Technical Memorandum

SMCSD Headworks, Primary and Secondary Treatment Pre-Design

Subject: **TM 1: Design Criteria**

Prepared For: SMCSD

Prepared by: Mark Takemoto, Dennis Gellerman

Reviewed by: Steve Clary

Date: October 12, 2011

Reference: 0055-003

The purpose of this technical memorandum (TM) is to present the design flows for the new headworks, primary and secondary treatment facilities and to summarize the overall flow schematic and design criteria for the Sausalito-Marin City Sanitary District (SMCSD) Wastewater Treatment Plant (WWTP). This TM is intended to be included as an appendix to the Recommended Project Summary, which includes a summary of major recommendations. All drawings referenced in this TM are bound together as a separate attachment. The TM is organized in the following sections:

1 Summary of Findings

SMCSD is evaluating process improvements to its WWTP including the addition of a headworks, a new primary clarifier and secondary upgrades including tertiary polishing. Recommended design flows and design criteria were developed for the treatment plant upgrades. Individual process upgrades are discussed in detail in their respective TMs; the design criteria for each progress upgrades have been compiled in this TM.

Historically, influent flows to the SMCSD treatment exceed 6.0 MGD infrequently and for short durations (on average 7 times per year with a total duration of 29.9 hours). The new treatment facilities at SMCSD should be designed to process flow up to 6.0 MGD while providing hydraulic capacity to handle peak wet weather events. Therefore, it is recommended that:

- Flows up to 6.0 MGD be routed through new screening facilities with flows above 6 MGD routed through a manual bar screen
- All flows, including those above 6 MGD, be routed through new grit removal facilities
- Flows up to 6.0 MGD be split equally between the new primary clarifier and the existing primary clarifier
- Hydraulic capacity of the new headworks and primary treatment facilities be 13 MGD to avoid flooding or overflows at the treatment plant up to the 10 year wet weather flow event
- Flows to the secondary be limited to 9.0 MGD with the addition of 0.6 MG of equalization
- Secondary treatment capacity be increased to 9.0 MGD to minimize blending

- Tertiary treatment be upgraded to 6.0 MGD to provide additional polishing treatment capacity during wet weather.

Based on recent conveyance system modeling by RMC, the peak wet weather flow from a 5-year event is 12.3 MGD. The peak 12.3 MGD flow will be handled without the need for blending by increasing the secondary treatment capacity to 9.0 MGD and with the addition of on-site equalization storage. Influent flows greater than the 12.3 MGD 5-year event will require blending.

2 Design Flow and Loadings

The existing WWTP includes the following treatment units: primary clarifiers, fixed film reactors (FFR), secondary clarifiers, effluent screens, side-stream granular media filters (up to 1 MGD), chlorine contact basins, and an outfall which discharges to San Francisco Bay. The treatment plant was designed to provide treatment for 1.8 MGD of average dry weather flow, 6.0 MGD of peak day flow and 10 MGD peak instantaneous hydraulic flow.

2.1 Current and Potential Flows

Design flows for the treatment plant were developed based on the Wet Weather Treatment and Conveyance System Evaluation (RMC, February 2008) and review of 15-minute flow data from 2002 through 2006. A more detailed discussion of how the influent flow values were developed can be found in the Wet Weather Treatment and Conveyance System Evaluation Report (Wet Weather Report).

Subsequent to the Wet Weather Report, additional conveyance system modeling was performed to develop information for the 5-year peak wet weather event as part of the "Sewage Spill Reduction Action Plan, Vol. III". The 5-year peak wet weather event was developed to identify conveyance system improvements. The 5-year peak wet weather event correlates to the actual inflow experienced at the SMCSD treatment plant on December 31, 2005. Current typical influent flow rates based on historical data are presented in Table 1, along with the estimated peak flows from the 5-year and the 10-year events. There are no plans for infill or future growth in the SMCSD service area. Therefore, influent flow to the treatment plant is not expected to increase. The minimum influent flow to the plant is approximately 0.25 MGD which typically occurs during the late evening or early morning on dry weather days.

