment processes are not effective in completely removing them, many are released into the environment through the discharge of final effluent.

An advanced oxidation process (AOP) will be required to address possible future CEC discharge regulations. A number of different treatment technologies can achieve a CEC destruction target of 90 percent, such as the addition of hydrogen peroxide or peracetic acid to a UV system, or ozone. Of these three AOP technologies, ozone has a life-cycle cost which is approximately 30 percent lower than that of hydrogen peroxide with UV.

In spite of the reduction in CECs that these AOPs achieve, there are compounds that are still able to pass through the treatment step unaffected. While ozone would appear to be the most efficient process, recent research indicates that flame retardants, for example, are not impacted by ozonation and would require a more elaborate treatment train. Research is ongoing into the most efficient and comprehensive process for the removal of CECs.

Due to this uncertainty, it is recommended that the outcome of ongoing research in the industry be monitored and evaluated before any definitive selection of AOP technology is made. Furthermore, since the disinfection and advanced oxidation processes are inter-related, it is recommended that any transition in disinfection technology be delayed pending the outcome of further CEC treatment research.

Footprint Requirements:

The largest site footprint would be based on installing new CCBs for chlorination during reuse, Bay discharge, and PHWWF conditions (Figure 7). Therefore, it is recommended that this space requirement be allocated for planning purposes. This is a placeholder footprint only, intended to provide sufficient land area for whichever final disinfection/advanced oxidation process is selected.

Economic benefit would be the primary trigger for switching to onsite hypochlorite generation or to UV disinfection. However, due to the inter-relationship between disinfection and advanced treatment processes required to meet possible future CEC regulatory requirements, a transition in disinfection technology should be delayed pending the outcome of further CEC treatment research.

7.0 PLANNING CONSIDERATIONS

The liquids treatment alternatives evaluation has assessed the major considerations, and identified solution alternatives for each unit process, as summarized in the following Table 8.

Notes:
1. Build 1 new CCB for reuse (34 mgd)
2. Build 2 new CCBs for discharge (146 mgd)
3. Build 2 new CCBs for PHWWF (155 mgd)

Figure 7
SODIUM HYPOCHLORITE USING NEW FACILITIES
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Table 8 Liquids Treatment Alternatives Summary
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Future Considerations and Trends	Impact on Strategic Plan
Raw influent PHWWF increases to 455 mgd (with recycle flows).	Retain and improve the raw equalization basin, and bypass the primary clarifiers directly to secondary treatment with flows in excess of 330 mgd.
Major maintenance required at Headworks 1.	Expand Headworks 2, and phase out Headworks 1.
Encroachment of commercial development on southern and western side of plant.	Implement aesthetic mitigation: <u>Odor control:</u> Cover the headworks and raw influent junction boxes, primary clarifiers, and dissolved air flotation thickeners (DAFTs), extract and treat the foul air. Line the raw equalization basin to allow rapid cleaning after peak flow events. <u>Noise and Visual:</u> Contain pumps, motors, etc. where possible.
Aging primary sedimentation infrastructure.	Improve the East Primaries, and phase out the West Primaries.
Improve plant operations and produce higher quality biosolids through fine screening.	Implement fine screening (5-6 mm openings) on primary sludge and WAS.
Anticipate more stringent nitrogen discharge regulations.	Accommodate flow and load growth only, i.e., continue step-feed operation, and modify operations to NAS mode around 2026. If TN <8 mg/L regulation is imposed, either stay with NAS mode of operation, but incorporate an additional denitrification step, such as denitrification filters, or transition to MLE mode or step-feed with IMLR, and include full tertiary filtration.
Improve power demand and maximize use of existing facilities.	Implement plant modifications, such as a connector between aeration systems, systematic conversion of coarse to fine bubble diffusion, expand the primary effluent equalization capacity to allow diurnal ammonia load equalization, improve the operation of the secondary clarifiers, and provide connector pipelines to incorporate BNR2 clarifier capacity into BNR1.
Major maintenance required at filtration facilities. Anticipate regulations or other drivers that will trigger the requirement for full filtration.	Perform minimal maintenance while piloting different candidate replacement filtration systems; systematically replace existing filters with selected filtration system; retain and upgrade only the portion of the existing filters that may form part of the final filter complex.
Transition from purchased hypochlorite to onsite hypochlorite generation, or UV disinfection.	Lay out footprint needs for the largest disinfection alternative, namely hypochlorite disinfection of reuse, Bay discharge flows, and PHWWFs; delay the transition to onsite hypochlorite generation or UV, in spite of the lower life-cycle cost of these two technologies pending further research into AOPs for the treatment of CECs.
Anticipate an increase in effluent reuse.	Expand reuse filtration and disinfection capabilities, taking into account the anticipated implementation and staged expansion of the AWTF.

REFERENCES

REFERENCES

1. Carollo (2010) “City of San José, California Headworks Condition Assessment Project.”
2. CH2MHill (2007) “Infrastructure Condition Assessment.”
3. Carollo (2008) “Ultraviolet Disinfection Bench Scale Data Analysis And Full Scale System Cost Estimates.”

APPENDIX A – SUMMARY OF PROJECTED RAW AND RECYCLE FLOWS

APPENDIX A – SUMMARY OF PROJECTED RAW AND RECYCLE FLOWS

A selection of the 2040 projected flows from PM 3.8 Projected Wastewater Flows and Characteristics, is presented in Table A-1.

Table A-1 2040 Projected Wastewater Flow Rates
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Type	ADAF	ADWIF	ADMMF	PHWWF
Raw	~172	~182	~195	~449
3% Recycle	~5	~5.5	~6	~6
Plant Master Plan Flow Rate	**~180**	**~190**	**~200**	**~455**

The liquids alternatives developed in this PM, however, have to include internal recycle streams. Figure A-1 shows the combined recycle streams for 2003 through 2007. These data show an average recycle stream of approximately two (2) million gallons per day (mgd) since the middle of 2004, with a period of higher flow variability during the second half of 2006. It is assumed that these higher flows are due to the return of treated filter backwash to the RSPS 1 wet well. The normal practice, however, is to return these flows to the disinfection contact channels.

The recycle flows are approximately three (3) percent of the influent flows during this period. For planning purposes, this percentage has been applied to projected flows up to the average day maximum month (ADMMF) flow. This constitutes approximately 6 mgd of the projected 2040 ADMMF. It is assumed that recycle streams do not increase above the ADMMF level during the peak hour wet weather flow (PHWWF). The calculated recycle flows, together with the total flows (raw plus recycle flows), are shown in Table A-1.

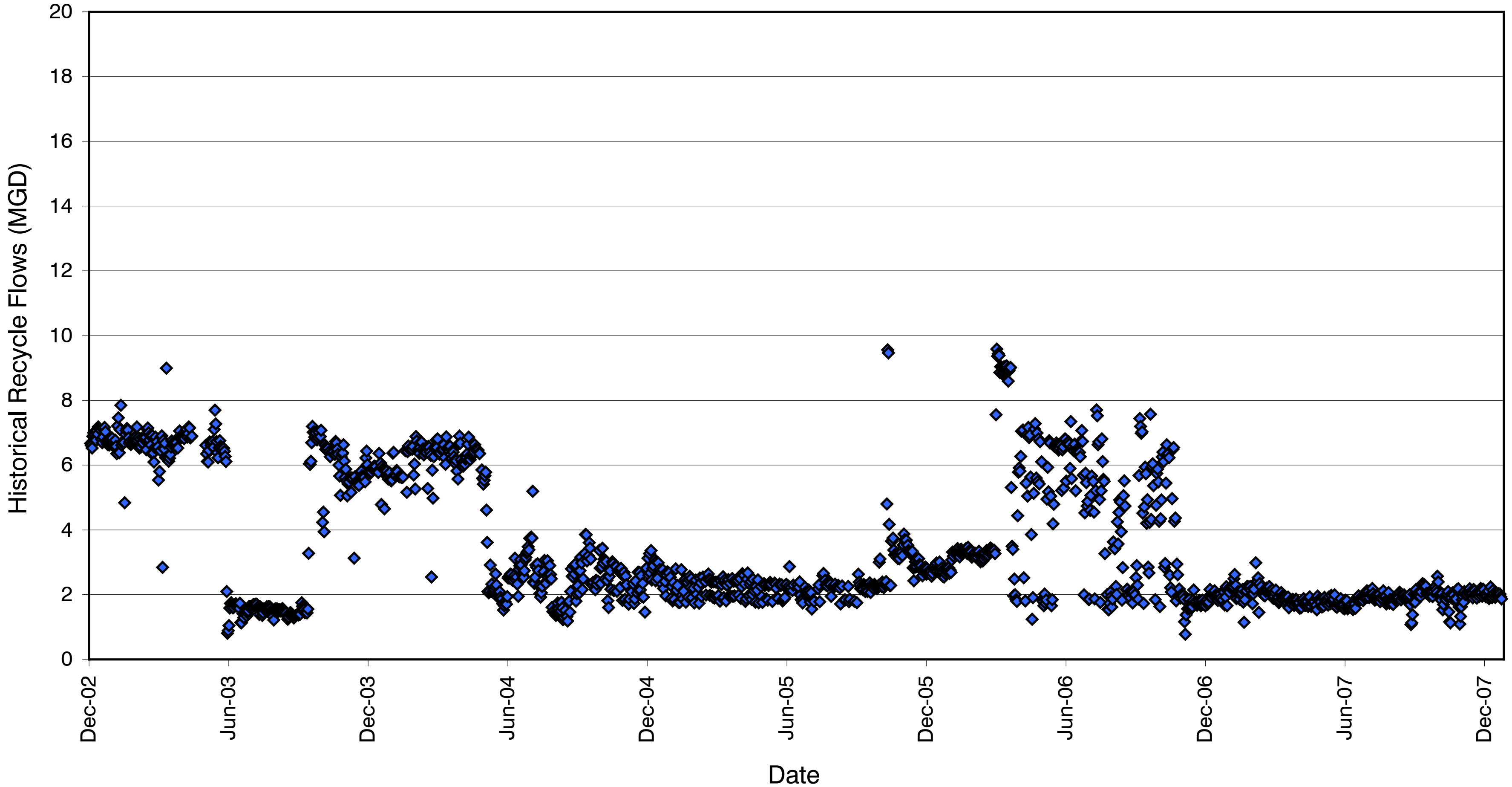

Figure A-1
HISTORICAL RECYCLE FLOW (MGD)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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APPENDIX B – PEAK FLOW HANDLING

APPENDIX B – PEAK FLOW HANDLING

ALTERNATIVE 1: RAW EQUALIZATION

Alternative 1 entails the following:

- Increasing the current raw equalization capacity to limit the PHWWF to 400 mgd
- Providing the necessary modifications to the downstream treatment processes to accommodate this reduced flow
- Using the existing primary effluent equalization to further reduce the flow to 355 mgd for secondary treatment

The existing raw equalization storage basin has a storage capacity of approximately 8 million gallons (MG). By increasing the capacity to 10 MG, the PHWWF to the headworks can be reduced from 455 mgd to 400 mgd. Without the increase in capacity, the PHWWF would only by reduced to 406 mgd, which is in excess of the headworks capacity.

The existing raw equalization storage basin is unlined, and has a design depth of approximately 6 feet. To increase the capacity to 10 MG, the design depth needs to be increased to 7 feet. This can be done by 1) raising the overflow weir by one foot, or 2) excavating the basin an additional foot. Both of these options are shown schematically in Figure B-1. The simplest of these two options is recommended, namely raising the overflow weir elevation by one foot.

In addition to increasing the capacity, the basin will need to be lined and may possibly require a cover.

The expanded Headworks 2 (Headworks 1 decommissioned) will have a capacity of 400 mgd (see main text), appropriate for the equalized flow.

Since the West Primaries will be phased out, primary treatment will be provided only by the East Primaries, which have a hydraulic (and process) capacity of 330 mgd (see main text). Due to this hydraulic limitation, 70 mgd (under peak conditions) from the headworks has to be bypassed directly to secondary treatment. There are two options to accommodate this bypass flow (see Figure B-2 for flow routing and associated flow rates):

- **Option 1**: Pump 70 mgd from RSPS 2 (at Headworks 2) directly to BNR 2:
  - The pipeline to provide this bypass capacity is already in place. However, during the expansion of Headworks 2, RSPS 2 will need to be modified to enable the simultaneous pumping of 70 mgd to BNR 2 and 330 mgd to primary treatment.

- 330 mgd will be treated in the East Primaries, and will then be routed to BNR 1 and BNR 2 (following primary effluent equalization) according to the flow rates shown on Figure B-2.

- **Option 2**: Install an 84-inch pipeline west of the East Primaries to bypass 70 mgd around primary treatment:
  - It is assumed that the existing 84-inch/72-inch diameter pipeline from primary clarification to the primary effluent pump station (PEPS) is adequate to convey 160 mgd (velocity = 6.4 feet per second [fps]). To convey the additional 70 mgd (total 230 mgd), an additional 60-inch diameter pipeline would be required.
  - To accommodate the additional 70 mgd, PEPS would need to be expanded from its current reliable capacity of approximately 160 mgd to 230 mgd (either including additional pumps and structurally modifying the pump station, or replacing the existing pumps with larger capacity pumps).

Planning level cost estimates are provided for these two options in Tables B-1 and B-2.

Table B-1 Alternative 1, Option 1: 10 MG Raw EQ Basin, 400 mgd Through the Front End of Plant, 70 mgd Primary Bypass Directly to BNR 2
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

	Element[3]		**Cost**[2]
1	Lining for Emergency Basin and modifications to increase storage capacity to 10 MG		$4,200,000
2	HW2 expansion to 400 mgd[1]		$29,600,000
	Subtotal		**$33,800,000**
	Construction Contingency	25%	$8,450,000
	CONSTRUCTION COST		**$42,250,000**
	Engineering, Legal & Administrative Costs	30%	$12,675,000
	TOTAL PROJECT COST		**$54,925,000**

Notes:
(1) Includes modification of RSPS 2 to simultaneously pump 70 mgd to BNR 2 and 330 mgd to primary treatment.
(2) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) Certain elements common to both alternatives not included.

A graphical representation of the distinguishing features between these options is shown on Figure B-3.

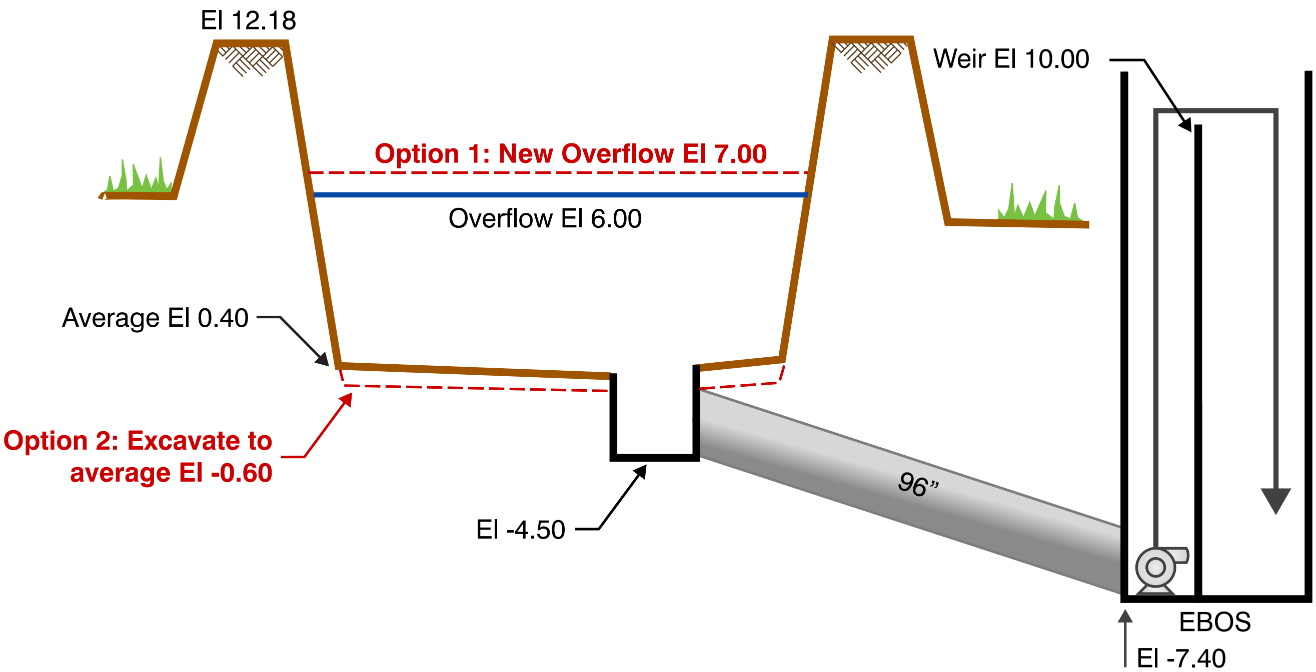

Figure B-1
INCREASING CAPACITY OF RAW EQUALIZATION BASIN FROM 8 MG TO 10 MG
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

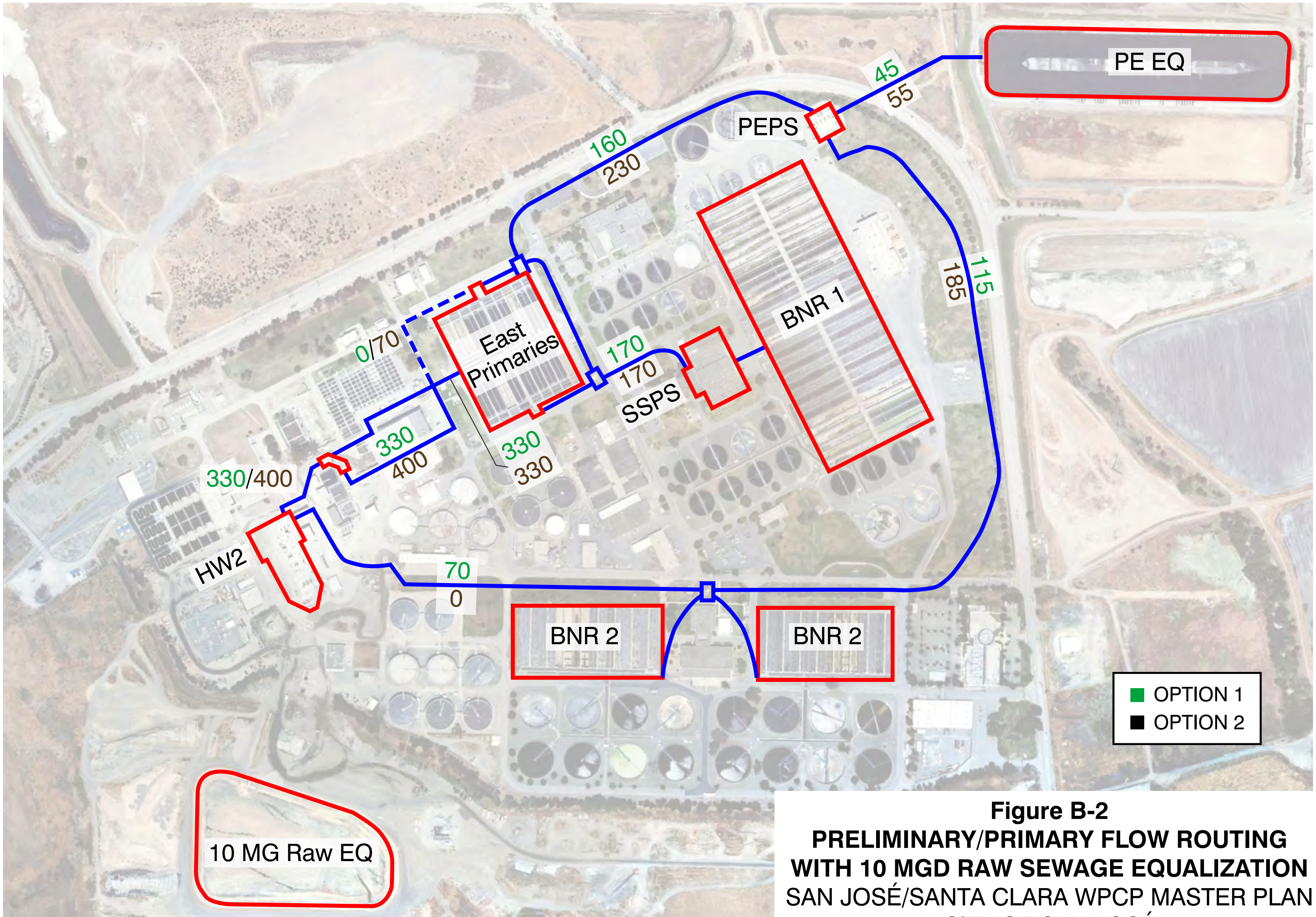

Figure B-2
PRELIMINARY/PRIMARY FLOW ROUTING
WITH 10 MGD RAW SEWAGE EQUALIZATION
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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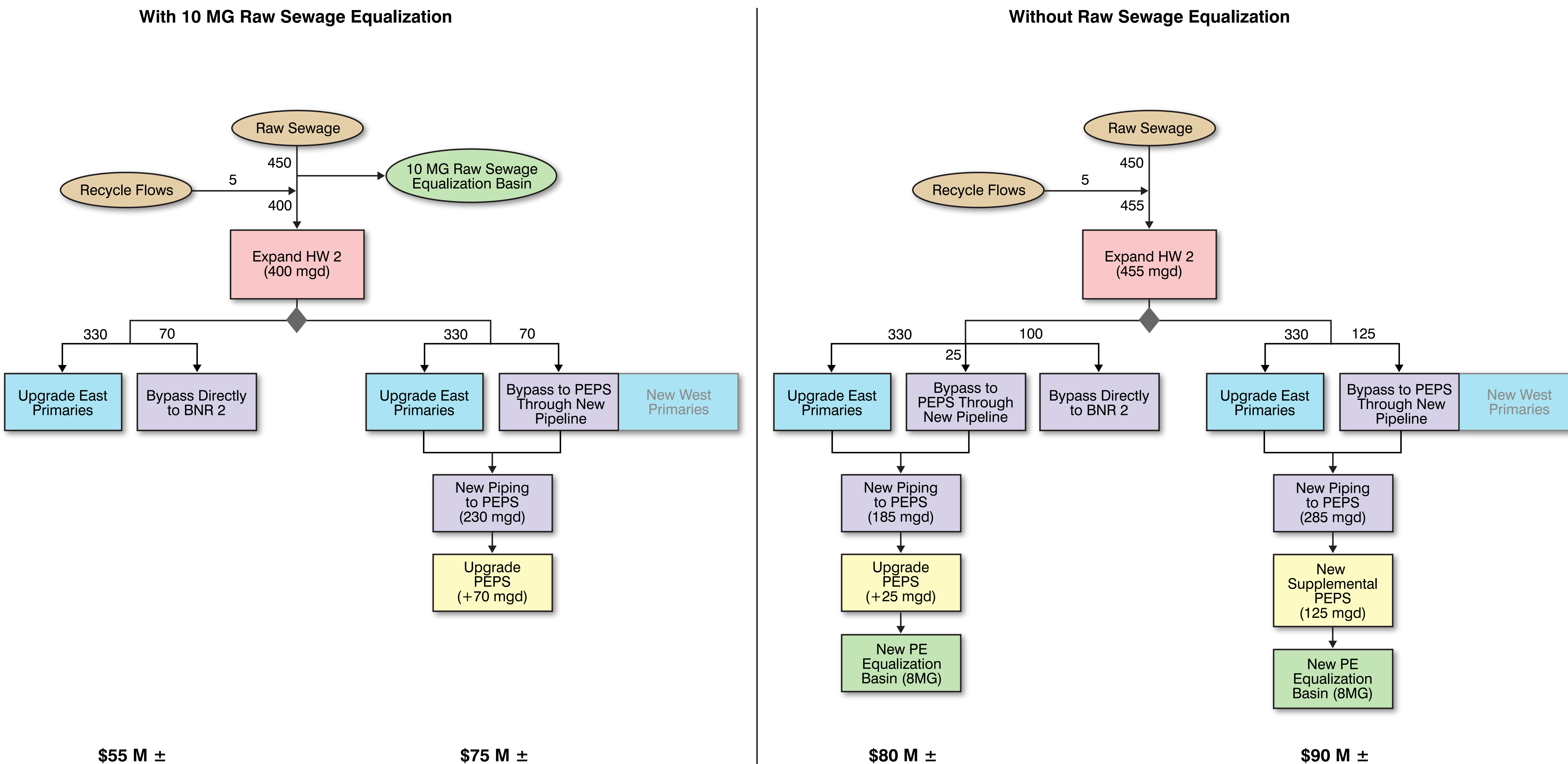

Costs are for comparison purposes only and do not include elements common to all alternatives, such as:
1) new influent piping from EBOS to HW 2; and 2) rehabilitation of East Primaries. Costs are presented in 2009 dollars.

Figure B-3
SUMMARY OF PRELIMINARY AND PRIMARY TREATMENT ALTERNATIVES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Table B-2 Alternative 1, Option 2: 10 MG Raw EQ Basin, 400 mgd Through the Front End of Plant, 70 mgd Primary Bypass to PEPS
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

	Element[1]		Cost[2]
1	Lining for Emergency Basin and modifications to increase storage capacity to 10 MG		$4,200,000
2	HW2 expansion to 400 mgd[3]		$29,600,000
3	84-inch diameter pipeline to bypass 70 mgd around primaries to PEPS[4]		$1,200,000
4	Additional 60-inch diameter pipeline to PEPS		$6,300,000
5	Upgrades to PEPS to 230 mgd capacity (additional approximate 70 mgd)		$3,900,000
	Subtotal		**$45,200,000**
	Construction Contingency	25%	$11,300,000
	CONSTRUCTION COST		**$56,500,000**
	Engineering, Legal & Administrative Costs	30%	$16,950,000
	TOTAL PROJECT COST		**$73,450,000**

Notes:
(1) Certain elements common to both alternatives not included.
(2) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) Includes modification of RSPS 2 to simultaneously pump 70 mgd to BNR 2 and 330 mgd to primary treatment.
(4) Other options are to (a) modify West Primaries to increase capacity from 50 mgd to 70 mgd; or (b) replace West Primaries with new 70-mgd primary treatment facility (replace element cost in table with $11,000,000).

