City of Pinole

Pinole/Hercules WPCP Project

Technical Memorandum 3

Plant Modeling

March 1, 2013

PRELIMINARY
FOR REVIEW ONLY

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TM 3 – TREATMENT PLANT MODELING STEADY STATE MASS BALANCE MODEL CALIBRATION & DESIGN CONDITIONS

Pinole/Hercules WPCP Project ***March 1, 2013***

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Executive Summary

Purpose

The purpose of this technical memorandum (TM) is to develop a steady state mass balance model of the existing treatment system at the Pinole/Hercules Water Pollution Control Plant (WPCP) that can be used to establish process design criteria for the secondary system treatment upgrades.

Background

In August 2012, the WPCP's renewed National Pollutant Discharge Elimination System (NPDES) permit was issued. The conditions in the permit require secondary treatment for peak hour flows up to 20 million gallons per day (mgd). Currently, the permitted capacity of the secondary treatment system is 10.3 mgd and flows greater than 10.3 mgd bypass secondary treatment. This TM provides the process design criteria for the secondary treatment upgrades, and is the basis for the facilities described in TM 8.

Conclusions

Two modes of operation were evaluated for secondary treatment: Carbonaceous Mode and Nitrification Mode. Two aeration trains were assumed and one train is designed to treat average dry weather flows and loads. Based on the permit conditions, process modeling focused on maximum month and maximum week loads. Conditions under maximum day and peak wet weather conditions were reviewed to confirm process stability and effluent quality under such conditions. Carbonaceous Mode is designed to provide biochemical oxygen demand (BOD) removal only and Nitrification Mode is designed to provide BOD, ammonia removal. Carbonaceous Mode would require the aeration basins to be extended by a minimum of 55 feet (ft) and Nitrification Mode would require the aeration basins to be extended by a minimum of 90 ft. Based on the process modeling performed, the aeration blowers will need to be sized to deliver air flows of 4,000 scfm under Carbonaceous Mode and 7,900 scfm under Nitrification Mode.

Introduction

The WPCP's renewed NPDES permit requires secondary treatment for peak wet weather flows up to 20 mgd. The purpose of this TM is to describe steady state and activated sludge modeling that was performed and to establish process design criteria for the secondary treatment upgrades that are further detailed in TM 8.

The first section of this TM describes the steady state mass balance calibration for the existing WPCP. The calibration establishes a baseline for the facilities design, and confirms that the model accurately reflects the treatment capacity of the plant. HDRs ENVision software was used for the steady state modeling efforts.

The second section of this TM develops process design criteria for the secondary treatment system (specifically the activated sludge system) using the calibrated steady state model and commercially available BioWin™ software. Two operational modes of the activated sludge system were modeled and process design criteria for each mode were developed.

Existing Facilities

The WPCP treats municipal wastewater flow from the City of Pinole and the City of Hercules. The WPCP liquid stream treatment process is shown in Figure 3-1 and includes coarse screening, primary sedimentation, secondary treatment (air activated sludge and secondary clarification) and chlorine disinfection. Disinfected effluent is discharged to San Pablo Bay via one of two outfalls (Rodeo Sanitation District's outfall or the WPCP's Emergency Outfall). The secondary treatment system is permitted to treat 10.3 mgd, and flows greater than 10.3 mgd bypass secondary treatment (Figure 3-1). Bypassed flows are blended with secondary effluent prior to disinfection and discharge to the San Pablo Bay.

The solids treatment process is also included in Figure 3-1. Primary sludge is degritted and co-thickened with waste activated sludge (WAS), prior to anaerobic digestion. Digested solids are dewatered and hauled offsite for beneficial reuse. Thickening and dewatering liquid waste streams are returned to the Influent Pump Station.

