City of San José

San José/Santa Clara Water Pollution Control Plant Master Plan

TASK NO. 3
PROJECT MEMORANDUM NO. 4
MASTER PLAN DESIGN/STANDBY CRITERIA

FINAL DRAFT
July 2009

in association with

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CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

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TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

MASTER PLAN DESIGN/STANDBY CRITERIA

1.0 INTRODUCTION

1.1 Purpose

The purpose of this project memorandum (PM) is to recommend appropriate design and standby criteria to be used for the San José/Santa Clara Water Pollution Control Plant (WPCP). These criteria are used for planning future wastewater treatment facilities for the San José/Santa Clara Water Pollution Control Plant Master Plan (Master Plan) and serve as the basis for determining the rated capacity of the existing facilities.

The rated capacities of existing facilities and future flow and loading projections are taken into account to determine future capacity needs. Required future capacities and these criteria are utilized to size, cost, and evaluate treatment processes identified in the Master Plan alternatives.

In addition to capacity, a key consideration in the design and operation of a major wastewater treatment facility is reliability. Reliability is defined as the ability to provide uninterrupted service while continuing to meet discharge requirements. This means that in many cases, standby tankage or equipment items must be available to allow processes, components or equipment to be removed from service for maintenance or repair.

1.2 Definitions and Terminology

Various definitions and terms for wastewater flows and loads are to characterize the naturally occurring variability in wastewater flows and loads. Table 1 presents the definitions of the various flow and load terms used in this PM.

Other terms frequently utilized and therefore requiring clear definition are described below.

Design/Standby Criteria are guidelines or assumptions that are used to determine the number and size of process equipment or capacity. Design/standby criteria are typically associated with a flow basis or averaging period, as defined in Table 1. For example, the design/standby criteria for influent pumping is that the largest pump is a standby pump, and all other pumps are sized to handle the peak hour wet weather flow (PHWWF).

Duty Units are treatment processes or pumps that are assumed to be operating on a regular basis.

Hydraulic Capacity is the maximum flow capacity of a process that does not result in submerged flow splitting weirs or flooding or overflowing of tank walls.

Table 1	Wastewater Flow and Loading Definitions San José/Santa Clara Water Pollution Control Plant Master Plan City of San José	
Term	**Definition**	**Purpose**
Wastewater Flow Definitions		
ADWIF	Average Dry Weather Influent Flow The average daily flow over any five weekday period between the months of June and October. The maximum of the weekday averages is reported for permit compliance.	To assess future permit compliance.
ADWF[(1)]	Average Dry Weather Flow The average daily influent flow occurring over the three consecutive lowest flow months in the dry weather season (May through October).	To develop base wastewater flow projections and to provide the basis for sizing certain treatment facilities. Also used to evaluate taking various process units out of service.
ADWEF	Average Dry Weather Effluent Flow The average daily effluent flow occurring over the three consecutive lowest flow months in the dry weather season (May through October).	To assess future permit compliance.
ADAF	Average Daily Annual Flow The average daily flow or loading for an annual period.	To evaluate annual power use.
ADMMF	Average Daily Maximum Month Flow The average daily flow occurring during the peak flow month of the year. Peak flow and peak loadings do not necessarily have to occur in the same month. ADMMF typically occurs in the wet season (November through April).	To size wastewater treatment facilities to meet 30-day National Pollutant Discharge Elimination System (NPDES) permit requirements.
PHWWF	Peak Hour Wet Weather Flow The peak hour flow resulting from a rainfall event.	To set plant hydraulic capacity.
MDWWF	Maximum Day Wet Weather Flow The maximum daily flow occurring in the wet season (November through April).	Used to evaluate ability to meet daily max permit limits.
Wastewater Load Definitions		
ADWL	Average Dry Weather Load The average daily loading occurring over the three consecutive lowest flow months in the dry weather season (May through October).	To develop base wastewater load projections and to provide the basis for sizing certain treatment facilities.

Table 1	Wastewater Flow and Loading Definitions San José/Santa Clara Water Pollution Control Plant Master Plan City of San José	
ADAL	Average Daily Annual Load The average daily loading for an annual period.	To size certain solids facilities (such as lagoons and drying beds) and evaluate annual power use.
ADMML	Average Daily Maximum Month Load The average daily organic or suspended solids loading occurring during the peak loading month of the year. Peak flow and peak loadings do not necessarily have to occur in the same month.	To size wastewater treatment facilities to meet 30-day NPDES permit requirements and sizing for various solids handling facilities including digesters and thickening equipment.
MDDWL	Maximum Day Dry Weather Load The maximum day loading occurring during the dry weather season (May through October).	Together with consideration of diurnal variation, often used to determine aeration demands as well as to check max day requirements.
MDWWL	Maximum Day Wet Weather Load The maximum daily loading occurring in the wet season (November through April).	Together with consideration of diurnal variation, often used to determine aeration demands as well as to check max day requirements.
MWWWL	Maximum Week Wet Weather Load The maximum week loading occurring in the wet season (November through April).	Used in a biological nutrient removal plant to determine the solids retention time for nitrification and denitrification.

Note:

(1) This definition for ADWF is equivalent to the Average Dry Weather Effluent Flow (ADWEF) in the WPCP NPDES Permit (No. CA0037842). In this PM, the ADWF averaging period is also used for influent flows (and loads in PM 3.2) for the purpose of developing base wastewater flow and load projections and to size treatment facilities.

Installed Capacity is the amount of wastewater flow that can be treated by a process assuming that all units are in service.

Reliability is the ability to provide uninterrupted service while continuing to meet discharge requirements.

Reliability Classification includes three classes of reliability as defined in a Technical Bulletin by Environmental Protection Agency (EPA) (Environmental Protection Agency, 1974). The Technical Bulletin provides reliability design criteria for wastewater treatment plants seeking federal financial assistance under PL 92-500. Unless identified as applying to a particular class, all criteria apply equally to all three classes. The reliability classification are selected and justified by the grant applicant, subject to the approval of the EPA

Regional Administrator, and are based on the consequences of degradation of the effluent quality on the receiving navigable waters.

- **Reliability Class I** applies to wastewater treatment plants that discharge into navigable waters that could be permanently or unacceptably damaged by effluent that was degraded in quality for only a few hours. Examples of Reliability Class I wastewater treatment plants might be those discharging near drinking water reservoirs, into shellfish waters, or in close proximity to areas used for water contact sports. The WPCP is considered a Reliability Class I facility for the purposes of this Master Plan.

- **Reliability Class II** applies to wastewater treatment plants that discharge into navigable waters that would not be permanently or unacceptably damaged by short-term effluent quality degradations, but could be damaged by continued (on the order of several days) effluent quality degradation. An example of Reliability Class II wastewater treatment plants might be one that discharges into recreational waters.

- **Reliability Class III** applies to wastewater treatment plants not otherwise classified as Reliability Class I or Class II.

Reliable or Firm Capacity is the amount of wastewater flow that can be treated by a process assuming that standby units are out of service.

Standby Units are treatment processes or pumps that are assumed to be operating only if one of the duty units fails or is taken out of service for maintenance.

The Ten States Standards were developed by a committee composed of representatives from the Great Lakes - Upper Mississippi River Board. These standards are intended for the more conventional municipal wastewater treatment systems. Innovative approaches to treatment are not included.