The options presented above assume the West Primaries will be phased out, and excess peak flows will bypass primary treatment. However, the following options would be available if the West Primaries were to be replaced by new 70 mgd primaries:

- Assuming PHWWF overflow rate of 2,500 gallons per day per square foot (gpd/ft^2), 10-foot sidewater depth, and additional 10 percent area for influent/effluent channels, new facility would require footprint of 30,800 square feet (sf). Estimated cost is $11.0 MM (no construction contingency, escalation, or Engineering, Legal and Administrative Costs [ELAC]).
- Footprint can be reduced by utilizing chemically enhanced primary treatment (CEPT) or ballasted flocculation. These enhanced primary treatment processes would entail increased O&M, even though this will be a wet-weather-only facility. CEPT facility, assuming overflow rate of 4,500 gpd/ft^2 and additional area of ten (10) percent for influent/effluent channels, would require a footprint of only 17,100 sf (plus footprint for chemical storage and feed).

ALTERNATIVE 2: DISCONTINUE RAW EQUALIZATION

Alternative 2 entails the following:

- Discontinuing raw equalization
- Accommodating the full PHWWF of 455 mgd through both the headworks and primary clarifiers
- Increasing the existing primary effluent equalization to reduce the peak flow to 355 mgd for secondary treatment.

Discontinuing use of the existing raw equalization storage basin liberates land currently occupied by the basin. However, the full PHWWF of 455 mgd would have to be accommodated in the downstream treatment processes.

As far as accommodating 455 mgd through the expanded Headworks 2, the original intent for the Headworks 2 expansion (see main text) was to construct a duplicate of the existing infrastructure (3 bar screens, 3 vortex grit basins, and 3 80-mgd pumps).

- A peak flow of 455 mgd through five (5) bar screens (one assumed to be out of service) would result in screen velocities of 5.1 fps, which is within standard peak flow design criteria.
- The five (5) vortex grit basins (one assumed to be out of service) would also be able to accommodate 455 mgd.
- Three (3) new larger RSPS 2 pumps would be provided with capacities of 108 mgd each (pump station would still have capacity of 455 mgd with one of largest pumps out of service).

Since the East Primaries have a hydraulic (and process) capacity of 330 mgd (West Primaries to be phased out), 125 mgd of the incoming 455 mgd will need to be bypassed. As with Alternative 1, there are two options to accommodate this bypass flow (see Figure B-4 for flow routing and associated flow rates):

- **Option 1**: Pump 100 mgd from Raw Sewage Pump Station No. 2 directly to BNR 2, and install 48-inch pipeline next to East Primaries to bypass additional 25 mgd around primary treatment.
    - The existing RSPS 2 and bypass pipeline to BNR 2 were designed for 100 mgd. Under this scenario, that capacity would be utilized in full, and the remaining 25 mgd would be bypassed around primary treatment through a new diversion pipeline. The bypassed 25 mgd would flow to PEPS, along with a portion of the primary effluent coming from the East Primaries. This would require additional pipeline capacity, additional primary effluent pumping capacity, and additional primary effluent equalization to reduce the flow to 355 mgd for secondary treatment.

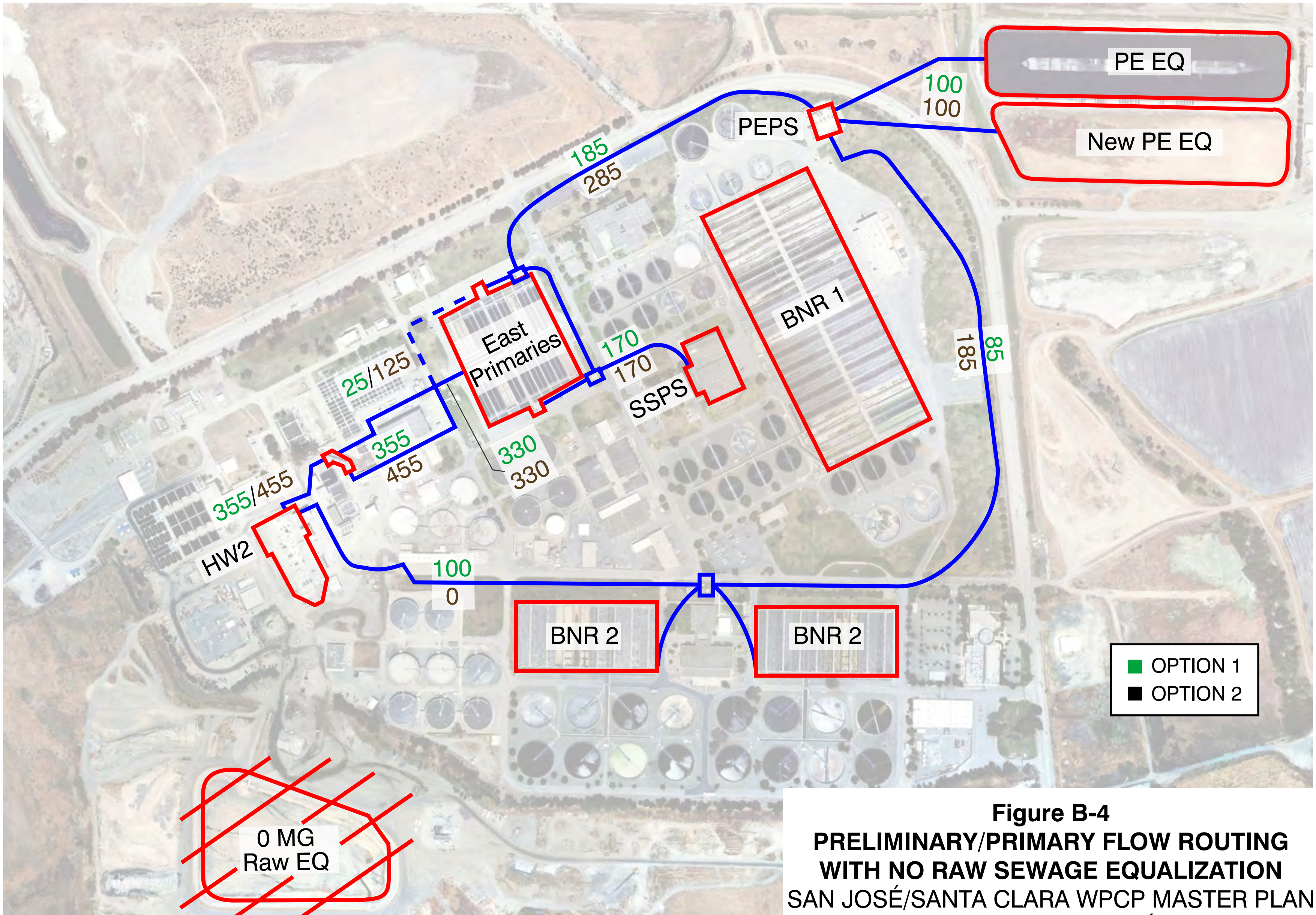

Figure B-4
PRELIMINARY/PRIMARY FLOW ROUTING WITH NO RAW SEWAGE EQUALIZATION
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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- Under this scenario, 185 mgd peak flow needs to be conveyed to PEPS, which would require an additional 36-inch diameter pipeline from the structure at the northeast corner of East Primaries to PEPS.
- PEPS would need to be expanded from its current reliable capacity of approximately 160 mgd to 185 mgd.
- An additional 8 MG primary effluent equalization capability would be required. This new basin (constructed adjacent and to the south of the existing equalization basin) would need to be lined, and provided with a 60-inch diameter pipeline to feed it from PEPS.

- **Option 2**: Install a new 108-inch diameter pipeline west of the East Primaries to bypass 125 mgd around primary treatment:
  - It is assumed that the existing 84-inch/72-inch diameter pipeline serving PEPS is adequate to convey 160 mgd (velocity = 6.4 fps). Under this scenario, a peak flow of 285 mgd needs to be conveyed to PEPS. This would require an additional 78-inch diameter pipe from the structure at the northeast corner of East Primaries to PEPS.
  - Total primary effluent (PE) pumping capacity to PE Equalization and BNR 2 would need to be 285 mgd. With the existing PEPS reliable capacity of approximately 160 mgd, a supplemental PEPS, with a capacity of 125 mgd, would need to be constructed.
  - An additional 8 MG PE Equalization Storage Basin would be needed. This new basin (constructed adjacent and to the south of the existing equalization basin) would need to be lined, and provided with a 60-inch diameter pipeline to feed it from Supplemental PEPS.

Planning level cost estimates are provided for these two options in the following Tables B-3 and B-4.

See Figure B-3 for a graphical representation of the distinguishing features between these options.

The options presented above assume the West Primaries will be phased out, and excess peak flows will bypass primary treatment. However, the following options would be available if the West Primaries were to be replaced by new 125 mgd primaries:

- Assuming PHWWF overflow rate of 2,500 gpd/ft^2, 10-ft sidewater depth, and additional 10 percent area for influent/effluent channels, new facility would require footprint of 55,000 sf. Estimated cost is $18.8 MM (no construction contingency, escalation, or ELAC). The approximate footprint of these new facilities is shown on Figure B-5. Due to the larger footprint, the existing filter backwash treatment flocculation/sedimentation basins would have to be replaced (as shown on the figure). These costs are not included in the estimate.

Table B-3	Alternative 2, Option 1: No Raw Sewage EQ, 450 mgd Plus Recycle Through the Front End of Plant, Primary Bypass Directly to BNR 2 San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
	Element(1)		**Cost**(2)
1	HW2 expansion to 455 mgd(3)		$30,200,000
2	48-inch diameter pipeline to bypass 25 mgd around primaries		$1,100,000
3	Additional 36-inch diameter pipeline to PEPS		$5,400,000
4	Upgrade PEPS to 185 mgd capacity (additional 25 mgd)		$3,000,000
5	Lining for new primary effluent EQ basin and new 60-inch diameter pipeline		$7,400,000
	Subtotal		**$47,100,000**
	Construction Contingency	25%	$11,775,000
	CONSTRUCTION COST		**$58,875,000**
	Engineering, Legal & Administrative Costs	30%	$17,662,500
	TOTAL PROJECT COST		**$76,537,500**

Notes:
(1) Certain elements common to both alternatives not included.
(2) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) Includes modification of RSPS 2 to simultaneously pump 100 mgd to BNR 2 and 355 mgd to primary treatment.

Table B-4	Alternative 2, Option 2: No Raw Sewage EQ, 450 mgd Plus Recycle Through the Front End of Plant, Primary Bypass to PEPS San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
	Element(1)		**Cost**(2)
1	HW2 expansion to 455 mgd		$30,200,000
2	108-inch diameter pipeline to bypass 125 mgd around primaries(3)		$1,300,000
3	Additional 78-inch diameter pipeline to PEPS		$7,200,000
4	Supplemental PEPS with additional 125 mgd capacity		$7,900,000
5	Lining for new primary effluent EQ basin and new 60-inch diameter pipeline		$7,400,000
	Subtotal		**$54,000,000**
	Construction Contingency	25%	$13,500,000
	CONSTRUCTION COST		**$67,500,000**
	Engineering, Legal & Administrative Costs	30%	$20,250,000
	TOTAL PROJECT COST		**$87,750,000**

Notes:
(1) Certain elements common to both alternatives not included.
(2) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) Other option is to replace West Primaries with new 125-mgd primary treatment facility (replace element cost in table with $18.8MM).

- Footprint can be reduced by utilizing chemically enhanced primary treatment (CEPT) or ballasted flocculation. Increased O&M with these enhanced primary treatment processes (this will be a wet-weather-only facility). CEPT facility, assuming overflow rate of 4,500 gpd/ft^2 and additional area of ten (10) percent for influent/effluent channels, would require a footprint of only 30,600 sf (plus footprint for chemical storage and feed).

Improvements Common to Both Alternatives

The following elements are common to the two equalization alternatives described above and are therefore not included in the cost comparison tables.

- Influent piping between EBOS and Headworks 2:
  In the Headworks Condition Assessment (Carollo, 2009), it was assumed that two (2) parallel 84-inch diameter pipelines would be added to carry future flows from EBOS to the expanded Headworks 2. However, a single 120-inch diameter additional parallel pipeline is also being considered.

- Upgrades to East Primaries.

SUMMARY OF EQUALIZATION ALTERNATIVES

Two flow equalization alternatives have been evaluated:

- **Alternative 1** partially equalizes the raw influent flow to lower the PHWWF from 455 mgd to 400 mgd, which benefits the headworks and primary clarifiers. The primary effluent is further equalized to 355 mgd to match the PHWWF capacity of the secondary treatment system.

- **Alternative 2** has no raw equalization, i.e. the full 455 mgd would have to be accommodated through headworks and primary treatment. Primary effluent equalization would have to be expanded to lower the 455 mgd PHWWF to the 355 mgd capacity of the secondary treatment system.

Within both of these two alternatives there are two options:

- **Option 1** utilizes the existing bypass pump station and pipeline directly from Headworks 2 to BNR2.

- **Option 2** does not.

Figure B-5
NEW 125-MGD WEST PRIMARIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

In both alternatives, using the existing pipeline from Headworks 2 to BNR 2 (Option 1) requires significantly less modifications and additions to the existing plant than not using it (Option 2). For Alternative 1 the difference is approximately $20 million (approximately 34 percent), and for Alternative 2 the difference is approximately $11 million (approximately 15 percent). From this comparison, it is clearly more cost efficient to use the existing bypass facilities (Option 1).

Furthermore, from the comparison of the two alternatives, not using raw equalization (Alternative 2) costs approximately $22 million (39 percent) more than using raw equalization (Alternative 1). This comparison is based on Option 1 for both alternatives.

Based on this analysis, it is recommended that raw equalization be maintained, and that the existing bypass capabilities from Headworks 2 to BNR2 be utilized in PHWWF management. This conclusion was corroborated by the TAG during the October 1, 2009 workshop, namely: “Keep raw equalization, unless there is an overriding benefit from the land use plan.” In addition, the equalization of primary effluent has a beneficial impact on equalization of the ammonia loading to the secondary treatment process, which is discussed further in the secondary treatment section.

APPENDIX C – SUMMARY OF HEADWORKS CONDITION ASSESSMENT PROJECT

APPENDIX C – SUMMARY OF HEADWORKS CONDITION ASSESSMENT PROJECT

PURPOSE

The purpose of this project was to evaluate a cost-effective long-term solution for the WPCP headworks operation either by 1) phased improvements to Headworks No. 1 to allow continued operation in conjunction with Headworks No. 2, or 2) expansion of Headworks No. 2 to handle all flows to the plant with Headworks No. 1 permanently out of service.

BACKGROUND

The original headworks at the WPCP, Headworks No. 1, was built in the mid 1950s and early 1960s and was designed to handle 167 mgd ADWF and 271 mgd PWWF. The newer headworks, Headworks No. 2, was built in 2008 and was designed to operate in parallel with Headworks No. 1 to handle a combined PWWF of 400 mgd. The facilities at Headworks No. 1 are aging and deteriorating and require ongoing repairs and replacement.

The key elements of this project included a visual condition assessment of Headworks No. 1 to identify major assets that need to be upgraded or replaced through the year 2040, an estimate of the cost of these improvements, and an estimate of the cost of expanding Headworks No. 2 to provide a wet weather peak capacity of 400 mgd and an average dry weather capacity of 167 mgd.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The analysis for Alternative 1, maintaining Headworks No. 1 through 2040, was based on a two-day on-site assessment by Carollo Engineers to determine the current condition of all major mechanical, structural, and electrical and instrumentation components. The original useful life was estimated for each asset, and the number of remaining years of service life was estimated based on the condition score assigned to each asset. The condition assessment confirmed that most components are functional but deteriorating due to age and the corrosive nature of a headworks environment. The replacement value for each asset was estimated assuming an in-kind replacement in 2009 dollars.

The analysis for Alternative 2, expanding Headworks No. 2, was conducted with the assumption that the expanded facility would mirror the recently constructed Headworks No. 2 facility. Additionally, costs were estimated for headworks improvements that are recommended regardless of which alternative would be selected. These recommendations were collectively termed “common elements.”

A present worth analysis was conducted in order to compare the costs of the two alternatives. This analysis accounted for the relative timing of the expenditures, the renewal efforts that would need to be repeated over the study period, and the differences in annual O&M costs.

Table C-1 presents the alternatives cost comparison. The overall present worth for Alternative 1 is $148,648,000, and for Alternative 2 is $117,604,000. Alternative 2 is therefore less costly in the long-term. Additional factors that could not be easily accounted for in this present worth cost analysis that would favor Alternative 2 include benefits of improved headworks performance to downstream processes, the benefit of improved seismic performance of newer structures, improved reliability, and improved safety for operators.

The common element tasks are recommended for implementation regardless of which alternative is chosen. The near-term projects are recommended to be implemented within five years and the far-term projects are recommended to be implemented within fifteen years. The benefits of implementing these common elements are:

- Improved reliability.
- Operational flexibility.
- Improved plant hydraulics.
- Energy savings.
- Ability to use Headworks 2 as the duty Headworks.

Based on this analysis it is recommended that Headworks No. 2 be expanded to a capacity of 400 mgd, and Headworks No. 1 be decommissioned.

Table C-1 Project Cost Summary
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Description	Alternative 1 Maintain Headworks No. 1	Alternative 2 Expand Headworks No. 2
Capital Cost Summary		
Capital Costs(1,2,3)	$49,408,000	$54,368,000
Common Elements		
Near-Term(1,4)	$10,137,000	$10,137,000
Far-Term(1,5)	$23,640,000	$23,640,000
Total	**$83,185,000**	**$88,145,000**
Present Worth Summary		
Present Worth Capital Costs(6)	$83,032,000	$61,367,000
Present Worth Salvage Value(7)	($15,524,000)	($8,124,000)
Present Worth Common Elements Capital(6)	$24,916,000	$24,916,000
Present Worth Operations and Maintenance(8)	$56,224,000	$39,445,000
Total	**$148,648,000**	**$117,604,000**

Notes:
(1) Costs shown in March 2009 dollars, San Francisco ENR of 9758.
(2) Costs for Alternative No. 1 were developed by estimating the in-kind replacement cost of each component within Headworks No. 1 that would need rehabilitation or replacement during the study period, based on the current condition and industry standard design lives. These costs will be spread out over time in the City's Capital Improvements Program (CIP). These costs do not include repeat replacement efforts for assets that would need to be replaced more than once during the study period.
(3) Costs for Alternative No. 2 were developed assuming the Headworks No. 2 expansion would mirror the existing Headworks No. 2. These costs will likely occur as a lump sum in the City's CIP.
(4) Costs for Near-Term Common Elements were developed for preliminary treatment improvements that are recommended with implementation of Alternatives 1 and 2. Near-term project costs are defined as those projects recommended to be completed within the next five years.
(5) Costs for Far-Term Common Elements were developed for preliminary treatment improvements that are recommended with implementation of Alternatives Nos. 1 and 2. Far-Term project costs are defined as those projects recommended for further evaluation, and if appropriate, implemented within fifteen years.
(6) Present worth costs reflect the impact of the timing of the expenditures assuming 3% annual inflation and 5% annual interest, i.e., an effective interest rate of 2%. In addition to effective interest, these costs include repeat replacement efforts for those assets that would need to be replaced during the study period, up to 2040.
(7) Salvage value calculated as the value remaining on each asset based on linear depreciation from year of renewal.
(8) Based on an estimated annual O&M cost of $2,331,000 for Alternative 1 and $1,636,000 for Alternative 2.

APPENDIX D – FINE SCREENING ANALYSIS

APPENDIX D – FINE SCREENING ANALYSIS

RAW INFLUENT SCREENING

Fine screening of the raw influent would be installed downstream of the coarse screens, and would be sized for the 2040 projected ADMMF of 200 mgd. Based on observations at other wastewater treatment plants, the equipment manufactured by Brackett Green USA, Inc. is being used for comparison purposes. There are a limited number of installations in the United States of comparable scale to the WPCP. Most notably the Neuse River WWTP in Raleigh, NC, with 56 mgd peak flow capacity screens, and the Orange County Water District, with 46 mgd capacity screens.

These facilities all use band type screens (see Figure D-1). Higher flows per screen are possible with drum type screens (Figure D-2). The upper flow limit per band screen is approximately 50 mgd to 60 mgd, after which it is typically more economical to consider drum screens. However, the associated screenings handling is much more involved than with the band screens, and therefore drum type screens were not considered for this analysis.

Two options were considered for a new fine screen installation on the raw influent stream.

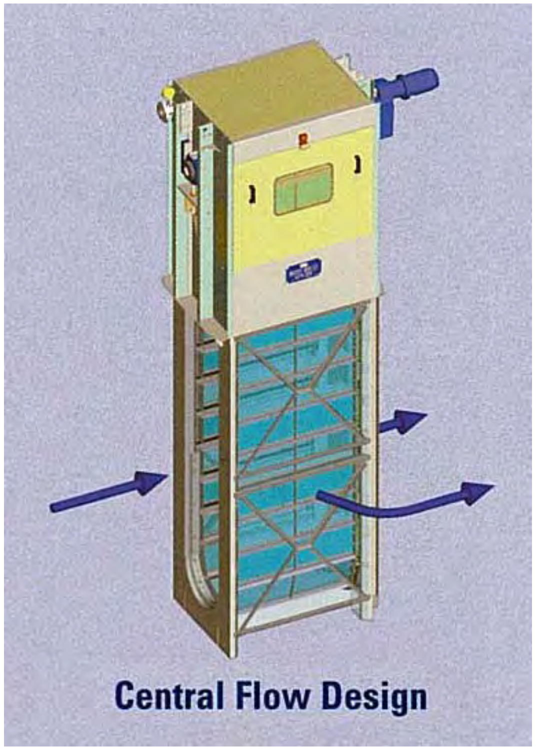
Option 1: Relocate the coarse screens to EBOS. With the discontinuation of Headworks 1 and expansion of Headworks 2, most influent flow would pass through EBOS and the new coarse screens. New fine screens would replace the existing coarse screens at their current location in Headworks 2.

Some of the major limitations of this approach are:

- The expense of constructing a new coarse screen facility at EBOS.
- Screenings handling required at two locations, i.e., decentralized operation.
- Difficulty in accommodating significant increases in screenings at Headworks 2.
- All raw influent flow does not pass through EBOS, i.e., flows introduced downstream of EBOS will not go through coarse screening.

Option 2: A new fine screen installation placed downstream of the expanded Headworks 2. Currently, once influent flow has passed through Headworks 2, it is pumped from RSPS 2 to the raw sewage flow distribution structure (California structure), from where it flows to primary treatment. Under Option 2, the pumped flow from RSPS 2 would be intercepted and diverted to a new screening facility, from where the screened flow would flow by gravity to the California structure.

Two possible locations were considered, as shown on Figure D-3.