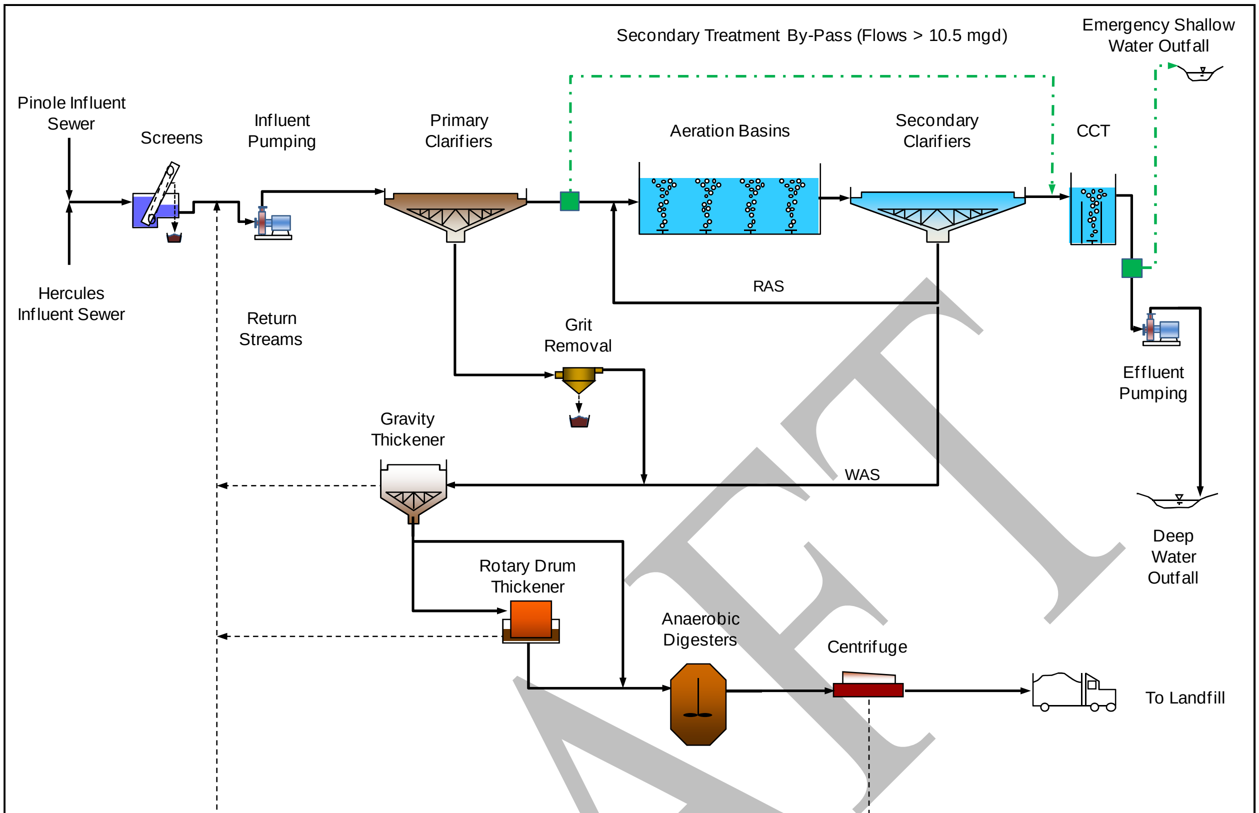

Figure 3-1. WPCP Existing Process Schematic

Steady State Mass Balance Model Calibration

Approach

HDR's ENVision steady state mass balance program was used to calculate flows and loads for each unit process within the plant. The ENVision program provides a mass balance for total suspended solids (TSS), biochemical oxygen demand (BOD), and nitrogen species through the treatment plant using models for each process. It provides a reasonable first estimate of process performance and an accurate measure of the flows and mass balances at various points throughout the plant.

The ENVision model was loaded with the physical dimensions of the existing unit processes. A screen capture of ENVision's model of the existing WPCP is shown in Figure 3-2. Using operational data from 2008 through 2011, the plant model was calibrated to reflect operating conditions. Table 3-1 provides the raw influent wastewater data that were used to calibrate the model. The values do not include contributions from the solids thickening and dewatering return streams. The influent flow, TSS, BOD and ammonia data are the annual average values for the past three years.

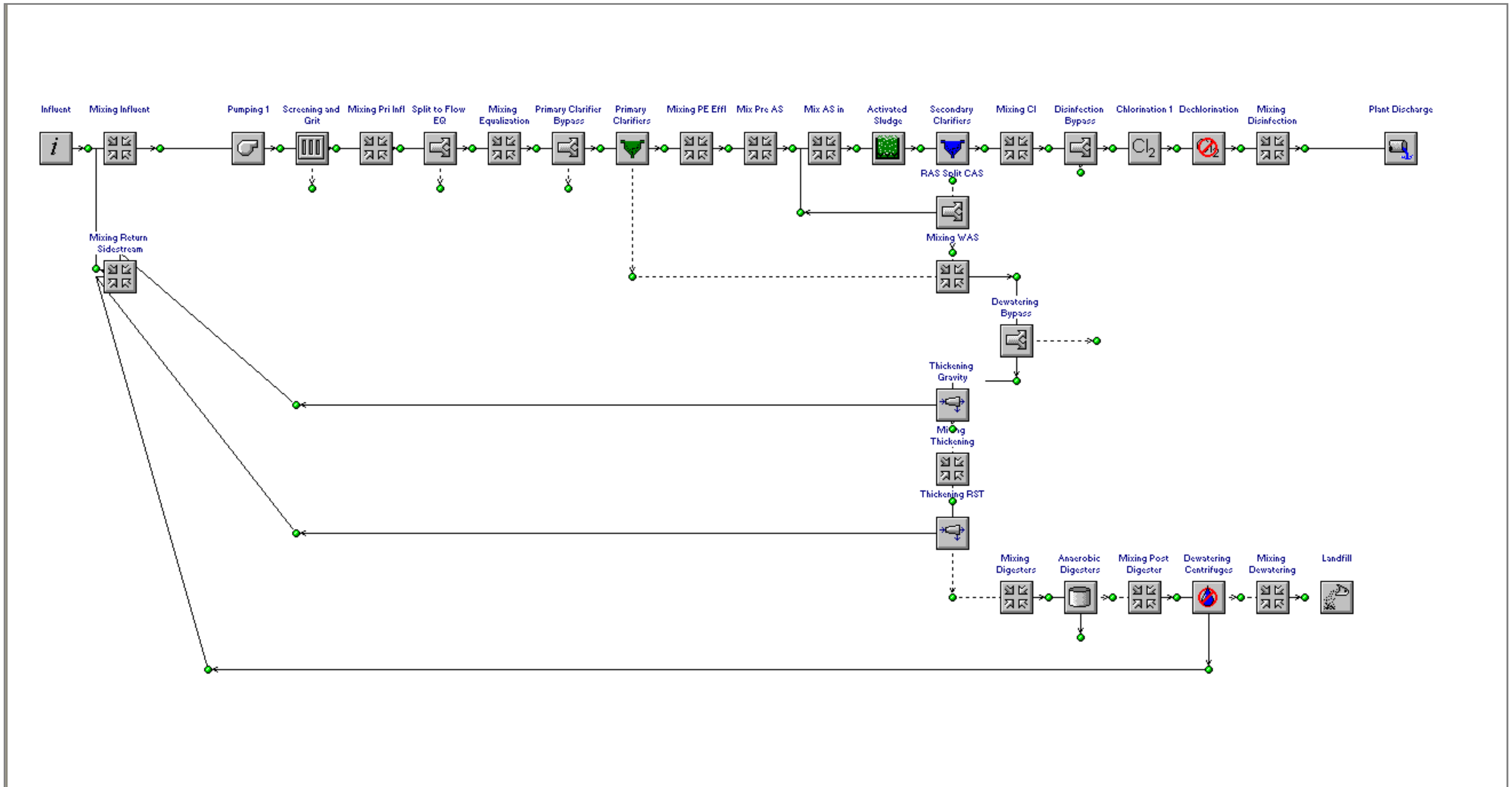

Figure 3-2. ENVision Sample Screen Capture Depicting Existing WPCP

Table 3-1. Annual Average Raw Wastewater Characteristics Used for Steady State Model Calibration

Item	Unit	Value
Flow	mgd	3.4
TSS	mg/L	301
BOD	mg/L	290
NH_3 – N	mg-N/L	31
TKN-N	mg-N/L	47

Calibration Results

The mass balance model results are divided between the liquid and solid streams. The liquid stream results are presented as Table 3-2 and the solid stream results are presented as Table 3-3. For both tables, the current operational data values are listed under the heading “Data” and the steady state mass balance results are listed under the heading “Model”. The percent difference between the average plant data and the calibrated model results is provided in the “Delta” column. A brief discussion is provided for parameters with a delta close to or greater than 10 percent. A delta within 10 percent was considered reasonable based on the accuracy of data and variability in the operation of the WPCP. A detailed breakdown of the mass balance is provided as Appendix A.

