Department of Utilities
Office of the Director

CITY OF SACRAMENTO
CALIFORNIA

1395 35th Avenue
Sacramento, CA 95822-2911
phone (916) 808-1400
fax (916) 808-1497/1498

June 28, 2013
(130148:hl)

Mr. Lucio Orellana
California Regional Water Quality Control Board – Central Valley Region
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670-6114

Re: Sacramento Combined Wastewater Collection and Treatment System (Order No. R5-2010-0004, NPDES Permit No. CAS0079111) Water Quality Assessment Report

Dear Mr. Orellana:

The water quality assessment report for the City of Sacramento's combined wastewater control system is enclosed and submitted in compliance with Provision C.2.a. Order R5-2010-0004.

Please contact Sherill Huun at (916) 808-1455 if you have any questions or require additional information.

Sincerely,

Dave Brent, P.E.
Director
Department of Utilities
City of Sacramento

Enclosures

Copies: Bill Busath, Engineering and Water Resources Division Manager
Michael Malone, Operation and Maintenance Division Manager
Dave Phillips, Water and Sewer Superintendent
Brett Grant, Supervising Engineer
Sherill Huun, Supervising Engineer

Department of Utilities
Office of the Director

CITY OF SACRAMENTO
CALIFORNIA

1395 35th Avenue
Sacramento, CA 95822-2911
phone (916) 808-1400
fax (916) 808-1497/1498

CITY OF SACRAMENTO
COMBINED WASTEWATER COLLECTION AND TREATMENT SYSTEM

NPDES NO. CA0079111
ORDER NO. R5-2010-0004

WATER QUALITY ASSESSMENT REPORT
JUNE 2013

CERTIFICATION

In accordance with Title 40, Section 122.22, Paragraphs (b) and (d) of the Code of Federal Regulations:

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.

Executed on the 28 day of June, 2013

Dave Brent, P.E.

Director
Department of Utilities
City of Sacramento

JUNE 2013

CITY OF SACRAMENTO COMBINED SEWER SYSTEM

Water Quality Assessment

prepared by

LARRY WALKER ASSOCIATES

LARRY WALKER ASSOCIATES

Table of Contents

List of Figures

List of Tables

List of Appendices

List of Terms and Acronyms

Basin Plan	Water Quality Control Plan for the Sacramento-San Joaquin River Basins
CDEC	California Data Exchange Center
CIP	Capital Improvement Plan
CIWQS	California Integrated Water Quality System
CMP	Sacramento Coordinated Water Quality Monitoring Plan
CSIP	Combined System Improvement Plan
CSO	Combined sewer overflow
CSS	Combined Sewer System
CTR	California Toxics Rule
CTR	California Toxics Rule
CVCWA	Central Valley Clean Water Association
CWA	Clean Water Act
CWTP	Combined Wastewater Treatment Plant
DO	Dissolved Oxygen
EC	Electrical Conductivity
EPA	Environmental Protection Agency
H&H	Hydrologic & Hydraulic
LID	Low Impact Development
LTCP	Long-Term Control Plan
MBAS	Methylene Blue Active Substances
MCL	Maximum Containment Level
MG	Million Gallons
MGD	Million Gallons per Day
MMP	Mandatory Minimum Penalty
MS4	Municipal Separate Storm Sewer System
MUN	Municipal and Domestic Supply
ND	Non-Detect
Near-field	Distance downstream from the point of discharge to the location where effluent and receiving water are well-mixed.
NMCs	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
Permit	NPDES Permit No. CA007911, Order No. R5-2010-0004
Pioneer	Pioneer Reservoir Treatment Plant
POTW	Publically Owned Treatment Works
Regional Board	Central Valley Regional Quality Control Board

SRCSD	Sacramento Regional County Sanitation District
SRWTP	Sacramento Regional Wastewater Treatment Plant
Sump 1/1A	Pumping facilities and point of untreated overflow discharge
Sump 2/2A	Pumping facilities and point of untreated overflow discharge
SW	Stormwater
SWP	State Water Project
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TTHMs	Total Trihalomethanes
USGS	United States Geoligical Survey
WLA	Waste Load Allocation
WQA	Water Quality Assessment
WW	Wastewater

~ This page intentionally left blank ~

Executive Summary

INTRODUCTION AND BACKGROUND

The City of Sacramento (City) operates a combined sewer system (CSS) serving approximately 11.3 square miles in the Downtown, East Sacramento, and Land Park areas. The CSS conveys domestic and commercial wastewater and stormwater in common pipelines, operating through four main facilities: Sump 1/1A, Sump 2/2A, Pioneer Reservoir Treatment Plant, and Combined Wastewater Treatment Plant (CWTP). The majority of flows from the CSS service area are routed to the Sacramento Regional Sanitation District's Wastewater Treatment Plant (SRWTP) for secondary treatment prior to discharge to the Sacramento River, except during large storm events. When rainfall causes flows at Sump 2A to exceed 60 million gallons per day (MGD), the excess is diverted to CWTP and Pioneer first for storage, and then when storage capacities are depleted, for primary treatment including disinfection, sedimentation, floatable removal and discharge to the Sacramento River. During rare extreme high flow conditions, untreated combined wastewater may be discharged at Sumps 2 and Sumps 1A.

The CSS operates in compliance with federal and state requirements. On the federal level, the Clean Water Act (CWA) specifies water quality-based requirements and technology-based requirements for combined sewer systems. The City implements Nine Minimum Controls (NMCs) to comply with the technology-based requirements of the CWA, and implements its Combined System Improvement Plan (CSIP) to fulfill the CWA requirement for a long-term combined sewer overflow (CSO) control plan (LTCP) to comply with the water quality-based CWA requirements. Since implementation of the CSIP in 1995, the City has completed major infrastructure upgrades including the conversion of Pioneer Reservoir to a primary treatment plant and capacity upgrades to Sumps 1 and 2. These improvements have decreased the frequency of untreated discharge events and the overall annual volume discharged to the Sacramento River. The average number of days with discharge decreased from 15 with treated discharge and 7 with untreated discharge during 1990-1995 to four with treated discharge and 0.2 with untreated discharge during the 2004-2012 period. The overall annual average discharge volume decreased by over 60%, from 455 MG of treated discharge and 119 MG of untreated discharge during 1990-1995 to 217 MG of treated discharge and 1.4 MG of untreated discharge during the 2004-2012 period. On the state level, the CSS operates under NPDES Permit No. CA0079111, Order No. R5-2010-0004. The Permit specifies that the City is required to perform a Water Quality Assessment (WQA) to evaluate the impact of CSS discharges on receiving water quality and beneficial uses.