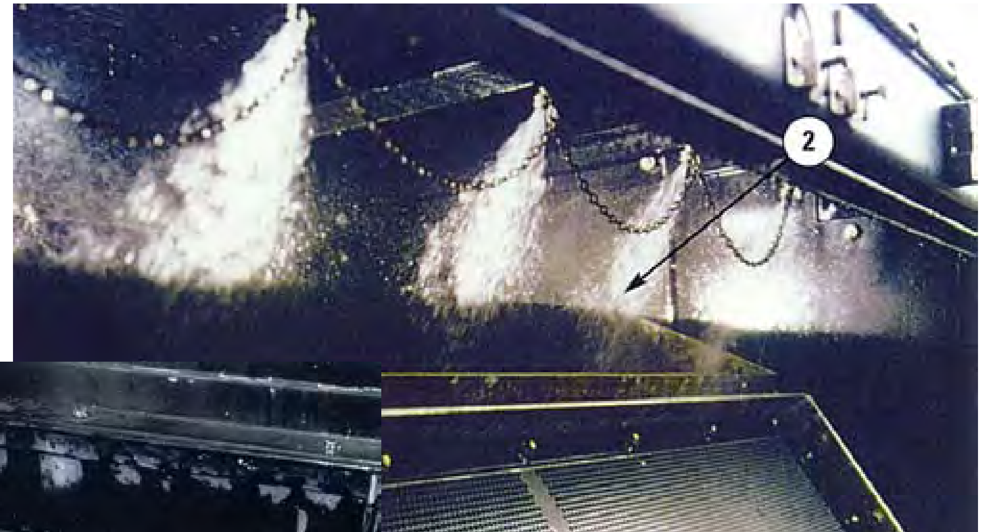


Figure D-1
BAND SCREENS FOR INFLUENT FINE SCREENING
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

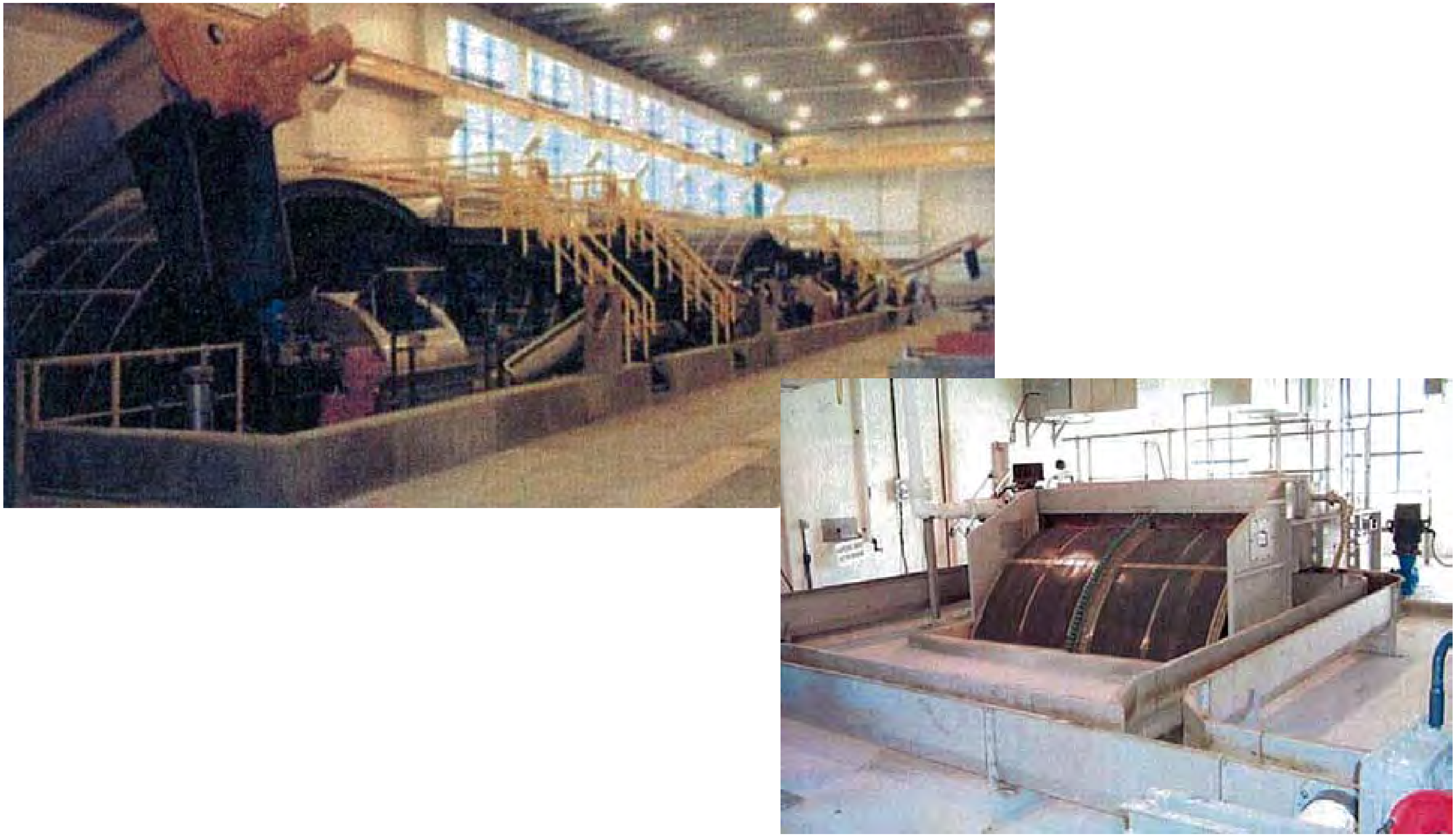


Figure D-2
DRUM SCREENS FOR INFLUENT FINE SCREENING
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Figure D-3
POSSIBLE LOCATIONS OF INFLUENT FINE SCREENING FACILITY DOWNSTREAM OF HEADWORKS
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Some of the major limitations of this approach are:

- Modifications would still be required at the Headworks 2 coarse screening facility to accommodate the current surges of screenings material during peak flows.
- The pumps in RSPS 2 may have to be modified to increase the pumping head by a few feet.

Of the two raw influent screening options, Option 2 was considered more feasible because of screenings handling issues.

The main features of this facility include the following:

- Four (4) plus one (1) standby band screens required with 50 mgd capacity per screen to accommodate the 2040 projected ADMMF of 200 mgd.
- Separate high pressure and steam spray connections to each screen.
- Sluiceway to either a washer/compactor (or a Muffin Monster) for each screen.
- Screw conveyors to collector bins.
- A building to house all the equipment, together with odor control collection ductwork and scrubber.

Data from various screening installations show the increase in screenings expected from additional 1/4-inch screening following 5/8-inch screening, is a factor of approximately 2.25. Based on the 2007-recorded screenings at the WPCP of approximately three (3) cubic yards, the 2040 coarse screenings is expected to increase to approximately four (4) cubic yards. Based on the above ratio, with the addition of fine screening the 2040 screenings would increase to approximately nine (9) cubic yards.

There is much uncertainty, however, regarding these estimates since they are based on a very limited number of installations. Wide variations in the predictions of screenings generated are to be expected, partly also because of widely varying wastewater characteristics observed from plant to plant. The Neuse River WWTP in Raleigh, NC, for example, uses band screens of approximately 50 mgd flow capacity each. Their average daily flow is 45 mgd, and they report a daily screenings volume of approximately 10 cubic yards. By direct ratio of observations at that facility, the WPCP could see screenings resulting from the addition of fine screening to increase to approximately 38 cubic yards.

PRIMARY EFFLUENT SCREENING

A fine screen installation on the primary effluent stream would be sized for the headworks effluent less the primary settled sludge. A number of fine screen manufacturers and their representatives were surveyed to assess the extent to which fine screening of primary effluent is applied, namely:

- MISCO (for JWC)

- Coombs-Hopkins (for OVIVO/Brackett-Green)
- Goble-Sampson (for Huber)
- Kusters Zima (for WasteTech)
- TEC (for Lakeside, WasteTech,)
- IPEC
- Johnson Screens (Contra-Shear)

The information gathered can be summarized as follows:

- Fine screening of primary effluent is more commonly practiced upstream of membrane bioreactors (MBRs) as observed in the industry. The fine screens used for this application are usually with 1 mm to 3 mm perforations. They are specifically intended to remove fine toilet tissues which tend to create threads in the aeration tank. These threads end up in the membrane tank and cause blinding of the membranes. In addition, such a high frequency of back flushing is required that the hollow fiber membranes break prematurely.
- There have been instances of fine screening of primary effluent upstream of an activated sludge process, but these are usually downstream of trickling filters where snail shell growth is an issue in the secondary clarifiers and aeration basins.
- Other instances where fine screening is performed upstream of an activated sludge process is usually when no primary clarification is performed. This is usually common in smaller treatment plants. The fine screen is typically in the 1 to 2 mm range, and is meant to partially fulfill the role of a primary clarifier. These treatment plants are mostly in the 1-10 mgd range, examples of which are located in the Caribbean.
- Preliminary pilot studies are being conducted in Europe for the application of fine screening of primary effluent. There have been other installations in China, though the exact objective behind the fine screening has not been clear.

In summary, discussions with manufacturers confirmed there are no specific applications where fine screening is being utilized upstream of an activated sludge process aside from the examples listed above. Any installations of fine screening upstream of activated sludge processes were mostly at a pilot study stage, or for much smaller plants outside the US where primary clarification was not being performed.

While fine screening of the primary effluent will likely result in the retention of less organic material than fine screening of influent to the headworks, the primary sludge would not be screened. That benefit would be lost through the biosolids treatment processes and the quality of the final biosolids product would not be improved, unless primary sludge and WAS fine screening was implemented.

Based on the above considerations, primary effluent fine screening was not considered further.

PRIMARY SLUDGE AND WAS SCREENING

A fine screen installation on the primary sludge and WAS streams would be sized for a combined flow rate of approximately 1.8 mgd. This flow rate is two orders of magnitude lower than a fine screen facility of the full influent flow, so will have dramatically lower screenings handling requirements. While the current maintenance issues on the liquids treatment processes will likely not be improved with this facility, it will benefit the solids treatment processes. In addition, the final biosolids product will be of a much higher quality (essentially free of nuisance materials), which will potentially increase its market value and disposition options.

There are a number of technologies available for this fine screen application, such as a press, or a step-type screen. For the purposes of this master plan, a step-type screen (Figure D-4) serves only as the placeholder technology. The final technology and product selection will be made during the implementation phase.

A possible location for this screening facility is shown on Figure D-5.

COST COMPARISON

Construction costs were obtained for fine screening installations most similar to those presented in this section. These costs were modified to the requirements for installations at the WPCP, and are presented in the following Table D-1.

Table D-1 Cost Comparison Between Influent and Primary Sludge/WAS Fine Screening Requirements
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

	Element		**Influent Flow Screening(1,3)**	**Primary Sludge/WAS Screening(2,3)**
1	Fine screening installation, including screens and appurtenances, building with odor control		$29,600,000	$4,900,000
2	Construction Contingency	25%	$7,400,000	$1,200,000
	CONSTRUCTION COST		**$37,100,000**	**$6,100,000**
	Engineering, Legal & Administrative Costs	30%	$11,100,000	$1,800,000
	TOTAL PROJECT COST		**$48,200,000**	**$7,900,000**

Notes:
(1) Based on a 200 mgd facility located downstream of Headworks 2.
(2) Based on a 1.8 mgd combined primary sludge/WAS facility.
(3) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.

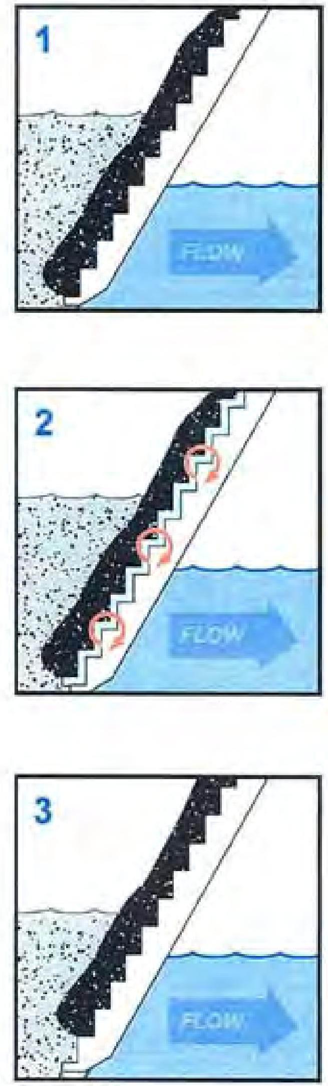

Figure D-4
STEP SCREEN FOR PRIMARY SLUDGE AND WAS FINE SCREENING
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Figure D-5
RECOMMENDED LOCATION OF PRIMARY SLUDGE AND WAS FINE SCREENING FACILITY
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

APPENDIX E – DETAILS OF SECONDARY TREATMENT ALTERNATIVES ANALYSIS

APPENDIX E – DETAILS OF SECONDARY TREATMENT ALTERNATIVES ANALYSIS

IDENTIFICATION OF ALTERNATIVES

If TN removal were not required in the future, the existing activated sludge secondary system (step-feed) would provide sufficient process capacity. However, based on the flow and loading projections, step-feed would only be sufficient until approximately 2026. After that time, the existing tankage could be converted to nitrification with anaerobic selector (NAS) to provide sufficient capacity for 2040 flows (see PM 3.5).

On the other hand, if TN removal becomes necessary, there are several alternatives identified for the biological treatment process as shown in Table E-1.

Table E-1 Preliminary Screening of Secondary Treatment Alternatives for TN Removal
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alternative	Make Use of Existing Facilities	Minimize External Carbon Use	Proven at Large Scale	Suitable for Additional Evaluation
Modified Ludzack-Ettinger (MLE)	YES	YES	YES	YES
Sequencing Batch Reactor (SBR)	NO	YES	YES	NO
Oxidation Ditch	NO	YES	YES	NO
Single Sludge Post Anoxic	NO	NO	YES	NO
4-Stage Bardenpho	YES	YES	YES	YES
Two Stage	YES	NO	YES	NO
Membrane Bioreactor (MBR)	YES	YES	YES	YES
Trickling Filter	NO	NO	YES	NO
Biological Aerated Filter (BAF)	NO	NO	YES	NO
Oxidation Pond/Aerated Lagoon	NO	NO	YES	NO
Wetlands	NO	NO	YES	NO

Of the alternatives listed in Table E-1, only three technologies (in addition to NAS modified to include an additional denitrification treatment step) met the selection criteria and were evaluated further. These technologies were:

- **Modified Ludzack-Ettinger (MLE).** The MLE process is a two-stage system consisting of an anoxic and aerobic zone. There is an internal mixed liquor recycle

(IMLR) stream that returns mixed liquor from the aerobic zone (nitrate rich) to the anoxic zone (carbon rich) to promote TN removal. An external carbon source can be added to the anoxic zone to promote additional TN removal.

- **4-Stage Bardenpho.** The first two stages of the 4-stage Bardenpho process are identical to the MLE process. A subsequent anoxic zone followed by an aerobic zone makes up the third and fourth stages of the process. An external carbon source is added to the second anoxic zone to promote additional TN removal.
- **Membrane Bioreactor (MBR).** The MBR process makes use of membranes (either ultrafilters or microfilters) for solid-liquid separation which eliminates the need for secondary clarification. The MBR process can be configured for TN removal in the MLE configuration or the 4-stage Bardenpho configuration. The process is not as efficient as the activated sludge counterparts for TN removal because of the high recycle rate that is required from the membranes (up to 400 percent of influent, compared to 25 to 100 percent for secondary clarification). External carbon source is added as needed.

Four alternatives were developed for 2040 flows and loads based on the technologies identified in Table E-1. Each alternative is presented in Table E-2.

Table E-2 Summary of Secondary Treatment Alternatives
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alternative	Name	Ammonia <3 mg-N/L	Total Nitrogen <8 mg/L	Total Nitrogen <3 mg/L
1	NAS	NAS w/ Tert. Filters	NAS w/ Denit. Filters(2)	NAS w/ Denit. Filters(2)
2	Activated Sludge w/ TN Removal	---	MLE(2) w/ Tert. Filters	Bardenpho(2) w/ Denit. Filters(2)
3	MBR	---	MLE Configuration(2)	Bardenpho Configuration(2)
4	Hybrid	---	50-mgd MBR; 150-mgd MLE w/ Tert. Filters(1),(2)	50-mgd MBR; 150-mgd Bardenpho(2) w/ Denit. Filters(1),(2)

Notes:
(1) Flows represent maximum month flow.
(2) External carbon source (as needed).

Alternative 1 would be sufficient if permit requirements did not change; other alternatives would provide an unnecessary level of treatment. Alternative 1 could be upgraded for TN removal with the addition of a denitrification treatment step, such as denitrifying fluidized-bed reactors, or denitrification filters. In this PM, denitrification filters are presented as the denitrification treatment step because of the associated large footprint allocation (the final selected technology will likely be able to fit into the footprint dedicated to denitrification), and because filtration is likely to remain a part of the WPCP treatment train.

For **Alternative 2** (activated sludge with TN removal), an MLE process would be sufficient for a TN < 8 mg/L; tertiary filtration would be retained to remove particulate material that could contribute to effluent TN. A 4-stage Bardenpho would be necessary for TN < 3 mg/L and denitrification filters would be used as a polishing step for TN removal.

Alternative 3 (MBR) would be configured as MLE for TN < 8 mg/L and would not require tertiary filtration. Alternative 3 would be configured as 4-stage Bardenpho for TN < 3 mg/L, and all TN removal would be performed in the MBR; no denitrification filters would be necessary. Alternative 3 would also require primary effluent screening (1 to 3 mm) to remove debris that could damage the membranes.

For **Alternative 4** (the hybrid alternative), 50 mgd of the influent flow would be treated to recycled water quality in a separate facility. A 50 mgd MBR was assumed, which includes primary effluent screening. The remainder of the flow would be treated by an activated sludge process with nitrogen removal (either MLE or Bardenpho depending on TN limit).

For Alternatives 2 through 4, it was assumed that an external carbon source (e.g., methanol) would be necessary to supplement TN removal in the aeration basins.

Figures E-1 through E-4 present process flow diagrams of each alternative. Anoxic or anaerobic regions are shown to indicate where aeration diffusers would not be required. For Alternative 1, the anaerobic zone is 25 percent of the total aeration basin volume. This could be reduced to 20 percent to match the other three alternatives.

PROCESS STAGING

Figure E-5 presents an overview of each of the alternatives as they relate to permit requirements and projected year. For instance, the existing step-feed configuration is sufficient until approximately 2026, assuming effluent requirements do not change. If regulations do change, an additional nitrogen removal process would be necessary. In the immediate term, this could be performed using denitrification filters. For the long-term, conversion either to MBR, or activated sludge with nutrient removal features or a hybrid facility could be performed.

Selection of a specific secondary process in the future could preclude the implementation of another process. This is illustrated in Figure E-6, where options for staging are presented at 2040 flows and loads. For instance, if NAS with denitrification filters were constructed to meet a TN < 8 mg/L, additional denitrification filters could be added to meet a TN <3 mg/L. Completely converting to another technology would result in abandoning already constructed facilities.

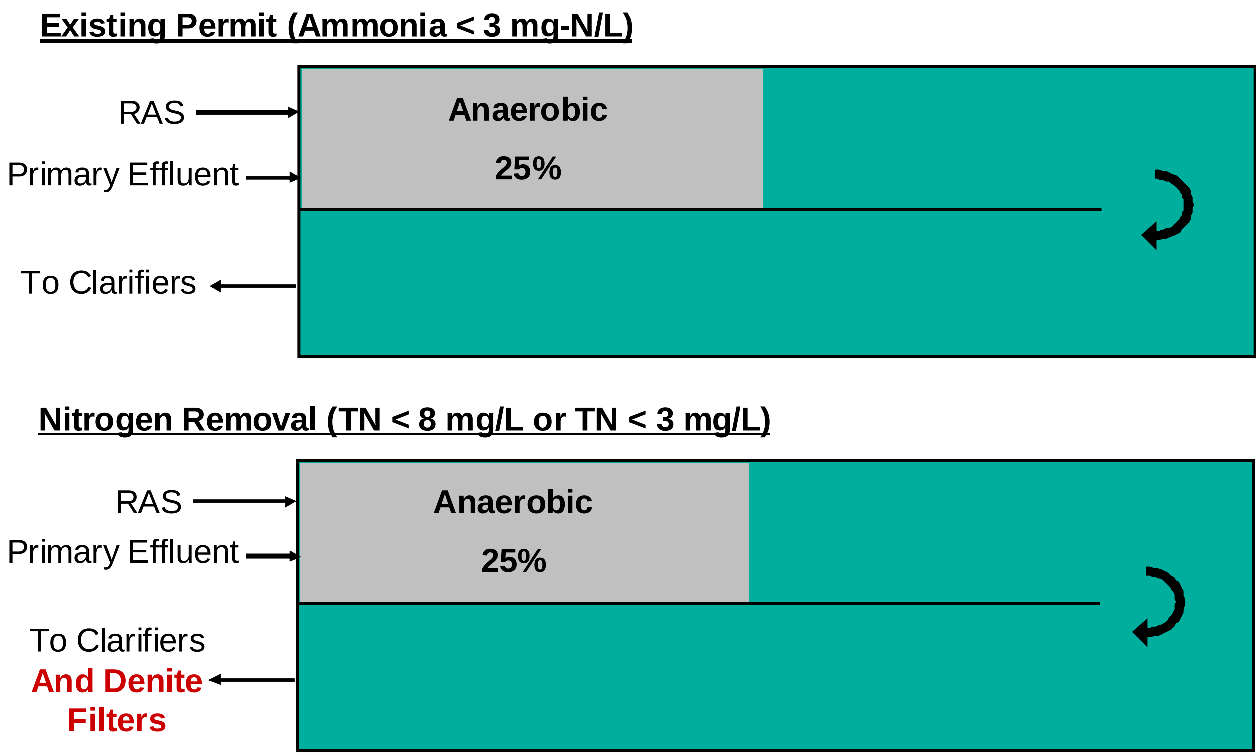

Figure E-1
PROCESS FLOW DIAGRAM
OF ALTERNATIVE 1 – NAS
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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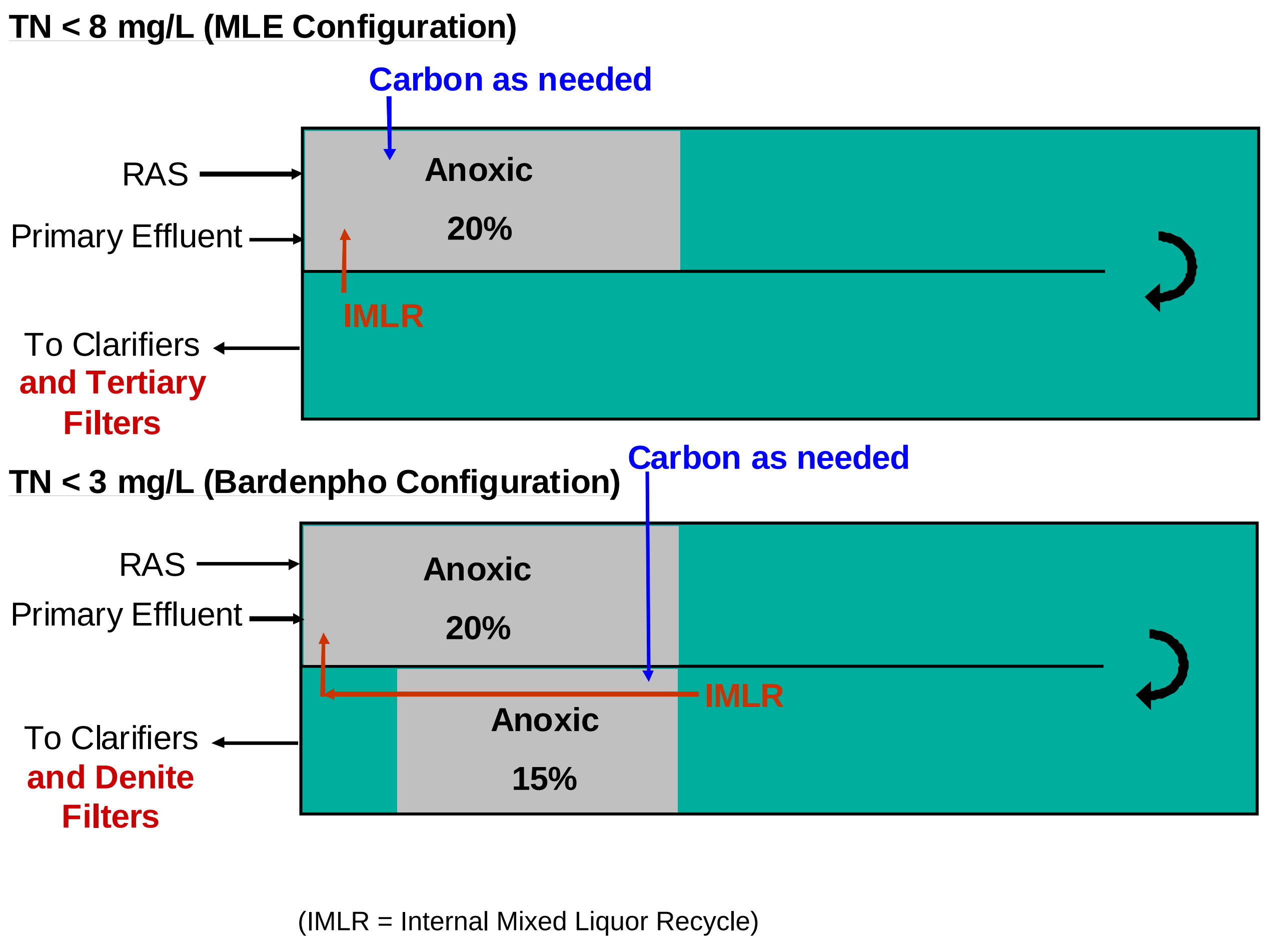

Figure E-2
PROCESS FLOW DIAGRAM OF ALTERNATIVE 2 – ACTIVATED SLUDGE WITH TN REMOVAL
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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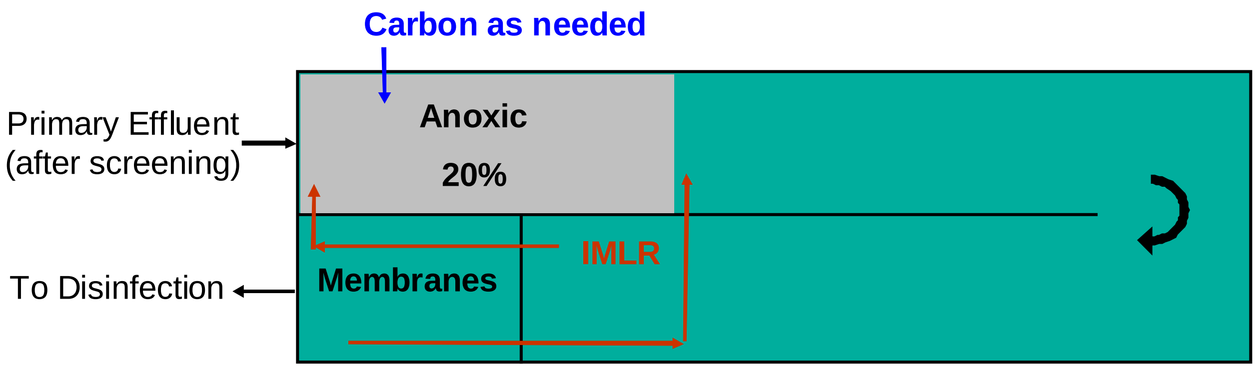
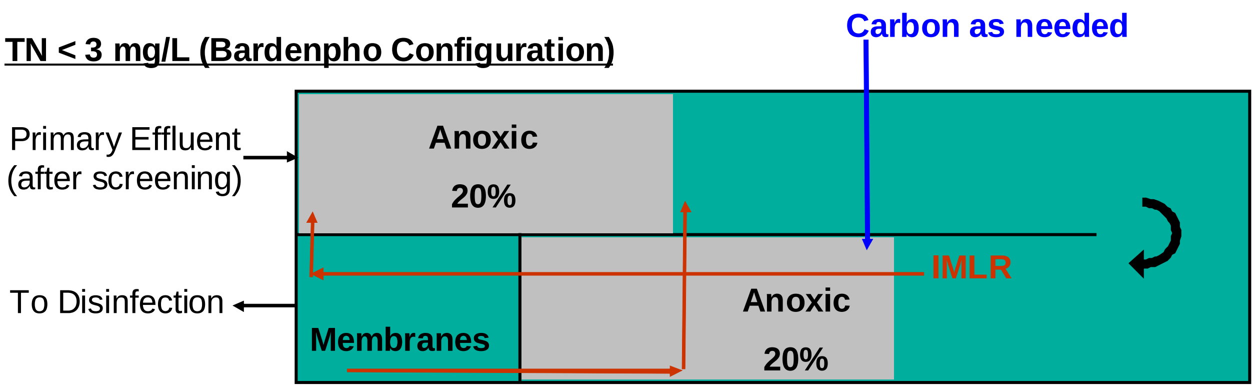
TN < 8 mg/L (MLE Configuration)