As shown in Table 3-2, the model calculated the solids residence time (SRT) to be 3.9 days by matching the MLSS, return activated sludge (RAS) and the wasting rates. The delta between the modeled SRT and the actual SRT was within 10 percent and is considered to be a reasonable difference. The secondary clarifier effluent TSS concentrations were used to calibrate the model as well, and close matches between the model and the data were achieved. The secondary effluent BOD value from the model calibration differs from the historic data, which could be attributed to the accuracy of the analytical method at low levels. Regardless, the secondary effluent BOD delta has a negligible impact on the overall mass balance.

Table 3-3 presents a summary of the solids stream calibration. There was limited operational data on the solids content of various streams as well as limited data on the quality of the thickening and dewatering liquid waste streams. Additionally, the rotary screen thickener and the dewatering centrifuge are not operated continuously. The rotary screen thickener is operated during the day shift, while plant Staff are onsite. Similarly, the dewatering centrifuge is operated during the day shift for approximately three to four hours a day, four to five times per week. The ENVision model assumes the dewatering and thickening equipment is operated continuously which impacts the model calibration, particularly with the anaerobic digester loading rate and detention time since operation of the rotary screen thickener impacts these values. The lack of data and the intermittent operation of the thickening and dewatering equipment contributed to greater differences between operational data and the model calibration.

Table 3-2. Steady State Mass Balance Liquid Stream Calibration

Parameter	Units	Data	Model	Delta	Discussion
Influent					
Flow	mgd	3.4	3.4	0%	
TSS	mg/L	301	301	0%	
BOD	mg/L	290	290	0%	
TKN – N	mg-N/L	47	47	-1%	
NH_3-N	mg-N/L	31	31	-2%	
Primary Clarifier					
TSS Removal	% removal	63%	60%	5%	
BOD Removal	% removal	45%	44%	2%	
Primary Effluent – TSS	mg/L	111	121	-9%	Internal plant return streams are variable in volume, quality and frequency. The impact of solids from the internal plant return streams was not accounted for in the calibration due to lack of available data and contributes to the delta between the model and plant data.
Primary Effluent BOD	mg/L	158	164	-3%	
Aeration Basins					
MLSS	mg/L	1,914	1,873	2%	
Solids Residence Time	days	3.61	3.95	-9%	
Activated Sludge Yield	lb TSS/lb BOD	0.64*	0.75	5%	2011 data was used to estimate the sludge yield. A WAS concentration of 3,800 mg/L.
Return Activated Sludge (RAS) Solids Concentration	mg TSS/L	3,946	3,768	5%	
RAS Flow	mgd	3.2	3.2	0%	
Waste Activated Sludge (WAS) Flow	mgd	0.1	0.1	-2%	
Effluent Quality					
TSS	mg/L	23	23	-2%	
BOD	mg/L	11.7	9.2	22%	BOD tests are not accurate at low concentrations which impacts the delta. The difference in the value of the results are within reason for the accuracy of the test.

* Based on 2011 data, and assumed WAS concentration of 3800 mg/L.

Table 3-3. Solids Stream Steady State Mass Balance Calibration

Location	Compound [unit]	Data	Model	Delta	Discussion
Gravity Thickener Effluent	% Solids [%]	2.5	2.3	9%	Limited data (fewer than 40 data points)
Gravity Thickener Effluent	VSS/TSS [%]	86	86	-1%	
Rotary Screen Thickener Effluent	% Solids [%]	9.1	8.3	9%	Limited Data(fewer than 40 data points), RST operates 5-6 hours per day, and staff controls the % solids concentration based on level in GT and available digester capacity.
Rotary Screen Thickener Effluent	VSS/TSS [%]	89	87	2%	
Anaerobic Digester	% Solids [%]	2.4	2.6	-6%	
Anaerobic Digester	VSS/TSS[%]	76	71	6%	
Anaerobic Digester Detention Time	HRT [days]	20	35		The model assumes solids are continually feed to digesters at a consistent rate and concentration. In actual operation the digesters are feed 6-18 hours per day with varying solids concentration.
Centrifuge Cake	% Solids [%]	19.5	19.5	0%	
Centrifuge Cake	VSS/TSS [%]	75	71	4%	

Conclusions

In general there is agreement between the operational data and model and significantly different values can be explained either by model limitations or insufficient data. The calibrated model used to model the proposed upgrades at the WPCP and to develop design criteria for the upgrades.

Process Design Criteria Development

A process flow diagram of the proposed upgrades to the WPCP is provided in Figure 3-3. Because the focus of this TM is to develop process design criteria for improvements to the secondary treatment system the modeling efforts described herein focus on the activated sludge system. The calibrated ENVision model was used together with the BioWin™ model to estimate plant performance under projected average and peak loading conditions. The model results were then used to develop process design criteria for the proposed upgrades to the secondary treatment system. Two activated sludge operational modes were modeled and are described in detail below: Carbonaceous Mode and Nitrification Mode.

