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July 30, 2014

VIA EMAIL AND U.S. MAIL
Derek Whitworth
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Robyn Stuber
United States Environmental Protection Agency
Region IX, Pacific Southwest Office
75 Hawthorne Street
San Francisco, CA, 94105

RE: Oceanside Efficacy Report

Dear Mr. Whitworth and Ms. Stuber,

Enclosed please find the San Francisco Public Utilities Commission's *Characterization of Westside Wet Weather Discharges and the Efficacy of Combined Sewer Discharge Controls*, submitted as required by the Oceanside Water Pollution Control Plant and Westside Wet Weather Facilities National Pollutant Discharge Elimination System Permit No. CA0037681, RWQCB Order R2-2009-0062. This Report summarizes the results of the SFPUC's monitoring efforts to evaluate the level of wet weather controls being provided by the Westside Wet Weather Facilities, and its effects on water quality. Please contact Laura Pagano at (415) 554-3109 if you have any questions about the content of this Report.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who *manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*

Sincerely,

for TM

Tommy T. Moala
Assistant General Manager
SFPUC Wastewater Enterprise

San Francisco
Water Power Sewer
Services of the San Francisco Public Utilities Commission

Characterization of Westside Wet Weather Discharges and the Efficacy of Combined Sewer Discharge Controls

San Francisco Public Utilities Commission
Oceanside Water Pollution Control Plant & Westside Wet Weather Facilities
RWQCB Order R2-2009-0062, NPDES No. CA0037681

July 30, 2014

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1.0 INTRODUCTION

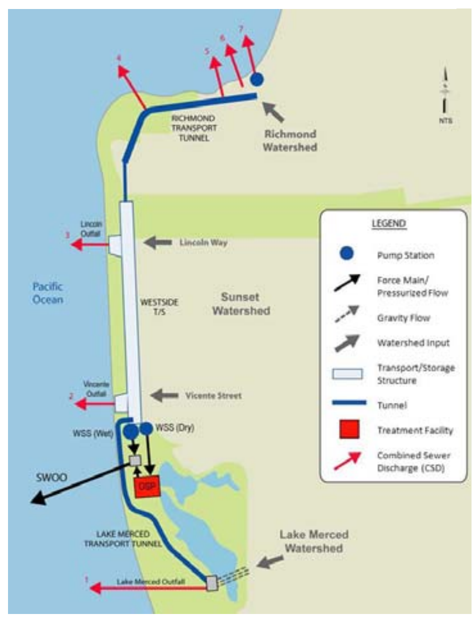
This Report is being submitted to comply with the requirements of the Oceanside Water Pollution Control Plant and Westside Wet Weather Facilities National Pollutant Discharge Elimination System (NPDES) permit, Permit No. CA0037681, Order No. R2-2000-0062 (Oceanside Permit), issued to the City and County of San Francisco (San Francisco) by the San Francisco Regional Water Quality Control Board (Regional Water Board) and the United States Environmental Protection Agency (USEPA) in August 2009.

Consistent with the federal Combined Sewer Overflow (CSO) Control Policy,[1] the Oceanside Permit requires monitoring to comply with the Nine Minimum Controls and to evaluate post-CSO control construction compliance.[2] The objectives of these monitoring requirements are to evaluate the effectiveness of construction and other wet weather controls in meeting established performance goals and to assess the impacts of wet weather discharges on receiving waters.[3] As described in this Report, San Francisco implements multiple monitoring programs designed to assess whether its Oceanside Wet Weather Facilities are performing as designed, and impacts, if any, to receiving waters. The results of these monitoring efforts confirm that the performance of the Westside Wet Weather Facilities is exceeding the original wet weather control design goals and that the level of control being provided is protecting beneficial uses.

1.1 Westside Facilities Description

San Francisco's Westside Facilities consist of the Oceanside Water Pollution Control Plant (OSP), the Westside Pump Station, and three large transport/storage (T/S) structures: the two-chambered Westside T/S Structure, the Richmond Transport Tunnel, and the Lake Merced Transport Tunnel. These facilities collect and treat stormwater and wastewater generated within San Francisco's Westside Drainage Basin, which comprises about forty percent of San Francisco's land area and includes a primarily residential service area population of around 250,000.

Figure 1-1 Westside Facilities



During dry weather OSP provides secondary treatment to an average of 14 to 15 million gallons per day (MGD) and discharges the treated effluent through the deep-water Southwest Ocean Outfall (SWOO) which extends approximately 3.8 miles (3.3 nautical miles) offshore. During wet weather, OSP can treat up to 65 MGD, with 43 MGD receiving secondary treatment and another 22 MGD receiving primary treatment. In addition to the wet weather treatment capacity at OSP, the Westside Facilities include approximately 72 million gallons (MG) of wet weather storage. As discussed further in Section 2 of this Report, this combination of storage and treatment capacity means that the majority of annual combined flows receive secondary treatment at OSP prior to deep-water discharge through the SWOO.

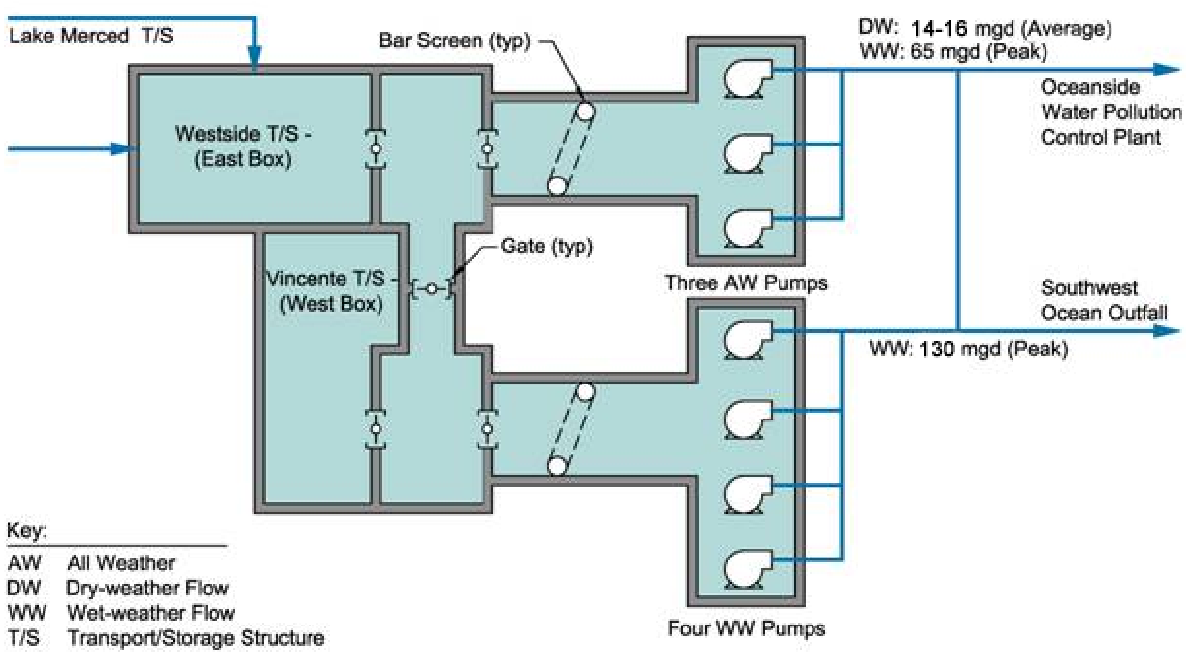
[1] *Combined Sewer Overflow Policy*, 59 Fed. Reg. 18688 (April 14, 1994).
[2] Oceanside Permit at p. 26.
[3] *See* USEPA *CSO Post Construction Compliance Monitoring Guidance*, EPA-833-K-11-001 (April 2011).

Almost all wet weather flows receive treatment either at OSP or in a T/S structure prior to deepwater discharge. In contrast, municipalities with separate storm sewer systems typically provide no treatment to stormwater flows.

Figure 1-2 shows a simplified schematic of the Westside's dry and wet weather flows and treatment capacity. The Westside T/S structure and the Westside Pump Station are the key components of the Wet Weather Facilities. When wet weather flows are less than 65 MGD, all flows are pumped to OSP for treatment and discharged through SWOO. When flows are greater than 65 MGD, the Westside T/S structure's "East Box" fills up and flows are "decanted" over a baffled weir into the "West Box." After passing through a bar screen, these flows are pumped by the Westside Pump Station wet weather pumps to SWOO. Decant pumping flow rates depend on the amount of decanted effluent in the West Box and on the tide level, but cannot exceed 130 MGD. In the event that the capacities of OSP, the T/S structures and the Westside Pump Station are exceeded, the combined flows in the T/S structures flow out combined sewer discharge (CSD) outfalls to the Pacific Ocean.

The decant flow and the CSDs from the T/S structures receive the equivalent of wet weather primary treatment by the T/S structures. The large volume of the T/S structures and the weir configurations allow for solids to settle prior to discharge, and the baffles hold back trash and other floatable materials, consistent with the minimum treatment requirements specified in the CSO Control Policy. Additionally, decant flow passes through bar screens prior to reaching the Westside Pump Station

Figure 1-2 Westside Wet Weather Flow Schematic



1.2 Westside Wet Weather Facilities Design and Construction

The Westside Wet Weather Facilities are the result of a lengthy planning and regulatory process that began in the 1970s and ended with the construction of the Richmond T/S structure in 1997, just three years after the adoption of the CSO Control Policy. The control plan for the Westside was based on a series of comprehensive studies that evaluated the benefits and costs of different levels of overflow control. The studies included surveys of use (including recreational and shellfishing) and evaluations of the potential impacts on public health and biological resources. They were submitted to the Regional Water Board which then issued an order finding that a long-term annual average CSD frequency of eight (8) on the Westside would protect beneficial uses and serve the public interest.[4] These studies also provided the basis for the State Water Board to approve an exception for CSDs to certain California Ocean Plan requirements, including those related to compliance with numeric water quality standards and prohibitions on the discharge of untreated waste.[5]

1.3 Westside Wet Weather Monitoring Program

San Francisco's Westside wet weather monitoring program is designed to generate information to evaluate whether the Westside Wet Weather Facilities are controlling wet weather flows consistent with the Facilities' design, and confirm that the current level of wet weather control continues to protect beneficial uses. The monitoring program consists of the following elements:

- Monitoring and hydraulic modeling of wet weather discharge frequency, duration and volume;
- Flow and total suspended solids (TSS) monitoring to estimate the annual mass of pollutants removed from combined flows and stormwater prior to discharge;
- Sampling and analysis of recreational receiving waters for bacteria on a weekly basis year-round and after CSDs;
- Collection of recreational use data;
- Sampling and analysis of CSD and decant for conventional and toxic pollutants; and
- Southwest Ocean Outfall monitoring of the effects of the discharge on marine waters.

This Report provides a synopsis of the results of this monitoring program; detailed results for several of these efforts have been submitted in previous reports, including the SFPUC's monthly and annual reports, the *Monitoring Study to Effectively Characterize Overflow Impacts and the Efficacy of CSO Controls Annual Status Reports*, and the *1997-2012 Southwest Ocean Outfall Regional Monitoring Program Summary Reports.*

The key results of this monitoring include:

- **Monitored CSD Frequency.** Since 1997, when the Westside Wet Weather Facilities were completed, the average annual number of storm events that resulted in one or more CSDs was seven, and no individual CSD outfall has an average annual discharge frequency of more than five. Both annual averages are below the system's design criteria, which is that no more than eight storm events will trigger CSDs on a long-term average annual basis.
- **Modeled CSD Frequency.** Hydraulic modeling of a typical year's rainfall patterns indicates that the average annual number of storm events that result in a CSD from one or more locations is seven, which is generally consistent with the historical data.
- **Level of Treatment for Combined Flows.** In the last three years of this permit (2011-2012, 2012-2013, and 2013-2014), the system collected for treatment an average of almost 1.5 billion gallons of stormwater and more 5.5 billion gallons of sanitary flows. Six billion gallons,

[4] RWQCB Order No. 79-12.
[5] SWRCB WQ Order 79-16.

86 percent, of combined flows received secondary treatment and only 100 million gallons, one percent, was discharged as CSDs.