TN < 3 mg/L (Bardenpho Configuration)



(IMLR = Internal Mixed Liquor Recycle)

Figure E-3
PROCESS FLOW DIAGRAM OF
ALTERNATIVE 3 – MBR
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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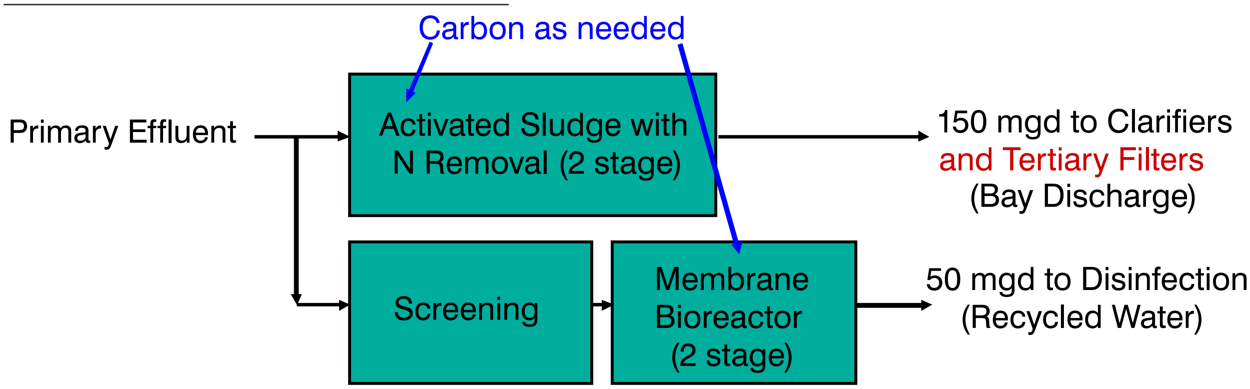
TN < 8 mg/L (MLE Configuration)



TN < 3 mg/L (Bardenpho Configuration)

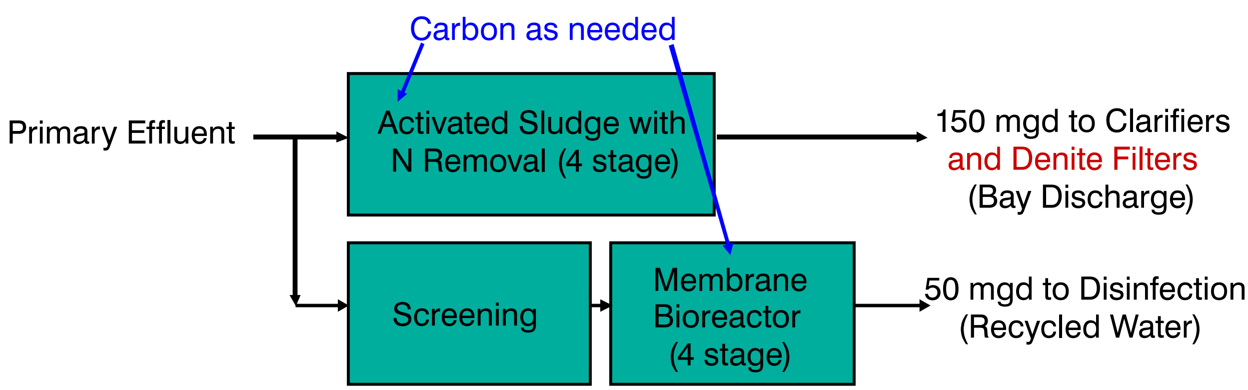
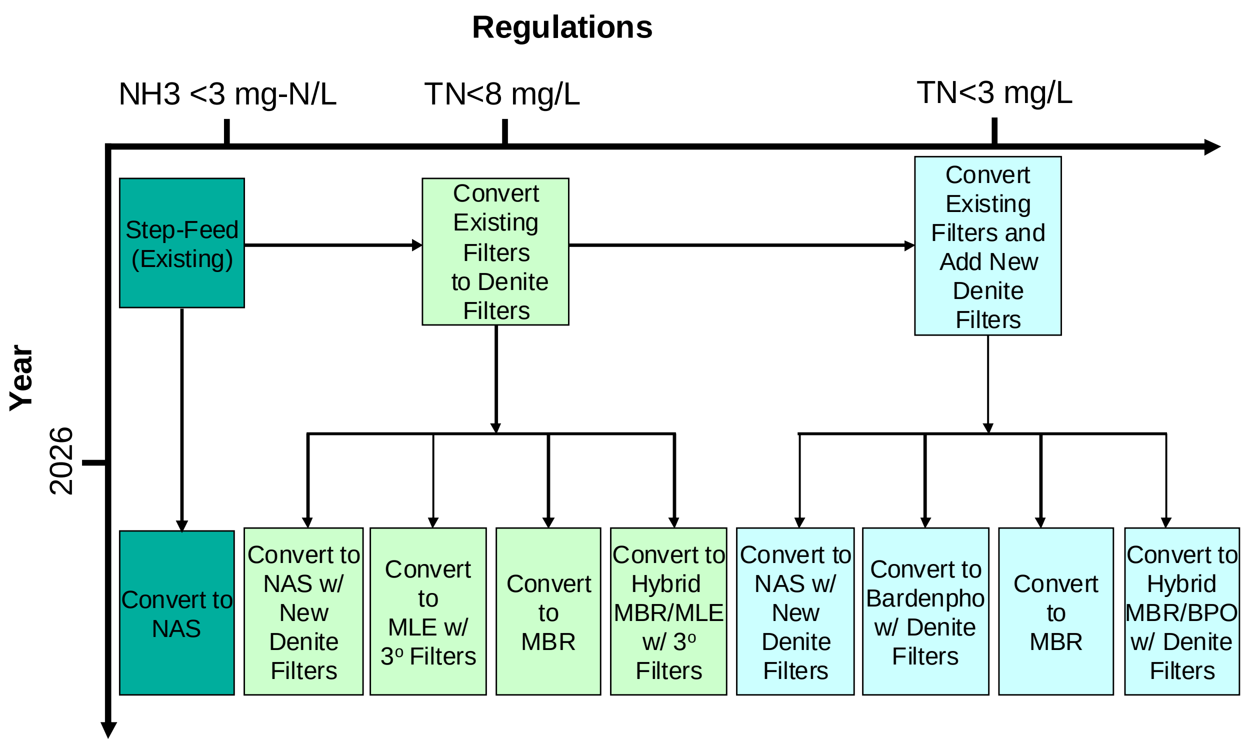


Figure E-4
PROCESS FLOW DIAGRAM OF ALTERNATIVE 4 – HYBRID
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ



Note: BPO = 4-stage Bardenpho

Figure E-5
SECONDARY ALTERNATIVES AS THEY RELATE TO REGULATIONS AND TIME
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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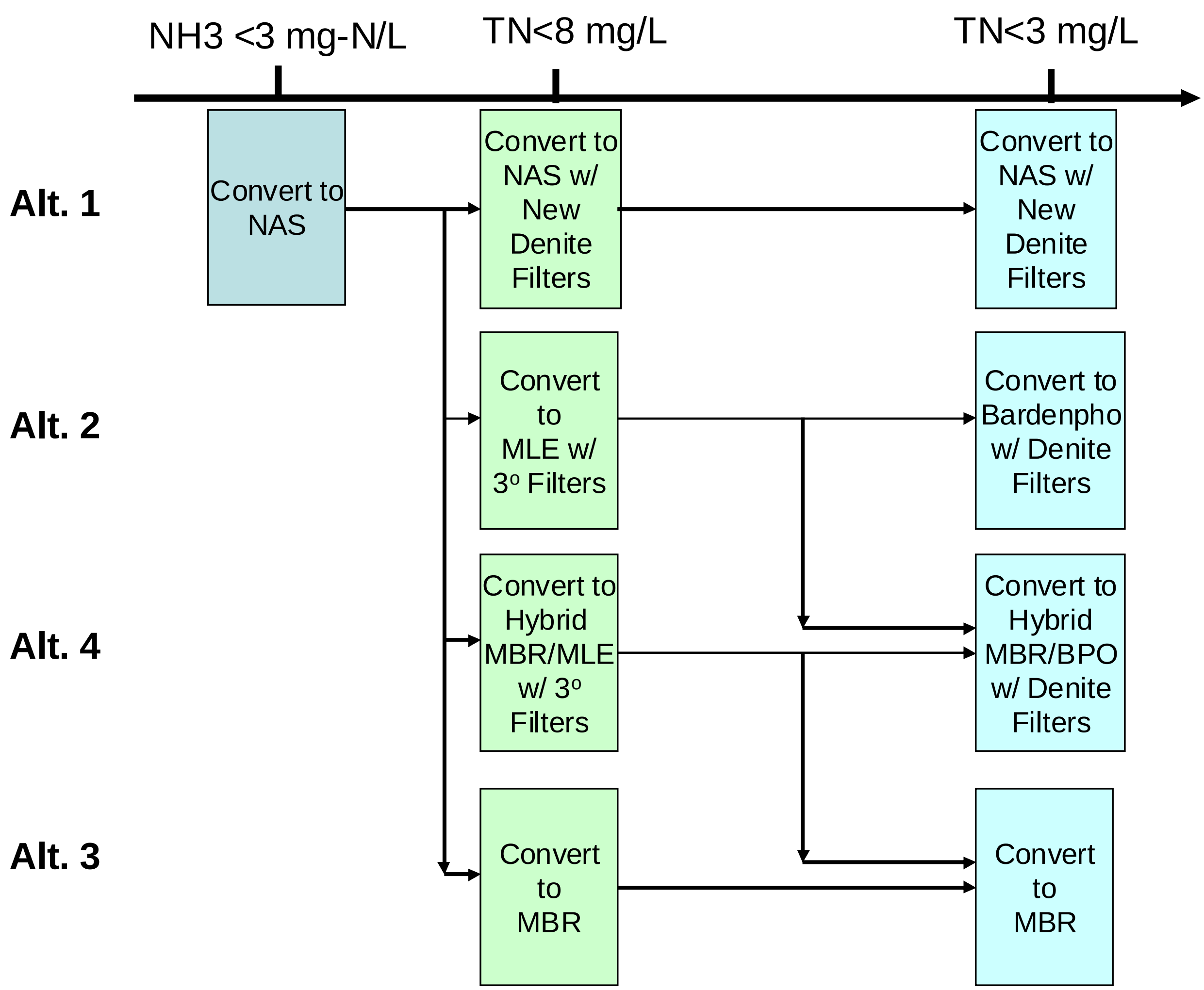

Figure E-6
STAGING OPTIONS FOR EACH ALTERNATIVE AT 2040 FLOWS AND LOADS
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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FOOTPRINT REQUIREMENTS

The footprint requirements are presented in Figures E-7 through E-14. Footprints were determined using the results from the activated sludge simulator, BioWin. Additional details on process modeling are provided in Appendix F. Steady-state modeling was performed at the maximum month flow and loading condition. Additional calculations were done to accommodate peak flow and load conditions. It was assumed that three secondary clarifiers (140-ft diameter) would be out of service and one aeration basin out of service in BNR 1 during maximum month loading.

Alternatives 1 through 3 were sized for a peak hour flow of 356 mgd. Alternative 4 was designed with a continuous 50-mgd recycled water treatment plant (MBR); the activated sludge portion was sized for a peak flow of 306 mgd. For all alternatives, process requirements were determined assuming that maximum month loading corresponds with peak hour flow and 90th percentile SVI. For each alternative, additional aeration tanks and secondary clarifiers were added as needed.

CAPITAL COST ANALYSIS

Planning level costs for Alternatives 1, 2, and 4 are presented in Table E-3. These costs represent necessary improvements to meet a TN <8 mg/L. If nitrogen removal were necessary in the future, a limit of TN <8 mg/L is more likely initially than a limit of TN <3 mg/L. Therefore, cost estimates for alternatives to meet TN <3 mg/L are not provided.

Alternative 3 was eliminated from the cost analysis since this alternative would completely abandon the existing secondary clarifiers. The plant has a considerable investment in these clarifiers, and is in the process of identifying potential operational improvements to maximize their performance.

The costs presented in Table E-3 include an allowance for tertiary improvements, as follows:

- NAS Alternative: Denitrification filters were included for 70 percent of the flow, with the remaining 30 percent to new tertiary filters.
- MLE Alternative: All flow through new tertiary filters.
- Hybrid Alternative: 75 percent of the flow through new tertiary filters, since 25 percent of the flow will have passed through the MBR, and would not need to be filtered.

Figure E-7
FOOTPRINT REQUIREMENT FOR
ALTERNATIVE 1 (TN <8 mg/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Figure E-8
FOOTPRINT REQUIREMENT FOR
ALTERNATIVE 1 (TN <3 mg/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Figure E-9
FOOTPRINT REQUIREMENT
FOR ALTERNATIVE 2 (TN < 8 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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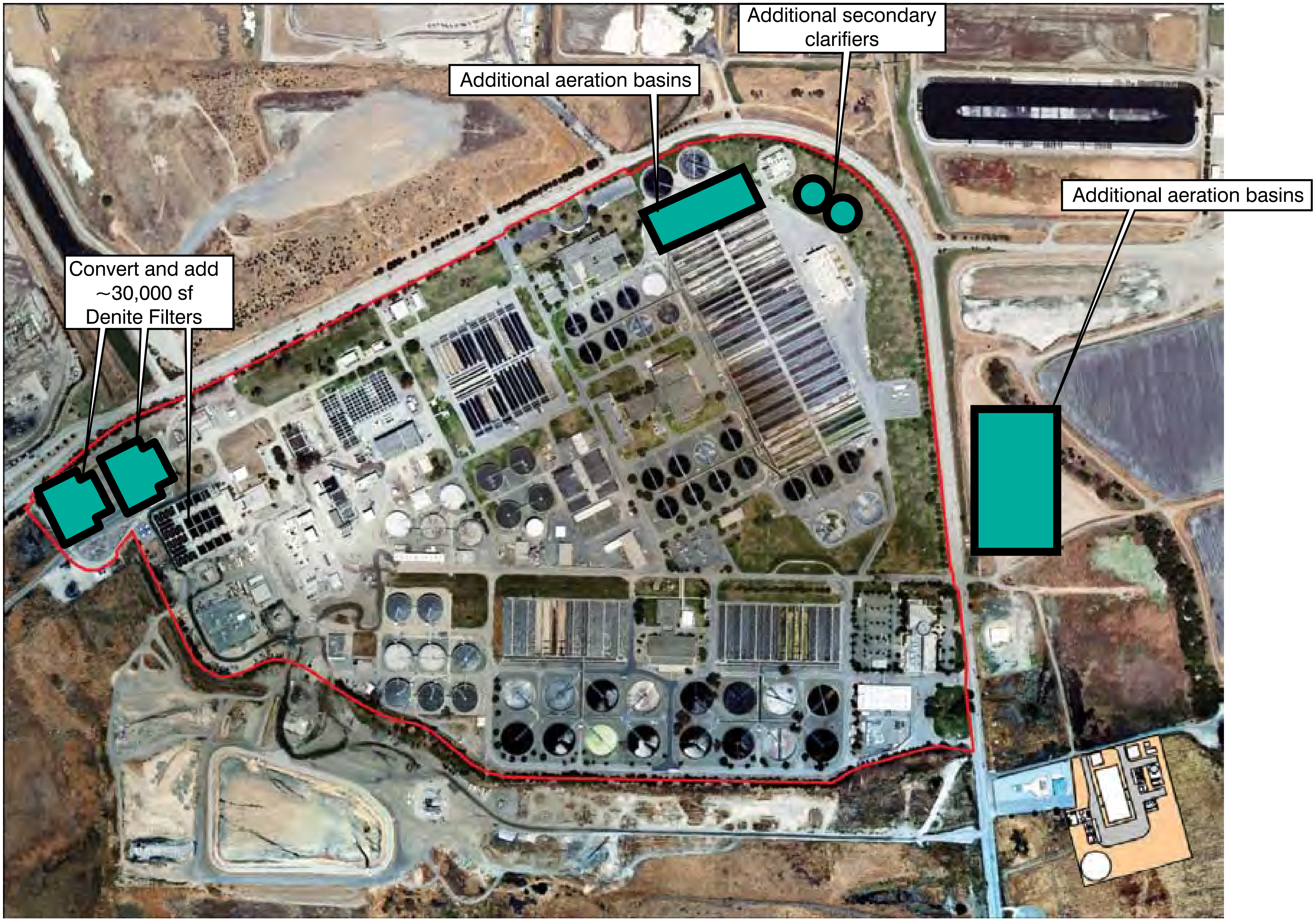

Figure E-10
FOOTPRINT REQUIREMENT
FOR ALTERNATIVE 2 (TN < 3 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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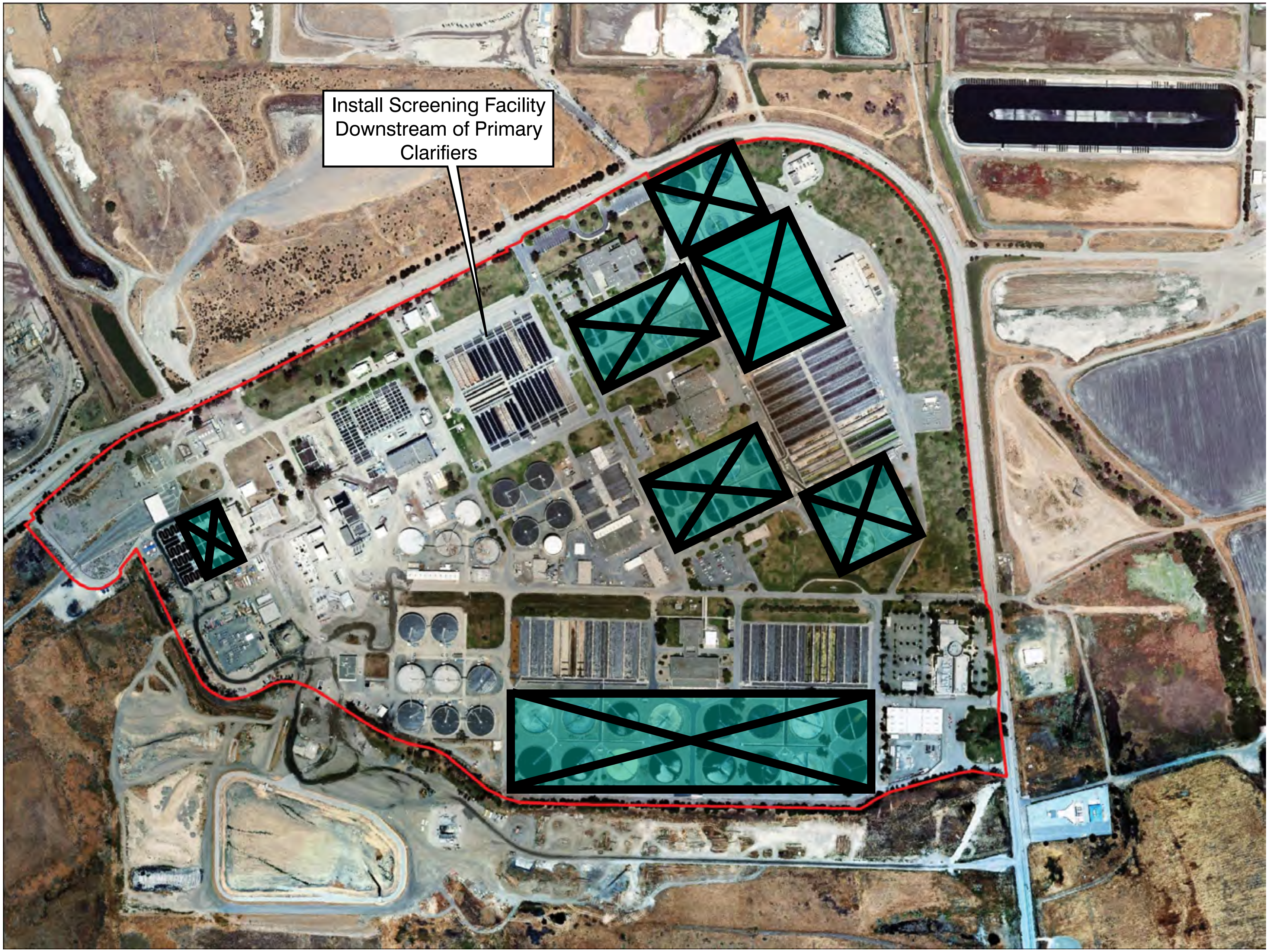

Figure E-11
FOOTPRINT REQUIREMENT FOR ALTERNATIVE 3 (TN < 8 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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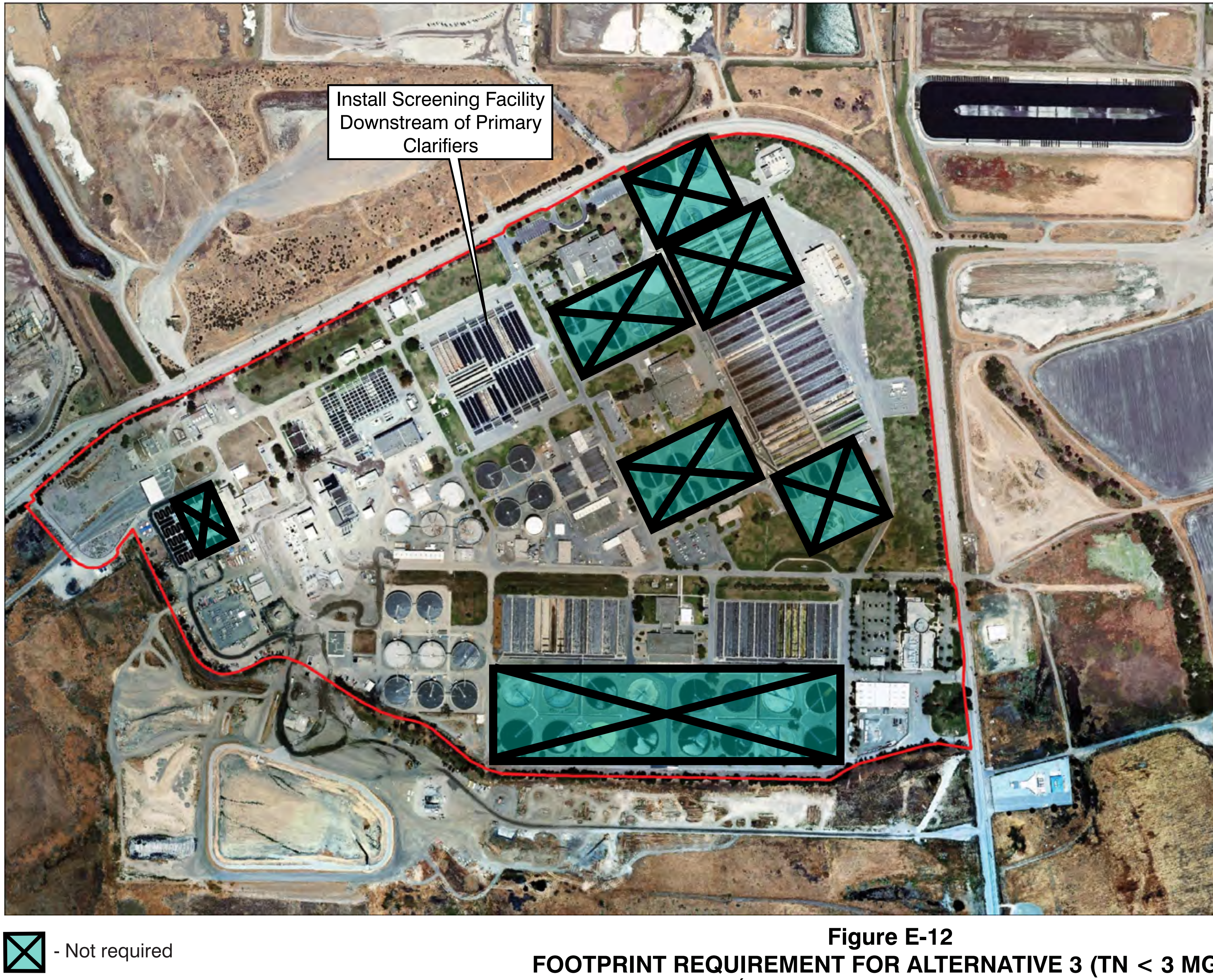