Table 1: Influent Flow Rates

Condition	Influent Flow (MGD)
Minimum Diurnal Flow	0.25
Average Day Dry Weather Flow (ADWF)	1.5
Peak Day Dry Weather Flow (PDWF)	3.2
Average Day Wet Weather Flow (AWWF)	1.8
Peak Day Wet Weather Flow (PWWF)	6.2
5-Year Event Instantaneous Peak Wet Weather Flow	12.3
10-Year Event Instantaneous Peak Wet Weather Flow	13.0

2.2 Design Loadings

The design of the new headworks and primary treatment will be based on hydraulic capacity. Therefore, influent loading from BOD, TSS, and other constituents will not have a significant impact on equipment selection or sizing. For the secondary process upgrades, the primary objective is to provide additional hydraulic capacity to handle peak wet weather flows while meeting NPDES permit effluent limits. The majority of wet weather flow can be attributed to inflow and infiltration which would not provide a substantial increase in influent BOD and TSS mass loadings. Therefore, a constant mass loading was assumed during wet weather. Influent loadings to the treatment plant used for the preliminary design are presented in Table 2.

Table 2: Typical Influent Loadings

Constituent	Average Concentration[1] (mg/L)	Wet Weather Mass Loadings[2] (lbs/day)
$cBOD_5$	219	6,000
TSS	327	6,500

[1]Values taken from the "Operational Audit Preliminary Design Report" by CH2MHILL, March 2006.
[2]For weather flow, a constant mass loading was assumed based on a review of recent loadings during wet weather events.

2.3 Current Process Capacity

An evaluation of the SMCSD treatment plant process capacity during peak wet weather events was completed using an approach similar to the average dry weather flow analysis completed by CH2M Hill (*Operational Audit Preliminary Design Report*, March 2006). The initial evaluation included comparing current process operating parameters during wet weather against the original plant design criteria and typical design criteria. The process criteria comparison is presented in Table 3.

Table 3: Current Design Process Loading

Process	Units	Average Day	Peak Day Wet Weather	5-Year Event Instantaneous Peak	Typical Peak Flow Design Value [a]
Flow					
Influent Flow	MGD	1.5	6.0	12.3	---
Primary Clarifiers					
Units	--	1	1	1	--
Side Water Depth	ft	9.5	9.5	9.5	14
Surface Area	ft^2	2,376	2,376	2,376	--
Surface Overflow Rate	gal/day- ft^2	631	2,525	5,177	2,000-3,000
Fixed Film Reactors (FFR) [b]					
Surface Area All Units	ft^2	2,514	2,514	2,514	---
Organic Loading Rate	lbs BOD/day-1000 ft^3	23.9	52.2	52.2	37-200
Hydraulic Loading Rate	gal/min-ft^2	1.66	1.66	2.49	1.0 - 2.0
Secondary Clarifiers					
Total Surface Area	ft^2	3,520	3,520	3,520	---
Surface Overflow Rate	gal/day-ft^2	426	1,705	2,557	1,000-1,200
Solids Loading Rate [c]	lbs TSS/day-ft^2	0.70	1.24	1.11	2
Granular Media Filters [d]					
Total Surface Area	ft^2	256	256	256	---
Surface Loading Rate	gal/min-ft^2	2.7	2.7	2.7	2-8

Notes:
[a]Typical design criteria taken from Metcalf and Eddy, Inc, *Wastewater Engineering Treatment, Disposal and Reuse*, 3rd edition.
[b]The current maximum flow through the Fixed Film Reactors (FFRs) is 6.8 MGD. Flow greater than 6.8 MGD would be routed around the FFRs, treated with a wet weather treatment step and recombined with the secondary clarifier effluent prior disinfection.
[c]Estimated based on assumed solids removal through the primary clarifier and solids produced from the FFRs.
[d]The granular media filters were added as a side stream treatment process after the secondary treatment plant was constructed. Maximum flow through the granular media filters is 1.0 MGD

2.4 Wet Weather Blending

During peak wet weather events, the influent flow to the treatment plant can exceed the process capacity of the fixed film reactors. Although the fixed firm reactors were designed for a 6.0 MGD peak flow, currently the maximum flow to the FFRs is 6.8 MGD which is the maximum capacity of the FFR feed pump station. Above 6.8 MGD, primary effluent is passively routed around the FFRs and directed to the secondary clarifiers. The operational strategy of mixing primary effluent and secondary effluent is commonly referred to as "blending" and is currently allowed under SMCSD's NPDES permit. However, when the WWTP is blending, additional sampling, data collection and record keeping is required. In addition, the Regional Water Quality Control Board (RWQCB) has required SMCSD to look at alternatives to blending including adding equalization, increasing secondary treatment capacity, and/or

adding treatment specifically for blended flows. A summary of recent flow events above 6.8 MGD is presented in Table 4.