- **Total Suspended Solids Removed from Stormwater.** The treatment of stormwater flows over the past three years of this permit resulted in an average annual 73 percent reduction in total suspended solids loading from stormwater; which represents an estimated 1.2 million pounds of TSS that would have been discharged in a separate system.
- **Recreational Use and Impacts.** The impact of CSDs on recreational use is minor; beaches on the Westside are posted as a result of a CSD less than an average of three percent of days during the year. Sampling of beach water quality during or as soon as practicable during daylight hours a CSD occurs indicates that bacteria concentrations typically drop to ambient levels within 24 hours of a CSD.

  Recreational use data collected by the SFPUC indicates that very few people use beaches for water contact recreation during or immediately following a CSD, so that the potential for recreational users to be exposed to elevated bacteria concentrations is small.
- **CSD Monitoring.** Direct sampling of CSDs for metals and conventional pollutants suggests that CSD pollutant concentrations are highly variable, but are typically relatively low. Concentrations of copper and zinc in CSDs were frequently elevated, but were in the range of concentrations expected in urban stormwater runoff.
- **Receiving Water Monitoring.** A voluntary near-shore receiving water sampling effort at Ocean Beach during CSDs found that concentrations of fecal indicator bacteria at and near the outfalls were elevated, but that concentrations of other pollutants were low.
- **Ocean Outfall Monitoring.** Sampling of sediment quality, benthic communities, and bioaccumulation in organisms over sixteen years has found no discernible impacts of the Southwest Ocean Outfall discharge on marine beneficial uses.

2.0 EFFECTIVENESS OF WET WEATHER CONTROLS

The federal CSO Control Policy describes two types of wet weather controls: (1) the Nine Minimum Controls (NMCs), and (2) Long Term Control Plans (LTCPs). NMCs are management measures to reduce the impacts of combined sewer overflows that do not require significant engineering studies or construction, and that can be implemented in a relatively short period of time.[6] LTCPs consist of an agency's long-range capital plans and projects to provide cost-effective controls that will protect water quality standards.

This section describes the measures that the SFPUC implements consistent with the NMCs to reduce, through non-capital efforts, the occurrence and effect of CSDs. It also describes the performance of the system in terms of controlling CSDs since San Francisco completed construction of its LTCP in 1997. Finally, this section includes a summary of the level of treatment provided to combined sewer flows in a typical year to demonstrate the large volumes of flow receiving treatment, and the results of a pollutant mass balance exercise conducted for three of the five permit years to illustrate the environmental benefit provided by treating hundreds of millions of gallons of stormwater annually.

2.1 Nine Minimum Control Implementation

The CSO Control Policy's NMCs described nine objectives that can be achieved through the selection of management actions based on system-specific considerations. This section briefly lists the programs that the SFPUC undertakes to further the objectives of the NMCs.

<u>CONTROL MEASURE 1: Conduct Proper Operations and Regular Maintenance Programs</u>

The purpose of this control measure is to ensure that an agency has in place operations and maintenance (O&M) programs that will reduce wet weather discharges by ensuring collection system performance. The SFPUC has a mature collection system asset management plan that utilizes closed circuit television (CCTV) inspections and the Maximo Computerized Maintenance Management System to store condition assessment information and prioritize work orders. In addition to collection system maintenance, the SFPUC is undertaking an extensive condition assessment of all pump stations, CSD outfalls, T/S structures and other conveyances greater than 36 inches in diameter. The purpose of this condition assessment is to identify schedules and costs for rehabilitation and replacement of these capital assets.

<u>CONTROL MEASURE 2: Maximize Use of the Collection System for Storage</u>

Maximizing the collection system for storage by keeping sewers clean and free of debris ensures that the agency is maximizing wet weather storage, thereby increasing wet weather treatment and minimizing combined sewer discharges. The SFPUC performs routine sewer cleaning at a rate of approximately 110-150 miles of pipe per year. Recognizing that fats, oils and grease (FOG) can significantly reduce the capacity of pipes, the SFPUC has also implemented an aggressive permitting and incentive program to reduce FOG entering the system, and a program to convert the waste into biofuel that is housed at OSP.[7]

[6] See USEPA *Guidance for Nine Minimum Controls*, EPA-832-B-95-003 (May 1993).
[7] See San Francisco's 2013 Pollution Prevent Program Annual Report, submitted on February 28, 2014.

CONTROL MEASURE 3: Review and Modify Pretreatment Program

The Westside only has three entities subject to pretreatment program requirements, all of which are medical facilities that are subject to local limits. The details of inspections of these facilities have been submitted in the SFPUC's 2013 Pretreatment Annual Report.

CONTROL MEASURE 4: Maximize Flow to the Treatment Plants

The SFPUC has developed wet weather operations plans and operator training to ensure that the Westside Wet Weather Facilities are operated in a way that maximizes the treatment capacity of OSP. Operations staff also routinely undertake studies designed to understand and improve operation of the facilities during wet weather.

CONTROL MEASURE 5: Prohibit Combined Sewer Overflows During Dry Weather

San Francisco has never experienced a dry weather wastewater discharge from its CSD outfalls. This is largely due to the unique moat-like configuration of the system, which, for example, would require that the Westside T/S structure be filled with wastewater before any discharge could occur.

CONTROL MEASURE 6: Control Solid & Floatables in Discharges

Most solids and floatables control in CSDs occurs because the extremely large storage capacity of the system allows for solids to settle out before they are discharged, and because the discharge occurs after the combined flows have passed over a weir and baffle structure. This is especially true on the Westside where the Westside T/S structure includes two settling boxes so that flows pass over two weirs prior to discharge. San Francisco also has an extensive street sweeping program, which is an effective way to reduce the amount of sediment, fine particulates and sediment-associated pollutants (such as dioxin from air deposition or copper from brake pads). In 2013, for example, city agencies conducted mechanical and manual street sweeping on approximately 143,800 curb miles. High use commercial areas are swept daily, lower-use commercial areas are swept two to three times a week, and most residential areas are swept weekly. Additionally, the SFPUC routinely cleans catch basins to help remove sediment and associated pollutants from the system. Out of an estimated 28,000 catch basins in San Francisco, 6,393 of them were cleaned and flushed in 2013 alone.[8]

CONTROL MEASURE 7: Implement a Pollution Prevention Program to Reduce the Impact of CSDs

The details of San Francisco's extensive pollutant prevention program were submitted to the Regional Water Board in the 2013 Pollution Prevention Program Annual Report.

CONTROL MEASURE 8: Notify the Public of Overflows

Despite the relatively infrequent nature of CSDs on the Westside, the SFPUC has an extensive public notification program. This program includes permanent signs posted that inform the public of the

[8] See San Francisco's 2013 Pollution Prevent Program Annual Report.

potential for CSDs. All recreational beaches are posted with additional notifications when a CSD has occurred and they remain posted until monitoring confirms that State standards for water contact recreation are being met. The public is also informed of CSDs (and any exceedance of water quality standards) through the SFPUC's Beach Water Quality website, an email distribution list and a telephone hotline. A mobile phone web-based application is currently being beta tested and is expected to be completed before the end of 2014.

CONTROL MEASURE 9: Monitoring to Characterize Impacts and the Efficacy of Controls

EPA Guidance describes the ninth minimum control as an "initial characterization of the [combined sewer system] to collect and document information on overflow occurrences and known water quality problems and incidents." Information to be collected includes maps and a general characterization of the system, documentation of overflow occurrences and summaries of information available on the quality or use of waters potentially affected by wet weather discharges. The SFPUC has extensively characterized its system, including the locations, size and conditions of collection system assets, storage structures, and outfalls and has even developed a detailed hydraulic/hydrologic model to simulate dry and wet weather flows. CSD occurrences are detected by the SFPUC's Distributed Control System, which includes sensors throughout the system that measure and transmit to operations real time information on the level of flows and the status of pump stations and other assets. Detailed information on the CSD frequency and water quality is included in the rest of this Report.

2.2 CSD Frequency, Duration and Volume

The performance target of San Francisco's LTCP was to reduce the frequency of near-shore wet weather discharges so that no more than eight storm events would trigger CSDs on a long-term annual average basis. As noted in the Regional Water Board order establishing this target, the design criteria of eight is not to be used for determining compliance or non-compliance because of the inherently variable nature of rainfall events and climate patterns. The design criteria is, however, helpful in understanding whether the Wet Weather Facilities are performing as designed, and thus providing the amount of wet weather control and water quality protection predicted. The SFPUC uses two approaches for assessing the performance of the Westside Wet Weather Facilities against the design criteria: direct monitoring of CSDs and hydraulic/hydrologic modeling of the Westside system. Both monitoring and hydraulic/hydrologic modeling of CSD frequency indicates that the Westside Wet Weather Facilities are controlling CSDs as, or even better than, predicted at the time of design and construction.

Direct monitoring involves measuring rainfall, the velocity of treatment plant flows, and flow levels in pump sumps and the T/S structures. These data are recorded in one minute increments and are then used to calculate the frequency and volume of CSDs and decant flow discharged, both of which are reported to the Water Board in monthly and annual reports. Table 2-1 shows the measured CSD frequency for each outfall on the Westside since CSD construction of controls was completed in 1997. The average annual discharge frequencies by outfall and for the system as a whole are lower than the design criteria of eight. System-wide, the long-term annual average number of storm events that result in one or more CSDs is seven. No individual outfall, however, has an annual average discharge frequency greater than five because not all storm events trigger CSDs at all locations.

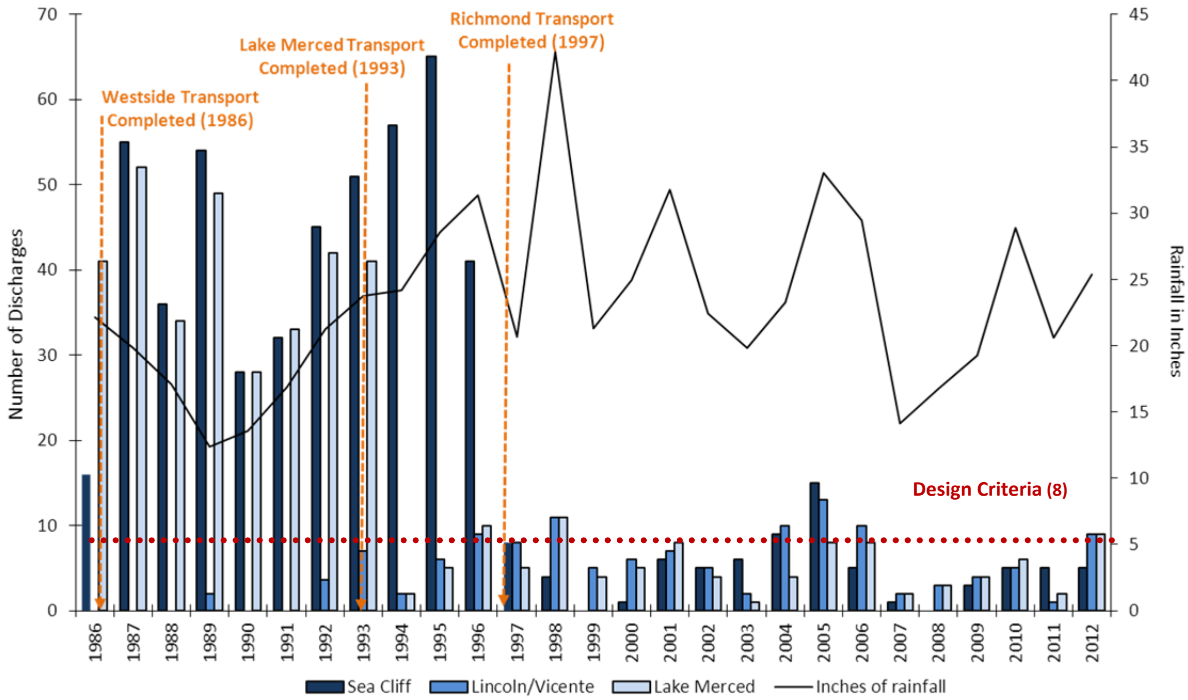
Similar results are presented graphically in Figure 2-1, which further highlights the dramatic decrease in CSD frequency, from an average of 114 times each year, to less than eight. It also shows the relationship between the different T/S structures and CSD frequency at particular outfalls. Since construction of the Westside T/S structure in 1986, the average annual frequency of discharges from the Lincoln and Vicente CSD outfalls has decreased to five. Similarly, the average annual CSD frequency from the Lake Merced outfall decreased to an average of six after construction of the Lake Merced T/S structure in 1997, and the Sea Cliff CSDs decreased to an annual average of four after construction of the Richmond Transport. Both Table 2-1 and Figure 2-1 exclude Mile Rock discharges because, as recognized in the OSP NPDES Permit, installation and maintenance of monitoring equipment at this location entails significant safety issues above and beyond routine closed space entry. The Mile Rock outfall is located at the end of a tunnel more than 4,000 feet in length that runs through hard rock from Cabrillo Street to the bottom of cliffs at Point Lobos. This outfall is only accessible by foot at the lowest tides, or through the tunnel.