Figure E-12
FOOTPRINT REQUIREMENT FOR ALTERNATIVE 3 (TN < 3 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Figure E-13
FOOTPRINT REQUIREMENT FOR ALTERNATIVE 4 (TN < 8 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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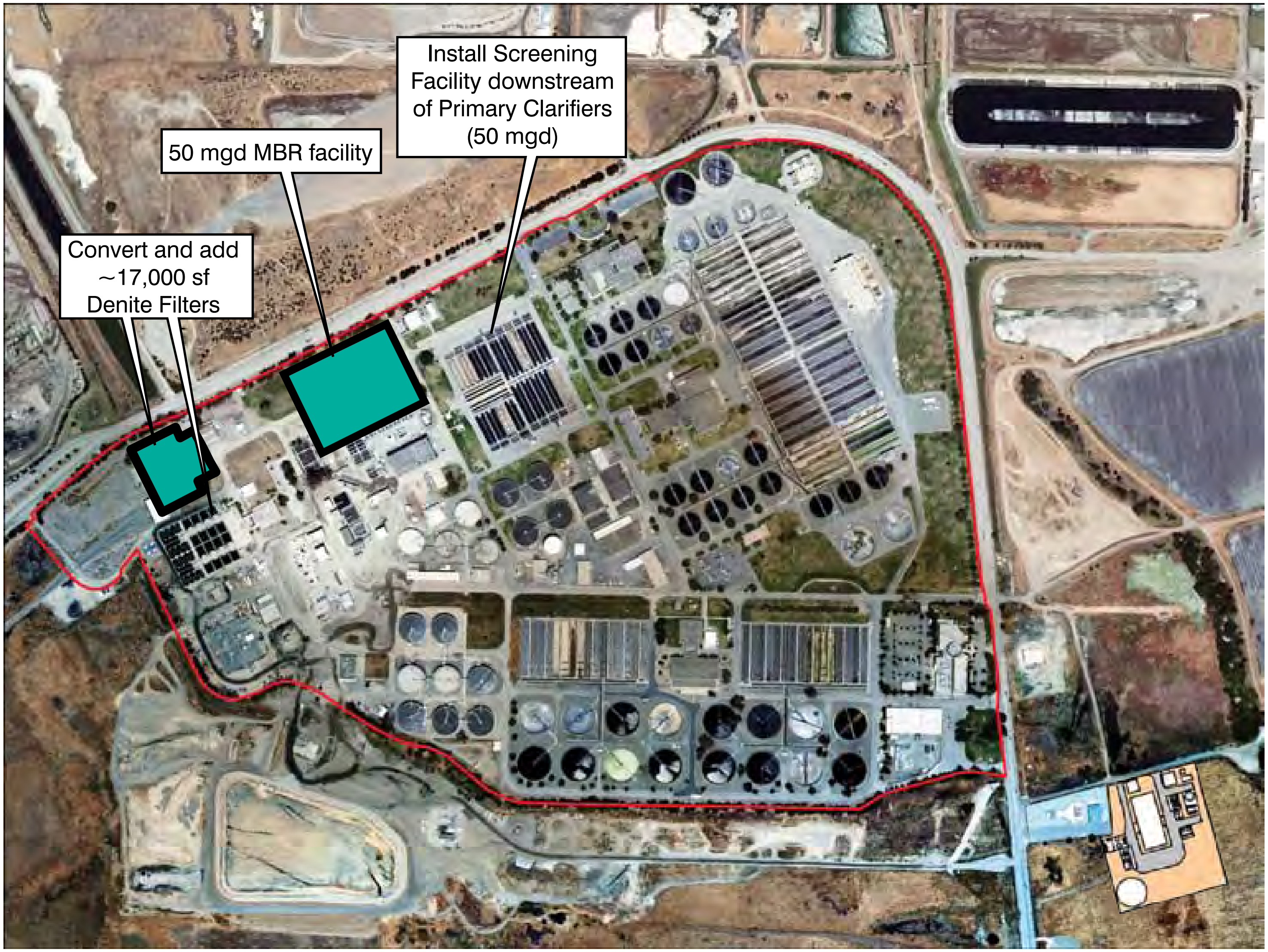

Figure E-14
FOOTPRINT REQUIREMENT FOR
ALTERNATIVE 4 (TN < 3 MG/L)
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Table E-3 Summary of Planning Level Project Cost Estimate for Secondary Treatment Alternatives (TN <8 mg/L) San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
Alternative	**Project Cost**(1)	**Description**
1 NAS	$160 MM±	RAS pumps, blowers, fine-bubble diffusers, anaerobic zone mixers, approximately 36,000 sf denite filters, and approximately 11,000 sf tertiary filters.
2 MLE	$215 MM±	Aeration basins, RAS pumps, blowers, fine-bubble diffusers, anoxic zone mixers, IMLR pumps, methanol system, and approximately 36,000 sf tertiary filters.
3 MBR	—	Not considered further.
4 Hybrid	$430 MM±	Aeration basins, RAS pumps, blowers, fine-bubble diffusers, anoxic zone mixers, IMLR pumps, methanol system, 50-mgd MBR, 50-mgd screening facility, and approximately 27,000 sf tertiary filters.

Notes:
(1) All costs presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(2) New tertiary filters sized assuming approximately 5.0 gpm/sf loading rate.

OPERATIONS COSTS AND PRESENT WORTH ANALYSIS

Table E-4 summarizes selected operations and maintenance (O&M) costs for the three alternatives considered for the capital cost analysis. These costs reflect electrical and methanol addition costs for each alternative under the TN <8 mg/L scenario. Significant differences in labor requirements between the alternatives were not anticipated, and were therefore excluded from the analysis.

The O&M costs were amortized to a present worth value assuming a real interest rate of 2 percent, and 30-year analysis period. The capital costs (Table E-3) were added to provide the estimated life-cycle costs for comparison purposes.

DISCUSSION OF ALTERNATIVES

The results of the cost estimate indicate that both the NAS and MLE alternatives are significantly less expensive than the Hybrid alternative. The high cost (both capital and O&M) associated with the Hybrid alternative is attributed to the MBR. The Santa Clara Valley Water District, in partnership with the City of San José, intends to construct an advanced treatment plant, consisting of microfiltration, reverse osmosis, and UV disinfection adjacent to the WPCP. The initial capacity of this plant is 10 mgd with the possibility to expand to 40 mgd. The construction of this membrane facility eliminates the need for MBR treated effluent. Furthermore, if additional membrane-filtered effluent is

**Table E-4 Summary of Planning Level Annual O&M and Life-Cycle Cost Estimates for Secondary Treatment Alternatives (TN <8 mg/L)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José**

Parameter	1. NAS	2. MLE	4. Hybrid
Aeration	$5,219,000	$5,303,000	$6,689,000
IMLR Pumping	---	$1,050,000	$1,050,000
RAS Pumping	$351,000	$351,000	$253,000
MBR Pumping	---	---	$778,000
Methanol addition	$2,750,000	$300,000	$300,000
Total	**$8,320,000**	**$7,000,000**	**$9,070,000**
O&M Present Worth	$186 MM	$157 MM	$203 MM
Capital Cost	$160 MM	$215 MM	$430 MM
Total Life-Cycle Costs	**$346 MM**	**$372 MM**	**$633 MM**

necessary in the future, constructing tertiary microfiltration would be less expensive than constructing an MBR.

NAS does not require additional tankage, however it does require denitrification filters to meet the possible future more stringent nitrogen limit. If nitrogen removal is not necessary in the future, NAS (without denitrification filters, i.e. with only secondary filters) would be the recommended alternative. If nitrogen removal is necessary, NAS will likely still have a slightly lower life-cycle cost than MLE (seven percent ± lower cost). However, the lower methanol requirement inherent to the MLE process, in comparison to NAS, is in keeping with the WPCP 2040 Vision (stated earlier in this document) of minimizing chemical use.

APPENDIX F - DETAILS ON PROCESS MODELING FOR SECONDARY TREATMENT OPTIONS

APPENDIX F - DETAILS ON PROCESS MODELING FOR SECONDARY TREATMENT OPTIONS

BioWin was used to estimate aeration tank requirements for each alternative. Steady-state modeling was performed at max month loading conditions. The secondary clarifier requirements were determined using state point analysis.

ASSUMPTIONS

Modeling for Alternative 1 (NAS) is detailed in PM 3.5. Model configurations for Alternatives 2 through 4 are show in Figures F-1 through F-3.

BIOWIN ASSUMPTIONS

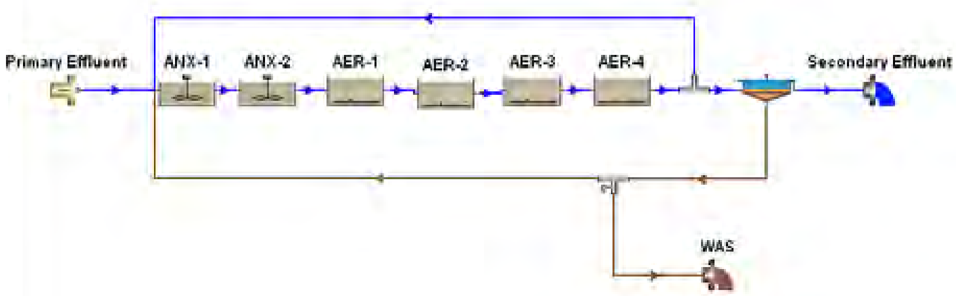
Specific parameter modifications incorporated into the model included the maximum nitrifier growth rate (decreased to 0.82 d^{-1})[4] and the dissolved oxygen (DO) half saturation constant (increased to 1 mg/L).[5] The DO concentration in all aerated regions was set to 3 mg/L. The aeration basin total volume was assumed to be 65.25 MG, which is the existing volume with one basin out of service in BNR 1A. A temperature of 16 degrees C was used for modeling. The overall approach was to assume that no new secondary clarifiers would be constructed (except where space was needed and existing units demolished to create it) and that only new aeration basins would be constructed. Activated sludge alternatives were modeled at a 6-d SRT to promote nitrification; MBR alternatives were modeled at an 8-d SRT to mitigate membrane fouling (lower SRT values have been shown to increase the membrane fouling rate).

CAPACITY EVALUATION

The critical mixed liquor suspended solids (MLSS) concentration for the aeration basins was determined using state point analysis at a 90th percentile SVI of 150 mL/g.[6] Total clarifier area available included existing secondary clarifiers with three 140-ft diameter secondary clarifiers out of service. The state point analysis prediction was derated by 20 percent to account for non-idealities. The maximum MLSS concentration was determined to be 2,600 mg/L. For the MBR alternatives, the MLSS concentration was

[4] Adapted from Jimenez, J. et al. (2009) The impact of degree of recycle on the nitrifier growth rate. WEF 2009 Nutrient Removal Conference.
[5] Adapted from Bratby, J and Parker, D. (2009) Accurately Modeling the Effect of Dissolved Oxygen on Nitrification. WEF 2009 Nutrient Removal Conference.
[6] Parker et al., 2004. North American performance experience with anoxic and anaerobic selectors for activated sludge bulking control, WST, 50 (7) 221-228.

TN < 8 mg/L



TN < 3 mg/L

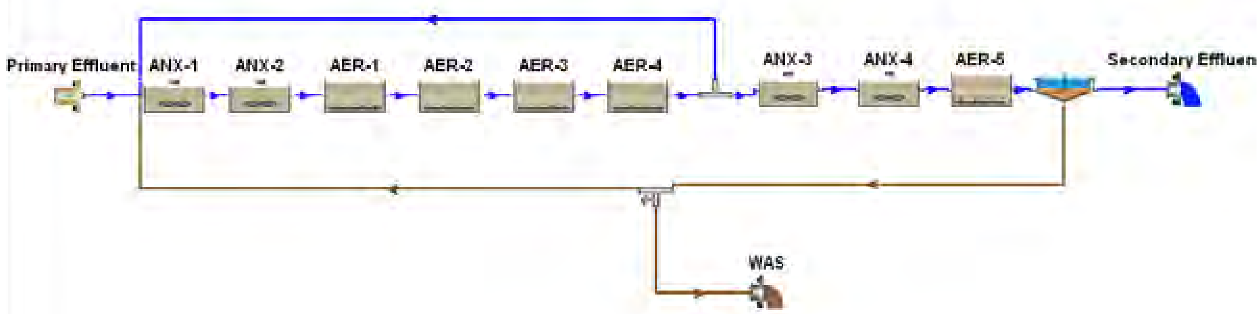


Figure F-1
PROCESS MODEL CONFIGURATION
FOR ALTERNATIVE 2
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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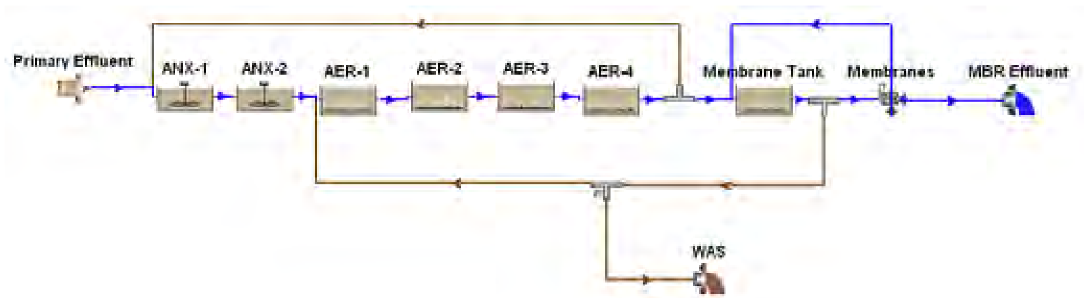
TN < 8 mg/L



TN < 3 mg/L

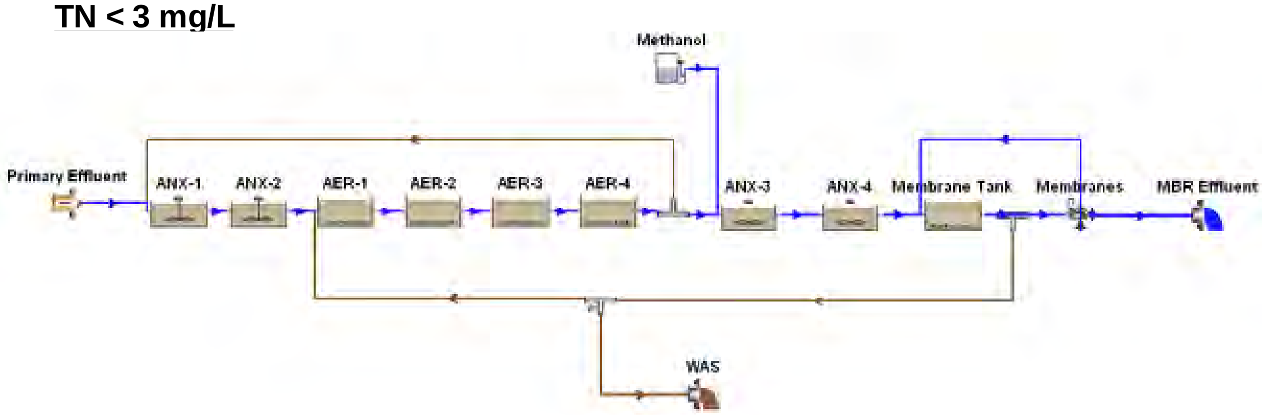


Figure F-2
PROCESS MODEL CONFIGURATION
FOR ALTERNATIVE 3
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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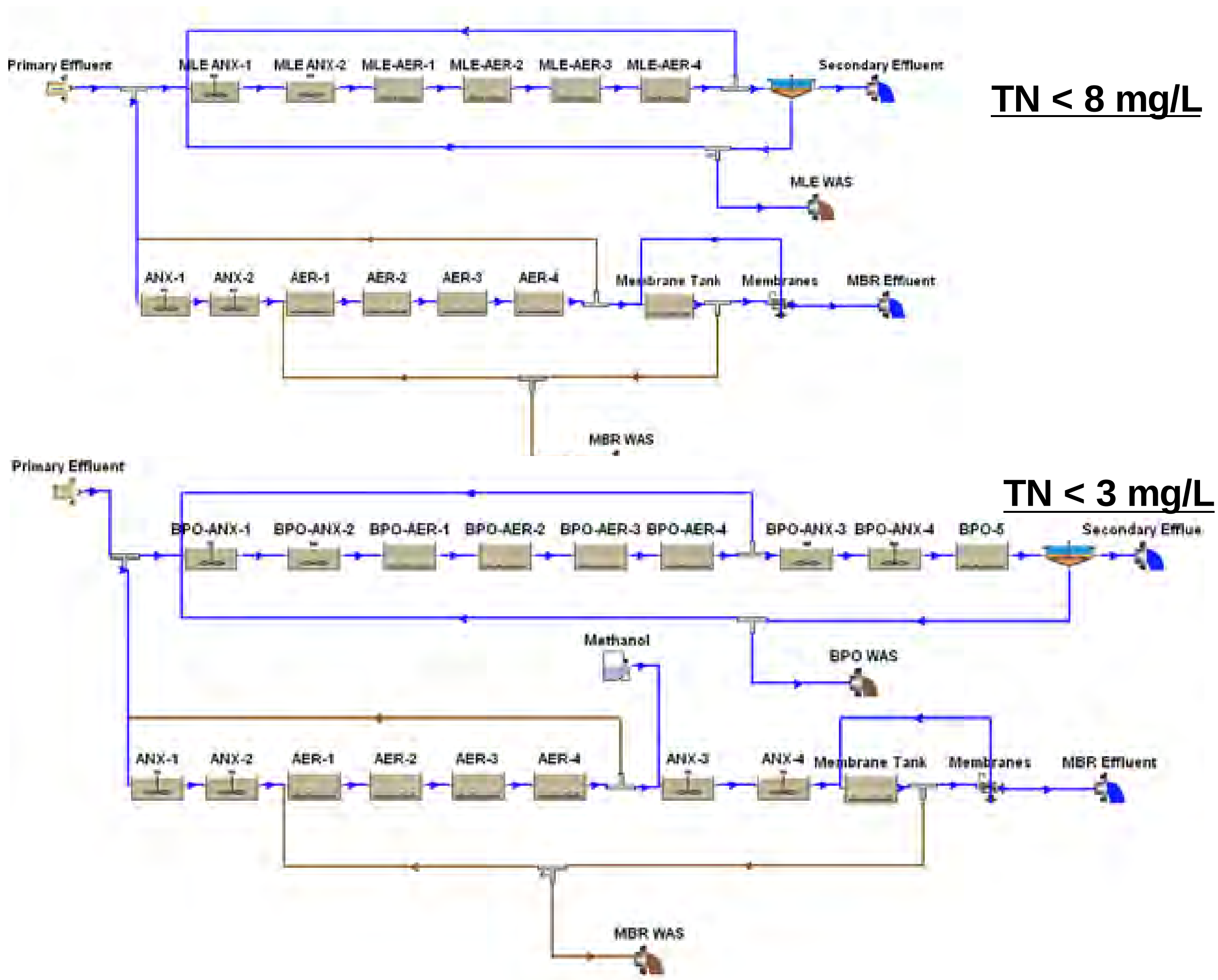

Figure F-3
PROCESS MODEL CONFIGURATION
FOR ALTERNATIVE 4
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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limited to 10,000 mg/L in the membrane tanks. Aeration requirements were limited to an oxygen uptake rate (OUR) of 120 mg/L-hr at peak day loading in the first aerobic cell which represents the approximate maximum an aeration system can satisfy. Table F-1 summarizes the results of the process modeling. Capacity was determined assuming that maximum month loading corresponds with peak hour flow and 90th percentile SVI.

Table F-1 Summary of Process Modeling
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alt	TN	New Aeration Tanks	New Clarifiers	Additional Equipment
1	< 8 mg/L	---	---	Methanol addition; denit filters
	< 3 mg/L	---	---	Methanol addition; denit filters
2	< 8 mg/L	11 new tanks to BNR 2 (16.8 MG)	---	Methanol addition
	< 3 mg/L	18 new tanks to BNR 2; 3 new tanks to BNR 1 (35.2 MG)	Relocate 2, secondary clarifiers	Methanol addition; denit filters
3	< 8 mg/L	Abandon 8 tanks from BNR 1 (abandon 22.8 MG)	Abandon all secondary clarifiers	Methanol addition; Membranes, screening equipment
	< 3 mg/L	Abandon 5 tanks from BNR 1 (abandon 15.3 MG)	Abandon all secondary clarifiers	Methanol addition; Membranes, screening equipment
4	< 8 mg/L	11.6-MG MBR	---	Methanol addition; Membranes, screening equipment
	< 3 mg/L	13.8-MG MBR; 5 new tanks to BNR2 (8.1 MG)	---	Methanol addition; Membranes, screening equipment; denit filters

AERATION EVALUATION

The OUR values from the BioWin modeling (at max month loading) were transformed to peak day demand. The carbonaceous OUR and nitrification OUR values were increased using the relationship between the peak month and peak day peak loading factors (Flows and Loads TM) for BOD and ammonia, respectively. This same technique was used to scale down max month OUR values to annual average OUR values using peaking factors.

Aeration estimates were performed at 16 degrees C. Alpha values of 0.5 and 0.4 were used for activated sludge and MBR alternatives, respectively. A standard oxygen transfer efficiency (SOTE) of 28 percent was used. For membrane aeration, Zenon membranes were assumed based on existing full-scale operating facilities. Table F-2 summarizes aeration requirements.

Table F-2 Summary of Average Aeration Requirements for Each Alternative
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alt	TN Objective	Firm Aeration Requirements, scfm	Average Blower Use, scfm
1	All conditions	Process Aeration = 243,100	Process Aeration = 155,500
2	< 8 mg/L	Process Aeration = 247,100	Process Aeration = 158,000
	< 3 mg/L	Process Aeration = 235,400	Process Aeration = 150,900
3	< 8 mg/L	Process Aeration = 285,800 Membrane Aeration = 235,400	Process Aeration = 183,000 Membrane Aeration = 117,700
	< 3 mg/L	Process Aeration = 262,900 Membrane Aeration = 235,400	Process Aeration =168,900 Membrane Aeration = 117,700
4	< 8 mg/L	MLE Process Aeration = 190,700 MBR Process Aeration =74,700 Membrane Aeration = 58,600	MLE Process Aeration = 122,000 MBR Process Aeration =47,900 Membrane Aeration = 29,300
	< 3 mg/L	Process Aeration = 192,200 MBR Process Aeration =68,000 Membrane Aeration = 58,600	MLE Process Aeration = 116,300 MBR Process Aeration =43,700 Membrane Aeration = 29,300

APPENDIX G – ADDITIONAL CONSIDERATIONS FOR SECONDARY PROCESSES

APPENDIX G – ADDITIONAL CONSIDERATIONS FOR SECONDARY PROCESSES

IMPACT OF RECYCLE STREAMS

The liquid stream resulting from the biosolids processing facilities is returned to the head of the treatment plant. The costs (capital and O&M) and footprint requirements for the secondary alternatives were determined assuming the existing solids processing facilities were still being used, i.e. no changes to the recycle stream. It typically increases the plant influent loading (TSS, BOD and ammonia) by three (3) percent at ADMML. However, when solids dewatering is implemented in the future, the recycle stream loadings are expected to increase significantly. A well designed and operated solids processing system is expected to increase influent BOD and TSS loading to ten (10) percent. Similarly, recycle stream nitrogen loading can account for 15 to 30 percent of plant loading.

An increase in BOD and TSS loading will increase reactor volume requirements by approximately ten (10) percent because of the additional biomass that would be generated. The increase in ammonia would not have a significant effect on sludge inventory, but would significantly increase aeration requirements. A 25-percent ammonia increase would increase aeration requirements by approximately 13 percent for the NAS and MLE alternatives.

For the existing permit condition (ammonia <3 mg-N/L), the impact of an increased ammonia loading can be reduced by equalizing the dewatering return stream. An equalization tank allows for dewatering shut downs with minimal impact to secondary loading. This would not reduce the overall nitrogen loading to the secondary system, but it would prevent shock loads to the secondary system.

For the nitrogen removal scenarios, a side-stream nitrogen removal process would both reduce nitrogen loading to the secondary system as well as reduce overall energy and carbon requirements. The DEMON® process is an example of a side-stream nitrogen removal system that represents an emerging best practice. The process is capable of up to 90 percent ammonia removal and consists of a sequencing batch reactor (SBR) designed for deammonification through pH and DO control (see Wett, B. [2007] Development and implementation of a robust deammonification process, Wat. Sci. and Tech. 56 [7] 81-88). The deammonification process is comprised of two metabolic steps: 1) approximately half of the ammonia is oxidized to nitrite and 2) the remaining ammonia is anaerobically oxidized to nitrogen gas using nitrite. The deammonification process eliminates the need for an external organic carbon source and significantly reduces the process oxygen requirements when compared with conventional nitrification.

There are other side-stream processes that could mitigate return stream nitrogen. The Ostara process, which is designed to recover phosphorus, will also remove ammonia. However, the Ostara process is not recommended unless biological phosphorus removal is necessary. Other processes that are currently developing, including algae treatment (one vendor will be pilot testing side-stream treatment at the Fairfield-Suisun Sewer District beginning in 2010), should continue to be evaluated in the future.

IMPACT OF WASTE MINIMIZATION

Two methods to reduce the influent loading to the WPCP are being considered:
1) implementing food waste separation (FWS) (see PM 4.10b), and 2) urine separation (see PM 4.10a). Table G-1 presents the potential decrease in influent constituents. Neither minimization option would have a significant impact on influent flow. Implementing FWS would have a significant impact on BOD and TSS loading. Implementing urine separation would have the greatest impact on influent nitrogen and a lesser impact on influent TSS.

Table G-1 Summary of Impact of Waste Minimization on WPCP Influent Loadings
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Constituent	Discontinuing FWS (Percent Decrease)[1]	Urine Separation in 50 Million Square Feet of Office Buildings (Percent Decrease)[2]
Flow	<1	<1
BOD Loading	14	<1
TSS Loading	16	3

Notes:
(1) Adapted from Table 6 (PM 4.10b).
(2) Adapted from Table 5 (PM 4.10a).