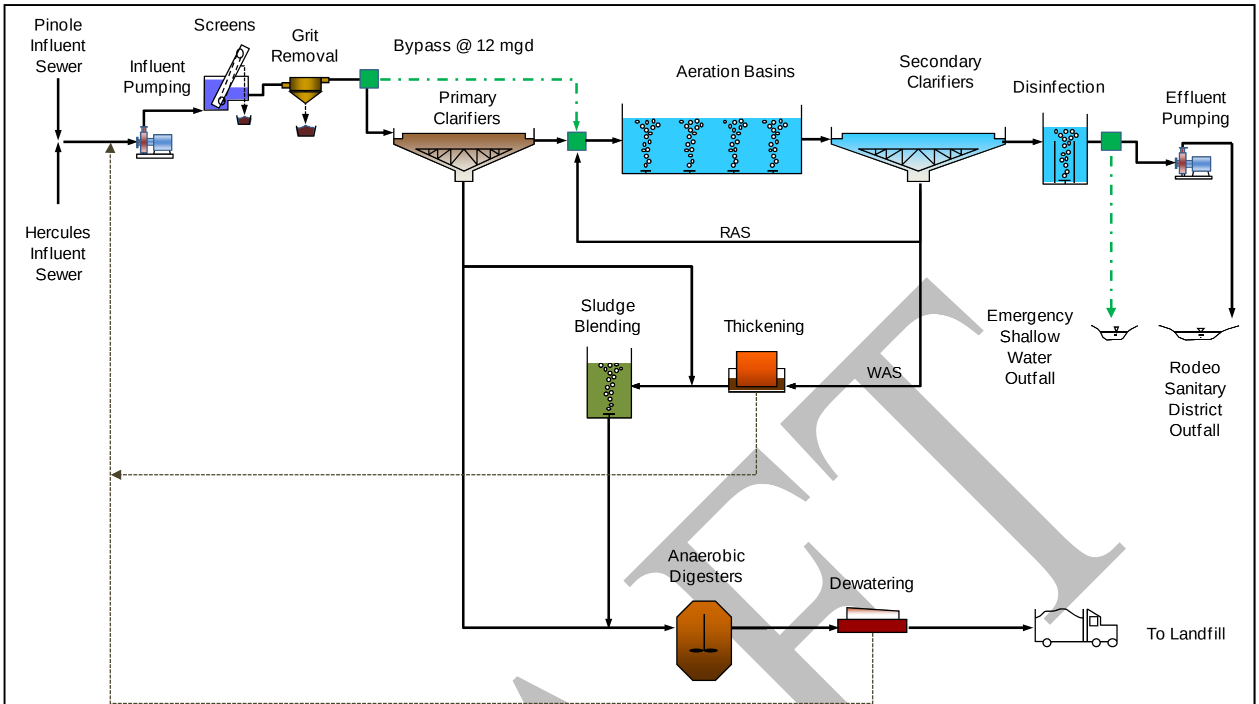

Figure 3-3. Proposed Process Flow Diagram

Aeration Basin Influent Loading

Table 3-4 provides a summary of the flows and loads to the aeration basins that were used to model the activated sludge system. The flows and loads include contributions from internal recycle steams (i.e., thickening and dewatering liquid waste streams). Removal efficiencies across the primary clarifiers were assumed to be 63 percent TSS removal and 45 percent BOD removal, which is consistent with historic data. Influent flows greater than 12 mgd were assumed to bypass primary clarification and be directly routed to the aeration basins.

Table 3-4. Aeration Basin Design Flows and Loads

Condition	Flow (mgd)[1]	Concentration (mg/L)			Load (lbs/day)		
		BOD	TSS	TKN	BOD	TSS	TKN
Average Dry Weather Flow	4.1	170	115	52	5,847	3,932	1,778
Average Annual Flow	4.7	158	112	52	6,193	4,390	2,038
Maximum Month Flow	6.2	133	100	52	6,877	5,170	2,688
Maximum Week Flow	9.0	112	100	42	8,407	7,580	3,152
Maximum Day Flow	11.4	108	102	35	10,268	9,698	3,327
Peak Hour Flow	20	NA	NA	NA	NA	NA	NA

1) Includes internal plant recycle streams from dewatering and thickening. TKN concentrations for maximum month, maximum week and maximum day are estimates because historic TKN loading during high flow periods was unavailable.
2) NA – data not available
3) TKN = total Kjeldahl nitrogen

Carbonaceous Mode Design Criteria

Overview

Carbonaceous mode was reviewed as an alternative for operation of the activated sludge system. In Carbonaceous Mode, the activated sludge system would be designed for BOD removal only and would be designed to operate at a 3-day SRT. Carbonaceous Mode would be similar to current operations at the WPCP.

Table 3-5 below provides the secondary effluent water quality objectives for Carbonaceous Mode. The water quality objectives are consistent with the conventional effluent limits in the WPCP's renewed permit (issued in August 2012).

Table 3-5. Carbonaceous Mode Secondary Effluent Water Quality Objectives

Parameter	Units	Average Month Effluent Limit	Maximum Week Effluent Limit	Maximum Day Effluent Limit
Carbonaceous Biological Oxygen Demand (cBOD)	mg/L	25	40	--
Total Suspended Solids (TSS)	mg/L	30	45	--
Ammonia - N	mg-N/L	113	--	182

1) Limits are consistent with WPCP's renewed NPDES permit (CA0037796), dated August 2012.
2) "—" = no limit

Process Modeling

Currently, the WPCP operates with two aeration trains, each having a volume of approximately 0.4 million gallons (MG). Based on the evaluation presented in TM 8, it was assumed that the existing trains would be reused and would be extended to accommodate future flows and loads. The current configuration of two aeration trains would be maintained. Based on the permit conditions presented in Table 3-5, the activated sludge system in Carbonaceous Mode would be designed for maximum month conditions, with both two trains in operation. The upgrades would enable average dry weather flows to be treated with one train to allow for maintenance. Air demands for maximum week conditions were used for aeration blower sizing. Steady state modeling was performed for all flow conditions to confirm effluent quality and process performance under all conditions.

To improve sludge settleability an anaerobic selector was included. The anaerobic selector would consist of two anaerobic zones with submersible mixers upstream of the aerobic zones. A total of three aerobic zones were assumed (Figure 3-4). The anaerobic zones would occupy approximately 20 percent of the total aeration basin volume. The existing trains are capable of operating in contact stabilization mode or step feed mode, and this flexibility would be maintained after the upgrades are completed. Figure 3-4 provides a flow diagram of Carbonaceous Mode and is a diagram of the BioWin model that was used together with the calibrated ENVision model.