Table 2-1 Measured Westside CSD Event Frequency, 1997 - 2014

Year (Jul1 – Jun 30)	Rainfall (inches)	Lake Merced (001)	Vicente (002)	Lincoln (003)	Sea Cliff #1 (005)	Sea Cliff Sewer (006) (3)	Sea Cliff #2 (007)	Annual CSD Events (2)
1997-1998	41.1	10	13	13	2	NR	10	14
1998-1999	18.9	6	7	7	0	NR	0	7
1999-2000	23.2	5	6	6	1	NR	1	7
2000-2001	13.8	2	0	0	2	NR	2	3
2001-2002	24.4	6	6	6	1	NR	1	6
2002-2003	22.3	5	6	6	1	NR	7	9
2003-2004	18.8	4	4	4	2	NR	8	8
2004-2005	26.2	7	7	6	5	NR	8	12
2005-2006	31.8	11	9	9	3	NR	9	13
2006-2007	14.8	2	1	1	0	NR	2	3
2007-2008	18.4	4	4	4	0	NR	1	4
2008-2009	18.3	4	4	4	0	NR	1	4
2009-2010	25.8	4	3	3	6	NR	7	7
2010-2011	30.1	5	4	4	0	0	3	7
2011-2012	17.6	3	3	2	2	0	3	6
2012-2013	19.7	6	6	6	3	1	3	8
2013-2014	12.0	3	2	2	0	1	3	5
AVERAGE	**22.8**	**5**	**5**	**5**	**2**	**1**	**4**	**7**
							DESIGN CRITERIA	**8**

(1) Per the Westside NPDES Monitoring and Reporting program, no CSD frequency data is reported for Mile Rock (004) because monitoring requires access which entails significant safety issues for inspection and maintenance personnel.
(2) A CSD event is a rainfall event that causes a discharge from one or more of the CSDs within the Westside System.
(3) The frequency of discharge from the Sea Cliff Sewer (006) was not recorded (NR) until telemetry was installed in 2010-2011.

Figure 2-1 Measured Westside CSD Frequency, 1986 - 2012



The SFPUC has invested substantial resources in developing, calibrating and validating a hydraulic/hydrologic (H&H) model, which is a planning tool capable of simulating both actual and artificial storm events, as well as sequences of storm events that account for the additive and antecedent effects of storms occurring close together. San Francisco's H&H model is a state-of-the art dynamic model that represents the system's actual physical characteristics (e.g., pipes, structures, pump stations) and operational set-points (e.g., pump start/stop elevations). This model is fully calibrated and results are routinely validated using rainfall information from the City's 20 rain gauges and data from more than 100 flow and level sensors installed throughout the system.

The results in Table 2-2 are the H&H model predictions for the "typical one year period", or "typical year." The typical year is an artificial year based on an analysis of 30 years of rainfall data for San Francisco that captures a range of storm magnitudes, durations and antecedent conditions and is intended to predict the long-term performance of a system. The H&H model predicts a system-wide average of 8 CSDs annually, which is higher than the actual performance. Differences between the typical year model predictions and actual performance are expected because, as stated previously, the typical year is an artificial year. Additionally, the model cannot fully replicate the judgment of experienced treatment plant operators who, during storm events, make informed decisions about storage and pumping speed to optimize system performance. For example, the model predicts an average annual CSD frequency of eight CSDs for Lake Merced, whereas the current frequency is five. Two of the eight CSDs predicted by the model, however, are less than 20 minutes in duration with volumes of less than 30,000 gallons. In the real world, operator experience and judgment could possibly prevent these discharges through pumping down in advance of a storm or other means to optimize system capacity.

The model results also show the relatively small volume and brief duration of CSDs. Approximately three billion gallons of stormwater are captured by the Westside Wet Weather Facilities in the typical year, yet less than 240 MG of combined flows are discharged as CSDs. Most of this CSD volume is from Vicente and Lincoln, with the discharges from the other outfalls – especially the Sea Cliff outfalls – being very small. The CSDs are typically very brief as well, with the median discharge being under three hours for all outfalls.

Table 2-2 Typical Year Model Results(1)

CSD Outfall	Annual CSD Event Frequency	Volume (MG)		Duration	
		Annual Total	Annual Median	Annual Total	Annual Median
Lake Merced (001)	8(2)	12.5	1.5	12 h 11 min	1 h 5 min
Vicente (002)	7	83.4	11	21 h 29 min	2 h 57 min
Lincoln (003)	7	124.6	16	21 h 6 min	2 h 51 min
Mile Rock (004)	6	15.7	3	8 h 30 min	1 h 20 min
Sea Cliff #1 (005)	1	0.0002	NA	6 min	NA
Sea Cliff Sewer (006)	3	0.2	0.1	1 h 59 min	40 min
Sea Cliff #2 (007)	2	0.02	NA	58 min	NA

(1) Results generated using CCSF H&H Model EHY13 ver. 211.
(2) Two of the eight CSDs at Lake Merced are triggered by the same storm event so that, on a system-wide basis only seven storm events result in one or more CSDs, which is below the design criteria of eight.

2.3 Level of Treatment for Combined Flows

Table 2-3 shows the estimated stormwater and wastewater flow into the system on an annual basis for the level of treatment provided to combined flows in the modeled typical year and for the past three years. The average dry weather flow in the system is 14.8 MG a day, or more five billion gallons annually. During a typical year, the system also collects and treats another three billion gallons of stormwater, with only four percent being discharged as CSDs. Over the past three years, an average of one percent of annual combined flows has been discharged as CSDs, with 99 percent of flows being treated either at OSP or within the T/S structures before deepwater discharge through the SWOO.

As is apparent from Figure 2-3, the percentage of annual combined flows treated to secondary standards over the past three years (an average of 85 percent) is greater than that predicted for the modeled typical year (75 percent). This is because the past three years have been exceptionally dry years for the region, so that the proportion of annual dry weather flows relative to wet weather flows is greater than it would be during wetter years. Because OSP only discharges primary and decant flows during wet weather events, the low amount of precipitation results in a higher percentage of annual flows receiving secondary treatment.

Table 2-3 Level of Treatment of Annual Combined Flows

	Monitored[1]				Modeled[1]
	2011-2012	2012-2013	2013-2014	3-Yr Average	Typical Year
Rainfall[3] (in)	**17.6**	**19.7**	**12.0**	**16.4**	**20.5**
INFLUENT (MG)	**7,000**	**7,160**	**6,720**	**6,950**	**8,140**
Stormwater	1,300	1,740	1,320	1,450	2,840
Wastewater	5,700	5,420	5,400	5,500	5,300
EFFLUENT (MG)	**7,000**	**7,140**	**6,720**	**6,950**	**8,140**
OSP Secondary	6,200	5,870	5,700	5,920	6,100
OSP Primary	200	230	180	200	500
Decant	530	910	780	660	1,300
CSDs	70	130	60	100	240

(1) Volume estimates based on level and flow data collected from the Distributed Control System.
(2) Results generated using CCSF H&H Model EHY13 ver. 211.
(3) Rainfall reported in monthly OSP reports.

Figure 2-2 Monthly Distribution of Combined Flows

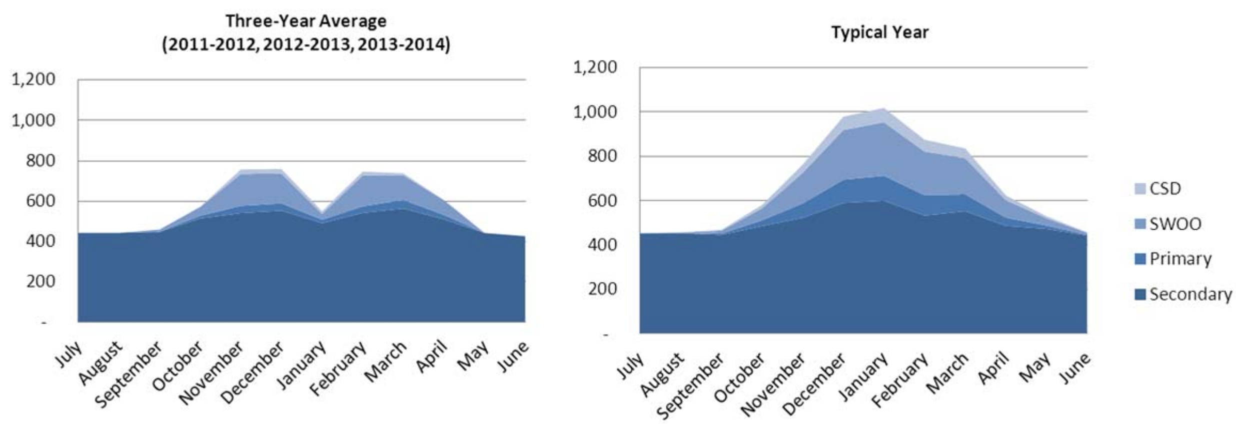
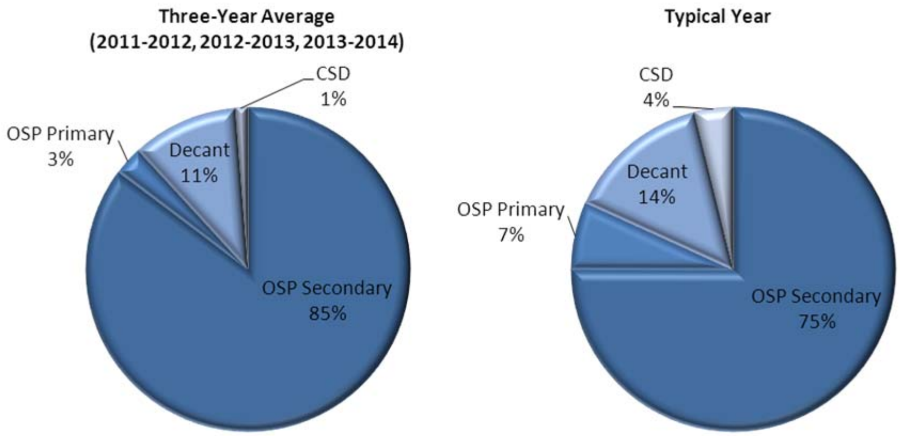


Figure 2-3 Annual Distribution of Combined Flows



2.4 Pollutants Removed from Stormwater Prior to Discharge

As an example of the Westside Wet Weather Facilities' efficacy in controlling pollutant loading from stormwater, the SFPUC developed a methodology to estimate the mass of total suspended solids (TSS) removed from stormwater prior to discharge. TSS was selected because it can be inexpensively and reliably measured and is often used as an indicator of other pollutants in stormwater.[9]

To estimate the mass of TSS of stormwater removed by the combined system, the SFPUC used its hydraulic model to simulate the volume of stormwater entering the system and the volume exiting the system, with base daily sanitary flows assumed to be 14.8 MG. The ratio of stormwater to wastewater in the influent was assumed to be the same as in all discharges (from OSP secondary and primary, decant and CSDs). Measured influent and effluent TSS concentrations from daily flow-paced composite samples were used to estimate the mass of TSS entering the system and exiting from OSP, respectively. The median of ten years of decant and CSD TSS samples were used to estimate the mass of TSS exiting the system in the form of decant and CSDs. The TSS removed from stormwater by the Westside Wet Weather Facilities was estimated to be the difference between the influent mass and the sum of the OSP, decant and CSD effluent masses.