Table 4: Flow Events Above 6.8 MGD - Annual Totals

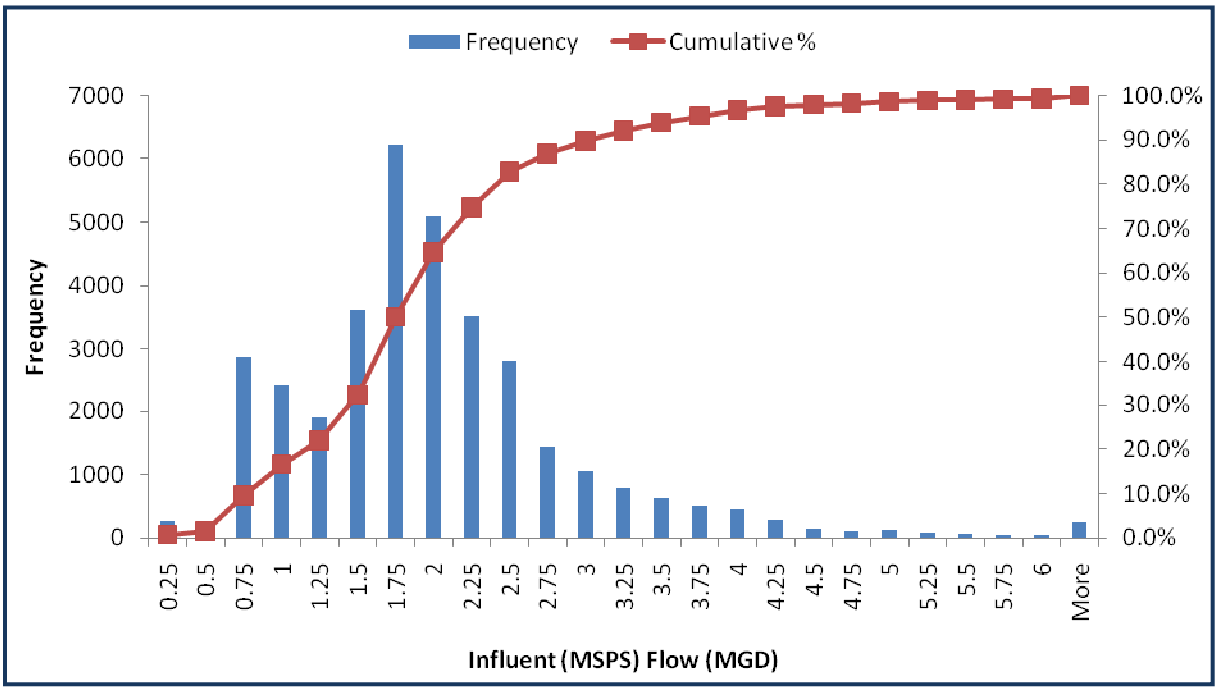
Wet Weather Year	Frequency (# of Events/ Year)[a]	Cumulative Duration (Hours/Year)	Cumulative Volume (MG/Year)
2002-03	6	4.3	0.1
2003-04	5	16.8	0.8
2004-05	2	12.3	0.7
2005-06	8	43.5	2.7
2006-07[b]	1	4.3	0.1
Average (not including 2006-2007)	**5.3**	**19.2**	**1.1**

Notes:
[a] Unique events above 6.8 MGD were defined based on one hour intervals (i.e. influent flows below 6.0 MGD for 1 hour followed by flow above 6.8 MGD was counted as a new above 6.8 MGD event)
[b] 2006-07 wet weather season includes influent flow data through January 24, 2007

Flow events over 6.8 MGD occur on average 5.3 times per year. Flows above 6.8 MGD typically last for a short duration (average 3.6 hours per event) and result in a relatively small volume in excess of 6.8 MGD (average 0.21 MG per event). Based on the average frequency of events above 6.8 MGD and the volume of these events, 99.8 percent of the annual flow into the SMCSD treatment plant occurs at influent flow rates less than 6.8 MGD.