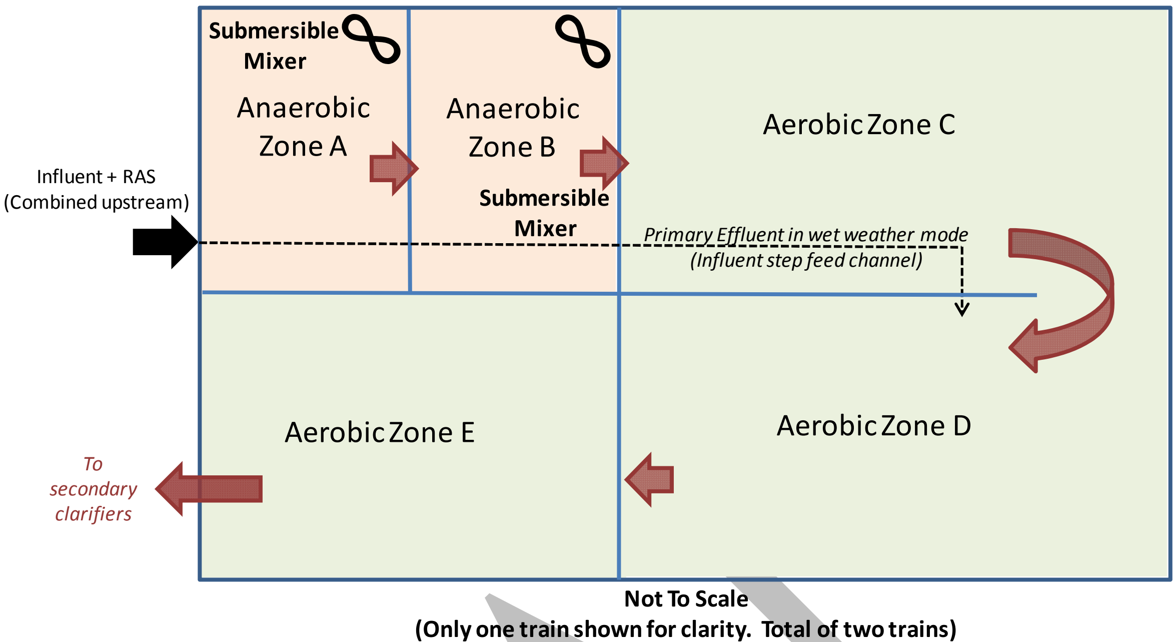

Figure 3-4. Carbonaceous Mode Schematic

Modeling under the various flow conditions was performed to optimize the size of the aeration basins. Key design process parameters such as MLSS, oxygen uptake rate (OUR), food to microorganism (F/M) ratio and sludge yield were monitored for maximum month loading and average dry weather loading, with one basin in service. To keep the process parameters within typical operating conditions, the aeration trains for Carbonaceous Mode need to be extended 55 feet (ft) to provide a volume per train of 0.7 MG.

An analysis of performance at different SRTs (1 day, 2 day and 3 day) was completed for maximum month conditions. A 3-day SRT was selected because it provides process stability and a reasonable F/M ratio.

To meet the effluent discharge requirements set forth in Scenario A, the existing aeration basins must be extended approximately 55 feet. This expansion would allow the WPCP to meet maximum month and maximum week permit conditions and would allow one train to be offline for maintenance during average dry weather conditions. Table 3-6 provides a summary of the process design criteria for Carbonaceous Mode.

Table 3-6. Carbonaceous Mode Process Design Criteria (Steady State Mode Results)

Location	Unit	ADWF	MM	MW
Number of Trains	#	1	2	2
Volume per Train	MG	0.70	0.70	0.70
Anoxic Volume per Train	MG	0.15	0.15	0.15
Aerobic Volume per Train	MG	0.55	0.55	0.55
Total SRT	days	3	3	3
Aerobic SRT	days	2.5	2.5	2.5
Hydraulic Retention Time				
Anoxic	hr	0.6	0.8	0.6
Aerobic	hr	2.1	1.5	1.8
Temperature	deg.C	20	15	15
MLSS	mg/L	2,500	1,600	1,900
F/M Ratio	lb BOD/Lb VSS/d	0.4	0.4	0.4
Average OUR (Zones C thru E)	mg/L/hr	77	24	29
Total Actual Oxygen Requirement	lbs/day	8,750	5,400	6,520
WAS Flow	lbs/day	4,500	5,700	6,870
Effluent Quality				
TSS	mg/L	7.5	4.7	5.8
BOD	mg/L	4.8	3.8	4.4
Ammonia	mg/L	1.7	39.0	30.5

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des the aeration design criteria for maximum month and maximum week loading and the total estimated air demand. Appendix B includes the calculations for the air demands. The aeration blowers for Carbonaceous Mode will need to deliver an air flow of approximately 4,000 scfm at the operating pressure.

Table 3-7. Carbonaceous Mode Aeration Design Criteria

Item	Unit	ADWF	MM	MW
No. of Trains	#	1	2	2
Total Actual Oxygen Requirement	lbs/day	8,750	5,400	6,520
Alpha Factor		0.4	0.4	0.4
Beta		0.98	0.98	0.98
SOTE (Standard Oxygen Transfer Efficiency)	%	25	25	25
DO Setpoint	mg/L	2	2	2
Standard Oxygen Transfer Rate (SOTR)	lbs/hr	1,120	985	1,000
Air Demand (all basins)	scfm	4,300	3,800	3,900

Nitrification Mode

Overview

Nitrification mode was reviewed as an alternative for operation of the activated sludge system. In Nitrification Mode, the activated sludge system would be designed for BOD and ammonia removal and would operate at a higher SRT. Anoxic zones and internal mixed liquor recycle would also be provided for denitrification.

Table 3-8 below provides the secondary effluent water quality objectives assumed for Nitrification Mode. The parameters in Table 3-8 are based on a recently adopted NPDES permit for the Novato Sanitation District, who is permitted to seasonally discharge secondary effluent to San Pablo Bay from September through May. Nutrient loading to the San Francisco Bay region is currently being studied by the Regional Water Quality Control Board (RWQCB) and ammonia or nitrogen limitations could be forthcoming. TM 2 provides additional information on the future regulatory climate with respect to nutrients and San Francisco Bay dischargers.

Table 3-8. Nitrification Mode Secondary Effluent Water Quality Objective

Parameter	Units	Average Month Effluent Limit	Maximum Week Effluent Limit	Maximum Day Effluent Limit
Carbonaceous Biological Oxygen Demand (cBOD)	mg/L	25	40	--
Total Suspended Solids (TSS)	mg/L	30	45	--
Ammonia - N	mg-N/L	6	--	21