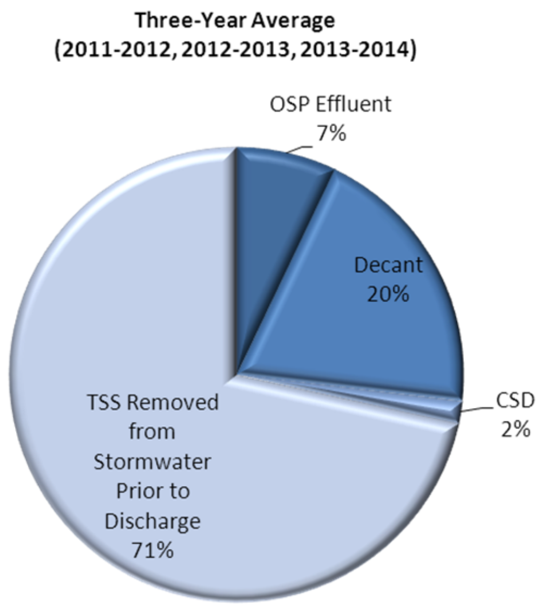
On average over the past three years, the Westside system removed an estimated 73 percent of TSS from stormwater prior to discharge through the SWOO or CSDs. The mass of all pollutants removed, however, is likely much greater than this because these estimates do not include the mass of large solids, such as trash and debris, that would not be collected by the samplers.

[9] A 2003 CalTrans study of thirteen storm events found that an average of 57 percent of cadmium, 75 percent of copper, and 92 percent of lead in stormwater was found in the particulate fraction.

Table 2-4 Mass Balance for TSS in Stormwater Portion of Combined Flows

	2011-2012	2012-2013	2013-2014	Average
TSS in Influent	**1,410,000**	**2,025,000**	**1,352,000**	**1,596,000**
TSS in Effluent	**411,000**	**506,000**	**390,000**	**436,000**
OSP	93,000	145,000	112,000	117,000
Decant	305,000	337,000	272,000	305,000
CSDs	13,000	24,000	6,000	14,000
TSS Removed from Stormwater (%)	71%	75%	71%	73%

Figure 2-4 Distribution of TSS in Stormwater



2.5 Historical Comparison

This section presents information collected by the SFPUC to compare the performance of the Westside T/S Structure to the performance and water quality benefits predicted at the time of its design. Unlike previous sections, which describe the performance of the system as a whole, this analysis is focused solely on the Westside T/S Structure because it is the keystone of the Westside Wet Weather Facilities and because detailed information on its expected benefits is available in historic facilities planning documents. These planning documents, completed in 1978, later became the basis of the Regional Board's order mandate to achieve an annual average CSD frequency of eight.

Table 2-5 compares the estimated design performance to actual performance for CSDs from the Westside T/S Structure for the past five years. Notably, the reduction in mass annual loading of BOD_5 and TSS was approximately 98 percent, which is substantially greater than the 1978 analysis which predicted a reduction of 84 percent. The impact in terms of the number of days the receiving waters did not meet total coliform standards was also less than expected. Pre-construction modeling predicted a reduction 84 percent over the uncontrolled levels, whereas actual reductions are greater than 95 percent on average for the past five years.

Table 2-5 Westside Transport Storage Structure Performance

Vicente & Lincoln CSD Structures (CSD 002 & CSD 003)						
	1978 Design Estimate	2009-2010	2010-2011	2011-2012[2]	2012-2013[2,3]	2013-2014[4]
No. CSD Events/Year[(1)]	8	3	4	3	6	2
% of Westside Combined Flows Treated at OSP Annually	96%	98%	99%	99%	99%	99.6%
% of Westside Combined Flows Discharged through CSD Outfalls 002 and 003	4%	2%	1%	1%	1%	0.40%
CSD Volume/ Yr (MG)	449	195	87	62	90	25
Total Duration of all CSD events (hours)	32	15.5	11.9	8.7	20.1	3.5
Minimum/Maximum Duration of CSD events (hours)	2/78	1.8/8.2	0.3/5.4	0.2/4.9	1.0/9.2	1.0/2.5
Average Duration of CSD events (hours)	4	5.2	3.0	2.9	3.3	1.7
Stormwater in CSDs (%)	94%	97%	96%	96%	95%	96%
Wastewater in CSDs (%)	6%	3%	4%	4%	5%	4%
Reduction in BOD_5 Loading v. 1978 Levels (%)[(5)]	**84%**	98%	99%	98%	98%	100%
Reduction in TSS Loading v. 1978 Levels (%)	84%	99%	100%	100%	100%	100%
No. Days Exceeding Total Coliform Standard (10,000 MPN/100mL)[(5)]	10	1	2	0	5	3
Reduction in No. Days Exceeding 10,000 MPN/100 mL Total Coliform Standard (%)	84%	99%	97%	100%	93%	95%

(1) A CSD Event is a storm event that resulted in a discharge from CSDs 002 and 003.
(2) Calculated using eDNA one minute data.
(3) For four events CSD-003 telemetry was non-functional, so data from CSD 002 was used to estimate the discharge volume.
(4) Calculated using Pi one-minute data.
(5) These rows show the reduction in BOD and TSS over uncontrolled (1979) levels that were predicted to occur after construction of the Westside T/S structure.

3.0 ASSESSMENT OF WET WEATHER IMPACTS

According to EPA, a post-construction monitoring program for combined sewer systems should include receiving water monitoring to assess the impacts of wet weather discharges on water quality.[10] This section describes the results of the SFPUC's related monitoring programs, which include fecal indicator bacteria (FIB) monitoring at public beaches, collection of data on recreational use, CSD sampling and analysis, and the extensive annual SWOO regional sampling effort.

3.1 Fecal Indicator Bacteria Monitoring

The SFPUC and the San Francisco Department of Public Health (SFDPH) jointly administer the city-wide Beach Water Quality Monitoring Program. The purposes of the program are to monitor fecal indicator bacteria concentrations at San Francisco beaches and notify the public when concentrations are likely to be elevated above the standards recommended by the California Department of Public Health for salt water beaches.[11] A detailed summary of the program and results are included in the *Southwest Ocean Outfall Regional Monitoring Program Sixteen Year Summary Report 1997-2012* (*SWOO Regional Monitoring Report*), which was submitted to the Water Board on April 3, 2014. This Report provides a synopsis of the program and the conclusions from the SWOO Regional Monitoring Report.

The main elements of the Beach Water Quality Monitoring Program are:

- Weekly Monitoring. Designated water contact recreation areas are sampled once a week year-round. If concentrations are elevated, the site is re-sampled daily until concentrations are below the CDPH levels.
- Post-CSD Monitoring. Designated water contact recreation areas in the vicinity of CSDs are sampled as soon as practicable following CSDs.[12] Samples are collected in ankle deep water on an incoming wave. If sample results indicate an exceedance of one or more FIB standards, the site is re-sampled daily are below the CDPH levels.
- Public Notification. Permanent signs in English, Spanish, and Chinese installed at major beach access points explain that beaches will be posted when it may be unsafe to enter the water.

  As a precautionary measure, beaches are sampled and posted when a CSD occurs at a location that could affect water quality at that beach even before sample results are available. Beaches remain posted until the sample results are available, which can be up to 24 hours after samples are collected. If the results indicate elevated bacteria levels, the beaches remain posted and are re-sampled. Beaches are also posted when no CSD occurs but when weekly sampling indicates FIB concentrations above the CDPH levels.

  Notification also includes a subscription email notification list, a recreational beach water quality hotline, and posting on the SFPUC website (http://beaches.sfwater.org). The SFPUC expects its web-based mobile phone notification application, which is being beta tested now, to be available before the end of the summer.

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[10] USEPA *CSO Post Construction Compliance Monitoring Guidance*, p. 48 .

[11] These standards are 104 MPN/100 mL for enterococcus, 400 MPN/100 mL for fecal coliform, and 10,000 MPN/100 mL for total coliform. The SFPUC measures E. coli, a subset of fecal coliform, as required by the OSP NPDES permit.

[12] If, for example, a CSD begins at 5:00 p.m. during the winter and there is insufficient light to safely collect water samples in the surf zone, staff will sample and post at daylight the next morning.

Figure 3-1 shows the Oceanside FIB monitoring locations. Sites 15, 15E, 17, 18, 19, and 21.1 are sampled weekly and after a CSD. Sites 20, 21, and 22 are sampled only after a CSD.

Figure 3-1 Beach Water Quality Monitoring Stations

Table 3-1 illustrates the short duration of the impact of CSDs on FIB concentrations. It shows the total number of CSD events that occurred at Westside Beaches, and the number of those CSDs events that were associated with elevated FIB concentrations. The duration of CSD impacts was brief enough that, for the majority of CSD events, sampling did not detect an exceedance in the surf zone either at the CSD outfall or the adjacent stations. Posting and sampling of the beaches occurs as soon as practicable (when there is sufficient daylight to safely sample) once a CSD begins, so this suggests that the impacts of CSDs are typically less than fifteen hours in duration and may be much shorter. For all the CSD events at Baker Beach, Ocean Beach and China Beach that resulted in elevated FIB levels; concentrations dropped below water quality standards by the second day of sampling (less than 48 hours after the event occurred).

Table 3-2 shows the very small number of days that use of Westside beaches was affected by CSDs. For all beaches, the average annual number of days that the beaches were posted as the result of a CSD or a CSD-related exceedance was less than three percent (ten days). The average percentage of days that these beaches actually had elevated bacteria levels is likely even lower considering that the beaches are proactively posted for the 24 hours it takes to culture samples and confirm that concentrations are below the CDPH levels.

Table 3-2 also highlights that events or factors other than CSDs contribute to exceedances, especially at Baker Beach at Lobos Creek, which is on the State's list of impaired waterbodies. The cause of these dry weather exceedances is currently unknown, but it is believed that Lobos Creek and wildlife may be significant contributors.

Table 3-1 CSD Events Correlated to Elevated FIB Concentrations, 1997 – 2013

	Lake Merced Outfall (Ft. Funston)	Vicente Outfall (Ocean Beach)	Lincoln Outfall (Ocean Beach)	Seacliff I Outfall (China Beach)	Seacliff II Outfall (Baker Beach)
No. of CSD Events by Outfall	84	83	81	28	67
No. CSD Events with Elevated FIB Concentrations	15	25	39	4	17
% of CSD Events with Elevated FIB Concentrations	18%	30%	48%	14%	25%

Table 3-2 Days of Beach Postings, 2003 – 2013

Year	Ft. Funston (Lake Merced Outfall)		Ocean Beach (Lincoln and Vicente Outfalls)		China Beach (Sea Cliff I Outfall)		Baker Beach (Sea Cliff II Outfall)	
	Non-CSD[1]	CSD	Non-CSD	CSD	Non-CSD	CSD	Non-CSD	CSD
2003-2004	3	12	6	13	3	7	12	15
2004-2005	NA	10	4	15	0	5	9	14
2005-2006	NA	22	4	19	1	6	25	14
2006-2007	NA	3	2	3	0	0	3	4
2007-2008	NA	7	0	11	1	0	7	2
2008-2009	NA	7	0	7	0	0	16	2
2009-2010	NA	8	0	7	0	7	35	11
2010-2011	NA	10	0	9	0	0	20	5
2011-2012	NA	3	0	5	2	1	3	4
2012-2013	NA	12	1	14	0	2	11	8
Average	NA	9	2	10	1	3	14	8
Average Days Posted Annually	NA	2%	1%	3%	0%	1%	4%	2%

3.2 Recreational Use Monitoring

San Francisco beaches are popular recreation areas used by San Francisco residents and visitors throughout the year. Although the number of days that beaches are posted annually is very small and the number of days that there are elevated fecal indicator bacteria is even smaller, the potential exists for beach users to be exposed to undisinfected stormwater and wastewater discharged as CSDs. To better understand the potential threat to human health the SFPUC conducted an extensive recreational use survey at Ocean Beach from October 1998 through September 2000. This study concluded that water contact and non-water contact (including surf fishing) recreational activities along Ocean Beach were extensive, but recreational use following CSDs was very limited. The study concluded that CSDs have little impact on recreational use because they occur during storm events and little use was observed during the cold, short days of winter when CSD events tend to occur. Of the 154,054 people observed during the two-year study, only 17 percent were engaged in water contact recreation. Of the 17 percent involved in contact recreation, only 25 percent (four percent of the total) were surfers, meaning that they were fully immersed for extended periods of time. Less than one percent of all observed water contact users were observed following a CSD.