APPROACH

The City performed water quality monitoring during periods of overflow discharge to the Sacramento River as described in the *Water Quality Assessment Plan* submitted to the Central Valley Regional Water Quality Control Board (Regional Board) on September 1, 2010. The City collected sampling and analysis data at all overflow discharge locations, including influent, discharge and receiving water. A water quality assessment was performed as a series of screenings and evaluations, as shown in **Figure ES-1**. These data were first screened through all applicable California Toxics Rule and Central Valley Basin Plan water quality objectives to identify a short list of constituents for further review. Constituents and their associated water quality objectives were then categorized based on the beneficial use potentially impacted by overflow discharges. The identified beneficial use can be used to develop an appropriate "exposure period" to evaluate overflow discharge impacts. The City assessed water quality impacts for these constituents with a mass loading comparison and assessment of the receiving water's assimilative capacity, and a loading comparison between the existing combined sewer system and a hypothetical separate sewer system.

Performance and discharge modeling was conducted for the CSS to analyze discharges to the Sacramento River under baseline and proposed improvement program projects conditions. The modeling was conducted using a hydrologic and hydraulic (H&H) numerical model for the CSS.

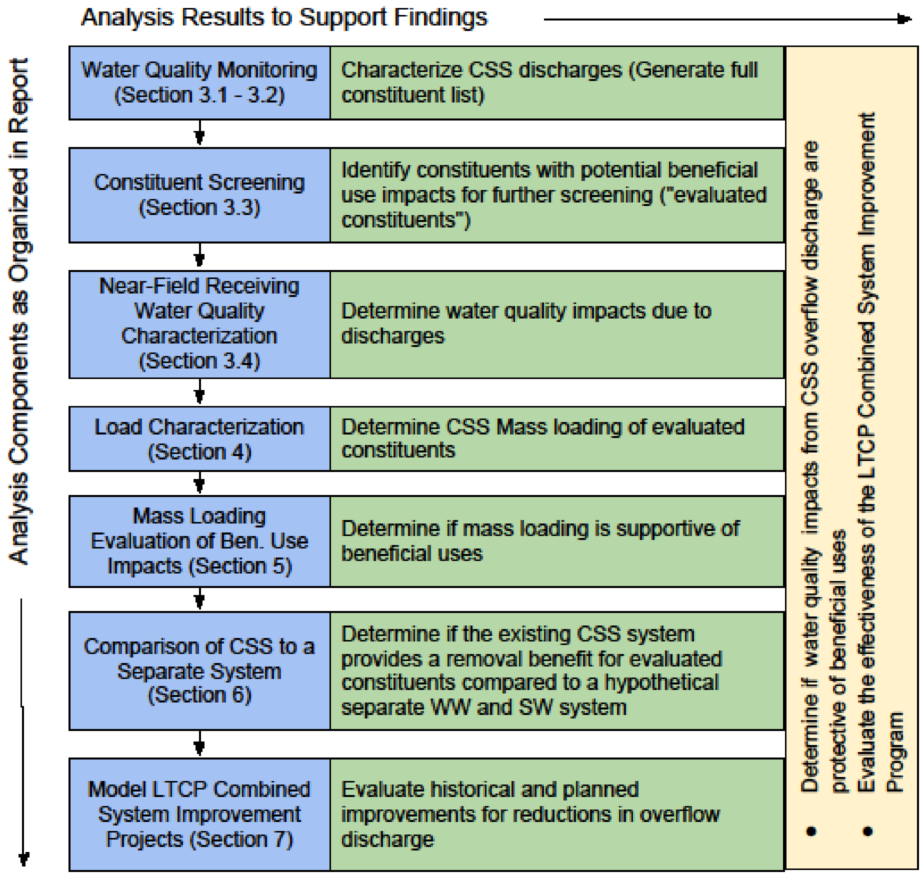


Figure ES-1. Water Quality Impact Assessment Approach

FINDINGS

The WQA addressed the Permit requirements through the findings presented below.

Permit requirement (p. 21) to evaluate the impact of CSO discharges in relation to all applicable water quality objectives and designated uses.

- The infrequent and short duration combined sewer system overflow discharges do not impact applicable receiving water beneficial uses. When considering beneficial use protection, the exposure period associated with the water quality objective should be considered. The City applied relevant exposure periods for the fully mixed assimilative capacity assessment that demonstrated that overflow discharge loads are only a small fraction of the existing loading and assimilative capacity of the Sacrament River (**Sections 3 - 5**).

- The combined sewer system provides a clear benefit over a hypothetical separate sewer system. Based on data from the 2010/2011 and 2011/2012 storm years, the combined system provides secondary treatment of approximately 97% of total wastewater and stormwater flows, exceeding the presumptive approach requirement of 85%. On average, only approximately 0.09% of flow is an untreated overflow discharge. The above mentioned secondary treatment benefits typically include all events less than 1 inch, and the "first flush" portion of all events preceded by any substantial dry weather period. Separating the combined system would increase the pollutant loading for most of the constituent evaluated **(Section** 6**)**.
- *Cryptosporidium* and *Giardia* in overflow discharges does not currently impact downstream municipal water supplies based on the findings of the Central Valley Drinking Water Policy Group Synthesis report that concluded that existing conditions are protective of municipal supplies (**Section** 8**)**.
- Excursions below the pH effluent limitations (6.5-8.5) do not cause downstream receiving water limitation excursions in the highly buffered Sacramento River. Visual inspections did not identify nuisance odor, foam, or floatables caused by the overflow discharges in the Sacramento River (**Section** 8**)**.

Permit requirement (p. 21) to evaluate if updates and/or revisions to the NMCs or LTCP are necessary (if the assessment indicates that applicable water quality objectives are exceeded or that designated uses are impaired).

- The Long Term Control Plan (LTCP), commonly referred to as the "Combined System Improvement Plan," is a long planning horizon effort. The frequency and volume of overflow discharge was reduced during the initial phases beginning in 1995, and current projects are focused on decreasing the frequency of flooding and overflows from five and ten year storm events. Since 1995 the frequency and volume of overflow discharges to the Sacramento River have been decreased by more than 50%. The City has developed a computational hydrologic and hydraulic model that is capable of evaluating the effect of system changes and improvements on system capacity and overflow discharges. The City's current efforts to reduce flooding episodes do not significantly change the frequency of overflow discharges. The City will continue to evaluate all new projects using the model to also consider changes to the frequency and duration of overflow discharge events (**Section** 7).
- Based on facility and operational improvements since the 1990s, the reduction in frequency and duration of overflow discharge events, the existing protection of applicable beneficial uses, and the overall benefit of the combined sewer system compared to a hypothetical sewer system, there are no significant changes recommended to the Nine Minimum Control and Long Term Control Programs **(Section** 9**)**.