2.0 ORIGINAL DESIGN INTENT

The WPCP was originally designed for an average daily maximum month flow (ADMMF) of 34 million gallons per day (mgd), and a PHWWF capacity of 120 mgd, and began operating in 1954. As the service area and population grew over the years, numerous projects were implemented to expand the WPCP to an ADWIF capacity of 167 mgd, and PHWWF capacity of 271 mgd (Carollo Engineers, 2003). In the late nineties, wet weather flows into the WPCP during storm events caused surcharging of various unit processes and structures that exceeded their design capacity. This included an event that occurred in 1998 when the WPCP experienced a PHWWF estimated at 320 mgd. The City of San José (City) was also concerned with the reliability of the WPCP to contain and treat wastewater during extended or emergency power outages, particularly during peak wet weather events (Carollo Engineers, 2003).

A Hydraulic Capacity and Bottleneck Summary (Malcolm Pirnie, 2001) was completed to assess and evaluate the hydraulic capacity of the WPCP, and to identify improvements required to provide operational reliability of the WPCP during peak wet weather events. As a result, the Weather Reliability and Hydraulic Capacity Project was completed in 2007 (startup in 2008) to relieve hydraulic bottlenecks by providing additional capacity at the headworks and filter influent pumping. These improvements allowed the WPCP to convey a sustained flow of 300 mgd, and PHWWF of 400 mgd.

A simplified process schematic of the existing WPCP is shown in Figure 1. The liquid stream treatment includes preliminary, primary, secondary, tertiary, and disinfection treatment processes, recycling and discharge to the San Francisco Bay. The solids stream treatment includes sludge thickening, anaerobic digestion, biosolids lagoons, and sludge drying.

3.0 MASTER PLAN DESIGN AND STANDBY CRITERIA

Wastewater treatment facilities are designed for reliable treatment of wastewater treatment at design flows and loads. Reliable treatment facilities are necessary so that scheduled maintenance, emergency repairs, equipment modifications, and routine operations can be performed while the WPCP continues to meet discharge requirements. Therefore, design and standby criteria must be jointly considered and developed with the goal of ensuring overall WPCP reliability. The determination of the future facility needs depends upon the criteria established for providing reliability.

In general, the design criteria selected for master planning of future facilities is conservative to allow for the uncertainties associated with changing future wastewater characteristics and variations in observed treatment plant performance. The WPCP has successfully operated beyond the range of the Master Plan design criteria. For reliability and ease of operation, however, these design criteria are recommended for establishing the timing of future facilities.

A list of the major process units of operation, equipment vital to plant operations, and equipment with specific reliability considerations was developed to establish which equipment would require redundancy. Standby and reliability criteria established by the EPA Technical Bulletin and the Great Lakes-Upper Missouri River Board of State Sanitary Engineers (Ten State Standards) were reviewed. These criteria are considered to be the minimum recommended standby criteria for reliable service as well as all units in service.

3.1 Operational Standby Criteria

Operational standby criteria are needed to determine the required number of duty and standby units for reliable treatment. Standby and reliability criteria from various sources are reviewed and summarized in Table 2 including:

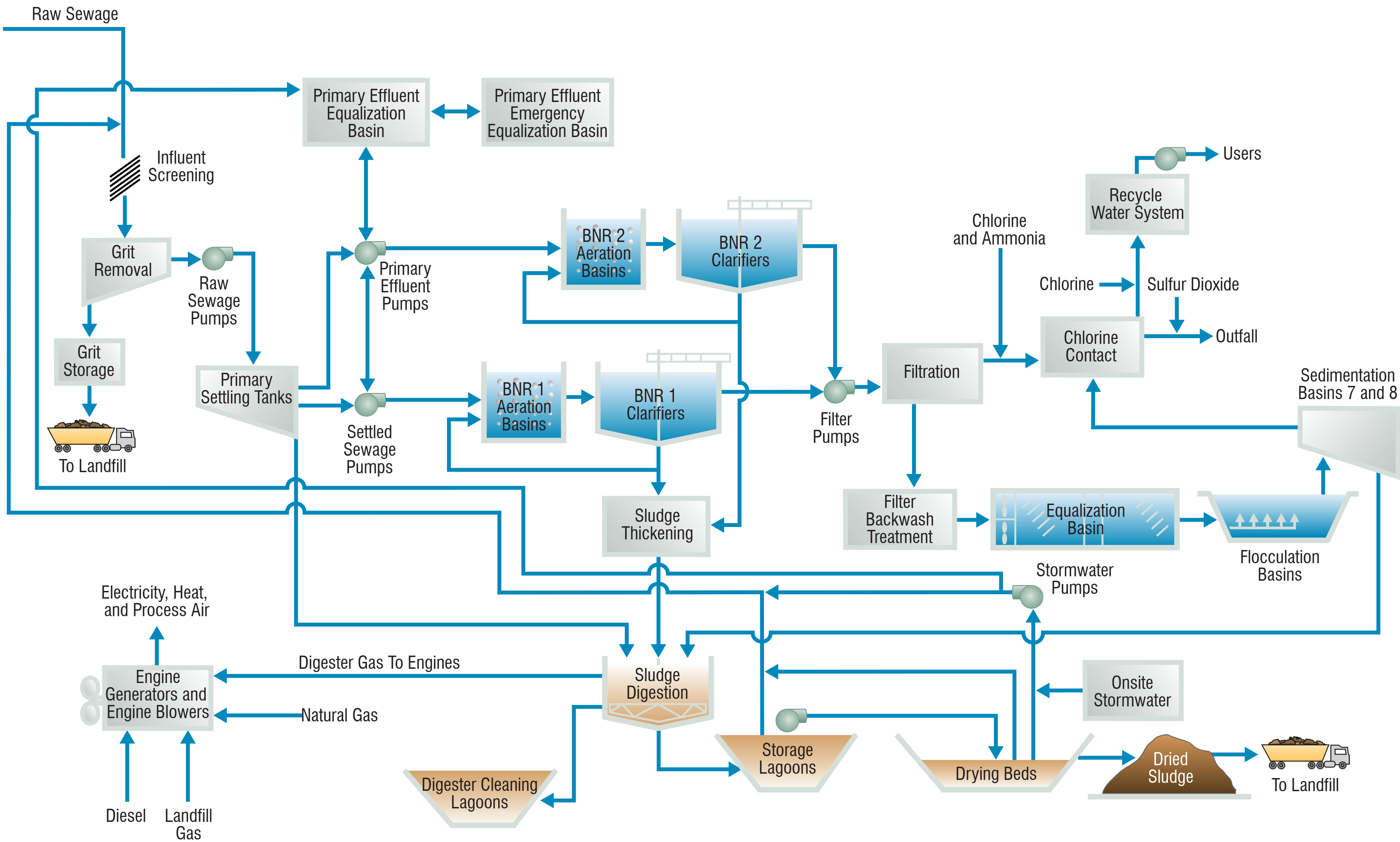

Figure 1
WPCP PROCESS FLOW SCHEMATIC
SAN JOSE/SANTA CLARA WPCP MASTER PLAN
CITY OF SAN JOSÉ

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Table 2 Standby Criteria Comparison and Recommended Values
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin [(1)]	Ten States Standards[(2)]	Title 22[(3)]	SRWTP[(4)]	OCSD[(5)]	Recommended Reliable Criteria
			Liquids Treatment			
Preliminary						
Emergency Overflow Basin	(211.4) A holding basin to augment the storage capacity of the collection system shall be provided.	–	(60341.a) Where short-term retention or disposal provisions are used as a reliability feature, these shall consist of facilities reserved for the purpose of storing or disposing of untreated or partially treated wastewater for at least a 24-hour period. The facilities shall include all the necessary diversion devices, provisions for odor control, conduits, and pumping and pump back equipment. All of the equipment other than the pump back equipment shall be either independent of the normal power supply or provided with a standby power source.	–	–	One Emergency Overflow Basin.
Barscreens	(212.1.1) A backup barscreen shall be provided. It may be manually cleaned.	(61.124) Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen shall be provided. Where 2 or more mechanically cleaned screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the design peak instantaneous flows.	–	One mechanically-cleaned standby with double gates for any out-of-service unit and one manually-cleaned channel. Remaining screens in service sized to treat PHWWF.	One standby unit plus wide-open bypass channel for each headworks.	One standby unit. Mechanically-cleaned preferred.
Influent Pumps (Raw Sewage Pump Station)	(212.1.2) A backup pump shall be provided for each set of pumps, which performs the same function. The capacity of the pumps shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow. It is permissible for one pump to serve as backup to more than one set of pumps.	(42.31) Multiple pumps shall be provided. Where only 2 units are provided, they shall be the same size. Units shall have capacity such that, with any unit out of service, the remaining units will have capacity to handle the PHWWF.	–	One long-term standby out-of-service for maintenance. Remaining pumps sized to handle PHWWF.	One standby pump for every four running. (Standby equal to largest pump). Minimum of one pump per station.	Pumps sized for PHWWF with largest pump out of service.
Grit Removal	(211.2) Grit removal required. Grit removal shall be sized for PHWWF with largest unit out of service.	(63.3) At least one mechanically cleaned unit with a bypass.	–	No standby.	Sized for PHWWF with largest unit out of service.	No standby units.
Primary Treatment						
Primary Settling Tanks	(212.1.4) With largest unit out of service, remaining units should be sized for at least 50% of PHWWF.	(54.2) PHWWF shall be handled hydraulically with the largest unit out of service.	(60343) All primary treatment unit processes shall be provided with one of the following reliability features: (a) Multiple primary treatment units capable of producing primary effluent with one unit not in operation. (b) Standby primary treatment unit process. (c) Long-term storage or disposal provisions.	One tank out of service during ADWF. One tank out of service at PHWWF. Ability to divert primary influent.	One standby for each set of sedimentation tanks.	One unit out of service in east and west settling tank batteries during ADMMF.

Table 2 Standby Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin[1]	Ten States Standards[2]	Title 22[3]	SRWTP[4]	OCSD[5]	Recommended Reliable Criteria
Secondary Treatment (BNR I and II)						
Aeration Tanks	(212.1.6.1) No backup tank required; however, at least two equal volume basins shall be provided.	((92.321) Total aeration tank volume shall be divided among 2 or more units, capable of independent operation, when required by the appropriate reviewing authority to meet applicable effluent limitations and reliability guidelines.	(60345) All biological treatment unit processes shall be provided with one of the following reliability features: (a) Alarm and multiple biological treatment units capable of producing oxidized wastewater with one unit not in operation. (b) Alarm, short-term retention or disposal provisions, and standby replacement equipment. (c) Alarm and long-term storage or disposal provisions. (d) Automatically actuated long-term storage or disposal provisions.	All trains in service during August. One standby train during remainder of the year. (Carbonaceous Oxidation Tanks)	One standby tank.	One aeration tank out of service during ADMMF.
Blowers	(212.1.6.2) Must have enough aerators to supply the design oxygen transfer with the largest unit out of service. Backup unit may be uninstalled, provided that the installed unit can be easily removed and replaced. At least two units shall be installed.	(92.332.e) The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.	–	Aerator provided by backup oxidation tank.	–	Sized to supply the design oxygen transfer with the two largest units out of service.
Clarifiers	(212.2.5) With largest unit out of service, remaining units shall have capacity of at least 75% of PHWWF.	(54.2) See Primary Settling Tanks criteria.	(60347) All secondary sedimentation unit processes shall be provided with one of the following reliability features: (a) Multiple sedimentation units capable of treating the entire flow with one unit not in operation. (b) Standby sedimentation unit process. (c) Long-term storage or disposal provisions.	One standby clarifier for every 12 in service.	One standby clarifier for every ten in operation.	Two large or four small clarifiers out of service in BNR 1 and one unit out of service in BNR 2 during ADMMF.

Table 2 Standby Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin[1]	Ten States Standards[2]	Title 22[3]	SRWTP[4]	OCSD[5]	Recommended Reliable Criteria
Tertiary Filtration						
Filter Influent Pumping	(212.1.2) See Influent Pumps criteria.	(42.31) See Influent Pumps criteria.	–	–	–	Pumps sized for peak flow capacity of filters with largest pump out of service.
Filters	(212.2.5) See Clarifiers criteria.	(112.32) Total filter area shall be provided in 2 or more units, and the filtration rate shall be calculated on the total available filter area with 1 unit out of service.	(60351) All filtration unit processes shall be provided with one of the following reliability features: (a) Alarm and multiple filter units capable of treating the entire flow with one unit not in operation. (b) Alarm, short-term retention or disposal provisions and standby replacement equipment. (c) Alarm and long-term storage or disposal provisions. (d) Automatically actuated long-term storage or disposal provisions. (e) Alarm and standby filtration unit process.	–	–	Total filter area shall be provided in 2 or more units, and the filtration rate shall be calculated on the total available filter area with 1 unit out of service.
Filter Backwash Treatment						
Flocculation Basins	(212.1.8) At least two flocculation basins shall be provided.	–	–	–	–	At least two flocculation basins shall be provided.
Sedimentation Basins	(212.2.5) See Clarifiers criteria.	(54.2) See Primary Settling Tanks criteria.	–	–	–	Sized for at least 75% of PHWWF capacity with largest unit out of service.
Disinfection						
Chlorine Contact Basins	(212.1.9) With largest unit out of service, remaining units shall have capacity of at least 50% of PHWWF.	(102.44) The tank should be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection. Duplicate tanks, mechanical scrapers, or portable deck-level vacuum cleaning equipment shall be provided. Consideration should be given to providing skimming devices on all contact tanks. Covered tanks are discouraged.	(60353) (a) All disinfection unit processes where chlorine is used as the disinfectant shall be provided with the following features for uninterrupted chlorine feed: (1) Standby chlorine supply, (2) Manifold systems to connect chlorine cylinders, (3) Chlorine scales, and (4) Automatic devices for switching to full chlorine cylinders. Automatic residual control of chlorine dosage, automatic measuring and recording of chlorine residual, and hydraulic performance studies may also be required. (b) All disinfection unit processes where chlorine is used as the disinfectant shall be provided with one of the following reliability features: (1) Alarm and standby chlorinator; (2) Alarm, short-term retention or disposal provisions, and standby replacement equipment; (3) Alarm and long-term storage or disposal provisions; (4) Automatically actuated long-term storage or disposal provisions; or (5) Alarm and multiple point chlorination, each with independent power source, separate chlorinator,	–	–	All units in service at PHWWF. One unit out of service during ADWF.