For both NAS and MLE, implementing FWS would reduce the MLSS concentration in the aeration basins and reduce the secondary sludge production. For NAS, there would be no change in the footprint requirements since no new aeration tanks would be necessary. However, there would be a 12-percent decrease in aeration requirements. For MLE, only two (2) (instead of 11) new aeration basins would be required at BNR 2. There would be a nine (9)-percent reduction in aeration requirements.

For both NAS and MLE, implementing urine separation would reduce aeration requirements by three (3) percent. There would be a minimal impact to aeration basin sizing since TSS reduction is only three (3) percent.

PRIMARY EFFLUENT FLOW AND LOADING EQUALIZATION

Currently, primary effluent is equalized on a daily basis in a 16 MG equalization basin to minimize the impact of diurnal loading to the secondary system. Daily flow equalization allows for a more consistent loading pattern to the secondary system. Another approach would be to equalize the influent loading, instead of the influent flow. Since influent ammonia has a higher air demand than influent BOD, equalizing the ammonia loading would result in less fluctuation in the air usage, and more stable operating conditions in the secondary system.

Equalization requirements were determined for 2010 and 2040 flow and load conditions for two scenarios: 1) flow equalization, and 2) ammonia load equalization. A typical diurnal flow curve and a diurnal ammonia concentration (Figure 4-21, 1/28/97 data, Plant Optimization Program, March 1998, City of San José) were used to estimate equalization requirements. Table G-2 presents the estimated equalization volumes required for the two scenarios. The requirements for ammonia load equalization are estimated to be approximately 22 to 24 percent higher, which is attributed to the diurnal concentration pattern of the ammonia. If this alternative is considered further, additional diurnal sampling is recommended to refine this estimate. On-line ammonia analyzers would be required to continuously monitor the ammonia concentration.

Table G-2 Estimate of Equalization Volumes for Primary Effluent Flow and Ammonia Load
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Year	Flow Equalization	Ammonia Load Equalization
2010	17 MG	21 MG
2040	23 MG	28 MG

Based on the 2040 ammonia load equalization requirement of 28 MG, expanding primary effluent flow equalization to include ammonia load equalization would entail an additional 12 MG equalization basin to augment the current 16 MG basin capacity.

NUISANCE FOAM CONTROL

Nuisance foaming is a serious issue in the secondary treatment system. The plant's transition to fine-bubble aeration is making the problem worse, because it generates more foam, and induces less mixing.

This problem particularly plagues activated sludge plants operating in the higher SRTs needed for nitrification. The organism most frequently associated with nuisance foaming is *Nocardia*. There are a number of schemes that are typically applied to combat nuisance foaming, namely:

- Surface chlorination
- Anaerobic and anoxic selectors
- SRT control
- Organic polymer control
- Classifying selectors

The plant has been successful at combating nuisance foam with SRT control, but is forced to operate within a very small SRT window. While it needs to maintain a minimum SRT to enable nitrification, it has an upper SRT limit to avoid the formation of excessive *Nocardia*.

Classifying selectors are widely used to control the population of foam-causing organisms to avoid the development of nuisance foams. It functions as a physical removal mechanism by which foam-causing organism, enriched into the solids in the foam, are systematically removed from the treatment system. This surface removal mechanism controls their population at low numbers in the mixed liquor, i.e., they are selected against. Since these organisms are continually wasted, they are prevented from being trapped in the treatment system, and from accumulating to nuisance level concentrations.

At the WPCP, the design of the aeration basins is fundamentally at the heart of the problem because of underflow between compartments, and underflow discharge to the clarifiers. Foam-causing organisms are therefore trapped throughout the reactors. To remedy this in the aeration basins will likely be prohibitively expensive.

Other methods of foam removal include downward opening gate installations along or at the end of mixed liquor distribution channels, rotating surface scrapers in the secondary clarifiers, and gate installations in an aerated RAS channel.

These and other solutions, together with results from case studies at wastewater treatment plants, are documented by Parker, *et al* (2003)[7]. They observed at the SCRSD (Sacramento, CA), for instance, that selectors at the end of the mixed liquor channels were more effective at controlling *Nocardia* than the selector placed in the RAS channel.

Parker, *et al* suggest the design of skimming and pumping systems for classifying selectors take the following three principal considerations into account:

1. The system should be capable of removing a limited amount of liquid continuously from the top layer of the channel/tank in which it is located.
2. The foam-causing organisms are concentrated into the surface foam in the liquid to be pumped.

[7] Parker et al., 2003. Making Classifying Selectors Work for Foam Elimination in the Activated-Sludge Process, WEF, 75 (1) 83-91

3. The pump and its inlet system must be designed for complete removal of the skimmed material.

It is recommended that a detailed assessment be conducted of the possibility of introducing surface wasting into the aeration basins. This should be compared to the possible introduction of surface wasting installations in the mixed liquor channels to the secondary clarifiers, or in the RAS tanks prior to return to the aeration basins.

BIOLOGICAL STRUVITE CONTROL

Struvite (ammonium magnesium phosphate) is a phosphate mineral that crystallizes into a hard white to brownish-white substance. It is particularly problematic in the anaerobic digestion system where ammonium and phosphate is released from the sludge, scaling on equipment and clogging pipelines.

One approach to limiting struvite formation is to limit the amount of phosphorus contained in the waste activated sludge (WAS) from the secondary treatment system. This limits the amount of available phosphorus in the digesters, and reduces struvite formation. Microorganisms in an activated sludge system exert a metabolic demand for phosphorus. However, in reactors with sequential unaerated (anoxic)-aerated zones, the microorganisms go through cycles of releasing previously assimilated phosphorus in the anoxic zones, and assimilating it again in the subsequent aerobic zones. Through a repetition of this cycle, the organisms respond by accumulating phosphorus in excess of their metabolic requirements. This phenomenon forms the basis of biological phosphorus removal from wastewater, since the excess phosphorus load is removed from the wastewater with the WAS.

The process can be limited by introducing an oxygen-rich internal mixed liquor return (IMLR) stream from the aerated zone into the anoxic zone. This stream diminishes the difference in DO concentration between the two zones, thereby limiting phosphorus uptake, and ultimately reducing struvite formation in the digesters.

The MLE process, proposed as one of the alternatives to meet a potential future TN < 8 mg/L limit, already utilizes IMLR, and is expected to limit phosphorus uptake. However, a modification to the current step-feed mode of operation was considered to test the potential of further limiting biological phosphorus uptake, and thereby inhibit struvite formation in the digesters even further. The modification entails the addition of IMLR, although at a much lower flow rate than is required by the MLE process. These two approaches are shown schematically in Figure G-1.

For the new step-feed with IMLR process to be considered, it must be capable of meeting a TN < 8 mg/L, and show an improved inhibition of phosphorus uptake. The evaluation is summarized as follows:

Nitrogen Removal. The additional tank volume requirement identified in Appendix E for the MLE process (target TN < 8 mg/L) is also required for the step-feed with IMLR scenario. Both scenarios assume 20 percent of the tank volume is unaerated.

The analysis shows step-feed with an IMLR of greater than 150 percent (SRT of 6.5 days) results in a similar nitrogen removal performance as MLE with an IMLR of 400 percent (SRT 6.0 days) (Figure G-2). MLSS concentrations to the clarifier are similar, so clarifier capacity is sufficient. This shows that the introduction of IMLR into the step-feed process will meet the target TN at a much lower IMLR than required for the MLE process, which will significantly lower the associated energy costs.

Phosphorus Removal. While an IMLR of 150 percent in the step-feed mode is sufficient to meet the TN requirement, it results in only approximately 10 percent reduction of phosphorus to the digester, as shown in Figure G-3. To maximize the reduction of digester phosphorus loading, and offer an improvement over the MLE process, an IMLR of 300 percent would be recommended for the step feed configuration. However, under these operating conditions, the difference in IMLR operating costs between the two processes would not be as dramatic.

Currently, the step-feed configuration has two anoxic zones that together constitute 50 percent of the aeration basin volume. However, the previous analysis was performed around a step-feed configuration with the two anoxic zones comprising only 20 percent of the aeration basin volume, similar to MLE (see Figure G-1). Additional analysis was performed to evaluate the benefits of adding IMLR to the current step-feed configuration.

Figure G-4 shows the effect of IMLR on the existing configuration (i.e. 50 percent unaerated scenario), namely an IMLR as high as 500 percent does not reduce phosphorus to the digester significantly. Therefore, to mitigate struvite formation, the unaerated volume should be reduced, and an IMLR of at least 300 percent should be added.

SECONDARY TREATMENT SYSTEM HYDRAULICS

Two secondary treatment modes of operation are recommended for consideration to meet a possible future discharge regulation of TN < 8 mg/L, namely NAS (with additional denitrification), and MLE. The details of the evaluation are presented in Appendix E. A third treatment mode, namely Step Feed with IMLR, was also considered because of its potential to reduce struvite in the digesters, at a lower IMLR flow rate than required for MLE.

All three of these modes of operation have been shown to meet the target TN removal objective. Additional hydraulic analysis has shown a minimal freeboard exists during PHWWF conditions in both the aeration basins and secondary clarifiers for all these modes of operation. However, these conclusions are based exclusively on hydraulic modeling results and it is imperative, therefore, that the results be field verified.

For the hydraulic analysis, the longest, controlling hydraulic paths for BNR1 and BNR2 were identified, and the hydraulic model developed for these paths from the downstream control point to the furthest upstream point along the path. Figure G-5 shows the governing hydraulic paths for the evaluation. The results of the hydraulic modeling effort under peak flow conditions are summarized in the following Table G-3.

The major assumptions that were used to set up the model are listed below.

- Facilities upstream of aeration basins and associated waterways (i.e., channels and pipelines) have sufficient hydraulic capacity to deliver the needed primary effluent flow rate to the secondary treatment processes.

- Similarly, facilities downstream of the secondary clarifiers and associated waterways (i.e., channels and pipelines) have sufficient hydraulic capacity not constrain the secondary treatment system hydraulics.

- The modifications to BNR1 aeration basin Nos. A-7, A-8, B-7, and B-8 that provided inter-quadrant channels within each aeration basin under the 1982 Phase IIA project were assumed for all other BNR1 aeration basins.

- The additional aeration basins that are required to expand BNR2 under the MLE and the Step Feed with Internal Mixed Liquor Return modes (identified as BNR2+ in Table G-3) will be identical to the existing BNR2 aeration basins from a hydraulic standpoint.

- New waterways required to connect the BNR2+ aeration basins to and from existing facilities will be designed with low enough headloss not to constitute the critical hydraulic path.

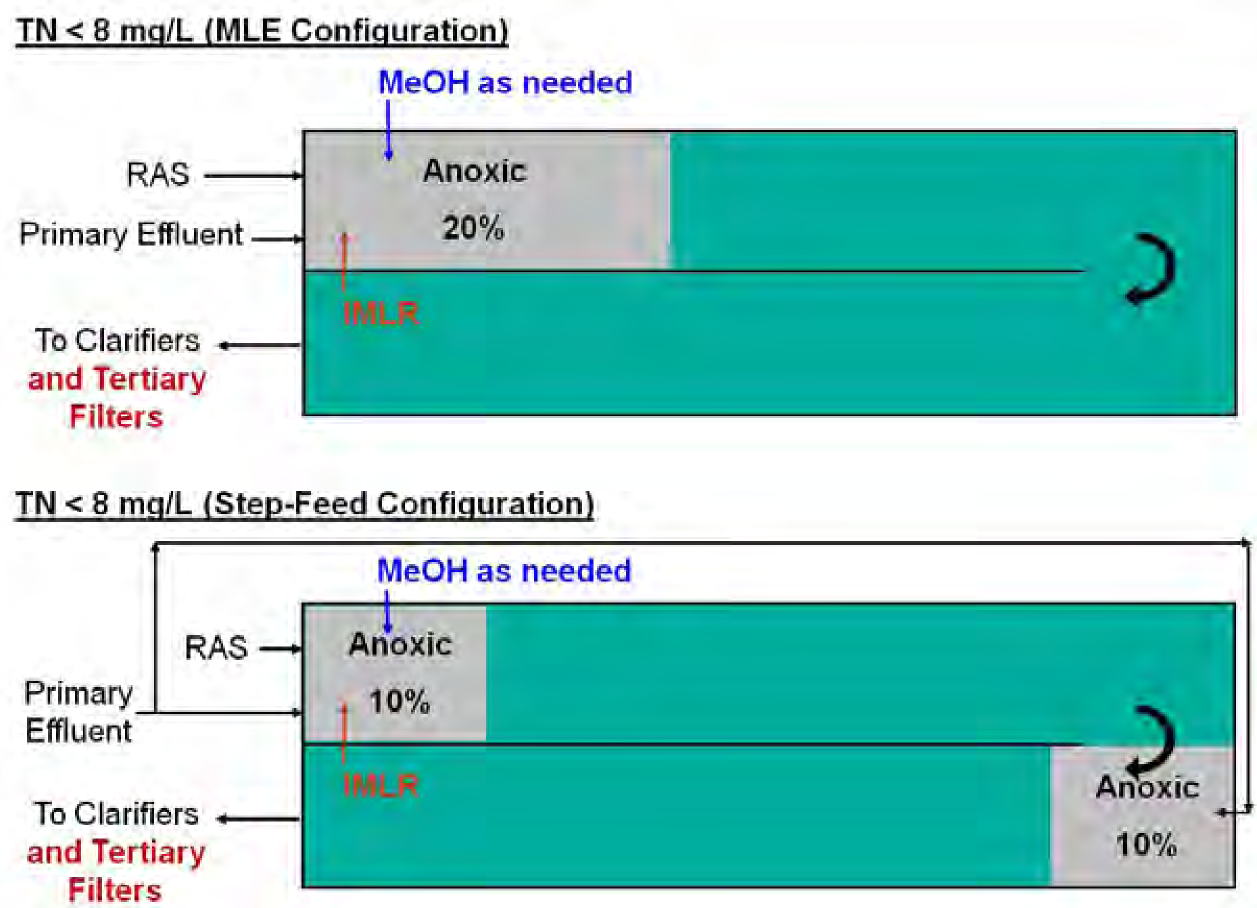

Figure G-1
STEP FEED WITH IMLR CONFIGURATION
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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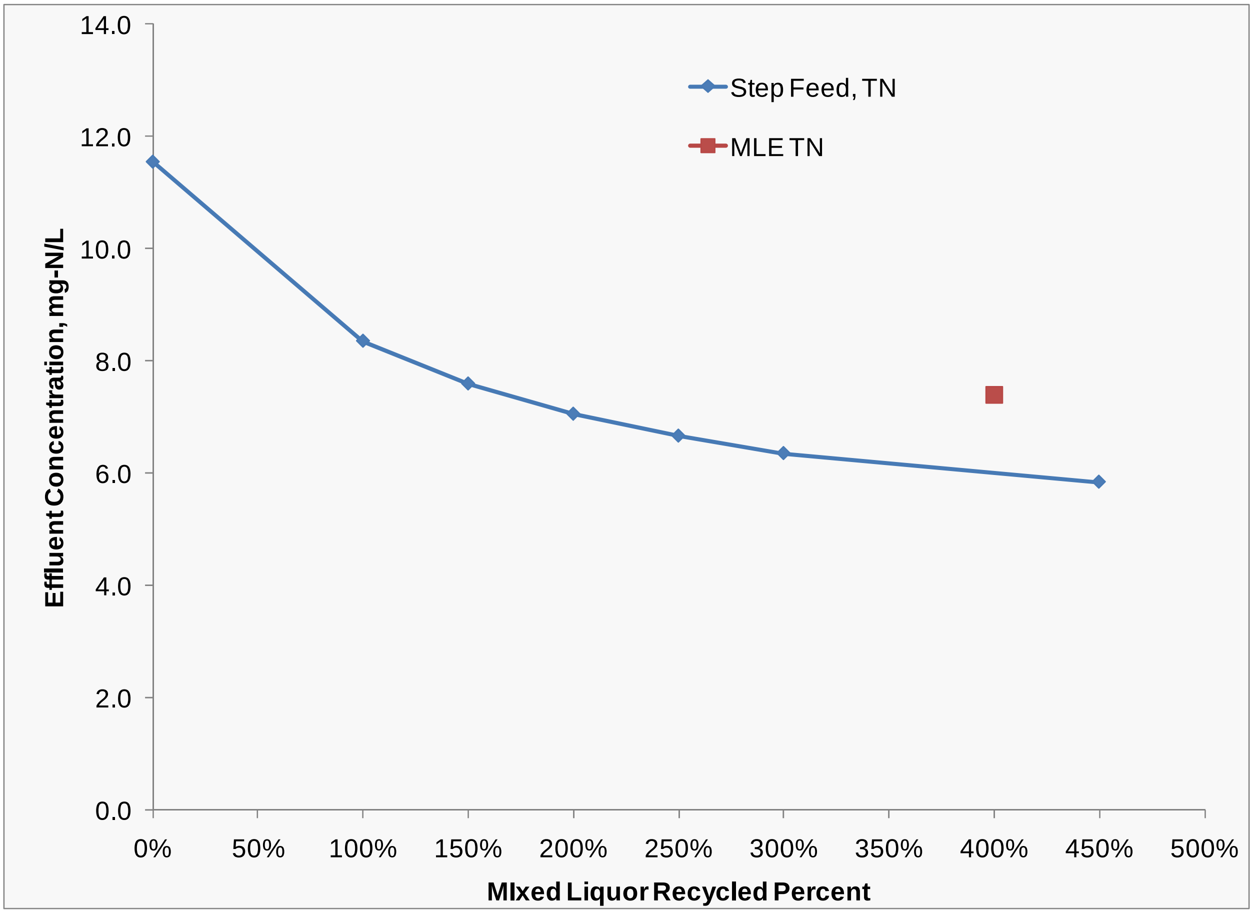

Figure G-2
NITROGEN REMOVAL
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

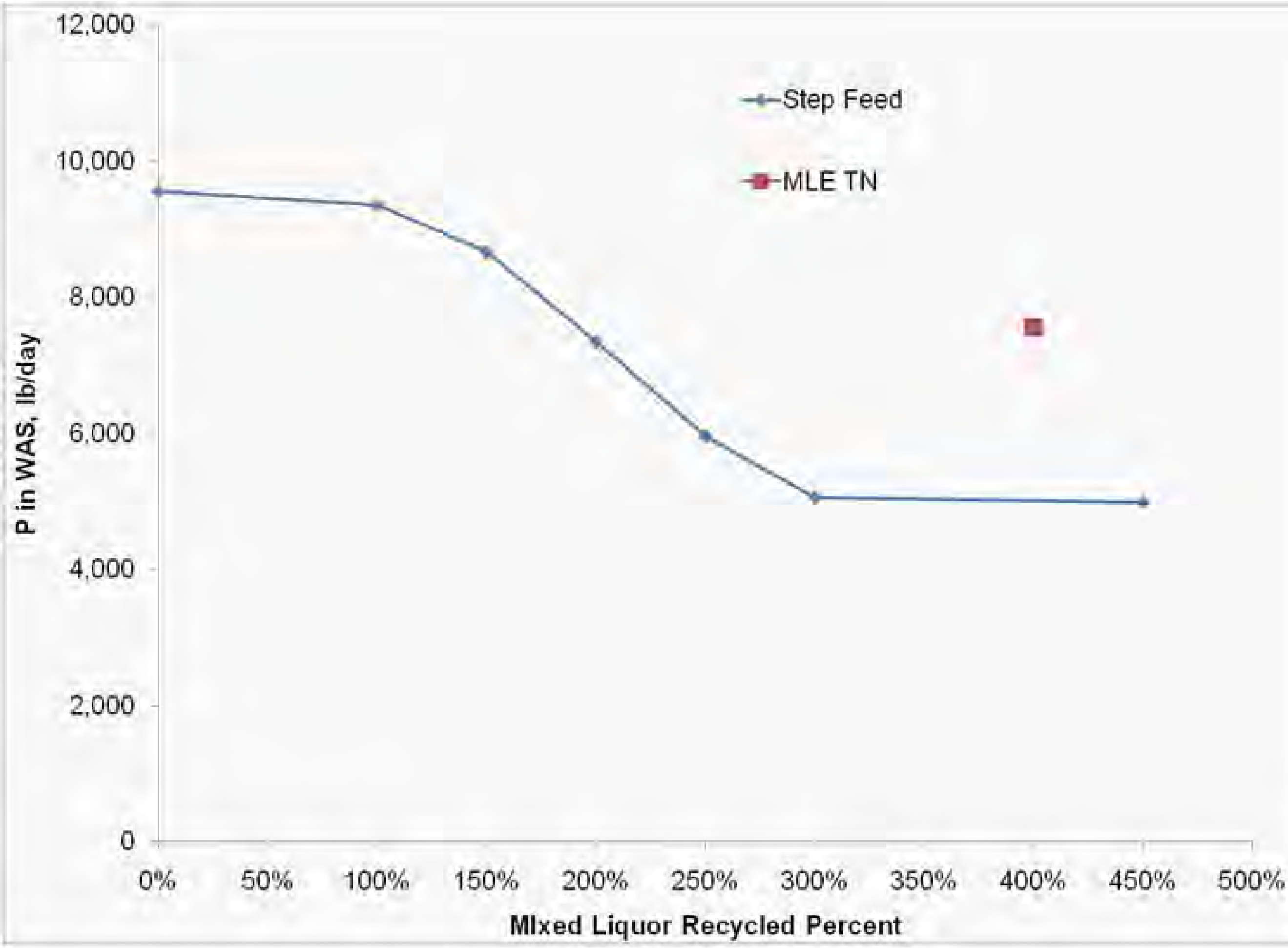

Figure G-3
PHOSPHORUS MASS IN WASTE SLUDGE
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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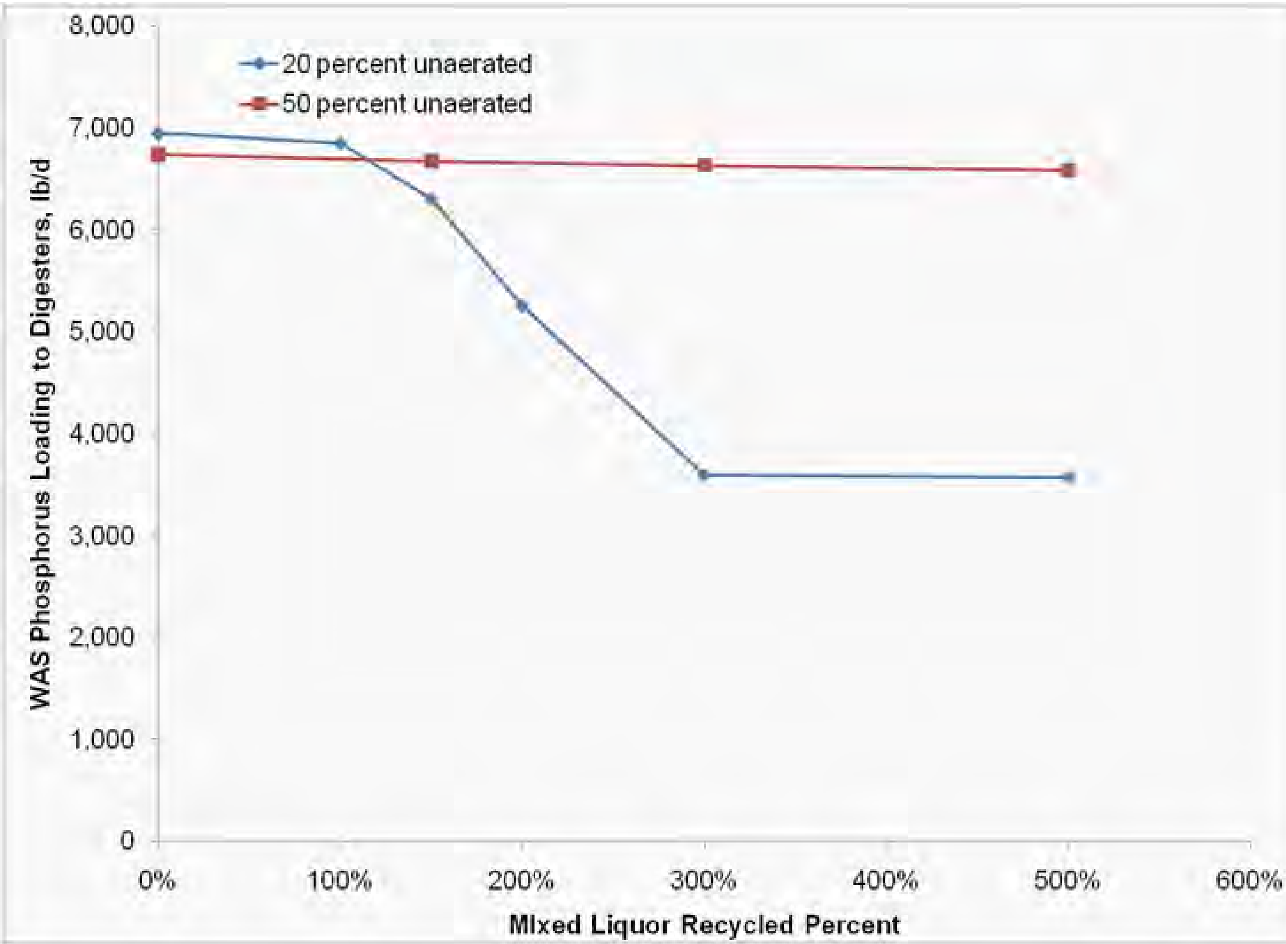

Figure G-4
COMPARISON OF EXISTING TANK CONFIGURATION
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Table G-3	Estimated Freeboard in the Secondary Treatment System in NAS, MLE, Step Feed Modes of Operation San José/Santa Clara Water Pollution Control Plant Master Plan City of San José							
Mode	**System**		**Primary Effluent mgd**	**RAS mgd**	**Mixed Liquor Return mgd**	**Ratio of MLR to Primary Effluent**	**Freeboard in Aeration Basins(1) inches**	**Freeboard in Secondary Clarifiers inches**
NAS	BNR1	1st Quadrant	202	150	0	0.0	8.6	5.3
		3rd Quadrant	0	0				
	BNR2	1st Quadrant	154	144	0	0.0	30.5	18.3
		3rd Quadrant	0	0				
		Total	**356(4)**					
MLE	BNR1	1st Quadrant	179.6	101.4	718.5	4.0	14.0	7.5
		3rd Quadrant	0	0				
	BNR2	1st Quadrant	104.5	59	418.1	4.0	23.3	18.7
		3rd Quadrant	0	0				
	BNR2+(2)	1st Quadrant	71.9	40.6	287.4	4.0	23.3(3)	NA
		3rd Quadrant	0	0				
		Total	**356(4)**					
Step Feed with Internal Mixed Liquor Return	BNR1	1st Quadrant	89.8	101.4	269.4	1.5	15.1	7.5
		3rd Quadrant	89.8	0				
	BNR2	1st Quadrant	52.25	59	156.8	1.5	32.7	18.7
		3rd Quadrant	52.25	0				
	BNR2+	1st Quadrant	35.95	40.6	107.8	1.5	32.7(3)	NA
		3rd Quadrant	35.95	0				
		Total	**356(4)**					

Notes:
(1) Freeboard in aeration basins is at the upstream end of the basins, which is in the first quadrant.
(2) Additional aeration basins required to expand BNR2.
(3) Freeboard for BNR2+ is assumed to be same as BNR2.
(4) Equalized PHWWF to the secondary treatment system.