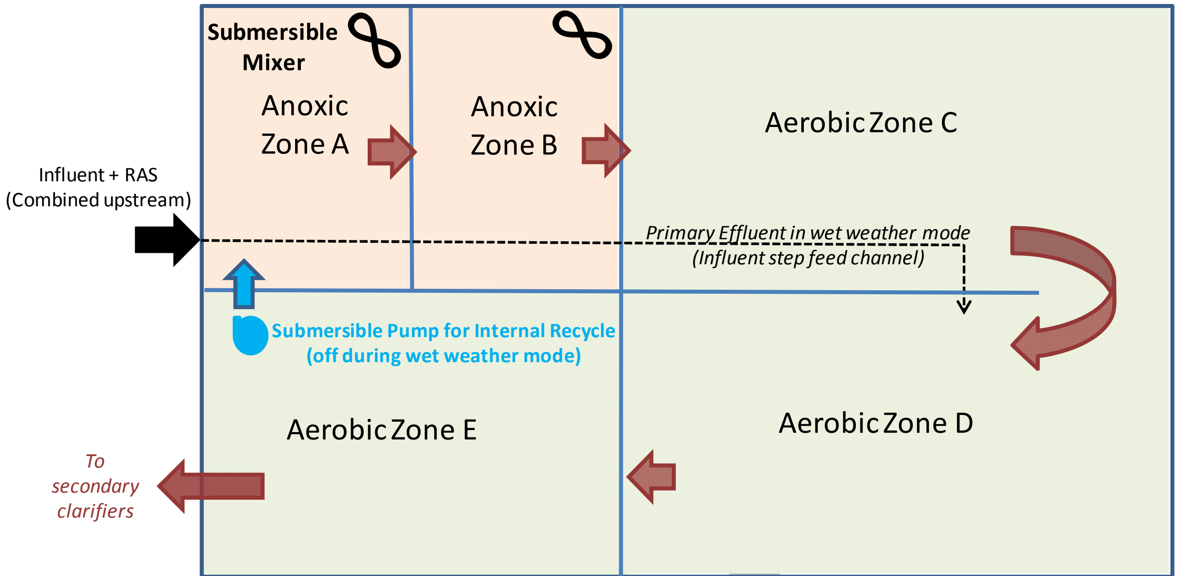
1) BOD and TSS limits are consistent with WPCP's renewed NPDES permit (CA0037796), dated August 2012. Ammonia limits are from Novato Sanitation District's NPDES permit No. CA 0037958 and apply to seasonal discharges to San Pablo Bay during the months of May, September and October.
2) "—" = no limit

Process Modeling

Similar to Carbonaceous Mode, two trains were assumed for Nitrification Mode. The system would be designed for maximum month conditions with the ability to treat average dry weather loads in a single train. Air demands for maximum week conditions were also considered for aeration blower sizing. Steady state modeling was performed for all flow conditions to confirm effluent quality and process performance under all operating conditions.

Figure 3-5 provides a schematic of a Nitrification Mode train. Two anoxic zones and three aerobic zones are assumed. Internal mixed liquor recycle would also be provided. Nitrification Mode operates at a higher MLSS concentration so the aeration basins would be designed to operate in Contact Stabilization Mode during peak wet weather events. This not only reduces secondary clarifier sizing but also minimizes the loss of nitrifying organisms during peak wet weather events.

An analysis for selecting the design SRT was completed under maximum month loading conditions. SRTs between 6 days and 12 days were reviewed and a total SRT of 6.5 days was selected to reduce construction costs while still achieving a stable MLSS concentration during ADWF when one aeration train is out of service. The SRT also produces effluent that can meet the water quality objectives in Table 3-8. Table 3-9 provides an overview of the modeling results.



Not To Scale
(Only one train shown for clarity. Total of two trains)

Figure 3-5. Nitrification Mode Schematic

Table 3-9. Nitrification Mode Liquid Stream Process Design (Steady State Models)

Location	Unit	ADWF	MM	MW
Number of Trains	#	1	2	2
Volume per Train	MG	0.9	0.9	0.9
Anoxic Volume per Train	MG	0.2	0.2	0.2
Aerobic Volume per Train	MG	0.7	0.7	0.7
Total SRT	days	6.5	6.5	6.5
Aerobic SRT	days	5.2	5.2	5.2
Hydraulic Retention Time				
Anoxic	hr	0.6	0.6	0.4
Aerobic	hr	2.6	1.5	1.1
Temperature	deg.C	20	15	15
MLSS	mg/L	3,400	2,300	2,800
Mixed Liquor Return	% of influent	200	200	200
Average OUR (Zones C thru E)	mg/L/hr	74	54	64
Total Actual Oxygen Requirement	lbs/day	10,260	15,140	17,830
WAS Flow	lbs/day	3,800	4,600	6,000
Effluent Quality				
TSS	mg/L	5.3	6.8	9.0
BOD	mg/L	3.0	4.0	5.0
Ammonia	mg/L	<0.1	0.4	0.4

Table 3-10 provides the aeration design criteria under maximum month and maximum week loading. The aeration blowers for Nitrification Mode will need to deliver an air flow of 7,000 scfm at the operating pressure.

Table 3-10. Nitrification Mode Aeration Design Criteria

Item	Unit	ADWF	MM	MW
No. of Trains	#	1	2	2
Total Actual Oxygen Requirement	lbs/day	10,260	15,140	17,830
Alpha Factor		0.46	0.46	0.46
Beta		0.98	0.98	0.98
SOTE (Standard Oxygen Transfer Efficiency)	%	25	25	25
DO Setpoint	mg/L	2	2	2
Standard Oxygen Transfer Rate (SOTR)	lbs/hr	1,200	1,760	2,050
Air Demand (all basins)	scfm	4,630	6,800	7,900

Dynamic Modeling

A dynamic model was developed to simulate peak wet weather events during which partial bypass of the primary clarifiers would occur and the secondary system would operate in contact stabilization mode. A forty-five day itinerary was developed based on historical data from 2011. The historical data set included two storm events, and represents the maximum month flow scenario. The 3-year historical data set (2008 through 2011) did not include a wet weather event where flows to the plant reached 20 mgd. Therefore, flows were scaled up to simulate a wet weather event where sustained peak hour flows reach 20 mgd. It was assumed that BOD, TSS and ammonia concentrations would remain the same and loading would vary due to the increase in flow. BOD, TSS and ammonia loading to the plant during wet weather scenarios has not historically been well defined and therefore assumptions were made for wet weather BOD, TSS and ammonia concentrations. Based on the results of the dynamic model, the MLSS concentration exiting the aeration basins is between 1,800 and 2,100 mg/L. This information was used in secondary clarifier sizing which is further described in TM 8.