Table 2 Standby Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin[(1)]	Ten States Standards[(2)]	Title 22[(3)]	SRWTP[(4)]	OCSD[(5)]	Recommended Reliable Criteria
			and separate chlorine supply.			
			Solids Treatment			
Primary Sludge Pumps	(222.2) One backup for each set of pumps. With any one pump out of service, remaining pumps must have capacity to handle peak flow. One pump may serve as backup to more than one set of pumps. Backup pump may be uninstalled, provided that the installed pump can be easily removed and replaced. At least two pumps shall be installed.	(87.12) Duplicate units shall be provided at all installations.	–	One uninstalled backup pump and variable speed drive.	–	One standby unit for each pump station.
Return Activated Sludge (RAS) Pumps	(222.2) See Primary Sludge Pumps criteria.	(87.12) See Primary Sludge Pumps criteria.	–	One standby at 50% RAS per clarifier at ADWF.	One standby for every four pumps, minimum of one pump per pump station.	One standby unit for each pump station.
Waste Activated Sludge (WAS) Pumps	(222.2) See Primary Sludge Pumps criteria.	(87.12) See Primary Sludge Pumps criteria.	–	One standby, with remaining pumps able to handle maximum daily wasting rate.	Minimum one pump per pump station.	One standby unit for each pump station.
Dissolved Air Floatation (DAF) Thickeners	–	(54.2) See Primary Settling Tanks criteria.	–	Ability to treat ADMML with one unit out of service.	One standby thickener for every two in operation.	Three DAF thickeners out of service at ADMML.
Anaerobic Digesters	(222.3.1) At least two tanks required. At least two of the tanks shall be designed to permit processing all types of sludge normally digested.	(84.11) Multiple units or alternate methods of sludge processing shall be provided. Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.	–	Ability to treat the ADAL with one out of every five units out of service. Maintain minimum 15-day solids retention time (SRT) under all pertinent loading conditions	Digester cleaned every five years. Loading criteria for digesters in service, full digester volume. Criteria allows for grit factor of 1.16.	Three digesters out of service at ADMML.
Digested Sludge Export Pumping	(222.2) See Primary Sludge Pumps criteria.	(54.2) See Primary Settling Tanks criteria.	–			Second pipeline to lagoons for reliability. One standby pump.
Biosolids Lagoons	–	(89.12) A minimum range of 120 to 180 days storage should be provided for the design life of the plant unless a different period is approved by the reviewing authority.	–	Surface loading rate limit (average annual) of 20 lb volatile solids per 1000 sq ft per day. Two solids storage basins out of service annually for dredging.	–	2-year minimum storage time in lagoons. Additional operational limitations (feeding, dredging and maintaining lagoons).
Drying Beds	–	–	–	–	–	4 beds out of service each year for maintenance. Ability to dry to 75 % solids over the April to September drying season.
			Miscellaneous			
Utilities						
Water Pumps	(212.1.2) See Influent Pumps criteria.	(42.31) See Influent Pumps criteria.	–	One standby pump for every-use.	One standby pump for every four in service.	Pumps sized for peak demands with largest pump out of service.

Table 2 Standby Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin[1]	Ten States Standards[2]	Title 22[3]	SRWTP[4]	OCSD[5]	Recommended Reliable Criteria
Service Air	(250) The system shall have backup capability in the number of vital components required for its function.	–	–	One (ready to run) standby and one long-term standby (for units out of service for repair).	–	One (ready to run) standby and one long-term standby (for units out of service for repair).
Other Compressors	–	–	–	Back up from service air.	–	Back up from service air.
Power	(231) Two separate and independent sources of electrical power. Either two substation feeds or one feed plus on-site generator. If the electric utility may reduce the rated line voltage (i.e., “brown out”) during peak utility system load demands, an on-site generator shall be provided as an alternate power source. The minimum capacity of the on-site generator should be sufficient to operate all vital components during PHWWF conditions together with critical lighting and ventilation.	(56.11) Alternate source of power should be provided either from separate feeder or generator.	–	100% back up at PHWWF from 69 KV to 480V switchboards. Common equipment from different motor control centers (MCCs).	–	Alternative source of power through separate feeder or standby generator. Sizing should be sufficient to operate all pump stations, maintain biological process, and maintain critical lighting, ventilation, safety, and control systems.
Fluid Power System	–	–	–	100% redundancy.	–	100% redundancy.
Storm Drainage	(252.1) Sufficient drainage to contain all spilled wastewater, sludge, chemical, or other spills.	–	–	Gravity bypass capability to plant influent.	–	Sufficient drainage to contain all spilled wastewater, sludge, chemical, or other spills. Gravity bypass capability to WPCP influent.
Control System						
Main Central Processing Unit (CPU)	–	–	–	100% redundancy.	–	100% redundancy.
Chemical Feed Systems						
Chlorination	(251) Chemical feed system shall have sufficient number of each component of the feed system such that the design function of the system can be fulfilled with any one component out of service. Systems with components of different capacities shall meet this criterion with the largest capacity component out of service. Backup components may be uninstalled if it can be easily removed and replaced. At least two components shall be installed[7].	(102.34) At larger facilities and locations where delivery is not a problem, it may be desirable to limit on site storage to one week.	–	–	One standby chlorinator for every three in operation. Provide standby chemical addition (chlorinators for odor control).	One standby for every service.
Dechlorination Facilities	(251) See Chlorination criteria.	(103.41) Where necessary to meet the operating ranges, multiple units shall be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the dissolved oxygen concentrations in the receiving waters.	–	One standby for every service.	–	One standby for every service.

Table 2 Standby Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process	EPA Technical Bulletin[(1)]	Ten States Standards[(2)]	Title 22[(3)]	SRWTP[(4)]	OCSD[(5)]	Recommended Reliable Criteria
Other Chemicals	–	–	–	5-day supply.	–	5-day supply.
Recycled Water Pump Station	(212.1.2) See Influent Pumps criteria.	(42.31) See Influent Pumps criteria.	–	–	–	Pumps sized for peak demand with largest pump out of service.

Notes:

(1) Numbers in parentheses indicate the section of the EPA Technical Bulletin: Design Criteria for Mechanical Electric, and Fluid System and Component Reliability (1974) from which that information was obtained.

(2) Numbers in parentheses indicate the section of the Ten States Standards document (2004) from which that information was obtained.

(3) California Code of Regulations, Title 22, Division 4, Environmental Health Regulations for Recycled Water.

(4) Sacramento Regional Wastewater Treatment Plant.

(5) Orange County Sanitation District Wastewater Treatment Plant.

(6) CT stands for CT-value, which is the product of the residual chlorine concentration and contact time.

(7) Example: A chemical feed system has 6 chlorinators and 1 dosing pump that just meets capacity requirements, would be required by this criterion to have one additional chlorinator and one additional dosing pump.