RECOMMENDED ACTION ITEMS

The City proposes the following action items (**Section 9)** to continue to minimize CSS outflows and protect receiving water quality:

- Participate in the Central Valley Drinking Water Policy Workgroup study on pathogens (July 2013- June 2016);
- Complete the Delta Methylmercury Phase 1 Control Study (July 2013-October 2016);
- Continue development of collection and treatment system model scenarios (Status reported annually; updated CSIP expected January 2014);
- Participate in Sacramento – San Joaquin River Delta modeling and monitoring programs (July 2013-ongoing); and
- Continue CSS infrastructure improvements through Phase 2 of the CSIP (Ongoing).

1 Introduction and Background

1.1 INTRODUCTION

The City of Sacramento (City) operates its Combined Sewer System (CSS), the collection and conveyance system for combined wastewater and stormwater, in its Downtown, East Sacramento, and Land Park areas (**Figure 1-1**). The CSS operates under NPDES Permit No. CA0079111, Order No. R5-2010-0004 (Permit) issued by the Central Valley Regional Water Quality Control Board (Regional Board).

In order to comply with federal Clean Water Act requirements for combined systems, the City implements Nine Minimum Controls (NMCs) to comply with technology-based requirements of the CWA. In addition, the City implements a long-term CSO control plan (LTCP) to comply with water quality-based requirements of the CWA. To assess any water quality impacts from CSS discharge events, the City has conducted a water quality monitoring program since 1991 and completed a Water Quality Assessment in 1995. Under its current Permit, the City conducted intensive discharge and receiving water monitoring over three wet seasons (targeting discharge events that occurred during 2010/2011, 2011/2012, and 2012/2013) in order to perform an updated Water Quality Assessment (WQA). This Water Quality Assessment evaluates the water quality impacts from the CSS on receiving water quality and beneficial uses, and the observed water quality improvements based on the LTCP.

The City collected these data and prepared this Water Quality Assessment to demonstrate compliance with the presumed protection of beneficial uses in the receiving water (Sacramento River between the ‘I’ Street Bridge and Hood). Because the CSS already provides treatment for more than 85% of the system flow at the Sacramento Regional Wastewater Treatment Plant (SRWTP) and averages less than five (untreated) overflow events per year, and is in compliance with the EPA’s 1994 Combined Sewer Overflow (CSO) Control Policy’s Presumptive Approach (Section 1.4), the LTCP projects are focused on flood protection to minimize street flooding during a 10-year storm event and prevent structure flooding during the 100-year storm event. Over the long-term planning horizon additional storage facilities may decrease the frequency and volume of overflow events under current climatic conditions.

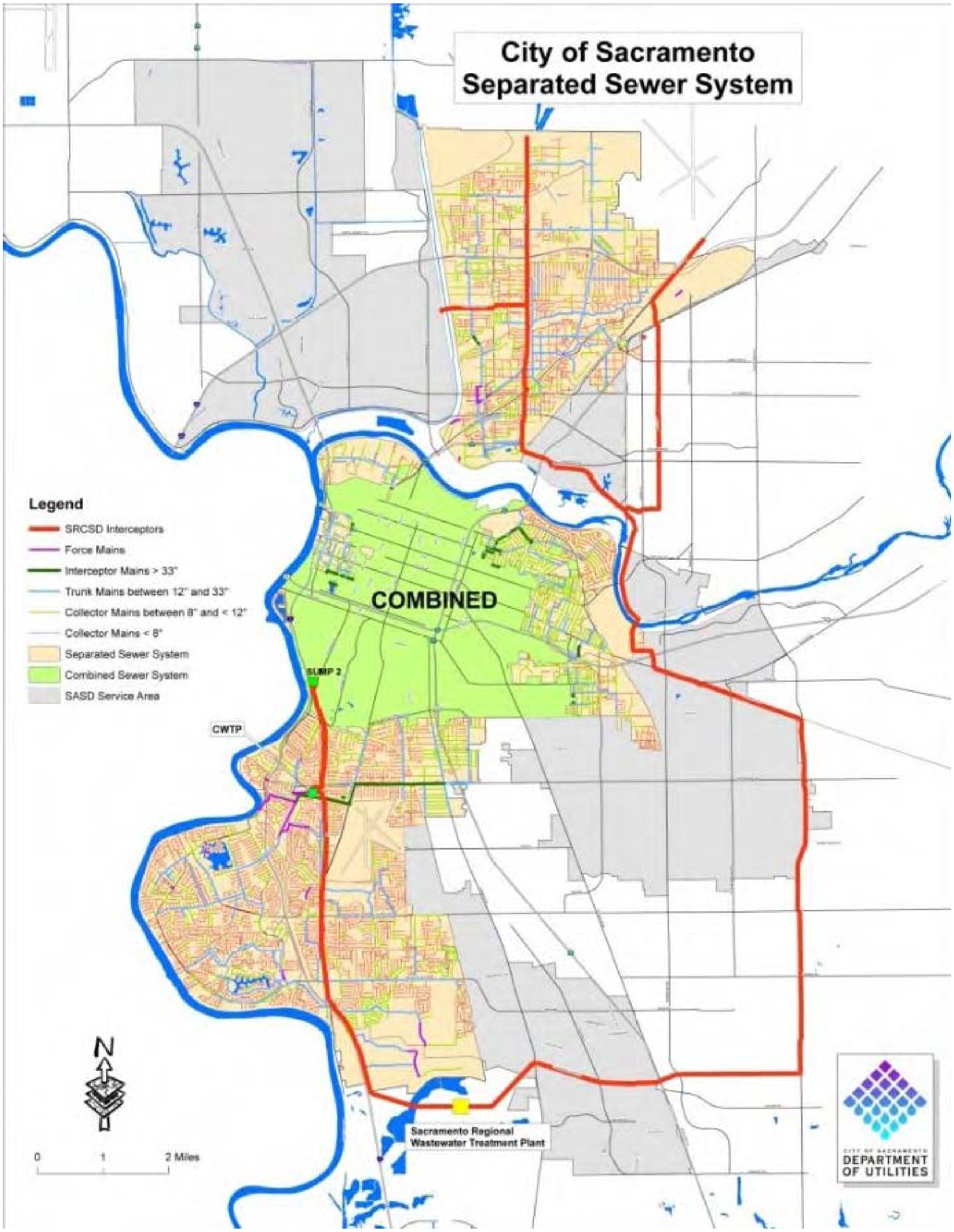


Figure 1-1. Location of the City of Sacramento Combined Sewer System and Separate Sewer System

1.2 OVERVIEW OF THE CSS

The City's wastewater collection system includes two distinct types of conveyance systems: the CSS and a separate sanitary sewer system **(Figure 1-1**). The CSS serves the downtown business district and adjoining areas south of the American River and east of the Sacramento River, covering approximately 10 square miles. The CSS conveys domestic and commercial wastewater and stormwater in common pipelines. The City operates four main facilities to manage CSS flows: 1) Sump 1/1A, 2) Sump 2/2A, 3) Pioneer Reservoir Treatment Plant, and 4) Combined Wastewater Treatment Plant (CWTP). The majority of the sewerage and drainage collected by the CSS is delivered by Sump 2 and 2A to the City Interceptor, and ultimately to the Sacramento Regional County Sanitation District's Wastewater Treatment Plant (SRWTP) for secondary treatment prior to discharge to the Sacramento River, except during large storm events as described below.