A more detailed picture of the overall influent flow range, a histogram of 15-minute influent flow date from July 2005 through June 2006 is presented as Figure 1.

Figure 1: Influent (MSPS) Flow Histogram (Based on 15-minute flow data from 7/2005 - 6/2006)



As shown in Figure 1, approximately 90% of the flow from July 2005 through June 2006 occurs at a flow rate of 3.0 MGD or less and 99.3% of the flow occurs at a flow rate of 6.0 MGD or less. The minimum influent flow to the plant is approximately 0.25 MGD which typically occurs during the late evening or early morning during dry weather.

3 Design Criteria

The following design criteria are recommended to improve plant operation, reliability, performance and to reduce wet weather blending events.

3.1 Design Flows

Based on the estimated influent flows to the SMCSD WWTP, it is recommended that the new headworks and primary treatment facilities be designed to treat 6.0 MGD with hydraulic accommodation for peak wet weather flows up to 13.0 MGD.

Design of the new processes was based on the projected flow data presented in Table 1. The design flows for the treatment plant improvements are summarized below:

- The mechanical screens at the headworks are designed to handle the future maximum day flow of 6.0 MGD. The addition of a manual bar screen allows screening of the current maximum instantaneous peak flow of 13 MGD.
- The grit process is sized to handle the future maximum day flow of 6.0 MGD. Depending on the actual sizing and configuration of the grit basin(s), the grit process should be designed to hydraulically handle up to the peak instantaneous flow of 13 MGD.
- The new primary treatment process is designed to match the existing primary clarifier and is nominally designed for a peak flow of 6.0 MGD. Using the new primary clarifier in conjunction with the existing primary clarifier will allow primary treatment of the current maximum instantaneous peak flow of 13 MGD. However, with the addition of equalization, the peak flow to the primary treatment process will be 9.0 MGD.
- The new on-site equalization is sized to provide 0.6 MG of storage and limit flow to the secondary process to 9.0 MGD.
- The FFR pump station is sized to pump 9.0 MGD to the fixed film reactors.
- The FFR reactor media is being replaced to address aging infrastructure and to accommodate the additional hydraulic loading of up to 9.0 MGD.
- Replace the existing sand filters with 6.0 MGD of rotating disk filtration capacity to address aging infrastructure and increase treatment capacity during wet weather.

3.2 New Process Design Loadings

The revised process loadings based on the recommend process improvements are presented in Table 5.

Table 5: New Design Process Loading

Process	Units	Average Day	Future Max. Secondary Capacity	5-Year Event Instantaneous Peak	Typical Peak Flow Design Value [a]
Flow					
Influent Flow	MGD	1.5	9.0	12.3	---
Primary Clarifiers					
Units	--	1	2	1	--
Side Water Depth	ft	9.5	9.5	9.5	14
Surface Area	ft^2	2,376	4,752	4,752	--
Surface Overflow Rate	gal/day- ft^2	631	1,894	2,588	2,000-3,000
Fixed Film Reactors (FFR) [b]					
Surface Area All Units	ft^2	2,514	2,514	2,514	---
Organic Loading Rate	lbs BOD/day-1000 ft^3	23.9	52.2	52.2	37-200
Hydraulic Loading Rate	gal/min-ft^2	1.66	2.49	2.49	1.0 - 2.0
Secondary Clarifiers					
Total Surface Area	ft^2	3,520	3,520	3,520	---
Surface Overflow Rate	gal/day-ft^2	426	1,705	2,557	1,000-1,200
Solids Loading Rate [c]	lbs TSS/day-ft^2	0.70	1.24	1.11	2
Rotating Disk Filters					
Total Surface Area	ft^2	1280	1280	1280	---
Surface Loading Rate	gal/min-ft^2	0.82	3.25	3.25	2-6

Notes:
[a]Typical design criteria taken from Metcalf and Eddy, Inc, *Wastewater Engineering Treatment, Disposal and Reuse*, 3rd edition.
[b]The maximum flow through the Fixed Film Reactors (FFRs) is 9.0 MGD. In the future, flow greater than 9.0 MGD would be routed around the FFRs, treated with a wet weather treatment step, and recombined with the secondary clarifier effluent prior disinfection.
[c]Estimated based on assumed solids removal through the primary clarifier and solids produced from the FFRs.