- EPA Technical Bulletin: Design Criteria for Mechanical, Electrical, and Fluid System and Component Reliability (Environmental Protection Agency, 1974).
- The Ten State Standards (Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2004).
- Reliability criteria for facilities similar in size to the WPCP (Sacramento Regional Wastewater Treatment Plant [SRWTP] and the Orange County Sanitation District's Wastewater Treatment Plant [OCSD]).
- Title 22 requirements for reclaimed water systems (Title 22). By satisfying operational reliability criteria, many of the Title 22 reliability requirements are satisfied per the California Code of Records (CCR).

Both the EPA Technical Bulletin and the Ten State Standards are commonly used for evaluating reliability for wastewater treatment facilities. Criteria for SRWTP and OCSD were provided as comparisons to similarly sized facilities. Title 22 requirements are incorporated where required for generating recycled water.

Recommended standby criteria were developed after review of each of these sources and the City's experience with routine and unscheduled outages. Since unscheduled outages can occur at any time, capacity ratings that are developed in PM 3.5 are based on having the recommended standby units out of service.

3.2 Process Design Criteria and Unit Sizing for Expansion of Existing Facilities

Process design criteria are the basis for sizing of new facilities identified in this Master Plan. For each of the major unit processes at the WPCP, Table 3 summarizes the original design criteria, historical performance and unit process loadings, design criteria recommended by the Manual of Practice (MOP 8), and the recommended design criteria. The recommended design criteria will be used to perform an initial capacity rating assessment in PM 3.5, and develop preliminary sizing requirements for accommodating facilities for future growth.

The original design criteria were collected from various sources including:

- Design criteria sheets from plant construction and as-built drawings for various projects.
- San José Operation and Maintenance (O&M) Manual (City of San José, 2008).
- Plant Optimization Program at the San José/Santa Clara Water Pollution Control Plant (City of San José, 1998).
- In some cases, design criteria were calculated based on the original design flow capacity and the WPCP configuration. This was only done where original design criteria could not be found from other sources.

Table 3 Design Criteria Comparison and Recommended Values
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process/Design Parameter	Design Flow or Load	Original Design	Existing Performance Range 2000 - 2007	Existing Performance Average 2000 - 2007	MOP 8[1]	Recommended Value
Liquids Treatment						
Barscreens						
Velocity (fps)	PHWWF	3[2]	NA[3]	NA[3]	2 - 4	3
Aerated Grit Removal and Detritor Tanks						
Overflow Rate (gpd/sf)	PHWWF	33,900[4]	21,360 - 31,060	26,060	40,000 - 60,000[5]	33,900
Vortex Grit Removal						
Overflow Rate (gpd/sf)	PHWWF	148,000[6]	NA	NA	NA	148,000
Primary Settling Tanks						
Overflow Rate (gpd/sf)	ADMMF	1,100 (West)[7]& 1,200 (East)[8]	1,120-1,530	1,274	785 -1,200	1,500
	PHWWF	1,930[9]	1,620 - 3,080	1,970	1,500-4,000	2,500
Aeration Tanks						
Total SRT (Days)	ADMML	6 - 10[9]	7.3 - 9.2	8.4	Temperature Dependent, Varies	10
Aerobic SRT (Days)	ADMML	NA[3]	3.6 - 4.6	4.2		5 (minimum)[10]
Last Pass Mixed Liquor Suspended Solids (MLSS) (mg/L)	ADAL	NA[3]	2,780 - 3,330	3,000	1,000-4,000	See PM 3.5, criteria developed in conjunction with PHWWF, clarifier loading rates, MLSS settleability, and design SRT.
	ADMML	NA[3]	2,760 - 3,300	3,100		
Clarifiers						
Overflow Rate (gpd/sf)	ADMMF	800[11]	400 - 590	491	300-600	See PM 3.5, criteria developed in conjunction with PHWWF, operating MLSS and settleability, and design SRT.
	PHWWF	930 (BNR 1), 810 (BNR 2)[12]	580 - 770	680	1,000-1,500	
Solids Loading Rate (ppd/sf)	ADMMF	NA[3]	19 - 26	23	20-30	
	AWL	28.7[12]	NA[3]	NA[3]	NA[3]	
	PHWWF	34.5[12]	19 - 28	24	NA[3]	

Table 3 Design Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process/Design Parameter	Design Flow or Load	Original Design	Existing Performance: Range 2000 - 2007	Existing Performance: Average 2000 - 2007	MOP 8[1]	Recommended Value
Tertiary Filters						
Hydraulic Loading Rate (gpm/sf)	PHWWF	7[12]	6.3 - 8.6	7.2	6	
	ADMMF	5[12]	4.4 - 6.0	5.0	NA[3]	7.5
	ADWF	5[12]	4.1 - 6.0	4.8	NA[3]	
Disinfection						
Theoretical Contact Time for Effluent Discharge (min) [13]	PHWWF	54 minutes modal [12]	29 - 50	40	NA[3]	30 minutes theoretical
	ADMMF		57 - 73	66		40 minutes theoretical, or 30 minutes modal [14]
Theoretical Contact Time for Recycled Water (min) [15]	ADMMF	NA	138 - 170	153	NA[3]	120 minutes theoretical, or 90 minutes modal [14]
CT-Value for Recycled Water (mg-min/L)	ADMMF	NA[3]	1,490 - 4,260[16]	2,530	NA[3]	450 [17]
Solids Treatment						
DAF Thickeners[18]						
Solids Loading (lb/sf/day)	ADAL	NA[3]	2.9 - 7.5	5.3	9.6 - 24	9.6
	ADMML	NA[3]	3.1 - 8.7	5.6	9.6 - 24	16.8
Hydraulic Loading (gpm/sf)	ADAL	NA[3]	0.08 – 0.09	0.08	0.5 - 2	0.5
	ADMML	NA[3]	0.07 – 0.09	0.08	0.5 - 2	0.8
Anaerobic Digesters[19]						
Volatile Solids Loading (lb VS/cf/day)	ADMML	NA[3]	0.04 – 0.08	0.05	0.1 - 0.4	< 0.15
	MPWL	0.17	NA[3]	NA[3]	NA[3]	Not Applicable
Solids Retention Time (days)	ADMML	NA[3]	20.8 – 58.8	38.2	10 - 20	15
Biosolids Lagoons[20]						
Minimum Storage Time (years)	–	NA[3]	> 2	> 2	NA[3]	> 2
Biosolids Lagoon Solids Loading Rat (lbs/day)	ADAL	NA[3]	128,250 – 152,450	140,420	NA[3]	See note 21
Thickening in Biosolids Lagoons (% solids)	ADAL	NA[3]	NA[3]	NA[3]	NA[3]	5.0

Table 3 Design Criteria Comparison and Recommended Values (Continued)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Process/Design	Design	Original	Existing Performance	MOP 8[1]	Recommended Value

Notes:

(1) Water Environment Federation/American Society of Civil Engineers, 1998.
(2) Carollo Engineers, 2003.
(3) NA = Not Available.
(4) Calculated based on 2 aerated grit chambers at 47 ft x 22 ft (each), 2 detriters at 55 ft x 55 ft (each), and 240 mgd PHWWF capacity (total).
(5) Based on 95% removal of grit mesh greater than 50.
(6) Based on 24 ft diameter and 67 mgd PHWWF capacity.
(7) Hyde and Sullivan Engineers, 1952.
(8) Brown and Caldwell, 1960.
(9) City of San José, 1998.
(10) Based on minimum monthly MLSS operating temperature of 16 degrees.
(11) Average week overflow rate for BNR I from San José O&M Manual.
(12) San José O&M Manual.
(13) Based on approximately 75% of secondary effluent to contact tanks 1-3.
(14) Assumed hydraulic efficiency of 75%.
(15) Based on approximately 25% of secondary effluent to tank 4 for recycled water use.
(16) Includes contact time in distribution pipeline upstream of compliance point.
(17) Title 22 requirement.
(18) Existing performance loadings assume 11 units in service at all times.
(19) Existing performance loading and SRT based on using temperature data to determine number of digesters in service. 90 degrees F was used to determine if a unit was in service or not.
(20) Biosolids lagoons are equally divided into 4 clusters. Each cluster is filled with digested biosolids for one year, allowed to sit for 2 years, and dredged in fourth year. The capacity is constrained by this necessary operational configuration so all criteria are based on cluster values, e.g., storage time in the cluster, volume of cluster, etc.
(21) Loading limitation will be based on solids loading, thickening in the biosolids lagoons and volume of biosolids lagoons by cluster.