During wet weather conditions, the combined wastewater and stormwater flows are managed by the City to limit the number of overflows and outflows by using a combination of storage and treatment facilities. This is accomplished by managing Sump 2 and 2A and the Flow Control Structure to maximize the combined wastewater delivered to SRWTP , and utilizing the City's Pioneer Reservoir and CWTP for storage and primary treatment. When rainfall causes flows at Sump 2/2A to exceed 60 million gallons per day (MGD), the excess is diverted to the CWTP, a wet weather treatment facility, for floatable removal, sedimentation and disinfection. Pioneer Reservoir Treatment Plant provides a similar level of primary treatment. When the storage capacities at Pioneer Reservoir (23 million gallons) and CWTP (7.1 million gallons) are reached, primary treated effluent is discharged to the Sacramento River. During extreme high flow conditions, discharges of untreated combined wastewater may occur at Sump 2 and at Sumps 1A to prevent downtown flooding. A simplified schematic of CSS flows is shown in **Figure 1-2**.

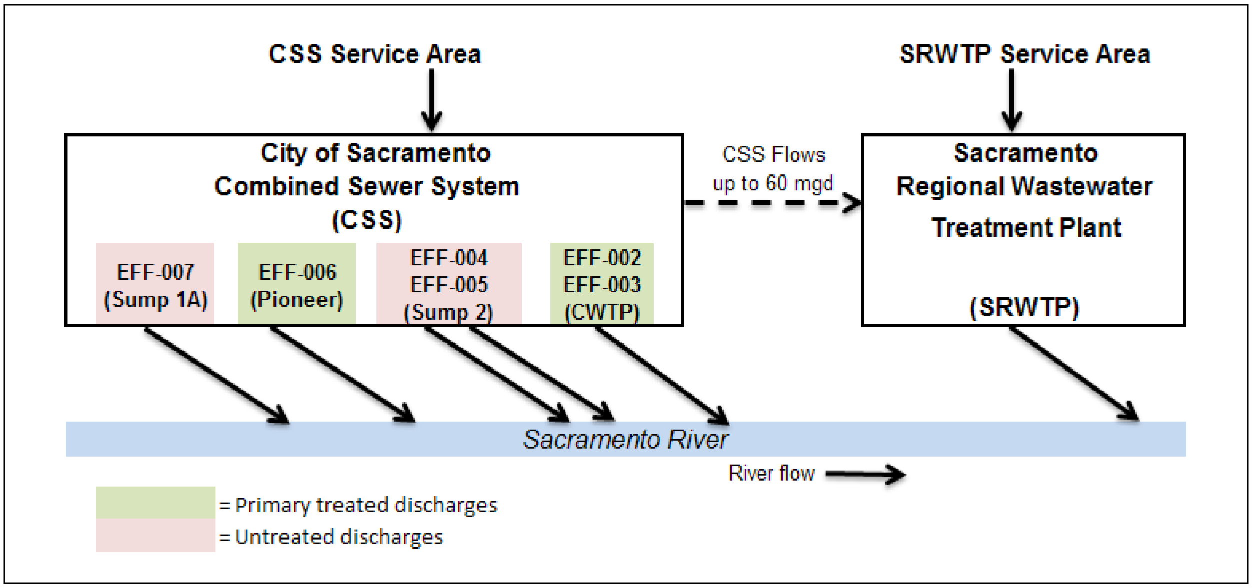


Figure 1-2: CSS Schematic Showing Direct Discharge Locations to the Sacramento River and Flow to the SRWTP.

1.3 WATER QUALITY ASSESSMENT OBJECTIVE

The City is required to perform a Water Quality Assessment to evaluate the impact of CSS discharges on receiving water quality and beneficial uses. Section VI.C.2.a.of the Permit includes the following requirements for the Water Quality Assessment:

> *(i) An analysis evaluating the potential impact of CSO discharges in relation to all applicable water quality objectives (including Basin Plan and CTR water quality objectives) and designated uses. If applicable water quality objectives cannot be achieved and designated uses cannot be adequately protected, then the Discharger shall also assess the need for coordination with the Regional Water Board for the review and revision of water quality objectives and implementation procedures to ensure that future CSS controls will be sufficient to meet water quality objectives.*
>
> *(ii) An evaluation of necessary updates and/or revisions to the Nine Minimum Controls and/or Long-Term Control Plan if the assessment indicates that applicable water quality objectives are exceeded or that designated uses are impaired. The Discharger shall also provide proposed time frames for implementation of any proposed CSS program updates and/or revisions (p. 21)*

1.4 CSS CONTROL POLICY REQUIREMENT

The EPA's 1994 Combined Sewer Overflow (CSO) Control Policy provides a national framework for Permittees to develop and implement long-term CSO control plans that will result in compliance with requirements of the Clean Water Act (CWA). The Control Policy is implemented through the NPDES permit program.

CSOs are defined as the discharge from the combined sewer system at a point prior to the publicly owned treatment works (POTW) treatment plant[1]. According to the CSO Control Policy, the CSS is required to implement NMCs, which constitute the technology-based requirements of the CWA. The NMCs (listed in Section 1.5.2) are intended to prevent CSOs and reduce their effects on receiving water quality. The City's implementation of the NMCs has been summarized annually in progress reports to the Regional Board.

Additionally, the City implements a long-term CSO control plan (LTCP) to comply with water quality-based requirements of the CWA. The City adopted the Combined System Improvement Plan (CSIP) in 1995 that is the infrastructure improvement portion of the LTCP. Since implementation of these programs, the frequency and volume of overflow discharge volumes has decreased 50% based on a modeling evaluation, and the upgrade of Pioneer Reservoir to a primary treatment plant and capacity upgrades to Sumps 1 and 2 reduced combined sewer overflows (CSOs) from an average of 6 untreated discharges per year to less than 1 per year.

The CSO Control Policy specifies a "presumptive" approach to comply with the water quality-based CWA requirements. The policy specifies that a CSS that meets any of the following specific criteria would be presumed to meet the water quality-based requirements, provided that the permitting authority determines that such presumption is reasonable given data and analysis conducted for the system.

---

[1] Federal Register, Vol. 59 No. 75, 19 April 1994, Section 1.A.

1) No more than an average of 4 overflow events per year (CSOs/overflow due to a precipitation event that does not receive the minimum amount of treatment). An additional 2 overflow events may be allowed at the discretion of the permitting authority; or
2) An average of at least 85% capture of CSS volume flows during storm events; or
3) The elimination of at least the mass of pollutants shown to be causing water quality impairment.