Since 2000 the SFPUC has continued collecting recreational use data but only during and immediately after CSDs. Staff recorded the number of full, partial and non-contact recreational use whenever posting, sampling, and de-posting a beach because of a CSD. The results of these observations for 2008 through 2014 are summarized in Table 3-3. Most (80 percent) users observed were engaged in non-water contact recreation, and fewer recreational users were observed when posting - which occurs during or shortly after a CSD - than when de-posting, which typically occurs one to two days after a CSD. While these observations cannot be extrapolated to estimate how many people were engaged in water contact recreation during periods of elevated FIB concentrations, they illustrate how the inclement weather conditions associated with CSDs discourage water contact recreation and limit exposure. This is consistent with an analysis of recreational use on the Bayside of San Francisco, which found that visibility, weather and temperature were the factors that most influenced recreational use. More details on Westside recreational use observations are included in the *SWOO Regional Monitoring Report.*

Table 3-3 Westside Recreational Use Observations, 2008 – 2014

Time of Observation	No. of Observation Events	Full Contact Users	Partial Contact Users	Non Contact Users	Total Users	Total Users/ Observation Event
Posting	117	38	3	274	315	2.7
Posting/Sampling	66	7	3	174	184	2.8
Sampling	88	81	16	308	405	4.6
De-Posting/Sampling	15	68	6	69	143	9.5
De-Posting	114	107	74	804	985	8.6
Total	400	301	102	1,629	2,032	-
Percent of Total	-	15%	5%	80%	100%	-

3.3 Combined Sewer Discharge Quality Monitoring

This section summarizes the results of ten years of sampling of the water quality of discharges from the Westside T/S structure CSD outfalls and of decant through the SWOO. Samples are collected by level-actuated refrigerated automatic samplers set up to collect time-paced composite samples. Because of the infeasibility of predicting the duration of discharges, the automatic samplers are typically set up to collect the minimum sample volume of three liters within the first five minutes and one liter each hour thereafter. This sampling regime is intended to maximize the number of laboratory analyses that can be performed for each sample. Occasionally the CSD is too brief to collect sufficient sample volume to perform all analyses, in which case conventional parameters and metals are prioritized.

A summary of the monitoring results is presented in Table 3-4, and more detailed results are included in Appendix A. The summary below compares the median and mean measured concentrations of various parameters against the results of a Caltrans study[13] characterizing pollutant concentrations in stormwater flows from highways, and Ocean Plan numeric water quality objectives. The comparison to the Ocean Plan numeric objectives for instantaneous maxima is provided only to illustrate the relatively low average concentrations of pollutants in CSDs. These Ocean Plan objectives apply only to the receiving waters, not stormwater or other effluent discharges. Moreover, the State Water Board order granting San Francisco an exception from certain provisions of the Ocean Plan explicitly notes that it is inappropriate to require compliance with numeric objectives during wet weather discharges.

As indicated in Table 3-4, the median and average concentrations of pollutants in CSDs are similar to those expected in stormwater runoff and are mostly below the water quality objectives specified in the Ocean Plan. Concentrations of zinc and copper are elevated, which is typical of urban stormwater. The primary sources of copper and zinc in urban stormwater runoff are likely to be car brake pads and tires, respectively. San Francisco's street cleaning program, which includes sweeping high-use commercial areas daily, reduces these pollutants, but source control programs are necessary for effective control. California has taken some steps in this direction, enacting a law requiring that the use of copper in brake pads be reduced to no more than 0.5 percent by weight by 2025,[14] and another phasing out lead tire weights.[15]

The toxicity of metals is also likely to be less than indicated by comparison with the water quality objectives. Zinc, as well as copper and several other metals have limited bioavailability and reduced toxicity when dissolved organic carbon and certain other chemicals are present. This reduced toxicity can be addressed by water quality criteria based on the biotic ligand model (BLM). In 2007, EPA promulgated revised water quality criteria for copper (freshwater) based on the BLM but has not yet done so for other metals or for marine waters.

The median and average concentrations for most parameters are higher in the decant samples than in the CSD samples. This may be the result of the timing of the sample collection and discharge relative to the storm event. Decant samples are collected much earlier during a storm event than the CSDs because CSDs do not occur until decant pumping through the SWOO has been maximized. This could result in higher concentrations of pollutants because the proportion of wastewater in the decant samples is likely to be higher than those in the CSDs, which may explain the higher concentrations of conventional pollutants and ammonia in the decant samples.

[13] California Department of Transportation, *Storm Water Monitoring & Data Management Discharge Characterization Study Report*, CTSW-RT-03-065.51.42 (2003).
[14] Senate Bill 346 (2010).
[15] Senate Bill 757 (2009).

Table 3-4 Wet Weather Discharge Analytical Results, 2004 - 2014

Analyte	Decant			Vicente (002) CSD			CalTrans Avg(6)	Ocean Plan Obj.
	No. Samples	Median(1)	Average(1)	No. Samples	Median(1)	Average(1)		
Conventional Pollutants								
TSS (mg/L)	113	82	100	40	44	59	113	NA
BOD (mg/L)	65	52	65	38	26	29	-	NA
COD (mg/L)	100	116	168	32	81	87	-	NA
pH (Std. Units)	106	6.8	6.7	40	6.6	6.5	7.1	6.0 - 9.0(2)
Oil & Grease (mg/L)	106	<5	<5	37	<5	<5	5.0	75(2)
Toxic Pollutants								
Ammonia (mg/L)	70	3.2	5.2	40	2.2	2.4	1.0	6(3)
Copper (µg/L)(5)	64	41	46	40	27	29	34	30(3)
Lead (µg/L) (5)	63	13	14	40	11	12	48	20(3)
Zinc (µg/L) (5)	64	152	175	40	111	118	187	80(3)
Nickel (µg/L) (5)	64	3.6	3.9	40	3.6	3.8	11	50(3)
Cadmium (µg/L) (5)	64	0.2	0.4	40	0.1	0.3	0.7	10(3)
Chromium(4) (µg/L) (4)	64	3.2	3.9	39	3.4	4.2	8.6	20(3)
Arsenic (µg/L)(5)	65	0.7	3.2	40	0.7	1.1	1.0	80(3)

(1) To calculate the median and the average, estimated values were used for pollutants detected but not quantified (DNQ) and zeros were used for pollutants not detected.
(2) California Ocean Plan, Table 2 (formerly Table A).
(3) California Ocean Plan, Table 1 (former Table B). These objectives are provided for illustrative purposes only. They do not apply to CSD or decant discharges because they are receiving water, not effluent, limitations.
(4) Chromium results are expressed as total, but the Ocean Plan objective is expressed as hexavalent chromium.
(5) All metals are expressed as total recoverable metals.
(6) CalTrans Highway Table 3-3, average of all samples collected,

3.4 Wet Weather Discharge Characterization Special Study

During this permit term, the SFPUC decided to voluntarily conduct a special study involving direct monitoring of receiving waters before and after CSDs. The objective of the one-time study was to better characterize the impacts of CSDs on the receiving waters rather than relying solely on CSD pollutant concentrations to estimate the potential impacts. In 2012, the SFPUC developed and implemented a receiving water sampling and analysis plan. The plan involved sampling the surf zone on an incoming wave prior to and during a CSD event at multiple locations along Ocean Beach shown in Figure 3-2. Two sets of samples were targeted: One set collected during the storm, but prior to a CSD ("pre-discharge sample"), and one set collected during discharge. The pre-discharge samples were to be collected at shoreline stations 18 (foot of Balboa Street), 19 (at the discharge structure, foot of Lincoln Way), 20 (foot of Pacheco Street), and 21 (at the discharge structure, foot of Vicente Street) (Figure 3-2). The discharge samples were to be collected at the same four stations with additional samples collected 30 meters upcoast and downcoast of the two discharge structures at stations 19 and 21.

Figure 3-2 Wet Weather Discharge Characterization Study Stations

Implementation of this plan was significantly hampered by logistical and safety issues. Specifically, the unpredictable nature of CSDs made it difficult to determine when to mobilize field staff. Staff were mobilized on multiple occasions on which CSDs did not occur. On other occasions, the CSDs occurred during non-daylight hour when field sampling would have been unsafe, or on weekends when limited staff are available. When staff were mobilized, the often-dangerous winter surf conditions at Ocean Beach made access to the discharge challenging as shown in the images in Figure 3-3.

Figure 3-3 Vicente Outfall, November 30, 2012

These photographs were taken on incoming and outgoing waves while staff were sampling at the Vicente CSD outfall on November 30, 2012. Despite multiple mobilizations, SFPUC field monitoring staff were only able to collect samples on two occasions. On March 12, 2012, staff mobilized and collected pre-discharge samples, but no CSDs occurred. On November 30, 2012, staff collected samples from all stations while CSDs were occurring from the Vicente and Lincoln outfalls. The discharge water quality samples were collected in the middle of the discharge event, which began at approximately 4:00 a.m. and lasted until around 1:00 p.m. The first water quality samples were collected at 7:25 a.m. and the last at 10:00 a.m.

Table 3-5 shows the maximum, average and median of all samples collected at all locations during each event. The results indicate that some, but not all, pollutants are elevated in the discharge sample as compared to the pre-discharge sample. Concentrations of ammonia, nickel, cadmium, chromium and arsenic were similar for pre-discharge and discharge samples. Concentrations of pollutants expected to be found in stormwater – copper, lead, zinc, bacteria and TSS – were elevated in the discharge samples as compared to the pre-discharge samples, but only bacteria and a single lead result were greater than the Ocean Plan objectives. Samples were also analyzed for other metals and organics, most of which were at or below method detection limits and so are not summarized here.

Table 3-6 shows the results by location for the November 30, 2012 discharge sampling event and the results of the CSD effluent sample collected on the same day. From this single dataset, no clear relationship between the CSD concentrations and the receiving water concentrations is discernible. This may be due to differences in the timing of samples and the sample collection methodology. CSD sample collection was initiated at the time of discharge and was a time-paced composite whereas the receiving water samples were collected mid-discharge and as grab samples.

Similarly, no spatial relationship between the receiving water samples is discernible except for FIB, which was highest at the stations located at the CSD outfalls. Samples collected the following day and analyzed for FIB as part of the routine beach monitoring program were elevated only for enterococcus and only at Balboa (Station 18) and Sloat (Station 21.1).

Table 3-5 Summary of Results for all Stations, Pre and During Discharge

Analyte	Receiving Water, Pre-Discharge (3/12/2012)			Receiving Water, During Discharge (11/30/2012)			Ocean Plan Objective(2)
	Max	Median	Average	Max	Median	Average	
Conventional Pollutants							
TSS (mg/L)	70	61	62	103	73	79	NA
Enterococcus (MPN/100 mL)	31	10	15	>24,196	3,654	7,074	104
E. coli (MPN/100 mL)	63	31	34	>24,196	2,282	9,193	400
Total Coliform (MPN/100 mL)	171	158	156	>24,196	6,131	12,587	10,000
Toxic Pollutants							
Ammonia (mg/L)	0.5	0.5	0.4	0.5	0.5	0.4	6
Copper (µg/L) (4)	3	0.8	1.1	13	4.6	5.6	30
Lead (µg/L) (4)	1.2	0.8	0.9	21	5.7	9.3	20
Zinc (µg/L) (4)	6.2	5.3	5.4	22	15	15	80
Nickel (µg/L) (4)	6.3	5.6	5.6	6.1	4.4	4.6	50
Cadmium (µg/L) (4)	0.8	0.6	0.6	1	0.7	0.6	10
Chromium(4) (µg/L) (3)	8.7	7.5	7.5	7.9	5.8	6.1	20
Arsenic (µg/L) (4)	3.5	3.1	3	4.6	3.7	3.5	80

(1) For calculating the median and the average, estimated values were used for pollutants detected but not quantified (DNQ) and zeros were used for pollutants not detected.
(2) California Ocean Plan, Table 1 (former Table B), all values are the instantaneous maxima. These objectives are provided for illustrative purposes only and do not apply to San Francisco's wet weather discharges because of SWRCB WQ Order 79-16.
(3) Chromium results are expressed as total, but the Ocean Plan objective is expressed as hexavalent chromium.
(4) Expressed as total recoverable metals.