Recommended design criteria are based on the following items and are described in subsequent sections of this document:

- Values utilized as part of the engineer's previous designs were used where historical records demonstrate satisfactory performance.
- Because original design criteria are not available for the secondary process in the current operational mode (i.e., with Biological Nutrient Removal (BNR) 1 and BNR 2 operating in parallel), a WPCP process model was developed and adjusted to match historical performance. Recommended criteria for the secondary process were developed from the modeling results and are reviewed in more detail in PM 3.5.
- Title 22 requirements were considered for tertiary treatment that produce recycled water.
- Where little or no original design criteria were found, values used in accepted engineering practice were used for establishing recommended criteria.

3.2.1 Preliminary Treatment

Bar screens are utilized to remove large solids such as rags, plastics, and organic matter. Solids removed by bar screens are then conveyed to compaction/dewatering facilities prior to landfill disposal. Wastewater that flows through bar screens is conveyed to grit removal processes. Grit removal processes remove inorganic debris such as sand, rock, or gravel. The primary purpose of grit removal at a wastewater treatment plant is to reduce maintenance and excessive wear of downstream facilities. Key benefits of grit removal include reducing grit accumulation in downstream channels, basins and digesters and reducing mechanical wear in equipment such as pumps, valves, and chain and flight collection mechanisms.

Design criteria are provided in the following sections for bar screens and grit removal processes. While these criteria are useful for evaluating a process within the headworks, a capacity rating will be developed in PM 3.5 based on the overall hydraulic and process capacity of the entire headworks.

3.2.1.1 Bar Screening

The key design criteria for bar screens are bar screen spacing and clear screen velocity. Bar screen spacing affects screenings removal efficiency, sizing of screens, WPCP influent hydraulics (headloss through the screen), and screenings handling equipment capacity and facility requirements. In addition, bar spacing affects the quantity and quality (e.g., amount of fecal material) of screenings removed from the flow stream. A smaller (closer) bar spacing will remove more solids, providing a greater degree of protection for downstream equipment, however, it also requires a higher degree of screenings washing and compacting, and also increases the risk for odors. Potential reductions in maintenance include reduced ragging of primary sludge pumps and digester mix pumps, and less plugging of digester heat exchangers. Removing additional inert material at the headworks reduces the buildup of this material in digesters, thus minimizing the frequency of digester cleaning. The existing bar screens at the WPCP have bar spacings of 5/8 and 3/4 inch. The WPCP staff has indicated that there are currently no significant problems with screenings at any of the downstream processes or equipment.

The clear screen velocity (flow velocity of wastewater through the bars) is the primary criterion used to determine the number and size of screens required. Recommended values range between 2 to 4 feet per second (fps). Higher velocities allow the use of fewer bar screens but also lead to higher headloss through the screens and lower screenings removal efficiencies (due to solids being pushed through the bars). Using a lower design velocity would require more bar screens and would increase the potential for the settling of solids in the channels, but would reduce headloss and maximize the efficiency of the screens. A clear screen velocity of 3 fps at PHWWF was used for the design of the new headworks and is recommended for evaluating the capacity of the screenings facilities. At a minimum, one mechanically-cleaned standby unit is recommended.

3.2.1.2 Grit Removal

The key design criterion for grit removal is the overflow rate at PHWWF in gallons per day per square foot (gpd/sf) of the grit removal basin. A wide range of design criteria are cited in the literature depending on the geometry and configuration of the grit removal systems. Aerated grit removal basins or detritor tanks are generally sized based on lower overflow rates than vortex grit removal basins. The aerated grit basins and detritor tanks were originally sized based on an overflow rate at PHWWF of 33,900 gpd/sf, which is well within typical criteria noted in MOP 8. Historical performance has approached these overflow rates without any problems noted by the City. It is recommended that the same criteria be used for evaluating the capacity of the old headworks. The new headworks has three vortex grit removal basins which were not yet in service at the time of this PM. They are 24 feet in diameter and are rated at a PHWWF capacity of 67 mgd. This results in a PHWWF overflow rate of 148,000 gpd/sf for the vortex grit removal tanks.

3.2.2 Primary Treatment

The purpose of primary treatment is to remove settleable solids and floating material, and thus reduce the suspended solids content of the wastewater. By reducing the solids (and BOD loading), primary treatment reduces the required sizing and oxygen demands of the downstream biological treatment.

Although several factors affect primary treatment efficiency (e.g., temperature and ratio of soluble to total BOD), the key design criteria for primary settling tanks are the overflow rate at the PHWWF and ADMMF conditions. The removal efficiency of particulate matter is typically a function of the overflow rate. The overflow rate is a flow rate per area of the primary settling tanks typically expressed as gallons per day per square foot (gpd/sf).

Historically, the primary settling tanks have operated within the range of 1,170 to 1,570 gpd/sf on an average annual basis. Under these operating conditions, ADAF TSS removal ranged from 57 to 70 percent with an average of 62 percent. The ADAF BOD removal ranged from 37 to 50 percent with an average of 42 percent. In general, BOD and TSS removal were not very sensitive to the overflow rate over the range of operating conditions observed.

The recommended overflow rates for primary settling tanks are 1,500 gpd/sf at ADMMF, and 2,500 gpd/sf at PHWWF. The recommended overflow rates are within the historical loadings and typical design criteria for primary settling tanks cited in MOP 8. It should be noted that the primary settling tanks could be operated at lower or higher overflow rates as long as the downstream secondary process is sized sufficiently to treat the primary effluent loadings. Since the recommended overflow rates are similar to historical loadings, it is anticipated that BOD and TSS removal efficiencies will not change significantly.

When evaluating the reliable capacity of the primary settling tanks in PM 3.5, it is recommended that the capacity be estimated with one primary settling tank from the east and west batteries out of service as summarized in Table 2. This allows for sufficient reliability for the WPCP to perform scheduled and unscheduled maintenance on these facilities.