1.5 HISTORY OF PROGRAM, PERMITTING, AND COMPLIANCE

The water quality monitoring program for the CSS has been in place since February 1991. The program was conducted pursuant to the Regional Water Quality Control Board's Waste Discharge Requirements (Order No. 90-315) and a 1990 Cease and Desist Order (CDO; No. 90-197 and Amendments No.'s 91-198 and 92-217). In accordance with the 1990 CDO, the City completed studies to identify measures to eliminate CSS outflows and not increase CSOs. The LTCP alternative was selected to meet the CDO along with the CSO Control Policy water quality-based requirements.

A dye dispersion study conducted in 1991 determined receiving water monitoring locations which are located within the discharge plume for their respective discharge locations, where the plume is mixed across the width of the Sacramento River and is relatively stable, and thus reflective of overall Sacramento River conditions (Christophel and Arsenault, 1991). Those receiving water locations were selected for monitoring to investigate potential impacts of CSS discharges on Sacramento River water quality.

The City completed a Water Quality Assessment in 1995 titled "Effluent and Receiving Water Quality and Toxicity Summary Report for 1991-1995" that used the presumptive approach to demonstrate compliance with the water quality-based requirements of the CWA (Tomko, 1995). At that time, the CSS had an average frequency of 15 discharge events per year from the CWTP (treated), and an average frequency of seven CSO events (untreated) per year. Between 1990 and 1995 the total annual volumes discharged by the CSS to the river ranged from 210 to 960 million gallons (MG) and an average of 575 MG. Approximately 92% of CSS flow volume received treatment (61% received secondary treatment from SRWTP). Assessment of water quality from primary treated CSS discharge and from untreated CSO events determined that, overall water quality impacts from discharges were minimal and transient. Analysis from CSO events showed that levels of indicator bacteria and metals (total and dissolved lead, and dissolved zinc) were significantly higher in downstream waters following CSO events. However, the assessment concluded that those increases were not problematic due to the short-term duration of discharge during periods when public contact with CSOs was minimal. The following water quality constituents in CSS effluent were detected at levels that exceeded relevant EPA water quality objectives:

- Dissolved mercury for CWTP discharges. However, background levels were high in the Sacramento River, and the detection limits at the time were higher than EPA criteria.
- Organic compounds: bis(2-ethylhexyl)phthalate, tributyl tin, tetrachloroethylene, 1,1-dichloroethene, and gamma BHC.
- Chlorination byproduct chloroform.

The assessment noted that due to the dilutional (assimilative) capacity of the Sacramento River during CSS discharges, it was unlikely that the CSS would have caused any exceedances of objectives for those constituents in the Sacramento River.

This Water Quality Assessment considers discharges that occurred during the 2010/2011, 2011/2012 and 2012/2013 storm years. The first discharge event of 2010 (October 24, 2010) was an untreated discharge event where full sample collection was not possible[2]; thus, the Water Quality Assessment includes all events occurring from December 2010 (the second discharge event of 2010/2011) through December 2012, as summarized in Table 3-3 in Section 3.

1.5.1 NPDES Permit Violations

The California Integrated Water Quality System (CIWQS) public reporting database (Facility At-A-Glance report from May 2013) since February 2009 states the CSS received 29 individual violations. Seven of these violations were related to effluent pH, two were residual chlorine, and two were percent solids removal. The remaining violations were six reporting deficiencies (e.g., omission of "no observed nuisance conditions"), sample location labeling deficiencies, missing thermometer calibration certification or refrigeration conditions, procedural violation in testing backup power, and unauthorized discharge violations, primarily due to the October 2010 incident. All violations have been addressed and/or corrected. During the past five years, the City received no Mandatory Minimum Penalty (MMP) violations for late reports; however, the City did receive six MMP effluent violations. As indicated in the Facility At-A Glance report, these six MMP effluent violations occurred between January 21, 2012 and December 2, 2012 and were for exceedances of pH, chlorine total residual and total suspended solids. The City addressed these violations as documented in communications with the Regional Board.

1.5.2 Nine Minimum Controls Compliance

The CSO Control Policy and the NPDES permit require compliance with the following nine minimum controls:

1) Proper operation and regular maintenance programs;
2) Maximization of the sewer collection system storage;
3) Review and modify the pretreatment program;
4) Maximization of flows to the publicly owned treatment works (POTW) treatment plant;
5) Elimination of combined sewer overflows (CSOs) during dry weather;
6) Control of solid and floatable materials in CSOs;
7) Implementation of pollution prevention programs to reduce contaminants in CSOs;
8) Implementation of public notification; and
9) Monitoring to characterize CSO impacts and efficacy of CSO controls

Annually the City documents activities supporting these controls and demonstrates compliance through operation and activity documentation, evaluation of system performance data, and the completion of the monitoring program.

---

[2] The October 24, 2010 Untreated discharge is described in the 2010/2011 Untreated Discharge Evaluation Report submitted by the City of Sacramento to the Regional Water Quality Control Board with the CSS Annual Progress Report in January 2011.

1.6 LONG-TERM CONTROL PLAN

The City developed its Combined Sewer System Improvement Plan in 1995 to be implemented over the following 30 years and to satisfy the CSO Policy LTCP requirements. For the purposes of this Water Quality Assessment the term "LTCP" is used to described the CSO Policy requirement and "Combined Sewer System Improvement Plan" is used to describe the City's program that satisfies this requirement. The CSO Policy presents two approaches for development of the LTCP: the Presumption Approach or the Demonstration Approach. The City developed the Combined Sewer System Improvement Plan according to the Presumption Approach, which presumes that the LTCP results in an adequate level of control to meet the water quality based requirements of the CWA if the treatment and discharge meets the minimum criteria presented in Section 1.4.

Performance of the CSS has exceeded the requirements of the Presumptive Approach in the CSO policy after completion of the 1995 Combined Sewer System Improvement Plan involving major improvements made in the first five years that include: conversion and expansion of Pioneer Interceptor and Reservoir to a primary treatment facility; increasing pumping capacity of Sumps 2 and 1/1A; and aggressively rehabilitating Sump 1/1A, Sump 2, and Pioneer. Continued improvements to the combined system involves rehabilitation and construction of local improvements to reduce flooding at specific locations that frequently flood.

The 2010 CSS Permit requires continued implementation of a LTCP to meet the interim goals and make progress towards the final goal of minimizing street flooding during the 10-year storm event and to prevent structure flooding during the 100-year storm event.