Table 3-6 Results for Individual Stations during Discharge Event (North to South)

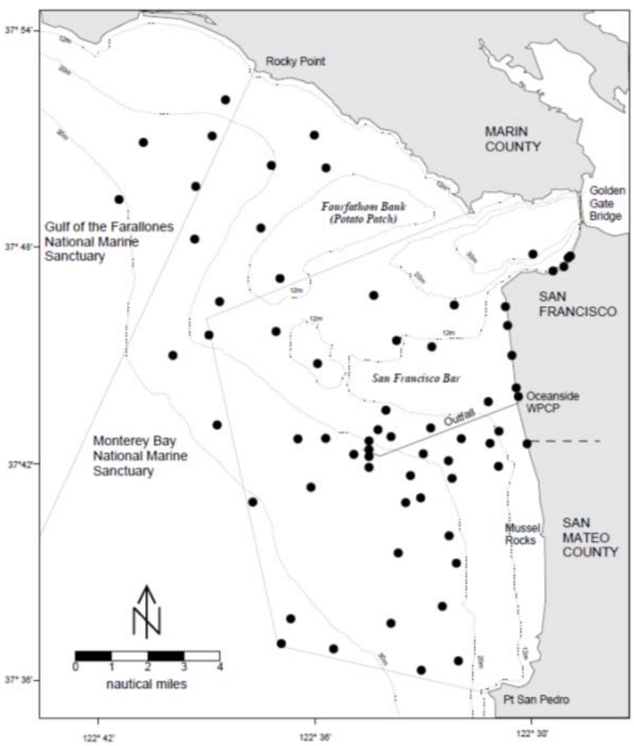
Station Name (Station Number)	Balboa (18)	Lincoln, 30 m N (19N)	Lincoln (19)	Lincoln, 30 M S (19 S)	Pacheco (20)	Vicente, 30 m N (21N)	Vicente (21)	Vicente 30m S (21S)	Vicente CSD
Conventional Pollutants									
TSS (mg/L)	62	74	72	103	67	88	68	97	68
Enterococcus	723	7,701	24,196	145	884	3,654	12,997	12,997	-
E. coli	2,282	14,136	24,196	443	583	15,531	24,196	158	-
Total Coliform	6,131	24,196	24,196	3,255	3,255	24,196	24,196	1,100	-
Toxic Pollutants									
Ammonia (mg/L)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	3
Copper (µg/L)[1]	3.1	13	3.9	6.3	7.5	3.9	5.3	1.9	1.5
Lead (µg/L) [1]	4	21.0	4	16.7	7	2.2	3	16	7
Zinc (µg/L) [1]	8	22	32	16.7	16	9	22	13	87

(1) Expressed as total recoverable metals.

3.5 Southwest Ocean Outfall Offshore Monitoring Program

In April of this year, the SFPUC submitted the *SWOO Regional Monitoring Report* to the Water Board. This Report describes the results of the extensive SFPUC Offshore Monitoring Program, which involves the collection and analysis of physical, chemical, and biological parameters in order to assess and compare outfall (potentially impacted) and reference conditions by analyzing chemical and physical sediment quality, benthic infauna community structure, demersal fish and epibenthic invertebrate community structure, and physical anomalies and bioaccumulation of contaminants in organism structure.

Figure 3-4 Offshore Monitoring Stations



Analysis of the data collected since 1997 has not identified any trends that indicate that discharges from the SWOO are adversely affecting the surrounding environment:

- Sediment grain size, organic and inorganic pollutant levels have revealed no trends in sediment characteristics that would indicate that the discharges from the SWOO have adversely affected the surrounding environment, and have not produced any discernable effects on the physical characteristics or sediment or resulted in contaminant accumulation in the vicinity of the outfall.

- Reference envelope analysis shows that benthic infauna indicators (abundance, species richness, diversity, evenness) at outfall stations are the same as at reference stations.

- Most organic pollutants are infrequently detected in sediment samples and, when detected, occur at low concentrations. One outfall station was above reference conditions for polycyclic aromatic hydrocarbons (PAHs) in sediment in seven of the sixteen years sampled, but the high concentrations appear to correlate in both reference and outfall stations to high percentage of sediment fines, of which that station had the highest. Sediment metals concentrations at the outfall and reference stations do not differ.

- Organic pollutants and trace metals in crab tissue were found in varying levels but no correlation between sediment and tissue concentrations has been detected. As with demersal fish and epibenthic organisms the mobility of crabs limits their utility in determining an outfall effect because the origin of body burdens cannot be determined.

4.0 CONCLUSION

The results of the post-construction and system efficacy monitoring illustrate how that San Francisco's combined sewer system is controlling wet weather pollution consistent with the requirements of the CSO Control Policy and state water quality requirements. The system's performance in terms of CSD frequency and pollutant reduction has exceeded that predicted at the time the level of wet weather control was established and the system was designed. Data collected on CSD pollutant concentrations and in receiving waters indicates that the impact, if any, to beneficial uses is small.

<u>The Level of Wet Weather Control is Consistent with the Design Criteria.</u>
The 1979 regional and state orders that mandated the current level of CSO control found that construction a system with sufficient storage and treatment so that no more than eight storm events would trigger CSDs on a long-term average annual basis would protect beneficial uses. Since the construction of the Westside Wet Weather Facilities was completed in 1997, the frequency of storm events that result in a CSD for the system as a whole is seven, and for individual outfalls is five. These frequencies are also consistent with the predictions of San Francisco's H&H model simulations for the typical year, which is designed to be representative of long-term performance.

<u>The Combined Sewer System Provides Significant Environmental Benefits.</u>
The capacity of the Westside Wet Weather Facilities to capture and treat enormous volumes of stormwater provides a significant environmental benefit over separate storm sewer systems, with more than one million pounds of TSS and associated pollutants removed from stormwater annually. Virtually all stormwater flows receive at least the equivalent of wet weather solids removal prior to discharge more than three miles offshore, and baffling throughout the system ensures capture of floatable debris.

<u>Identified Impacts of the System are Small.</u>
Chemical analyses of CSD discharges show that the concentrations of metals and conventional pollutants in CSDs are usually lower than those found in urban stormwater. Exceptions are copper and zinc, the concentrations of which are similar to those in urban stormwater but, which based on the SFPUC's receiving water special study, appear to be rapidly diluted and dispersed after discharge.

The primary pollutant of concern in CSDs is fecal indicator bacteria, which is present in stormwater and in the small percentage of sanitary waste in CSDs. The dispersion and die-off of fecal indicator bacteria in San Francisco's receiving waters is not well-characterized, but appears rapid based on beach water quality monitoring program data that indicate that concentrations frequently return to ambient levels within 24 hours after a discharge. Recreational use monitoring further indicates that human exposure to high levels of fecal indicator bacteria is limited as a result of the very small contact recreation use that occurs during and shortly after CSDs.

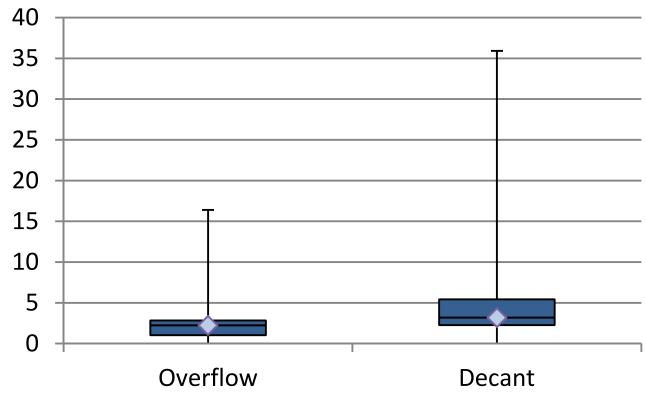
Long-term monitoring of the potential impacts of wet and dry weather discharges from the SWOO has not identified any discharge-related impacts to sediment quality or monitored organisms. This may be attributable to the high level of treatment provided to dry and wet weather flows, the small volume of discharge relative to other California ocean publicly owned treatment works, and the high dilution provided by the SWOO configuration which was designed to take advantage of ocean currents.

APPENDIX A
DECANT AND CSD CHEMISTRY RESULTS

These whisker plots show the range of results. for CSD and decant chemistry analysis The end points of the whiskers represent the minimum and maximum of each data set. The top box represents third quartile; the bottom box represents the second quartile; the line between them is the mean, and the diamond is the median.

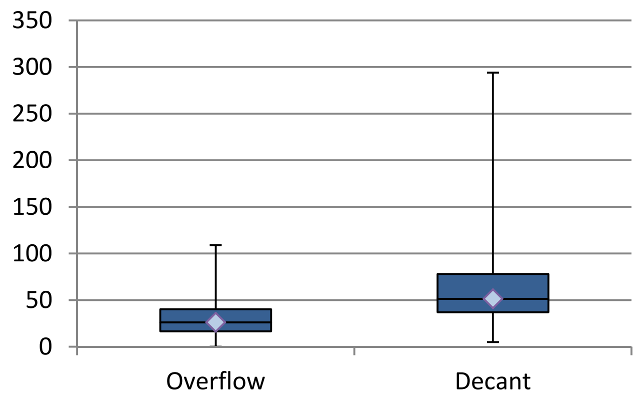
Total Suspended Solids (mg/L)

Statistic	Overflow	Decant
Count	40	113
Mean	59	100
Std. Deviation	37	80
Median	44	82
Maximum	169	525
Minimum	15	ND



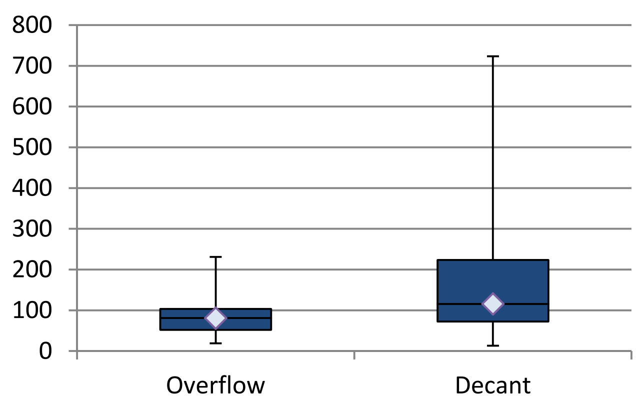
Biological Oxygen Demand (mg/L)

Statistic	Overflow	Decant
Count	38	65
Mean	29	65
Std. Deviation	20	50
Median	26	52
Maximum	109	294
Minimum	ND	5



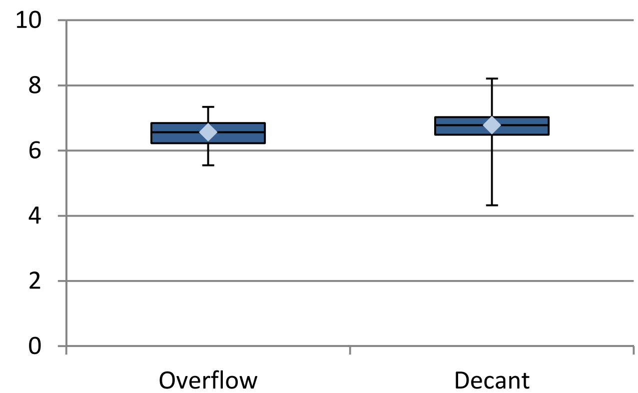
Chemical Oxygen Demand (mg/L)

Statistic	Overflow	Decant
Count	32	100
Mean	87	168
Std. Deviation	51	146
Median	81	116
Maximum	231	724
Minimum	19	13



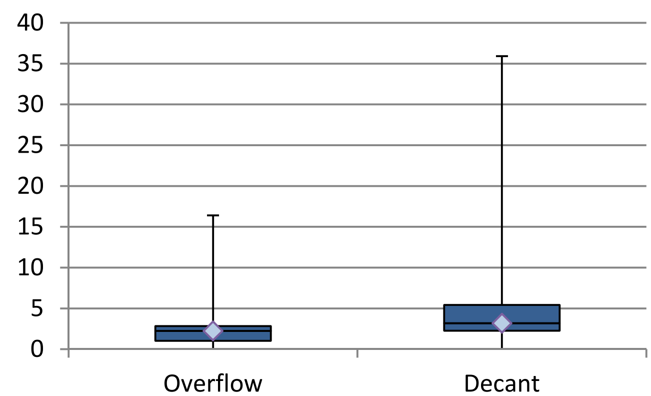
pH

Statistic	Overflow	Decant
Count	40	106
Mean	6.5	6.7
Std. Deviation	0.4	0.5
Median	6.6	6.8
Maximum	7.3	8.2
Minimum	5.6	4.3



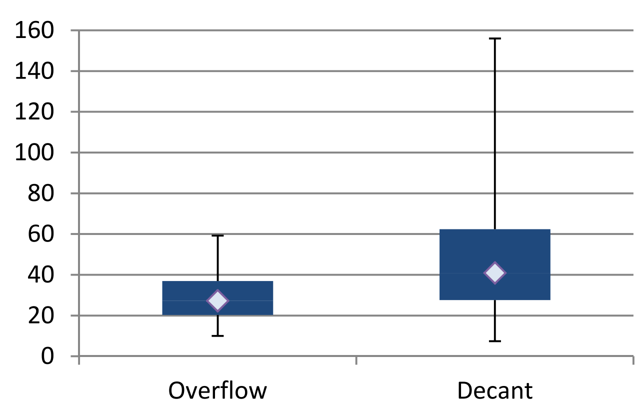
Ammonia (mg/L)