Process Control

Key features of the secondary system upgrades include the following:

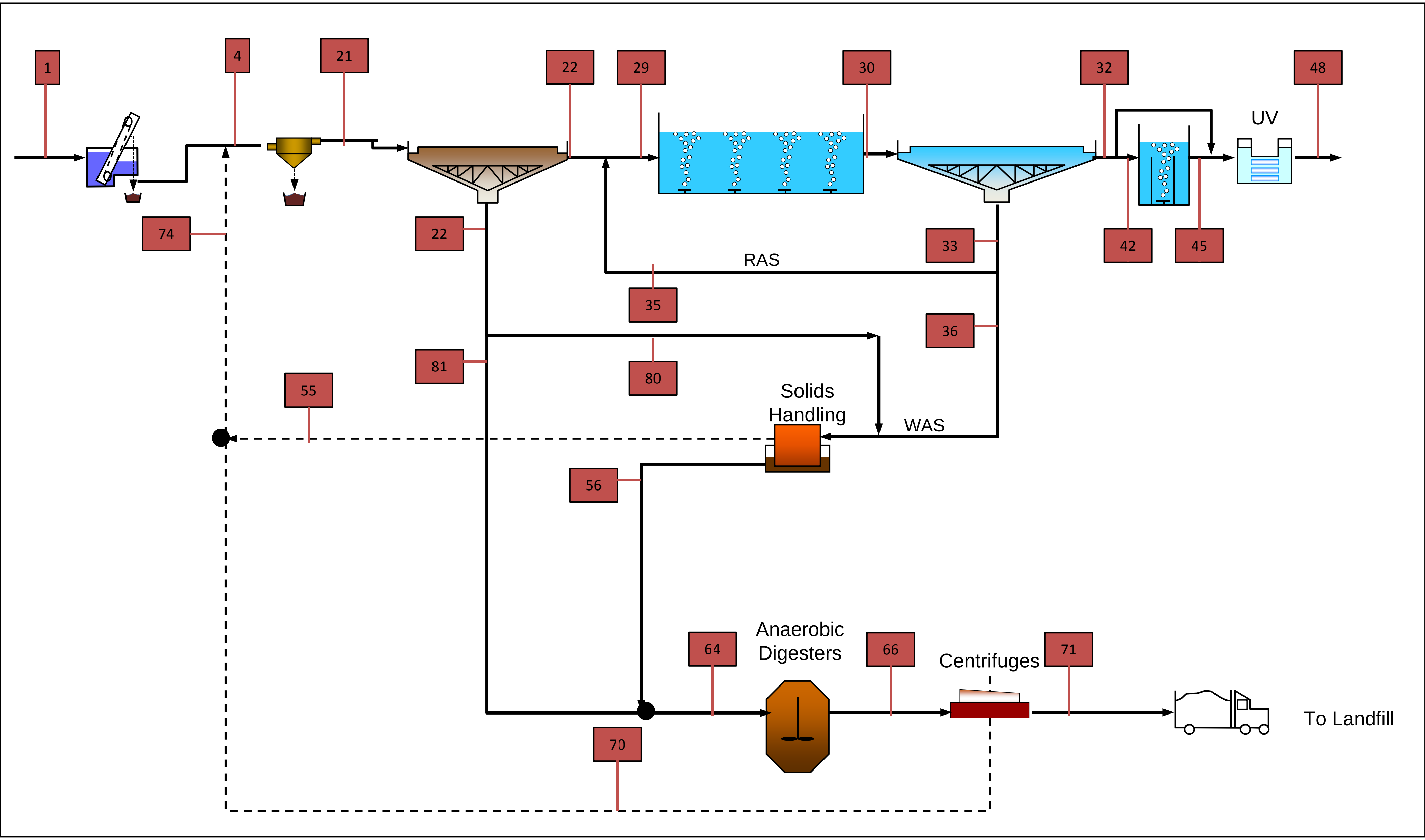
- Each anoxic zone will be installed with one or more mixers to at least 0.5 horsepower per 1,000 cubic feet of volume.
- Fine bubble membrane diffusers will be used throughout the aeration basins.
- A minimum of three new high efficiency turbo blowers will be installed to meet the peak air demands.
- One aeration header will be provided to each aeration train. One aeration dropleg will be provided to each aeration zone (three zones per train). Each header will be equipped

with an air flow control valve and each zone will be equipped with a DO probe. Air flow to each zone will be modulated to meet a DO set-point.

- In Nitrification Mode, the mixed liquor return pumps will be flow-paced with the plant influent flow. The pump output will range from 150 to 300 percent of influent flow. An operator set-point override for the mixed liquor return pumps will be provided.
- The activated sludge system will be operated in contact stabilization mode during peak wet weather storm events. The switch to contact stabilization will be manually controlled through a series of slide gates and valves. Mixed liquor recycle pumps will not operate during contact stabilization.

Appendix A. ENVision Model Calibration

Figure A-1 Numbered Schematic of the Existing Facility



Stream Summary for Calibration

ENV_Cal

Stream Summary for Calibration

Line	Name	Flow		BOD		TSS		VSS		NH4		TKN		TN		Alk	
		mgd	gpm	mg/L	lb/d	mg/L	lb/d	mg/L	lb/d	mg/L	lb/d	mg/L	lb/d	mg/L	lb/d	mg/L	lb/d
1	Influent (Raw)	3.38	2,347	290	8,175	301	8,485	271	7,636	31	874	47	1,325	47	1,325	100	2,819
4	Influent + Recycle	3.66	2,540	324	9,887	371	11,310	331	10,080	41	1,236	61	1,862	61	1,862	134	4,097
74	Recycle Streams	0.28	193	741	1,712	1,224	2,830	1,059	2,448	157	362	233	538	233	538	553	1,278
20	Primary Clarifier Influent	3.66	2,540	324	9,887	371	11,310	331	10,080	41	1,236	61	1,862	61	1,862	134	4,097
22	Primary Clarifier Effluent (Liquid)	3.47	2,410	164	4,732	121	3,508	108	3,126	41	1,173	47	1,367	47	1,367	134	3,887
23	Primary Clarifier Effluent (Solid)	0.19	130	3,301	5,154	5,000	7,807	4,457	6,958	41	63	317	496	317	496	134	210
35	RAS	3.20	2,225	917	24,510	3,768	100,700	3,046	81,390	37	998	342	9,137	342	9,137	134	3,589
29	AS Influent	6.67	4,635	525	29,240	1,872	104,200	1,518	84,520	39	2,170	189	10,500	189	10,500	134	7,475
30	AS Effluent/SC Influent	6.67	4,635	458	25,480	1,873	104,200	1,514	84,250	37	2,078	189	10,500	189	10,500	134	7,476
30	AS Effluent/SC Influent	6.67	4,635	458	25,480	1,873	104,200	1,514	84,250	37	2,078	189	10,500	189	10,500	134	7,476
32	Secondary Clarifier Effluent (Liquid)	3.38	2,346	9	258	23	648	19	524	37	1,052	39	1,104	39	1,104	134	3,784
33	Seconary Clarifier Effluent (Solid)	3.30	2,289	917	25,220	3,768	103,600	3,046	83,730	37	1,027	342	9,400	342	9,400	134	3,693
36	WAS	0.09	64	917	705	3,768	2,895	3,046	2,340	37	29	342	263	342	263	134	103
42	Chlorination Influent	3.38	2,346	9	258	23	648	19	524	37	1,052	39	1,104	39	1,104	134	3,784
45	Dechlorination Effluent	3.38	2,346	9	258	23	648	19	524	37	1,052	39	1,104	39	1,104	166	4,682
80	Primary Sludge to Dewatering	0.19	130	3,301	5,154	5,000	7,807	4,457	6,958	41	63	317	496	317	496	134	210
55	Thickening Gravity Effluent (Liquid)	0.23	160	546	1,051	834	1,605	724	1,395	39	76	91	176	91	176	134	259
56	Thickening Gravity Effluent (Solid)	0.05	34	12,130	4,905	22,500	9,096	19,550	7,903	39	16	1,440	582	1,440	582	134	54
60	RST Effluent (Liquid)	0.03	22	2,365	626	4,386	1,160	3,810	1,008	39	10	313	83	313	83	134	36
61	RST Effluent (Solid)	0.01	7	44,410	3,516	83,000	6,572	72,110	5,710	39	3	5,206	412	5,206	412	134	11
64	Digester Influent	0.02	12	30,410	4,252	56,760	7,936	49,320	6,896	39	6	3,573	500	3,573	500	134	19
66	Digester Effluent	0.02	12	8,207	1,148	25,690	3,592	18,250	2,551	2,266	317	3,573	500	3,573	500	8,082	1,130
70	Recylced Centrate	0.01	10	289	35	531	65	377	46	2,265	276	2,292	279	2,292	279	8,081	984
71	Solids to landfill	0.00	2	58,630	1,060	195,000	3,527	138,500	2,505	2,265	41	12,190	221	12,190	221	8,081	146
48	Plant Discharge	3.38	2,346	9	258	23	648	19	524	37	1,052	39	1,104	39	1,104	166	4,682