3.2.3 Secondary Treatment (BNR 1 and 2)

The WPCP's secondary process consists of two parallel processes, BNR 1 and BNR 2. BNR 1 and BNR 2 include aeration tanks and clarifiers. The aeration tanks maintain a biomass (MLSS), which has a primary purpose to metabolize BOD and ammonia. The MLSS from the aeration tanks flows to the clarifiers where the biomass and byproducts settle out as solids. Most of the solids collected from the clarifiers are recycled to the aeration tanks as RAS and excess sludge generated in the process is "wasted" or transferred to solids handling facilities as WAS in order to maintain a target MLSS concentration and solids retention time (SRT). The total SRT is calculated as the total inventory of biomass in the aeration tanks divided by the solids wasted from the clarifiers (WAS and secondary effluent) and represents the average residence time of the MLSS in the aeration tanks. The SRT can also be calculated as an aerobic SRT, which only considers the inventory in the aerobic zones of the aeration tanks. The aerobic SRT impacts the degree of removal that can be expected for constituents such as soluble and particulate BOD and ammonia-nitrogen and is an important control parameter for the secondary process.

Choosing an appropriate SRT (aerobic and total) depends on several factors including degree of treatment needed, proposed tank configuration (e.g., aerobic, anoxic), and the anticipated minimum temperatures. The temperature is very critical for nitrifying systems as it often sets the minimum aerobic SRT that is needed, which will drive the aeration tank sizing. The WPCP has been successfully operating at an average total SRT of 8.4 days at

ADMML, with an average aerobic SRT of 4.2 days at ADMML, which is on the low end for facilities that must nitrify in this climate. It is possible that the aerobic SRT is higher than estimated here if the anaerobic and anoxic zones are partially aerobic. If this explanation is true, it would be consistent with the WPCP's excellent performance for ammonia-nitrogen removal. Based on the anticipated minimum 30-day temperature (16 degrees), a minimum aerobic SRT of 5 days is recommended. The recommended value for the total SRT is 10 days. This recommendation is based on continuing to operate in the current mode while meeting an ammonia-nitrogen limit of 3 mg/L as a monthly average.

Because the aeration tanks and clarifiers operate as a system, allowable clarifier loading rates will depend on the operating MLSS and settleability. To develop recommended criteria for the secondary process, the entire system must be considered as a whole, thus, a WPCP-wide process model was developed using the commercially available software Biowin (Version 3.1 from Envirosim). Modeling results were used to establish recommended design criteria for the aeration tanks and clarifiers.

The general approach for establishing secondary treatment capacity and design criteria is as follows:

- Identify the peak flow that the clarifiers will see;
- Given the historical settleability of the MLSS, establish a maximum allowable MLSS that the aeration tanks can be operated at without overloading the clarifiers at peak flows; and
- Determine the maximum month flow and loading that will result in the maximum allowable MLSS in the aeration tanks. This will be based on operating with a five (5) day aerobic SRT.

Modeling results and recommended criteria for the aeration tank MLSS and clarifier loading rates are presented and discussed further in PM 3.5.

For estimating reliable capacity, it is recommended that one aeration tank be out of service, two large or four small clarifiers be out of service in BNR 1, and one clarifier out of service in BNR 2 during ADMMF conditions. This allows for sufficient reliability for the WPCP to perform scheduled and unscheduled maintenance on these facilities.

3.2.4 <u>Tertiary Filtration</u>

Filtration is a well-established operation for achieving supplemental removals of suspended solids from wastewater effluent. The removal of pollutants is achieved in filtration by the deposition of solids containing the pollutants onto the filter media. In the treatment of municipal wastewater streams, filtration has been used as an intermediate process for further treatment (i.e., reverse osmosis), or as a final polishing step following other treatment processes such as chemical addition.

The key design criteria for multi-media filtration are hydraulic loading rate (gpm/sf) at ADMMF. The hydraulic loading rate is used to determine filter area, and also affects filter performance. Historical data show that the hydraulic loading rate ranged from 4.4 to 6.0 gpm/sf during ADMMF periods, and from 6.3 to 8.6 gpm/sf on a PHWWF basis. At these loading rates, the filters performed well resulting in a range of monthly average of 1 to 7 mg/L TSS.

Original design criteria for the filters is listed as 5.0 gpm/sf in the WPCP's operation and maintenance manual. Previous research on the filters at the WPCP suggests that the maximum sustained hydraulic loading rate (i.e., ADMMF) for the filters is 5.7 gpd/sf with pre-chlorination (City of San José, 1998). Since then, the City has also found that hydraulic loading rates can exceed 5.7 gpm/sf for short periods of time and by optimizing coagulant dosing.

According to Title 22 requirements for treatment of recycled water, a hydraulic loading rate of no greater than 5 gpm/sf is specified, however, recent studies have been submitted to DHS (Department of Health Services) for approval to allow filter loading rates up to 7.5 gpm/sf (Holden et al., 2006). In the referenced study, the City participated in a pilot filtration study in collaboration with the Monterey Regional Water Pollution Control Agency. Results from this study show that it is possible to meet Title 22 requirements at filter loading rates as high as 7.5 gpm/sf by optimizing coagulant doses. It is anticipated that the higher filter loading rate will be approved for Title 22 use and that the WPCP can operate their existing filters and design new filters with filter loading rates as high as 7.5 gpm/sf for Title 22 and non-Title 22 uses.

Recommended filter loading criteria at ADMMF for Title 22 and non-Title 22 uses is 7.5 gpm/sf. For non-Title 22 uses, the filters can be operated at loadings higher than 7.5 gpm/sf during PHWWF conditions because it will be for a short duration and the backwash facilities will have sufficient capacity for handling the increased solids loading for a short period of time. The filtration capacity at PHWWF will be established by the peak hydraulic capacity of the facilities rather than a PHWWF filter loading rate.

When evaluating the capacity of the filtration process in PM 3.5, it is recommended that the capacity be estimated with one unit out of service at all times since normal operation will have at least one of the sixteen filters out of service for backwash as summarized in Table 2.

3.2.5 Disinfection

Disinfection of wastewater effluent is practiced as a means to improve water quality for downstream use by reducing the amount of microorganisms in the treated water. Disinfected wastewater can be quenched of disinfectant and discharged to streams or other receiving waters, or reused, with residual disinfectant per Title 22. While there are numerous types of bacteria that are present in wastewater, the most common indicator organisms are total and fecal coliform. The organism monitored for NPDES permit requirements is Enterococcus, whereas the organism monitored for recycled water is total coliform.

The key components of a disinfection system via chlorination are chlorine dosing and storage, and chlorine contact basins. The key design criteria for disinfection via chlorination are CT value in mg-min/L (residual chlorine in mg/L multiplied by modal contact time in minutes), and modal contact time in minutes. The CT value impacts the sizing of chemical dosing pumps and storage. The sizing of the chlorine contact basin is impacted by CT value, and modal contact time. The required minimum CT value is 450 mg-min/L for meeting Title 22 standards. The required minimum modal contact time is 90 minutes for meeting Title 22 standards. Modal contact time is usually less than the theoretical contact time, and hydraulic efficiency testing is needed to determine the correlation for the City's contact tanks. For this Master Plan, it was assumed that the modal contact time is 75 percent of the theoretical contact time, which is likely a conservative assumption.

For non-Title 22 applications, the Ten States Standards recommends a target chlorine dose of 6 mg/L for tertiary filtered or nitrified effluent, and a minimum contact time of 15 minutes at PHWWF (Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2004). The Criteria for Sewage Works Design reference ("Orange Book") produced by the State of Washington Department of Ecology recommends a minimum contact time of 20 minutes at PHWWF (Washington State Department of Ecology, 2008).