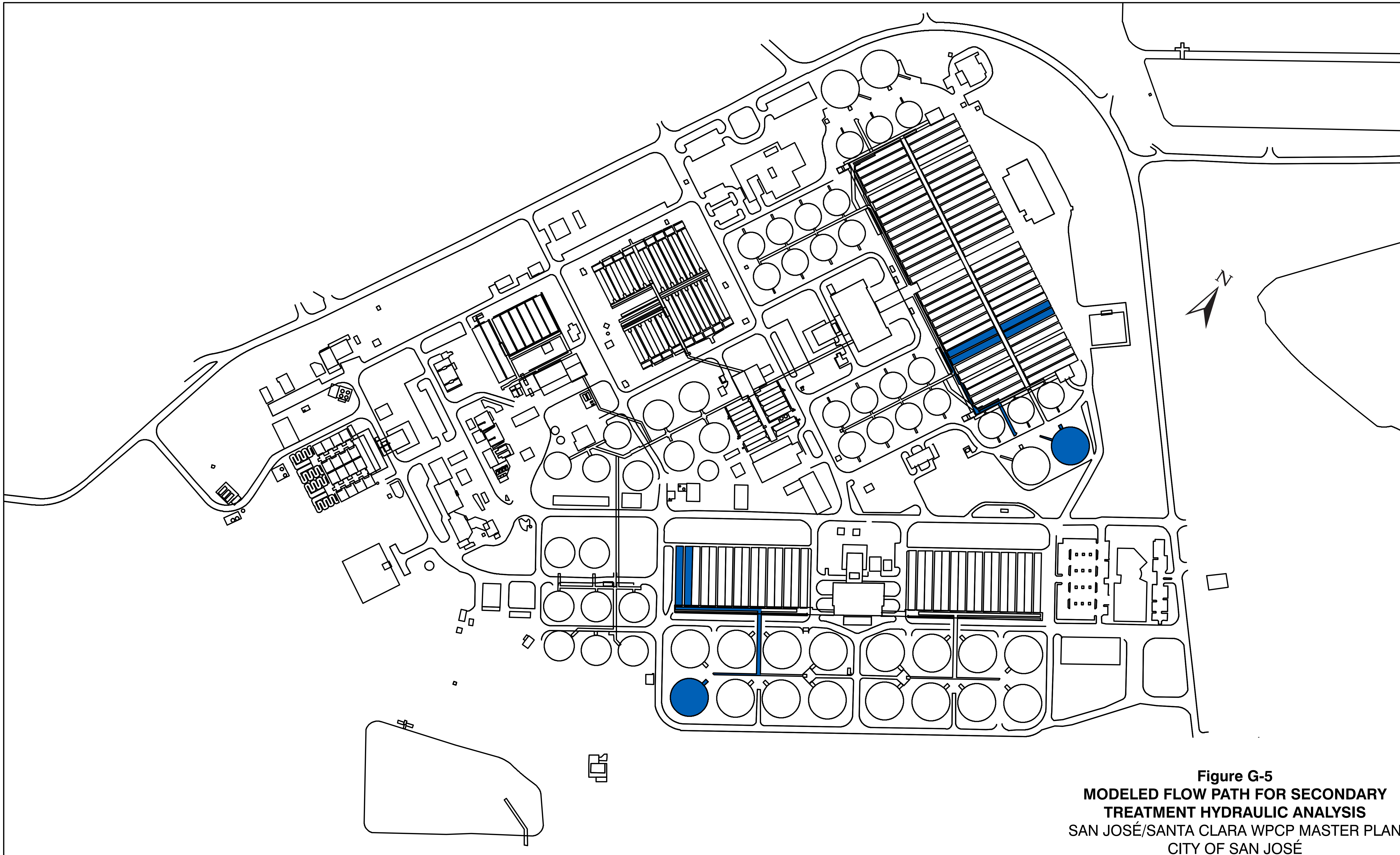

Figure G-5
MODELED FLOW PATH FOR SECONDARY TREATMENT HYDRAULIC ANALYSIS
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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APPENDIX H – UV DISINFECTION BENCH-SCALE STUDY

APPENDIX H – UV DISINFECTION BENCH-SCALE STUDY

The City conducted a bench-scale UV disinfection study using a collimated beam device, with sampling dates of 6/20/2007, 6/27/2007, 7/11/2007, and 7/18/2007[8]. Three discrete filtered effluent samples, and one unfiltered effluent sample from the WPCP, were exposed to a series of UV dosages (seven UV dose values, each performed in triplicate) and then analyzed for four pathogenic indicators (indigenous total coliforms, indigenous fecal coliforms, indigenous enterococci, and *E. Coli*) and seeded MS2 coliphage.

The UV dose-response for total coliform, fecal coliform, and enterococcus for the three discrete filtered effluent samples, and one unfiltered effluent sample, are presented in the following Figures H-1 through H-4.

Table H-1 shows the regulated disinfection effluent microbiological limits for bay discharge. As a measure of conservatism, target disinfection effluent microbiological limits were chosen to be 1-log below the regulated limits (90 percent reduced). These conservative targets are also shown in Table H-1, along with the UV dose required on the filtered effluent to meet the microbiological targets.

Table H-1 Determination of Conservative Log Reduction Values for Total and Fecal Coliform and Enterococcus
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Organism	Regulated Limit, MPN / 100 mL	UV Disinfection Target Limit(1), MPN / 100 mL	UV Dose, mJ/cm^2
Total Coliform	100	10	25
Fecal Coliform	20	2	25
Enterococcus	35	1	20

Note:
(1) Except for enterococcus, which currently has a target limit of 1 MPN / 100 mL, all other target limits are 1-Log below the regulated limit.

The data presented for the unfiltered samples in Figure H-4 show a leveling off of the UV dose responses long before even the regulated limits are met. These data indicate UV disinfection of an unfiltered effluent will not be possible, even at very high doses.

[8] Details of the analysis are documented in the Carollo Engineers report for the City of San José Environmental Services Department, entitled "Ultraviolet Disinfection Bench Scale Data Analysis And Full Scale System Cost Estimates", April 2008.

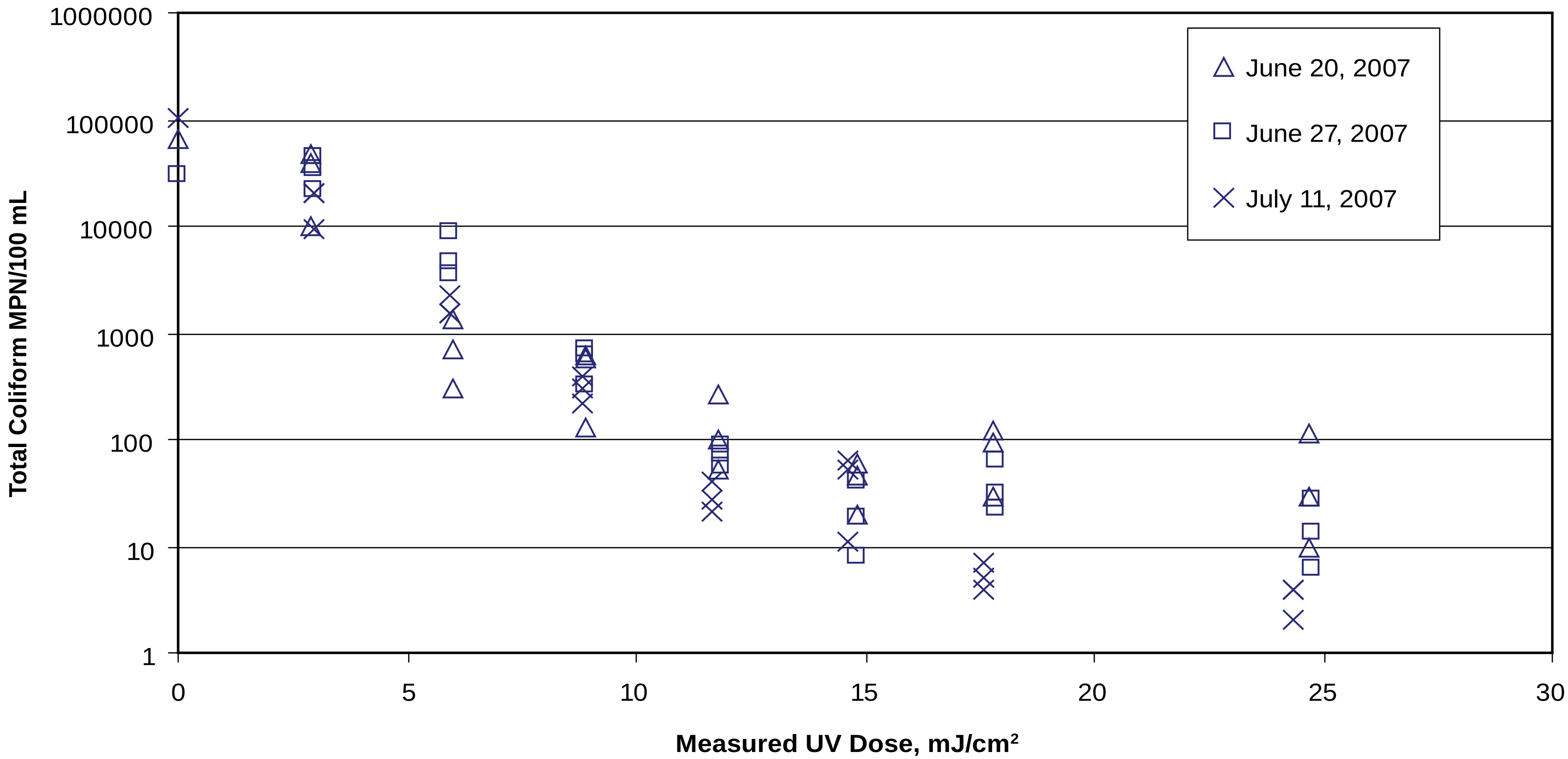

Figure H-1
TOTAL COLIFORM VERSUS UV DOSE IN FILTERED EFFLUENT
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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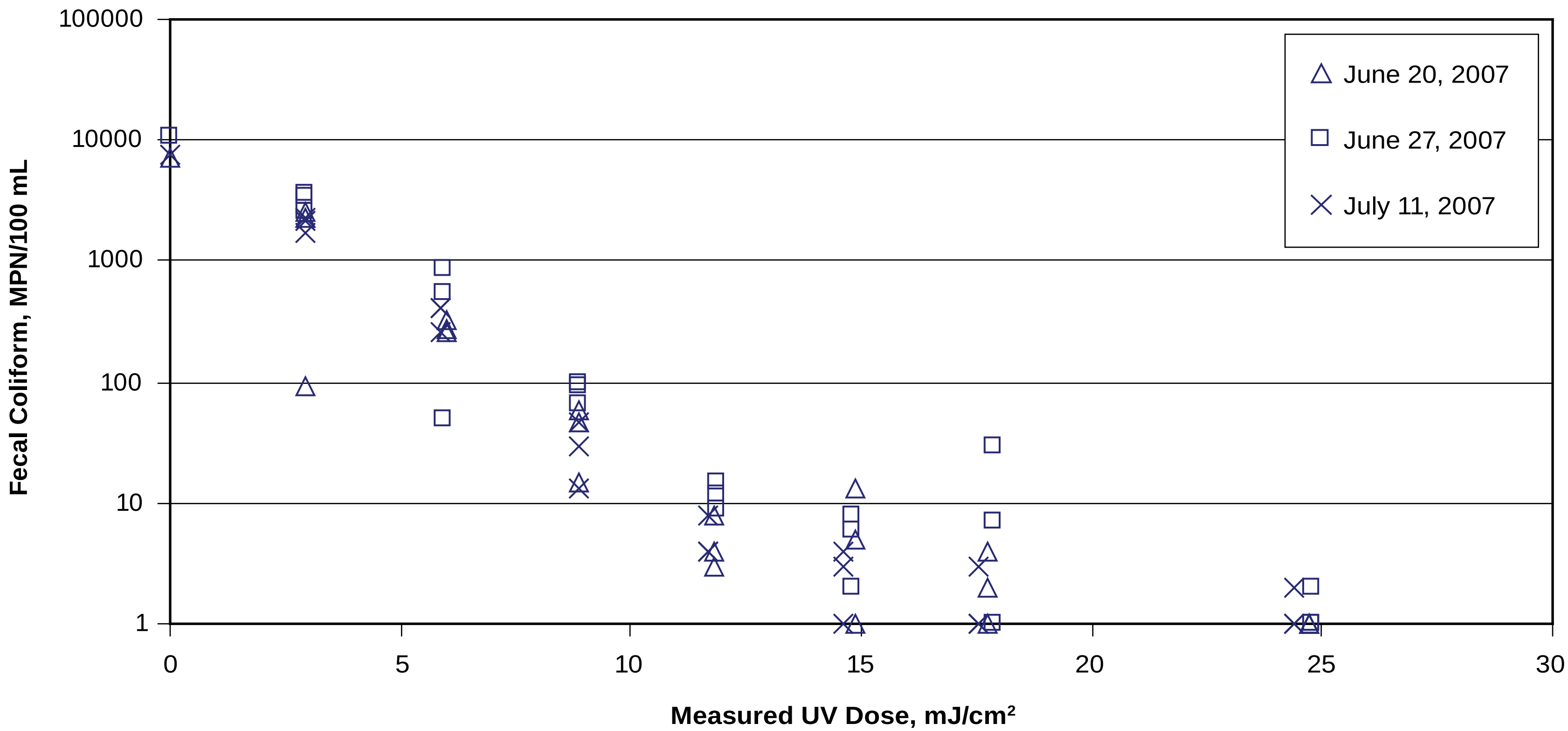

Figure H-2
FECAL COLIFORM VERSUS UV DOSE IN FILTERED EFFLUENT
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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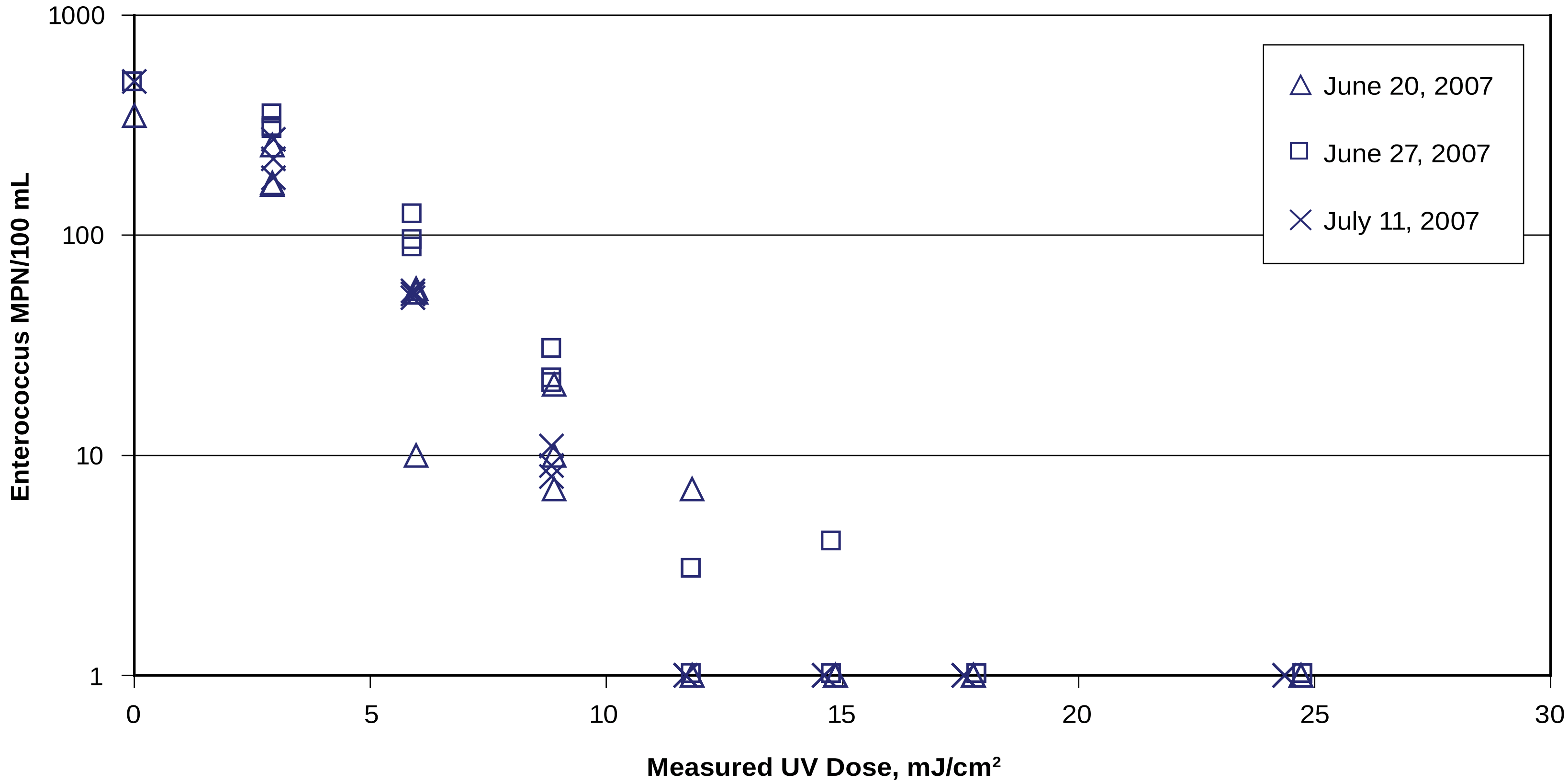

Figure H-3
ENTEROCOCCUS VERSUS UV DOSE IN FILTERED EFFLUENT
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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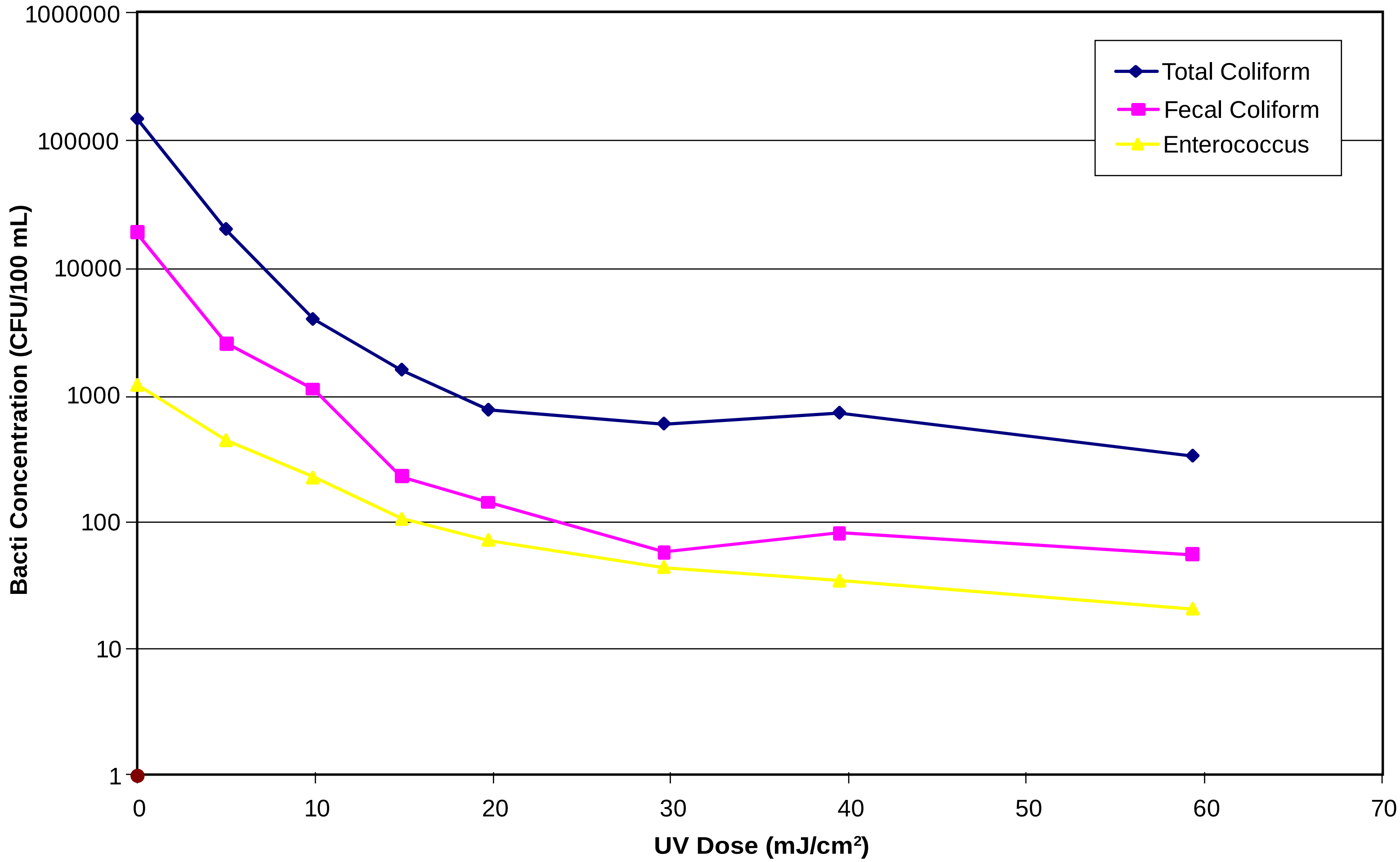

Figure H-4
TOTAL COLIFORM, FECAL COLIFORM, AND ENTEROCOCCUS VERSUS UV DOSE IN UN-FILTERED EFFLUENT
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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APPENDIX I – FILTRATION ALTERNATIVES ANALYSIS

APPENDIX I – FILTRATION ALTERNATIVES ANALYSIS

FINAL EFFLUENT DISCHARGE AND REUSE

Whether the final effluent is ultimately discharged or reused has a direct impact on future filtration requirements. Currently, a portion of the secondary effluent stream is filtered and disinfected to reuse standards, and the remainder is filtered to the standards required for discharged to the bay. The capability exists to partially bypass the filters and disinfect in the discharge slough, where it would be blended with the filtered and disinfected stream. This is the practice typically during peak flow events.

The AWTF, which is currently estimated to become operational in 2012, will intercept 10 mgd of the secondary effluent before filtration and treat it to a very high quality. A 10-mgd second phase is already being considered for this facility, with future expansions possibly increasing it to a combined capacity of 40 mgd.[9] Figure I-1 is a schematic representation of secondary effluent discharge options, including the new AWTF facility.

Current reuse projections are 55 mgd by the year 2040.[10] Due to the uncertainty of AWTF expansions, which will be coupled directly to future increases in demand for high-quality reuse water, it is assumed that its capacity will only be 20 mgd by 2040. Under this assumption, the remaining 35 mgd of projected reuse will be generated by the WPCP.

The projected secondary effluent ADMMF of 200 mgd by the year 2040, therefore, is assumed to be directed as follows:

- AWTF: 20 mgd (filtered and disinfected in a separate facility)
- Reuse: 35 mgd (filtered and disinfected)
- Discharge to bay: 145 mgd (fully or partially filtered, and disinfected)

Under PHWWF conditions, it is assumed that the portion of the PHWWF in excess of the ADMMF is not filtered.

PARTIAL OR FULL FILTRATION

WPCP operation data show that, for the period 1998 through 2007, the average secondary effluent TSS concentration was 7.6 mg/L, lowering to 2.3 mg/L after filtration. These data would suggest filtration might not be necessary to meet the plant discharge TSS limit of 10 mg/L. However, due to variability in secondary effluent TSS concentration inherent to the wastewater treatment process, filtration of at least a portion of the secondary effluent stream should be provided to consistently meet the discharge regulations.