The City initiated an update to the Combined System Improvement Plan in 2008, to guide further improvements to the system. The update is an ongoing multiyear project comprised of 2 phases with the intent of charting the next series of projects intended to reduce outflows and eventually meet the LTCP final goals of minimizing flooding. Phase 1 of the project consisted mainly of replacing the old hydraulic combined system model and validating the new hydraulic model for the combined system. Phase 1 will also evaluate outflow reduction for six improvement projects, which will be constructed as a result of the 2008 Combined System Improvement Plan. The results from the Phase 1 modeling study and its implications for the water quality impact are discussed in Chapter 7 of this report. Phase 2 of this project will use the new hydraulic model to develop and evaluate the efficacy of additional construction projects in the combined system. The Combined System Improvement Plan will allow for the City to evaluate, compare, and implement the most efficient and cost-effective projects that will contribute towards meeting the LTCP goals as well as water quality requirements.

Since implementation of the Combined System Improvement Plan in 1995, the City has decreased the frequency of untreated discharge events and the overall annual volume discharged to the Sacramento River. The average number of days with discharge decreased from 15 with treated discharge and 7 with untreated discharge during 1990-1995 to four with treated discharge and 0.2 with untreated discharge during the 2004-2012 period. The overall annual average discharge volume decreased by over 60%, from 455 MG of treated discharge and 119 MG of untreated discharge during 1990-1995 to 217 MG of treated discharge and 1.4 MG of untreated discharge during the 2004-2012 period. During the 2010/2011 and 2011/2012 storm years, approximately 97% of CSS flow was diverted to the SRWTP to receive secondary treatment (**Figure 1-3**). The total volumes discharged from EFF-006 (Pioneer) and EFF-002 (CWTP) by storm year are shown in **Figure 1-4**. The status of the LTCP was reported in the Fiscal 2011-12 Annual Progress Report to the Regional Board submitted on January 30, 2013.

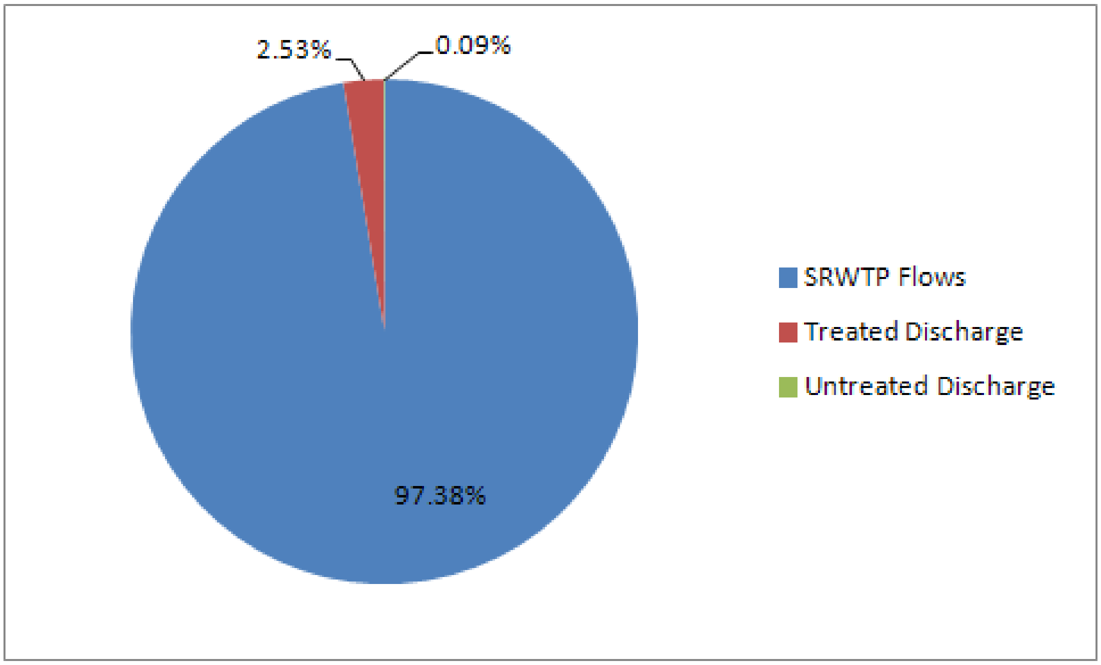
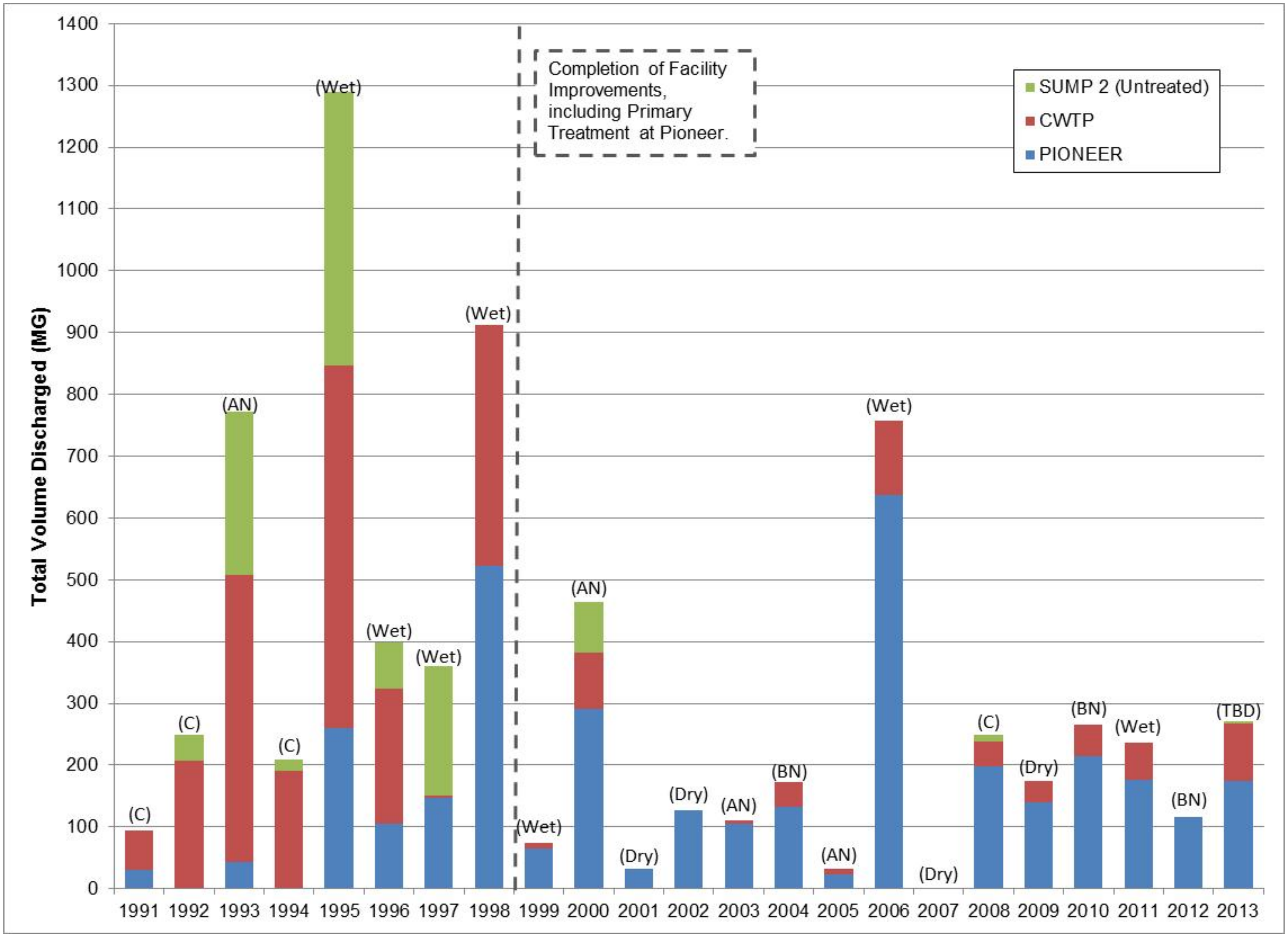