The original design criteria for the existing disinfection system at the WPCP is a target chlorine dose of 8 mg/L and a modal contact time of 54 minutes at 160 mgd. It is anticipated that the NPDES permit requirements for Enterococcus discharged to the outfall will be 35 colonies/100 mL on a monthly average basis. Historical data show that the theoretical contact time ranged from 29 to 50 minutes at PHWWF, and that the WPCP produced effluent with less than 21 colonies/100 mL of Enterococcus discharged to the outfall. These data and other design standards suggest that a theoretical contact time of 30 minutes is sufficient to meet the anticipated NPDES permit requirements for Enterococcus.

Historical data show that the CT value for recycled water averaged 2,530 mg-min/L, which is significantly higher than the minimum value of 450 mg-min/L required per Title 22 requirements. Although no site-specific data is available to confirm the performance of City facilities at CT values closer to 450 mg-min/L, it is anticipated that a CT value of 450 mg/min/L will be sufficient. The City will have an opportunity to confirm this as recycled water demands increase and actual operating CT values decrease. For future disinfection facilities for recycled water, required design criteria are a modal contact time of 90 minutes, and a CT value of 450 mg-min/L.

In addition, new chlorination systems should be sized such that, with the largest unit out of service, the remaining units have capacity for at least 50 percent of the PHWWF. One standby chlorine and sulfur dioxide feed system should be included for each new train.

3.2.6 <u>Solids Handling</u>

3.2.6.1 Thickening

The purpose of solids thickening is to reduce the volume of solids for disposal, thus reducing disposal costs. Primary sludge is thickened in the primary settling tanks to approximately 3.0 to 4.0 percent solids. Waste sludge from the secondary aeration tanks and BNR 2 is much thinner, less than 1.0 percent solids, and is thickened with DAF thickeners to between 3.0 to 4.0 percent. Sludge is thickened to increase the capacity of the digesters by decreasing the amount of sludge to be digested. The WPCP system does not use any polymer to aid in thickening the sludge.

The key design criteria of the DAF thickeners are the solids or hydraulic loading rates for both average and peak hour conditions. These loading criteria determine the surface area for the DAF thickener and relate to how well the thickener will be able to meet desired sludge solids concentrations.

Historical WPCP data show that the solids loading rate ranged from 2.9 to 7.5 lbs/sf/day at ADAL conditions, with an average of 5.3 lbs/sf/day. Under ADMML conditions, the solids loading rate ranged from 3.1 to 8.7 lbs/sf/day, with an average of 5.6 lbs/sf/day. The range for solids loading rate listed in MOP 8 is 9.6 to 24 lbs/sf/day at ADAL or ADMML. The recommended sizing criteria for solids loading are 9.6 lbs/sf/day for ADAL conditions and 16.8 lbs/sf/d for ADMML conditions; this is within the range for solids loading rates listed in MOP 8 and historical performance data. Historical WPCP data show that the hydraulic loading rate ranged from 0.08 to 0.09 gpm/sf at ADAL conditions, with an average of 0.08 gpm/sf. Under ADMML conditions, the hydraulic loading rate ranged from 0.07 to 0.09 gpm/sf, with an average of 0.08 gpm/sf. The range for hydraulic loading rate listed in MOP 8 is 0.5 to 2 gpm/sf at ADAL or ADMML. The sizing criteria recommended for hydraulic loading are 0.5 gpm/sf for ADAL conditions and 0.8 gpm/sf for ADMML conditions; this is within the range for hydraulic loading rates listed in MOP 8 and historical performance data.

Since there are 16 DAF thickeners, sizing assumptions should include three units are out of service during peak conditions, providing approximately 20 percent redundancy.

3.2.6.2 Anaerobic Digestion

The purpose of anaerobic digestion is to stabilize the thickened sludge and significantly reduce the volatile suspended solids in the sludge. Anaerobic digestion includes a large amount of equipment including floating tank covers, heat exchangers, pumps, mixing equipment and gas management systems. When sizing a digestion system, the key criteria apply to the digester tanks. Related equipment should be sized after tank capacity is determined. Key operational measurements include SRT, volatile solids reduction rate and temperature. The WPCP operates the digesters with a target temperature of 95 degrees F (minimum) to obtain reliable performance.

The key design criteria for sludge digestion are SRT and volatile solids loading rate. Historical data show that the SRT ranged from 20.8 to 58.8 days, with an average of 38.2 at ADMML conditions. The typical range for SRT for anaerobic digestion listed in MOP 8 is 10 to 20 days. It is recommended that the digesters be sized such that a 20-day SRT can be met at ADMML conditions; this is within the range listed in MOP 8. Historical data show that the volatile solids loading ranged from 0.04 to 0.08 pounds (lb) volatile solids per cubic feet per day (cf/day), with an average of 0.05 lb volatile solids/cf/day at ADMML conditions. The typical range for volatile solids loading listed in MOP 8 is 0.1 to 0.4 lb volatile solids/cf/day. It is recommended that the digesters volatile solids loading not exceed 0.15 lb/cf/day at ADMML conditions; this is within the typical range listed in MOP 8 and is adequate compared to historical performance. These criteria apply to the existing digestion facilities at the WPCP; however, modifications to the tanks or equipment could be considered to revise the recommended criteria.

Since there are 16 digesters, sizing assumptions should include three digesters out of service during peak conditions for approximately 20 percent redundancy.

3.2.6.3 Biosolids Lagoons and Drying Beds

The biosolids lagoons at the WPCP are used for additional volatile solids reductions, product stability and sufficient pathogen reduction to achieve Class A standards. The biosolids lagoons are divided into four clusters and are operated on a four-year cycle. Each cluster is fed digested sludge for one year, allowed to sit with a water cap for two years and is dredged the fourth year. The year of dredging is the only opportunity for maintenance on the biosolids lagoons within that cluster. This operational scheme has, over time, become the main capacity constraint in the system (Ken Rock, personal communication, 2008).

The key criterion for the biosolids lagoons is a minimum 2-year storage period during which no filling or dredging must occur. This 2-year period is what allows for adequate pathogen destruction in order to meet Class A standards. No hydraulic or solids loading criteria are used for sizing of these lagoons, because they were reconfigured in the 1990s for the Class A processing scheme described above (Brown and Caldwell, 1996). The ability to feed only one cluster of biosolids lagoons in a given year provides limited feeding capacity, and, at times, the WPCP is approaching difficulty in keeping all digested sludge within the cluster being fed.

The drying beds are used to reduce the water content in the biosolids so that they can be used as landfill cover. The biosolids are also much less costly to haul once they are dried. Dredging of the biosolids (normally January to April each year) is typically conducted at about 4 to 5 percent solids since thicker material is difficult to pump the required distance.

Drying beds are filled with this dredged biosolids and dried over the summer months to about 75 percent solids using various, mobile equipment and supernatant decanting. The maximum depth of the dredged biosolids slurry within each drying bed is usually kept below 30 to 36 inches, although this is variable depending on drying bed levee conditions and operating constraints.

3.3 Process Design Criteria and Unit Sizing for New Facilities

Process design criteria and sizing for new facilities will be developed as part of the alternatives evaluation in subsequent project memoranda.

REFERENCES

REFERENCES

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