3.3 Process Flow Schematic and Hydraulic Profile

The overall process flow schematic is attached as Drawing G-4. The updated treatment plant hydraulic profile is attached Drawing G-5.

3.4 Process Design Criteria

The basis for the process design criteria presented in this section is available in the individual process TMs. A summary of the recommended design criteria for the process equipment for the new headworks/primary treatment facility is presented in Table 6.

Table 6: Process Design Criteria Summary

Criteria	Value	Unit
Headworks		
Mechanical Screens		
Type	Sieve auger screen	-
Number	2	-
Openings	1/4	inch
Capacity	3 to 4	MGD
Manual Screen		
Type	Bar	-
Number	1	-
Screen Opening Width	1	inch
Capacity	10	MGD
Screenings Washer Compactor		
Number	1	-
Compactor Motor Size	3	HP
Grinder Motor Size	10	HP
Grit Chamber		
Type	Vortex	-
Number	2	-
Diameter	7 to 8	ft
Capacity	4(process), 7 (hydraulic)	MGD
Grit Pumps		
Type	Air Lift	-
Number	2	-
Capacity	200	gpm
Grit Handling		
Type	Huber Coanda (or Equivalent)	-
Number	2	-
Influent Metering		
Type	Mag Meters	-
Number	3	-
Diameter	12	inch
Equalization		
EQ Storage Tank		
Compartments	2	-
Volume (Total)	0.6 (min)	MG
EQ Return Pumps		
Type	Centrifugal	-
Number	2	-
Capacity (Each)	695	gpm
TDH	45	feet
Motor Size	15	HP

Criteria	Value	Unit
Primary Treatment		
Primary Clarifier		
Number	2 (1 new/1 existing)	-
Type	Circular	-
Maximum Design Flow (each)	6 to 7	MGD
Diameter	55	feet
Side Water Depth	9.5	feet
Surface Area (Each Tank)	2,376	ft^2
Overflow Rate at Average Dry Weather Flow (1.5 MGD)	631	gpd/ft^2
Overflow Rate at 5-Year Peak Wet Weather Flow (12.3 MGD with 2 Units in Service)	2,588	gpd/ft^2
Primary Sludge/Scum Pumps		
Type	Progressive Cavity	-
Number	2	-
Capacity	100	gpm
TDH	20	feet
Motor Size	5	HP
Secondary Treatment		
FFR Feed Pumps		
Type	Centrifugal	-
Number	3	-
Capacity (Each)	3,125	gpm
TDH	62	feet
Motor Size	75	HP
Fixed Film Reactor		
Media Type	Cross Flow	-
Media Surface Area/Volume	32	ft^2/ft^3
Reactor Surface Area (Total)	2,514	ft^2
Media Depth	32	ft
Volume (Total)	81,060	ft^3
Tertiary Treatment		
Filter Feed Pumps		
Type	Centrifugal	-
Number	3	-
Capacity (Each)	2,085	gpm
TDH	20	feet
Motor Size	20	HP

Criteria	Value	Unit
Tertiary Filtration		
Type	Rotating Disk	-
Units	2	-
Disks Per Unit	12-18	-
Filter Area Per Disk	54-60	ft^2
Total Submerged Filter Area	1,280	ft^2
Design Loading Rate	3.25	gpm/ft^2
Maximum Loading Rate	6.0	gpm/ft^2
Maximum Backwash (% of average flow)	5	%
Filter Backwash Pumps		
Type	Centrifugal	-
Number	2	-
Capacity (Each)	150	gpm
TDH	20	feet
Motor Size	5	HP

Drawings

Drawing G-4

Drawing G-5