Figure 1-3. Percentages of CSS flow treated by SRWTP, released during treated discharge events, and during untreated discharge events during the 2010/2011 and 2011/2012 storm years



Note: California Department of Water Resources Water Year Designations for the Sacramento River based on observed stream flows for the river and tributary system: C = critically dry, Dry = dry, BN = below normal, AN = above normal, Wet = wet. TBD = to be determined.

Figure 1-4. Discharge Volume by Monitoring Year

1.7 SACRAMENTO RIVER BENEFICIAL USES

1.7.1 Applicable Beneficial Uses

The Water Quality Control Plan for the Sacramento-San Joaquin River Basins (Basin Plan) identifies the beneficial uses of surface waters, along with water quality objectives to protect those beneficial uses. While a number of beneficial uses are identified for the Sacramento River (**Table 1-1**), their consideration in this assessment depends on whether applicable water quality criteria exist to protect such beneficial uses. Where water quality criteria exist, the potential for impact from CSS discharge is assessed using the appropriate averaging period for CSS discharge events. Because discharge events are short in duration, acute 1-hour (rather than 4-day) EPA water quality criteria are considered for protection of the aquatic life beneficial use. The average discharge duration during December 2010 through December 2012 was approximately 5 hours per event. The Permit states that only protection for acute impacts is considered necessary[3].

Where beneficial use impacts are based on longer term averaging periods, annual average CSS discharge impacts are considered when determining potential impacts to beneficial uses such as municipal and domestic water supply and agricultural water supply. In consideration of the recreational beneficial uses (specifically, REC-1 and REC-2), the Permit specifies that water contact recreation is unlikely during CSS discharge events, which occur during the rainy season when river flows are high.

Table 1-1. Basin Plan Beneficial Uses Applicable to the Sacramento River

Beneficial Uses Applicable to the Sacramento River	Appropriate Averaging Period to Evaluate CSS Discharge Impacts
Municipal and Domestic Supply (MUN)	**Annual**
Agricultural Supply, including stock watering (AGR)	**Annual**
Industrial Process Supply (PROC)	No applicable objective
Industrial Service Supply (IND)	No applicable objective
Water Contact Recreation: Contact Recreation (REC 1)	Not an applicable beneficial use during discharge events (Order NO. R5-2010-0004 Page, F-32)
Non-Contact Water Recreation (REC 2)	Not an applicable beneficial use during discharge events (Order NO. R5-2010-0004 Page, F-32)
Warm Freshwater Habitat (WARM)	**Acute 1-hour**
Cold Freshwater Habitat (COLD)	**Acute 1-hour**
Migration of Aquatic Organisms: Warm and Cold (MIGR)	**Acute 1-hour**
Fish Spawning Habitat (SPWN)	**Acute 1-hour**
Wildlife Habitat (WILD)	**Acute 1-hour**
Navigation (NAV)	No applicable objective

Source: Water Quality Control Plan for the Sacramento River Basin and San Joaquin River Basin, Fourth Edition, Revised October

---

[3] NPDES Permit No. CA007911, Order No. R5-2010-0004, Section C.3.d.i., Page F-30

2007 (CVRWQCB, 2007)

1.7.2 303(d) Listings

Section 303(d) of the Clean Water Act requires states to develop lists of water bodies (or segments of water bodies) that will not attain water quality standards (“objectives”, in California) after implementation of minimum required levels of treatment by point-source dischargers (i.e., municipalities and industries). Section 303(d) requires development of a Total Maximum Daily Load (TMDL) for each of the listed pollutant and water body combinations for which there is impairment. A TMDL is the amount of loading of a given constituent that the water body can receive and still meet water quality standards for that constituent. The TMDL must include an allocation of allowable loadings for both point and non-point sources, with consideration of background loadings and a margin of safety. NPDES permit limitations for listed pollutants must be consistent with allocations identified in adopted TMDLs.

U.S. EPA approved California’s 2008-2010 Section 303(d) List of Impaired Waters on November 12, 2010. The 2010 303(d) list includes listings for eight portions of the Sacramento-San Joaquin Delta. The CSS discharges into the northern portion of the Delta. The constituents identified in the 2010 303(d) list for the northern portion of the Delta, along with the status of their associated TMDLs, are summarized in **Table 1-2**, below.

Table 1-2. 2010 303(d) Listed Pollutants for the Northern Portion of the Delta

Pollutant	Pollutant Class	Approved TMDL	Proposed TMDL Completion Date	Current Status
Chlordane	Pesticide		2011	No current activity
Chlorpyrifos	Pesticide	2007		Expected 2013 Amendment
DDT	Pesticide		2011	No current activity
Diazinon	Pesticide	2007		Expected 2013 Amendment
Dieldrin	Pesticide		2011	No current activity
Group A Pesticides	Pesticide		2011	Under Development
Invasive Species	Miscellaneous		2019	
Mercury	Metals/metalloids	2009		
PCBs	Other organics		2019	
Unknown Toxicity	Toxicity		2019	

1.7.3 Delta Methylmercury TMDL Control Study

To address methylmercury impairment in the Sacramento-San Joaquin Delta, the Central Valley Regional Water Quality Control Board developed a TMDL for methylmercury in the Delta (CVRWQB, 2010). The TMDL establishes a methylmercury load allocation for the CSS, which corresponds to a 55% reduction of the current estimated load. The CSS is participating in a methylmercury control study undertaken by the Central Valley Clean Water Association

(CVCWA) Methylmercury Special Project Group, as well as conducting a separate study at the CSS facilities to evaluate methylmercury fate during its primary treatment process.