Mass Balance Notes

The flow and loadings above are **daily average** values.

For solids streams, the actual flows may be different if the unit performance does not meet the concentration limits. Bracket flows based on **mass loading** with accomodation for lower/higher concentrations. Instantaneous flow for solids streams is often intermittent and higher to match minimum pipe velocities and actual operating conditions. Adjust to match mass loading.

AS YIELD (lb TSS/lb BOD) = 0.75

Appendix B. Aeration Calculations

	Number Basins	No	2

Job No.			Calc No.

Computation

HDR

Project	Pinole Hercules WPCP Project	Computed	MR
System	Aeration Process	Date	2/1/13
Component	Diffuser Selection	Reviewed	
Task	Diffuser and Blower design	Date	

C:\Users\mramanat\Desktop\Pinole\updated air calc\[Air Calc_Future NDN.xls]DiffuserCalc

Basin Layout

						Each basin	Each basir	Each basir	Each basir	Each basir	Each basin							
			Design ADWF	Design ADWF	Design ADWF	Design ADWF	Design AA	Design AA	Design AA	Design AA	Design MM	Design MM	Design MM	Design MM	Design MD	Design MD	Design MD	Design MD
ix	Zone #		Basin 1	Basin 2	Basin 3	All	Basin 1	Basin 2	Basin 3	All	Basin 1	Basin 2	Basin 3	All	Basin 1	Basin 2	Basin 3	All
ix	Length	ft	152	152	152	457	152	152	152	457	152	152	152	457	152	152	152	457
ix	WIdth	ft	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
ix	Depth	ft	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
ix	Diff height above floor	ft	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Site Conditions

SITE CONDITIONS

Elevation	ft	100	weather.com
Chlorinity	-	0	
DO_sat - standard, depth	mg/L	10.60	
Theta	for temperat	1.024	
Air density (std)	lb/cf	0.075	
O2/Air (w/w)	%	23%	

Oxygen Required

	O2 Demand+Transfer	lb/d	4,339	3,480	2,444	10,263	2,395	1,921	1,349	5,665	3,769	3,023	2,123	8,916	4,731	3,795	2,665	11,191
	Peaking Factor	-	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35
ix	Peak hour O2 req'd/zone	lb/d	5,857	4,698	3,299	13,855	3,233	2,594	1,821	7,648	5,088	4,082	2,866	12,037	6,387	5,123	3,598	15,108
	OUR - avg	mg/L/hr	31	25	18	25	17	14	10	14	27	22	15	21	34	27	19	27
	OUR - peak	mg/L/hr	42	34	24	33	23	19	13	18	37	29	21	29	46	37	26	36
	DO	mg/L	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
ix	Temperature	C	20	20	20	20	20	20	20	20	12	12	12	12	12	12	12	12

AERATION DESIGN SPEC SUMMARY PER BASIN

Number diffusers	No	1,265	1,265	1,265	3,794	1,265	1,265	1,265	3,794	1,265	1,265	1,265	3,794	1,265	1,265	1,265	3,794
OTR	lb/h	181	145	102	428	100	80	77	257	157	126	88	371	197	158	111	466
SOTR	lb/h	573	409	215	1,198	317	226	164	706	490	350	184	1,024	616	439	231	1,286
Air flow	scfm	2,216	1,580	832	4,628	1,223	872	632	2,728	1,895	1,352	712	3,959	2,379	1,696	893	4,969
CHECK - Air/diffuser	scfm/dif	1.75	1.25	0.66	1.22	0.97	0.69	0.50	0.72	1.50	1.07	0.56	1.04	1.88	1.34	0.71	1.31
OTR	lb/d	4,339	3,480	2,444	10,263	2,395	1,921	1,857	6,173	3,769	3,023	2,123	8,916	4,731	3,795	2,665	11,191
SOTR	lb/d	13,762	9,813	5,168	28,743	7,597	5,417	3,927	16,941	11,771	8,393	4,420	24,584	14,775	10,535	5,548	30,858

All BASINS

Number Basins	No	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
Number diffusers	No	1,265	1,265	1,265	3,794	2,529	2,529	2,529	7,588	2,529	2,529	2,529	7,588	2,529	2,529	2,529	7,588
OTR	lb/h	181	145	102	428	200	160	155	514	314	252	177	743	394	316	222	933
SOTR	lb/h	573	409	215	1,198	633	451	327	1,412	981	699	368	2,049	1,231	878	462	2,572
Air flow	scfm	2,216	1,580	832	4,628	2,447	1,745	1,265	5,456	3,791	2,703	1,424	7,918	4,758	3,393	1,787	9,938