Statistic	Overflow	Decant
Count	40	70
Mean	2.4	5.2
Std. Deviation	2.5	5.8
Median	2.2	3.2
Maximum	16	36
Minimum	ND	ND



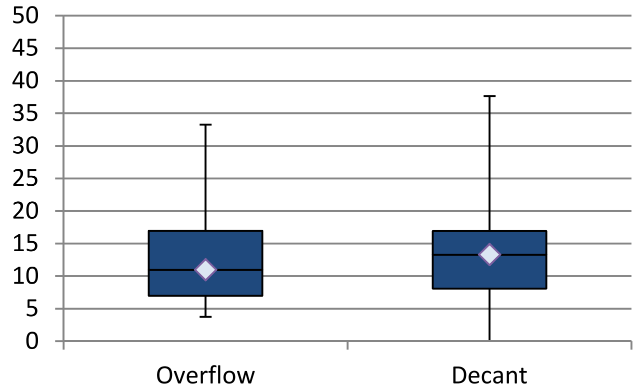
Copper (μg/L)

Statistic	Overflow	Decant
Count	40	64
Mean	29	46
Std. Deviation	12	26
Median	27	41
Maximum	59	156
Minimum	10	7



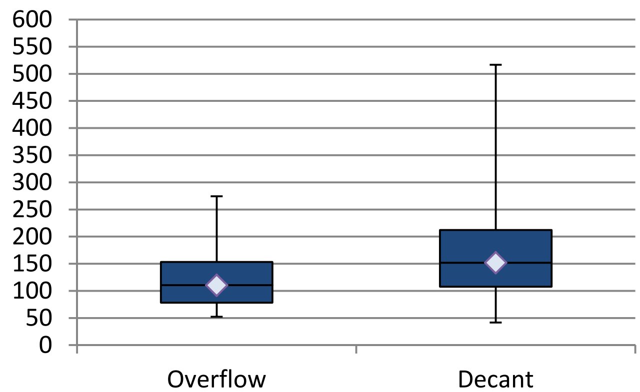
Lead (µg/L)

Statistic	Overflow	Decant
Count	40	63
Mean	12	14
Std. Deviation	7	8
Median	11	13
Maximum	33	38
Minimum	4	ND



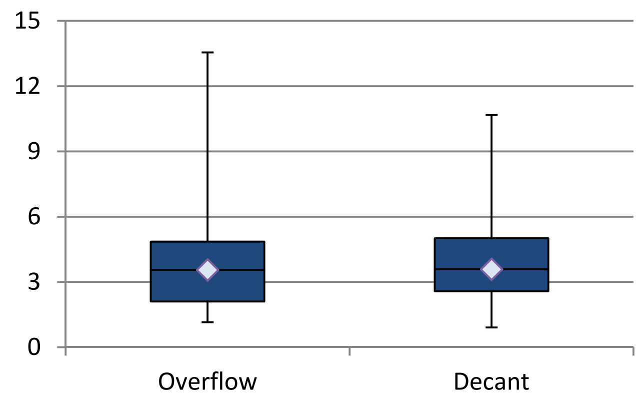
Zinc (µg/L)

Statistic	Overflow	Decant
Count	40	64
Mean	118	175
Std. Deviation	47	99
Median	111	152
Maximum	274	517
Minimum	52	42



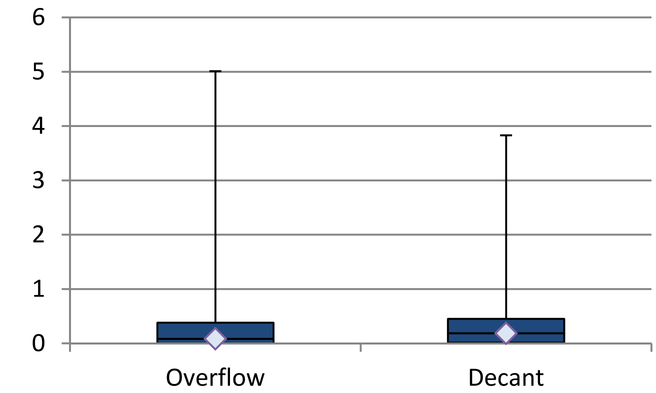
Nickel (µg/L)

Statistic	Overflow	Decant
Count	40	64
Mean	3.8	3.9
Std. Deviation	2.3	1.9
Median	3.6	3.6
Maximum	14	11
Minimum	1.2	0.9



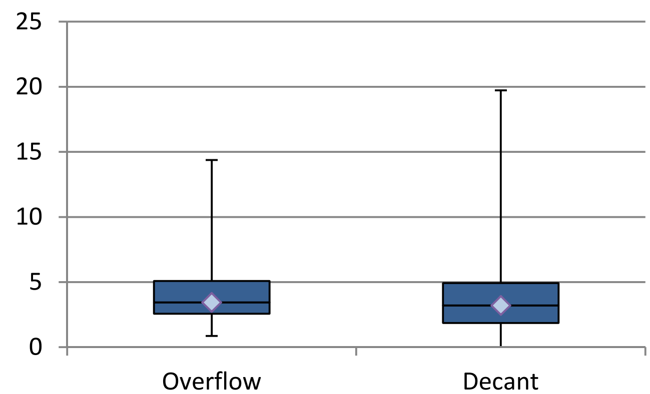
Cadmium (µg/L)

Statistic	Overflow	Decant
Count	40	64
Mean	0.3	0.4
Std. Deviation	0.8	0.7
Median	0.1	0.2
Maximum	5.0	3.8
Minimum	ND	ND



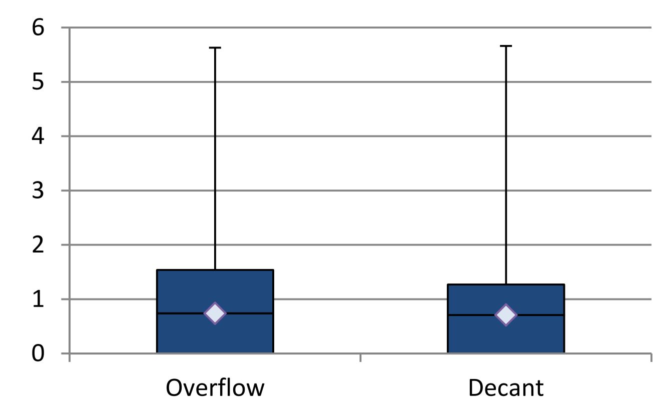
Chromium (µg/L)

Statistic	Overflow	Decant
Count	39	64
Mean	4.2	3.9
Std. Deviation	2.8	3.1
Median	3.4	3.2
Maximum	14	20
Minimum	0.9	ND