[9] Discussion with S. Reddy, Project Manager, Black and Veatch, August 12th, 2009
[10] PM 3.7 Summary of Historical and Projected Water Reuse Demands

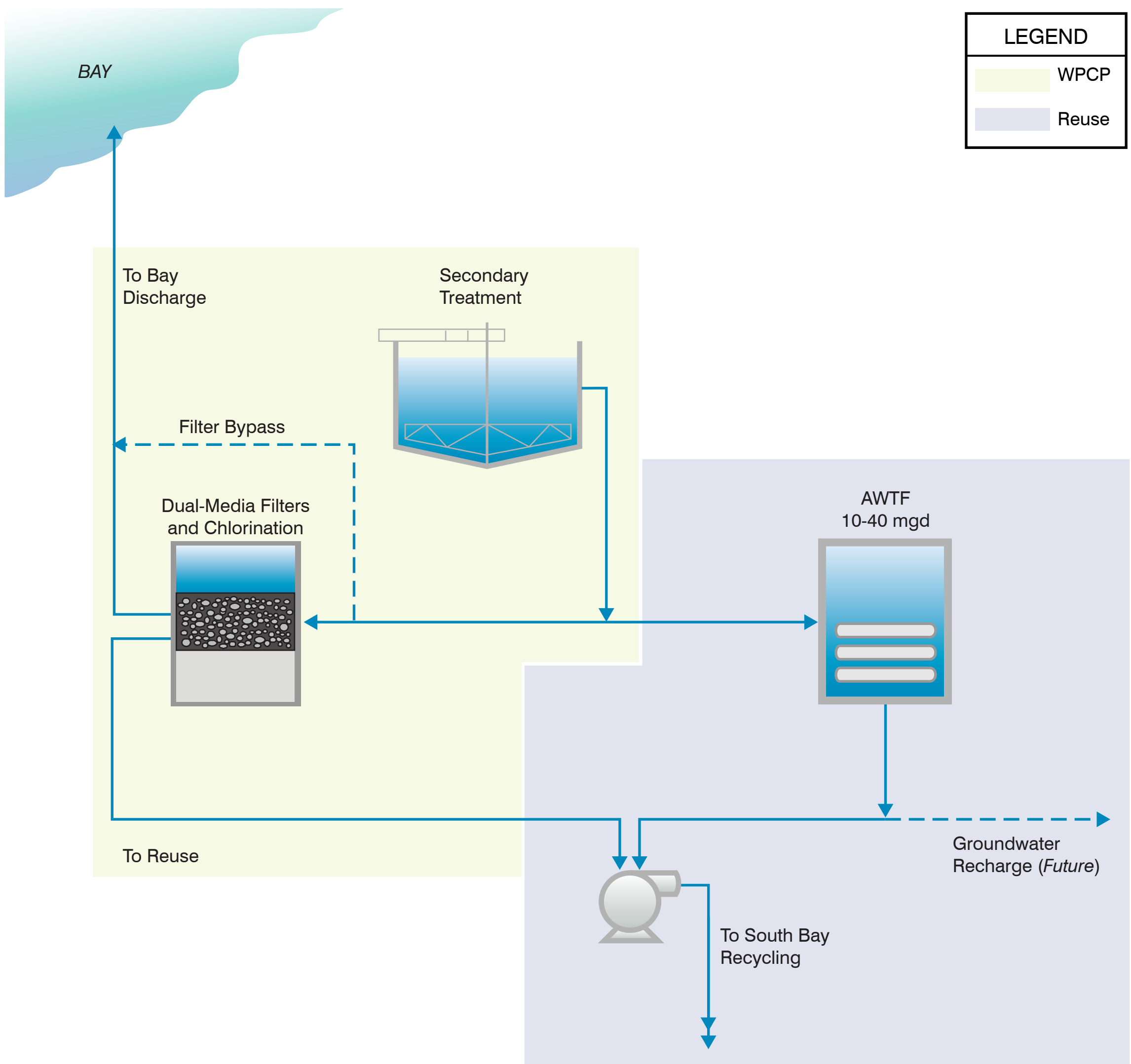

Figure I-1
SCHEMATIC OF SECONDARY EFFLUENT DISCHARGE ROUTING
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

Bypassing approximately 50 percent of the secondary effluent past the filters would still have achieved a conservative average effluent TSS concentration of 5 mg/L. Based on these observations, partially bypassing the filters is a viable option for the WPCP. However, there are a number of drivers for full filtration of the secondary effluent stream:

- Future CEC regulations may require full filtration.
- The City's collimated beam tests, conducted in 2007, show that transitioning from hypochlorite to UV disinfection would require filtration of the full secondary effluent stream.
- A possible future discharge regulation of TN <8 mg/L would require full filtration of the effluent streams of all three viable secondary treatment alternatives, namely NAS with denitrification, MLE, and Step-feed with IMLR.
- In future, all final effluent may go to reuse, for which full filtration is a Title 22 requirement.

REFURBISHMENT OF EXISTING FILTERS

Whether partial or full filtration is required, refurbishing the existing filters will require a significant investment. The City already has an estimate of $50 million from an Infrastructure Condition Assessment Study (CH2MHILL, May 2007), which includes the following upgrades:

- Architectural upgrades to improve compliance with ANSI Accessibility Standards, CAL OSHA Accessibility codes, and NFPA Building Codes.
- Structural upgrades to improve seismic reliability.
- Mechanical upgrades to replace boiler and chiller HVAC units.
- Process mechanical upgrades to replace filter backwash piping, other piping, valves, pumps, and filter mechanisms.
- Instrumentation and controls upgrades to replace control panels and pressure instrumentation.

PHASED IMPLEMENTATION APPROACH

A preferred approach may be to invest in new filters, possibly utilizing a different suitable technology, rather than refurbishing the existing filters. However, the decision of which replacement technology to use would depend on the ultimate filtration objective, which could be:

- Full filtration to meet future CEC, UV disinfection, or TN <8 mg/L regulations. A wide range of filtration technologies could be considered to meet these needs.

- Filtration combined with denitrification (NAS alternative) to meet a possible TN <8 mg/L requirement. This would entail maintaining some of the existing tertiary filters (or replace with new filters), and implementing a new denitrification treatment step for the remainder of the flow, such as denitrification filters, or fluidized-beds, for example.

- Filtration to conform to Title 22 water reuse regulations. Although a wide range of technologies are currently available, newer technologies with potentially higher filter loading rates are subject to approval by the Department of Public Health (DPH). Some technologies with very high surface loading rates have been approved by the DPH, such as Schreiber fuzzy filters (30 gpm/sf), although the TAG recommended against Schreiber fuzzy filters because they are unproven at large wastewater treatment facilities.[11] Another newer technology is the NOVA stainless steel mesh-type filter, which the DPH recently approved for Title 22 at 16 gpm/sf, if followed by UV, ozone, or pasteurization disinfection (6 gpm/sf if followed by chlorination disinfection). However, the only large installations currently using this technology are outside of the US.

- Filtration as pretreatment to an advanced membrane treatment technology, such as RO, to meet higher quality water reuse objectives. Pretreatment microfiltration cartridges are being designed for the new AWTF for this purpose.

Research and development of filter technologies is ongoing in the wastewater industry, with a resulting large range of loading rates and filtration performance. Furthermore, since the secondary effluent produced at each wastewater treatment plant is so unique, the performance of these technologies is expected to be similarly unique to each plant. Therefore, identifying the most appropriate filtration technology for the WPCP is best achieved through full-scale piloting.

The piloting effort will need to be conducted over a number of years, during which time the ultimate filtration objective(s) will also become clearer. In the interim, maintaining the current filters will allow the City to 1) continue producing Title 22 reuse water, and 2) filter the portion of the secondary effluent stream that will produce a blended bay discharge effluent that will comfortably meet the discharge regulations.

The WPCP is currently in the process of installing a new underdrain system and new filtration media in one of the existing filters. The performance improvements resulting from this upgrade will help the City establish the preferred upgrade approach to a portion or all of the remainder of the filters.

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[11] TAG Workshop, October 1, 2009.

FOOTPRINT ALLOCATION

For planning purposes, space should be allocated to accommodate whichever filtration technology is selected after the piloting phase. The WPCP currently has deep-bed dual-media filters that have been operated at loading rates slightly below 5 gpm/sf. Tetra denitrification filters, which is one of the options that would provide the necessary denitrification for the NAS alternative to meet a possible future TN requirement of <8 mg/L, have a surface loading rate of 1-3 gpm/sf. Meeting this TN discharge requirement with denitrification filters will entail filtering a portion of the secondary effluent through these new filters, and the remainder through tertiary filters (refurbished current or new). The filtration footprint for this combination of filters is presented in Figure I-2. Planning level costs are shown in Table I-1 for 1) required upgrades if the existing filters were retained, 2) new tertiary filters, and 3) a new Tetra denitrification plus tertiary filter installation.

Table I-1 Representative Filtration Alternatives
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Alternative(3)	Cost(1)
Upgrade existing filter building	\$50 million(2)
New tertiary filters	\$65 million
New Tetra denitrification plus tertiary filters	\$100 million

Notes:
(1) All costs are presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(2) From Infrastructure Condition Assessment Report, May 2007, CH2MHILL.
(3) Sufficient for filtration of the full ADMMF, less 20 mgd secondary effluent routed directly to the AWTF.

Notes:

1. 35 mgd is for reuse
2. 145 mgd is for bay discharge. This assumes an NAS process with a TN limit of 8 mg/L-N.

Figure I-2
NEW 180 MGD
DENITRIFICATION PLUS TERTIARY FILTRATION FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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APPENDIX J – DISINFECTION ALTERNATIVES ANALYSIS

APPENDIX J – DISINFECTION ALTERNATIVES ANALYSIS

INTRODUCTION

The analysis of disinfection alternatives was limited to a comparison of sodium hypochlorite and UV. Pasteurization and ozone are not considered disinfection technologies that are proven at large-scale wastewater treatment facilities, and were not considered further.

The disinfection alternatives comparison includes the following:

- Requirements for each alternative (hypochlorite and UV) using existing and new facilities.
- Infrastructure requirements to enable hypochlorite disinfection of PHWWFs (i.e., the portion of the PHWWF in excess of the ADMMF).
- For hypochlorite disinfection, the continued use of purchased hypochlorite vs. on-site hypochlorite generation.

Similar to the flow assumptions for the filtration analysis, the 2040 projected secondary effluent ADMMF of 200 mgd is assumed to be directed as follows:

- AWTF: 20 mgd (filtered and disinfected in a separate facility)
- Reuse: 35 mgd (filtered and disinfected)
- Discharge to bay: 145 mgd (fully or partially filtered, and disinfected)

The 2040 secondary effluent PHWWF is 355 mgd, of which 20 mgd is still routed to the AWTF. Since there will be no reuse water produced at the WPCP during PHWWF conditions, the full remaining 335 mgd will be disinfected for Bay discharge. Note that for all alternatives, it was assumed that the peak flow component (i.e., the portion of the PHWWF in excess of the ADMMF) would be disinfected using sodium hypochlorite. Since peak flows are expected to be highly dilute, it is assumed these peak flow volumes will not require filtration.

SODIUM HYPOCHLORITE DISINFECTION

- **Existing Facilities** (Figure J-1):
  - 35 mgd reuse is disinfected in one (1) existing CCB with a 120-minute contact time.
  - 145 mgd Bay discharge is disinfected in the remaining three (3) CCBs with 30-minute contact times.

Notes:

1. Refurbish exisiting facilities
   (35 mgd reuse, 145 mgd discharge)
2. Build 1 new CCB for PHWWF
   discharge (47 mgd)

Figure J-1
SODIUM HYPOCHLORITE
USING EXISTING FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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– Since there is no reuse during PHWWF, all four (4) existing CCBs will be used to disinfect Bay discharge flows. The capacity of all four (4) existing CCBs is 288 mgd with 30-minute contact times.

- An additional 47 mgd[12] CCB with a 30-minute contact time is needed to accommodate additional PHWWF.

- **New Facilities** (Figure J-2):
  - 35 mgd reuse is disinfected in one (1) new CCB with a 120-minute contact time.
  - 145 mgd Bay discharge is disinfected in two (2) new CCBs with 30-minute contact times.
  - 155 mgd[13] PHWWF is disinfected in two (2) new CCBs with 30-minute contact times.

UV DISINFECTION (WITH SODIUM HYPOCHLORITE FOR PEAK FLOWS ONLY)

- **Existing Facilities** (Figure J-3):
  - 35 mgd reuse is disinfected in two (2) new UV channels.
  - 145 mgd discharge is disinfected in four (4) existing retrofitted channels.
  - 155 mgd PHWWF is disinfected in two (2) new CCBs with 30-minute contact times.

- **New Facilities** (Figure J-4):
  - 35 mgd reuse is disinfected in two (2) new UV channels.
  - 145 mgd discharge is disinfected in five (5) new UV channels.
  - 155 mgd PHWWF is disinfected in two (2) new CCBs with 30-minute contact times.

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[12] The equalized peak flow coming from the secondary process is 335 mgd after 20 mgd is routed to the AWTF. Of this 335 mgd, 288 mgd can be accommodated in the existing CCBs. Therefore, 47 mgd needs to be disinfected in a new, additional CCB.

[13] The equalized peak flow coming from the secondary process is 335 mgd after 20 mgd is routed to the AWTF. Of this 335 mgd, 180 mgd is accommodated in the new CCBs. Therefore, 155 mgd needs to be disinfected in the new CCBs.

Notes:
1. Build 1 new CCB for reuse (34 mgd)
2. Build 2 new CCBs for discharge (146 mgd)
3. Build 2 new CCBs for PHWWF (155 mgd)

Figure J-2
SODIUM HYPOCHLORITE USING NEW FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Notes:
1. Build 2 new UV channels for reuse (35 mgd)
2. 145 mgd discharge is disinfected in
   4 existing retrofitted channels
3. Build 2 new CCBs for PHWWF (155 mgd)

Figure J-3
UV USING EXISTING FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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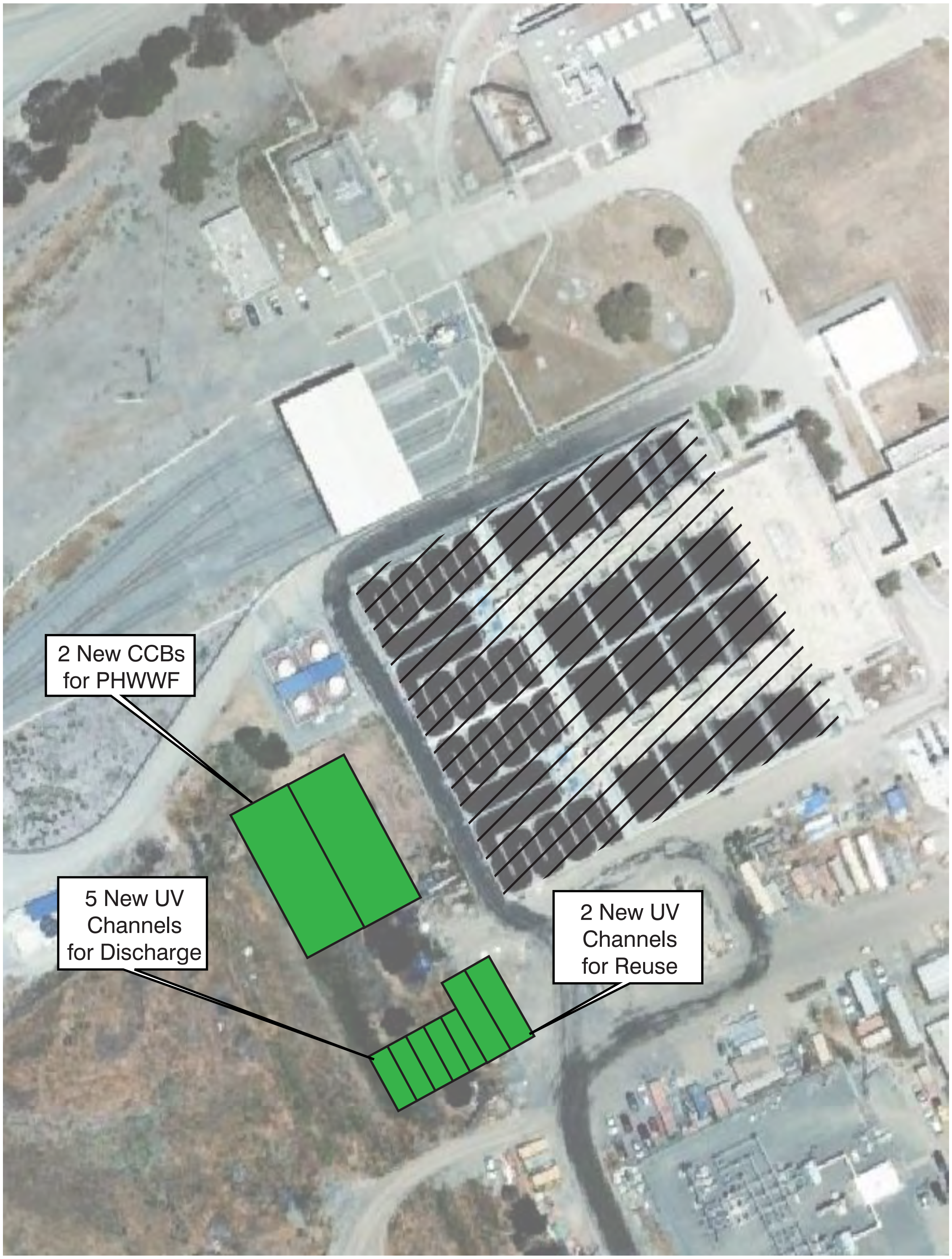

Notes:
1. Build 2 new UV channels for reuse (35 mgd)
2. Build 5 new UV channels for discharge (145 mgd)
3. Build 2 new CCBs for PHWWF (155 mgd)

Figure J-4
UV USING NEW FACILITIES
SAN JOSÉ/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

O&M COSTS

Planning level cost estimates for the disinfection alternatives are presented in Table J-1 below. The assumptions for O&M costs are as follows[14]:

Electricity:	$0.105/kWh
Sodium hypochlorite (12.5%):	$0.7745/gallon to $1.00/gallon
Salt:	$0.07/lb
Sodium bisulfite (25%):	$0.8625/gallon
Labor rate: $50/hour	

Table J-1 Disinfection Alternatives Life-Cycle Cost Comparison For Equivalent Levels of Filtration[(1)]
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Disinfection Alternative	Capital Cost[(2)]	O&M Cost[(2,3)]	TOTAL Present Worth Cost
Refurbish Existing Disinfection Facilities			
Hypochlorite On-site Generation[(4)]	$12.4 MM	$43.8 MM	$57 MM
Hypochlorite @$0.7745/gal[(4)]	$4.3 MM	$75.0 MM	$80 MM
Hypochlorite @$1.00/gal[(4)]	$4.3 MM	$86.2 MM	$91 MM
UV[(5)]	$33.7 MM	$26.0 MM	$60 MM
New Disinfection Facilities			
Hypochlorite On-site Generation[(5)]	$28.0 MM	$43.8 MM	$72 MM
Hypochlorite @$0.7745/gal[(5)]	$19.8 MM	$75.0 MM	$95 MM
Hypochlorite @$1.00/gal[(5)]	$19.8 MM	$86.2 MM	$106 MM
UV[(5)]	$27.3 MM	$26.0 MM	$54 MM

Notes:
(1) Costs do not include filtration since full filtration is common to both chlorination and UV disinfection.
(2) All costs are presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) O&M costs are considered over the 30-year life cycle of the project, and amortized to present worth using a real interest rate of 2%.
(4) Includes the cost of one (1) new CCB to accommodate peak flows of 47 mgd.
(5) Includes the cost of two (2) new CCBs to accommodate peak flows of 155 mgd.
(6) All costs are rounded up to the nearest million.

[14] Based on information received from plant staff on September 22, 2009.

For chlorination, life-cycle cost comparisons were developed for the current lower hypochlorite cost, as well as for a higher vendor-anticipated cost, anticipated to materialize in the near future. In addition, an onsite generation hypochlorite scenario was developed to illustrate the possible lower end of chlorination.

The life-cycle cost analysis for existing facilities shows:

- UV is significantly less expensive than the purchased hypochlorite scenarios.
- UV is comparable in cost to onsite hypochlorite generation.

The life-cycle cost analysis for new facilities shows:

- UV has a lower cost than any of the hypochlorite options.
- It costs more to use the existing CCBs for UV disinfection than to construct new UV facilities because of the size of the existing channels.
- The cost to refurbish CCBs (and add one new CCB for peak flows) is approximately $15 million less than constructing all new CCBs.

This analysis represents the case where full filtration is required, i.e., common to both chlorination and UV. However, this would only be a necessity for UV disinfection, i.e., other drivers (CECs, TN <8 mg/L, 100 percent reuse, pretreatment for high-quality reuse) apply in the case of chlorination. A separate evaluation is needed to show the cost comparison if the current partial filtration continues (assume 50 percent of the effluent stream bypasses filtration, based on historical secondary effluent TSS data). In this comparison, the cost of full filtration is added to the UV scenario, and a smaller filtration cost to chlorination.

This analysis is presented in Table J-2, and shows the following:

- Onsite generation of hypochlorite results in the lowest life-cycle cost.
- Chlorination with purchased hypochlorite (at the current purchase price) would be comparable to UV.
- Incorporating onsite hypochlorite generation will have a payback period of between seven and ten years, depending on increases in the purchase cost of hypochlorite.

One of the additional potential benefits of onsite hypochlorite generation is the production of hydrogen gas as a byproduct. One technology that is still in its early stages of development, is delivering hydrogen gas through bubble-less membranes to serve as electron donor in a biological denitrification step.[15] As this application is developed further it could be a candidate denitrification technology to be considered with NAS to meet a target TN <8 mg/L.

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[15] Rittmann, B.E., *et al*, (2005) "Hydrogen-Based Membrane Biofilm Reactor for Wastewater Treatment", IWA Publishing, Water Intelligence Online, No. 200504029

ADVANCED OXIDATION FOR THE TREATMENT OF CECS

Industrialization and advancement in human lifestyle have resulted in the increased presence of man-made, mostly refractory, organic compounds in the environment. Of these, the CECs include endocrine disrupting chemicals (EDCs) and pharmaceuticals, and personal care products. Most CECs are life-improving drugs and useful household products, such as anti-bacterial agents and flame retardants. Due to their wide-spread use and range of application, effective source control of these compounds is infeasible until less refractory substitutes are developed. These compounds are discharged into the wastewater stream, and since conventional wastewater treatment processes are not effective in completely removing them, many are released into the environment through the discharge of final effluent.

Future regulations are anticipated due to the impact CECs have on aquatic organisms living in the receiving water, and the potential effect it may have on people ingesting water containing CECs, especially through access to reuse water. A study for the WateReuse Foundation[16] is in the final stages of completion, and presents a comparison of different treatment technologies that can achieve a CEC destruction target of 90 percent. It shows an advanced oxidation process, such as the addition of hydrogen peroxide or peracetic acid to a UV system, or ozone would be required.

A cost comparison (capital and O&M) for these and other technologies is also presented in the study. The cost comparison shows ozone would have the lowest life-cycle cost of the three aforementioned technologies, approximately 30 percent lower than UV with peroxide. It entails less chemical handling too, since sodium bisulfite addition would be needed to lower residual concentrations of both hydrogen peroxide and peracetic acid.

In spite of the reduction in CECs that these advanced oxidation processes achieve, there are compounds that are still able to pass through the treatment step unaffected. While ozone would appear to be the most efficient process, flame retardants, for example, are not impacted. Researchers have proposed a more elaborate treatment train for the removal of this and other CECs that are particularly difficult to remove. They proposed micro filtration, followed by ozonation, and finally biological activated carbon. In addition they proposed the addition of peroxide and the seasonal addition of ammonia to mitigate bromate formation.[17]

Research is ongoing into the most efficient and comprehensive removal of CECs. While ozone is currently the most cost-effective option, it may not be sufficient to meet the likely future CEC regulations. Due to this uncertainty it is recommended that the outcome of ongoing research in the industry be monitored and evaluated before any definitive selection of technology is made.

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[16] "Study of Innovative Treatments for Reclaimed Water", (2010), WateReuse Research Foundation.
[17] Sundaram, V., *et al*, (2010) "Energy Efficient Advanced Treatment Process for Microconstituents Removal," Water Environment Federation.

Table J-2	Disinfection Alternatives Life-Cycle Cost Comparison For Non-Equivalent Levels of Filtration[1] San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
Disinfection Alternative	**Capital Cost[2]**	**O&M Cost[2,3]**	**TOTAL Present Worth Cost**
Refurbish Existing Disinfection Facilities			
Hypochlorite On-site Generation[4,7]	$37.4 MM	$43.8 MM	$82 MM
Hypochlorite @$0.7745/gal[4,7]	$29.3 MM	$75.0 MM	$105 MM
Hypochlorite @$1.00/gal[4,7]	$29.3 MM	$86.2 MM	$116 MM
UV[5,9]	$83.7 MM	$26.0 MM	$110 MM
New Disinfection Facilities			
Hypochlorite On-site Generation[5,8]	$65.9 MM	$43.8 MM	$110 MM
Hypochlorite @$0.7745/gal[5,8]	$57.8 MM	$75.0 MM	$133 MM
Hypochlorite @$1.00/gal[5,8]	$57.8 MM	$86.2 MM	$144 MM
UV[5,10]	$102.3 MM	$26.0 MM	$129 MM

Notes:

(1) Costs include partial filtration for chlorination, and full filtration for UV disinfection.
(2) All costs are presented in 2009 dollars. All costs are for comparison of alternatives only, and should not be used for CIP planning.
(3) O&M costs are considered over the 30-year life cycle of the project, and amortized to present worth using a real interest rate of 2%.
(4) Includes the cost of one (1) new CCB to accommodate peak flows of 47 mgd.
(5) Includes the cost of two (2) new CCBs to accommodate peak flows of 155 mgd.
(6) All costs are rounded up to the nearest million.
(7) Assumes half of the existing filters will be refurbished for $25 million.
(8) Assumes new tertiary filters will be constructed for a flow of 100 mgd (half of the 2040 ADMMF of 200 mgd) for $38 million.
(9) Assumes all the existing filters will be refurbished for $50 million.
(10) Assumes new tertiary filters will be constructed for full 2040 ADMMF for $75 million.