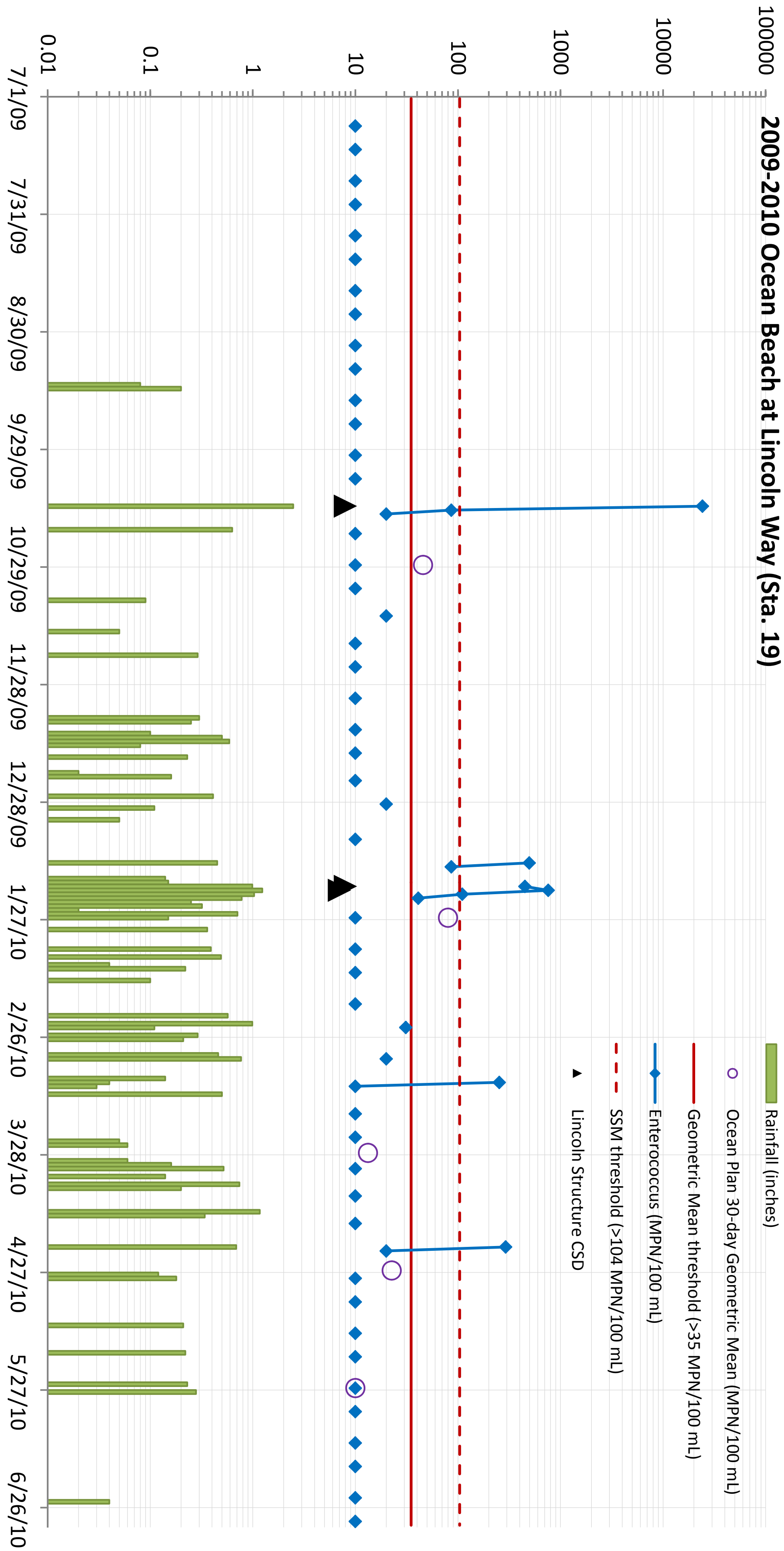


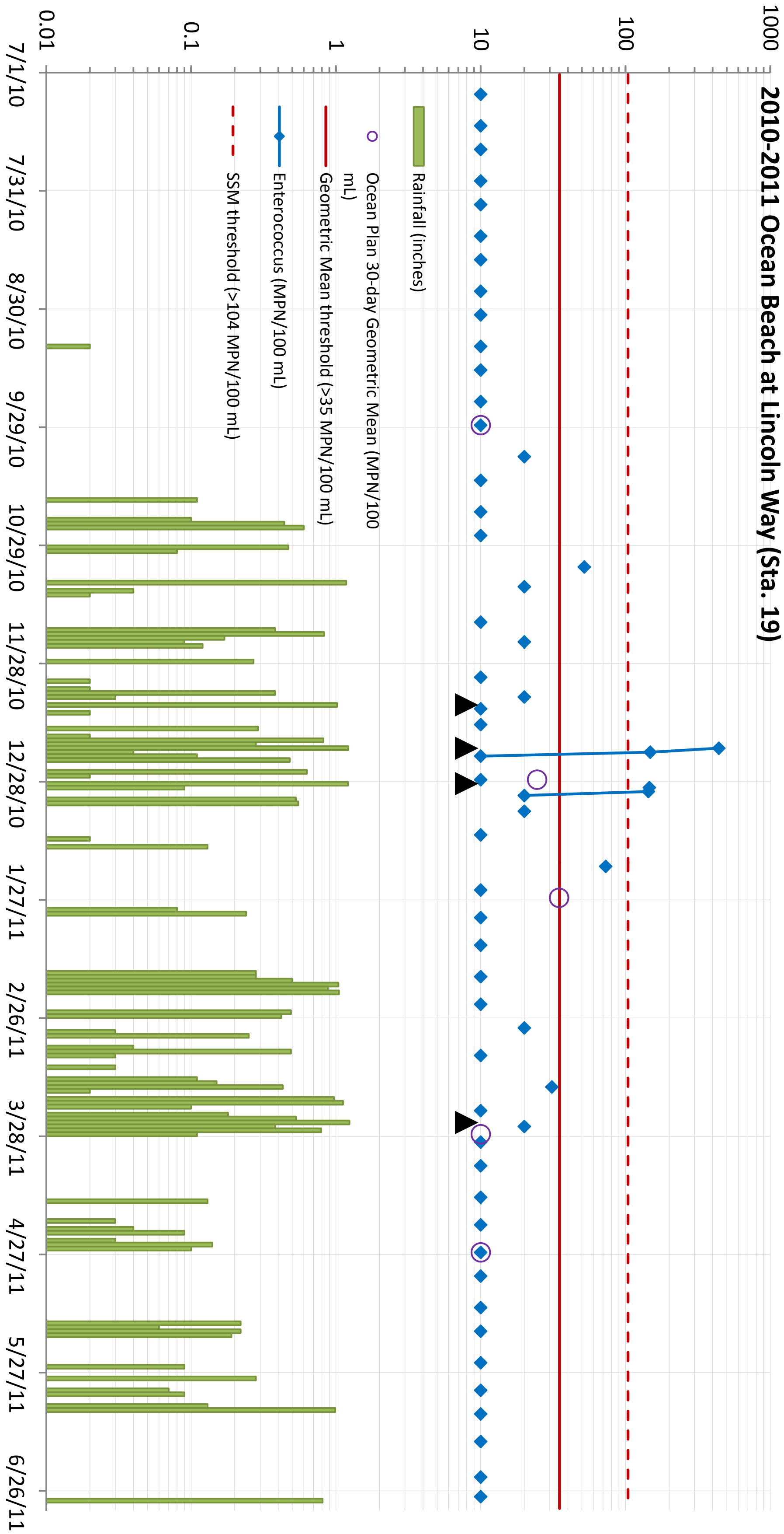
Arsenic (µg/L)

Statistic	Overflow	Decant
Count	40	65
Mean	1.1	3.2
Std. Deviation	1.3	1.1
Median	0.7	0.7
Maximum	5.6	5.7
Minimum	ND	ND

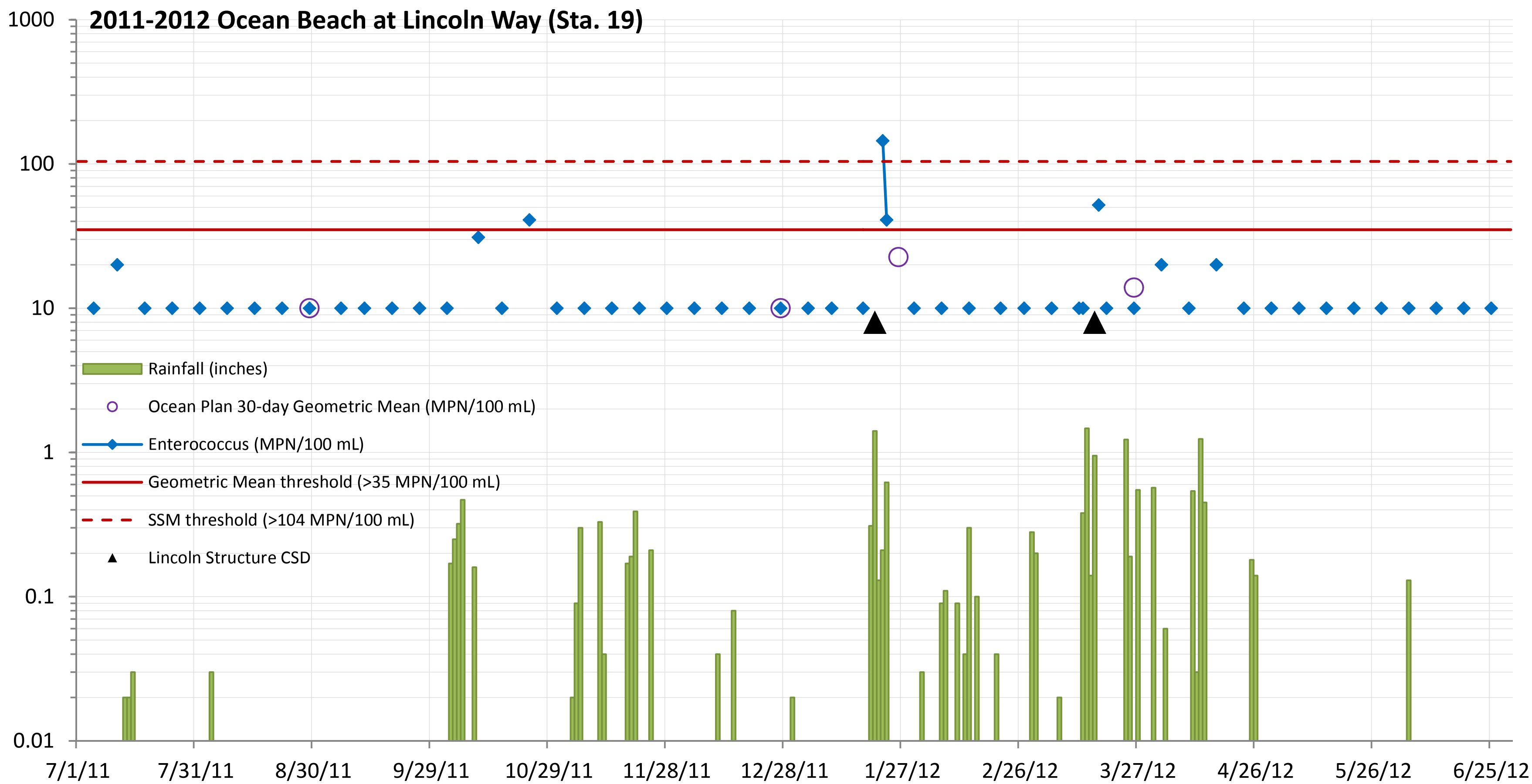


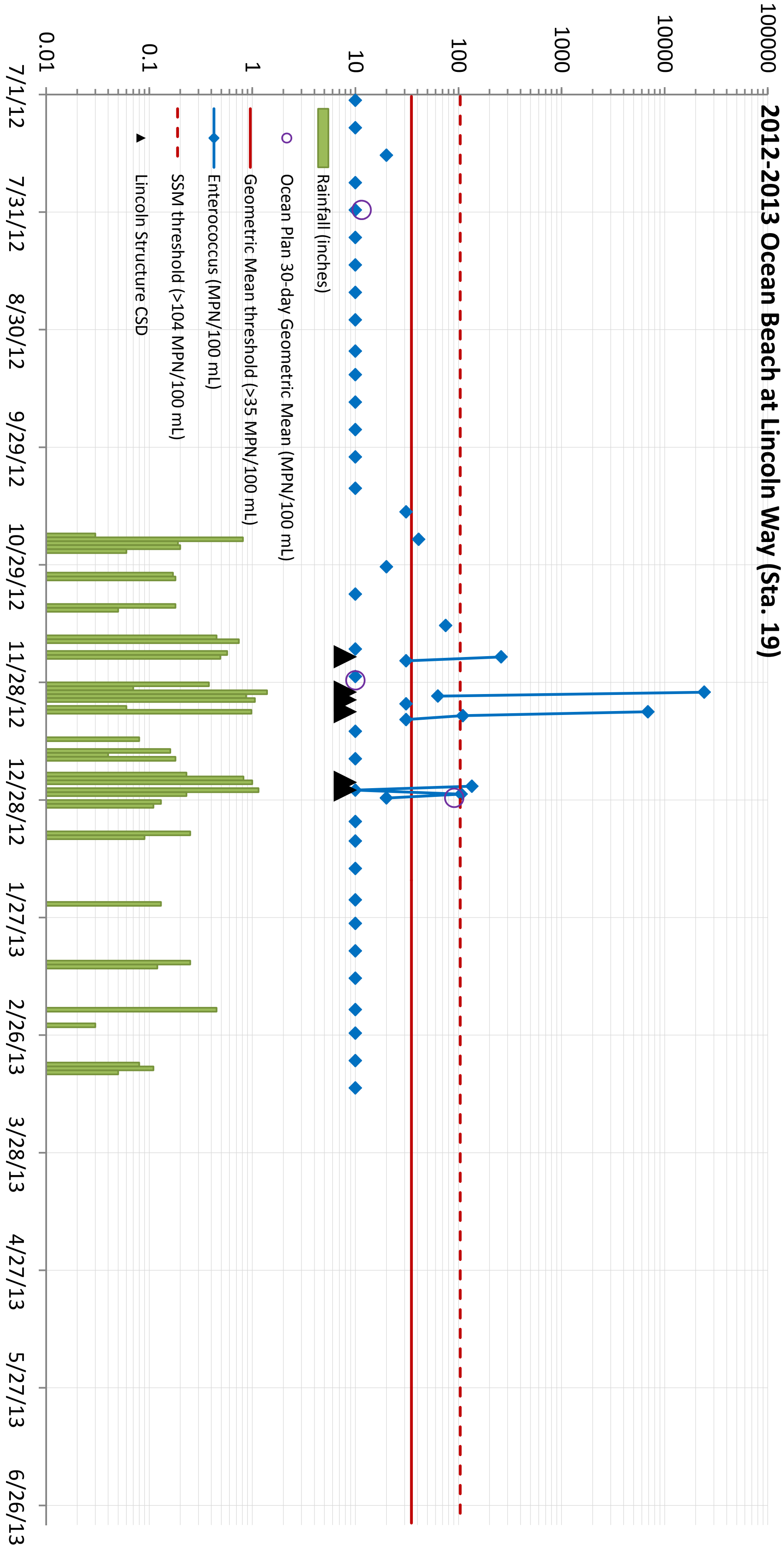
APPENDIX B
LINCOLN WAY BEACH MONITORING RESULTS


2009-2010 Ocean Beach at Lincoln Way (Sta. 19)
Rainfall (inches)
Ocean Plan 30-day Geometric Mean (MPN/100 mL)
Geometric Mean threshold (>35 MPN/100 mL)
Enterococcus (MPN/100 mL)
SSM threshold (>104 MPN/100 mL)
Lincoln Structure CSD
100000
10000
1000
100
10
1
0.1
0.01
7/1/09
7/31/09
8/30/09
9/29/09
10/29/09
11/28/09
12/28/09
1/27/10
2/26/10
3/28/10
4/27/10
5/27/10
6/26/10



2010-2011 Ocean Beach at Lincoln Way (Sta. 19)
1000
100
10
1
0.1
0.01
Rainfall (inches)
Ocean Plan 30-day Geometric Mean (MPN/100 mL)
Geometric Mean threshold (>35 MPN/100 mL)
Enterococcus (MPN/100 mL)
SSM threshold (>104 MPN/100 mL)
7/1/10
7/31/10
8/30/10
9/29/10
10/29/10
11/28/10
12/28/10
1/27/11
2/26/11
3/28/11
4/27/11
5/27/11
6/26/11


2011-2012 Ocean Beach at Lincoln Way (Sta. 19)
1000
100
10
1
0.1
0.01
Rainfall (inches)
Ocean Plan 30-day Geometric Mean (MPN/100 mL)
Enterococcus (MPN/100 mL)
Geometric Mean threshold (>35 MPN/100 mL)
SSM threshold (>104 MPN/100 mL)
Lincoln Structure CSD
7/1/11
7/31/11
8/30/11
9/29/11
10/29/11
11/28/11
12/28/11
1/27/12
2/26/12
3/27/12
4/26/12
5/26/12
6/25/12


2012-2013 Ocean Beach at Lincoln Way (Sta. 19)
100000
10000
1000
100
10
1
0.1
0.01
7/1/12
7/31/12
8/30/12
9/29/12
10/29/12
11/28/12
12/28/12
1/27/13
2/26/13
3/28/13
4/27/13
5/27/13
6/26/13
Rainfall (inches)
Ocean Plan 30-day Geometric Mean (MPN/100 mL)
Geometric Mean threshold (>35 MPN/100 mL)
Enterococcus (MPN/100 mL)
SSM threshold (>104 MPN/100 mL)
Lincoln Structure CSD