Due to the intermittent nature of CSS discharges, the primary reductions in methylmercury loading from the CSS will be focused on reducing methylation potential from the treatment and conveyance processes and reducing the discharge volumes to the Sacramento River using a combination of Low Impact Development (LID) strategies and continuing Capital Improvement Plan (CIP) projects described in the LTCP. The City submitted a Control Study Workplan to the Regional Board in April 2012, which outlined the approach proposed to evaluate the following study objectives:

1) Evaluate the potential for methylation during plant and conveyance processes, including (a) existing treatment processes; (b) solids handling; and (c) within the collections system.
2) Determine whether decreasing the stormwater runoff component of wet weather flows through LID and CIP projects will result in reductions in overflow discharge volume and methylmercury loads.

It is anticipated that the Control Study will allow the CSS to better characterize its methylmercury loading potential.

2 Water Quality Assessment Approach

The overall approach to assess water quality impacts is outlined in **Figure 2-1,** and the individual components of the Water Quality Assessment are described in the sections below.

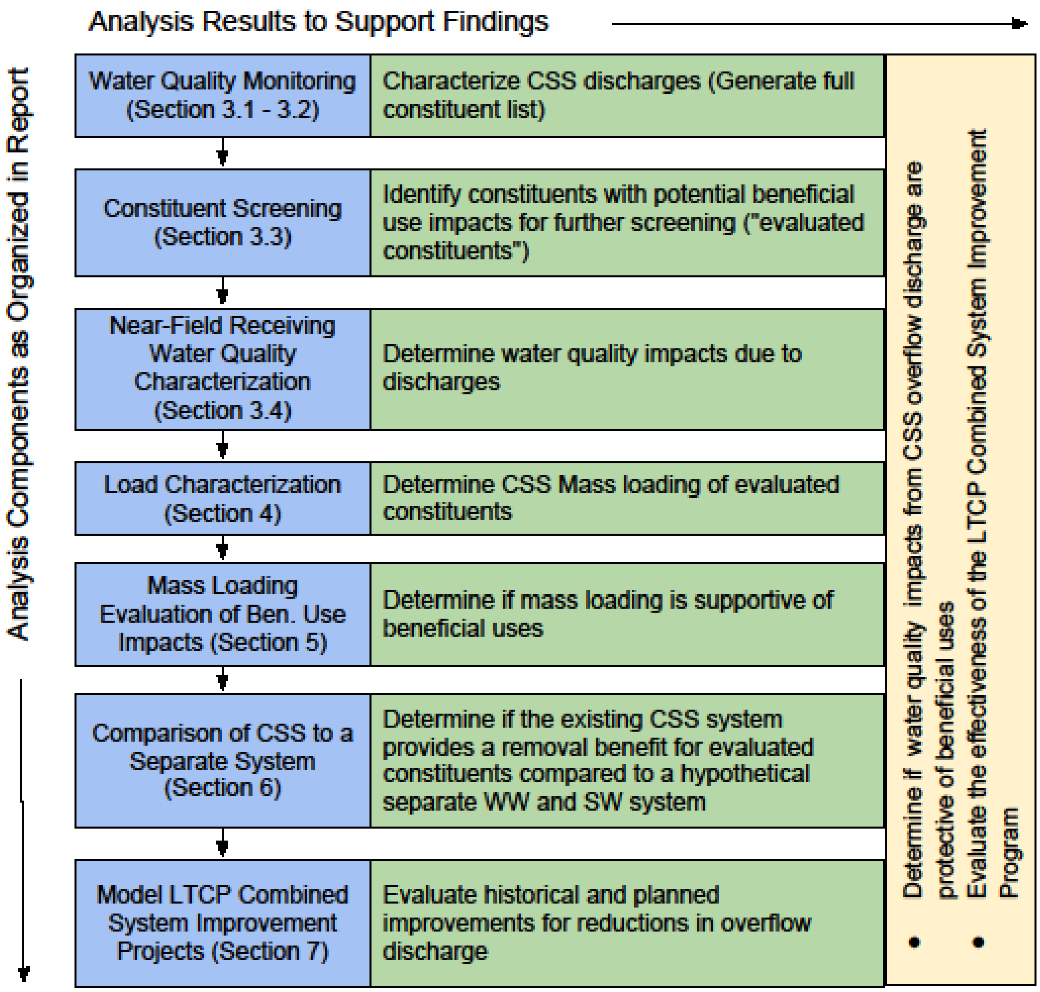


Figure 2-1. Water Quality Impact Assessment Approach

2.1 WATER QUALITY MONITORING

The City conducts a water quality monitoring program to assess the quality of CSS discharges and impacts to receiving waters. Water quality monitoring data that were collected from December 2010 through December 2012 were analyzed for this Water Quality Assessment. Effluent and receiving water quality monitoring is described in **Section 3.1**. In addition, continuous data sensors were deployed in the Sacramento River at two locations, upstream and downstream from Pioneer Reservoir. The continuous sensors measured temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and ammonium, and were used to determine the relative magnitude and duration of impacts to receiving waters from CSS discharges. Continuous sensor monitoring is described in **Section 3.2**.

2.2 CONSTITUENT SCREENING

In order to determine if the constituents monitored in the water quality monitoring program potentially impact a beneficial use in the Sacramento River, a constituent screening was conducted to identify constituents for further evaluation (evaluated constituents). Monitoring data were compared to relevant water quality objectives in the Sacramento River, and a list of constituents for evaluation was developed based on detected data in CSS effluent and availability of stormwater data collected by the Sacramento Stormwater Quality Partnership nearby the CSS service area to characterize CSS influent. In addition, constituents that did not exceed water quality objectives, but are of regional concern in the Sacramento-San Joaquin Delta and Sacramento River were evaluated. The constituent screening process is described in **Section 3.3.**

2.3 NEAR-FIELD RECEIVING WATER QUALITY CHARACTERIZATION

Median concentrations of evaluated constituents were calculated from monitoring data for the effluent (CSS effluent and SRWTP effluent) and influent. The calculated median concentrations are presented in **Section 3.4.**

2.4 OVERFLOW LOAD CHARACTERIZATION

The mass loading of evaluated constituents from the CSS to the Sacramento River was estimated using CSS discharge event volumes and median constituent concentrations. An estimated average annual mass loading for each evaluated constituent from the CSS directly to the Sacramento River was calculated based on 2011 and 2012 data. Because a substantial portion of CSS flows are diverted to the SRWTP for secondary treatment, SRWTP discharges were included in the overall consideration of loading from CSS flows. The mass loading estimates are presented in **Section** 4.

2.5 MASS LOADING EVALUATION OF POTENTIAL BENEFICIAL USE IMPACTS

Assimilative capacity is the mass of a constituent that a receiving water could “carry” over a specified exposure period that is still protective of beneficial uses. Because the CSS overflow discharges occur during periods of higher river flows and are infrequent and short in duration, substantial assimilative capacity is available for the protection of beneficial uses (and associated constituents) with longer exposure periods. Assuming fully mixed conditions at some near downstream location, a mass loading comparison is an appropriate means to assess available assimilative capacity. Each beneficial use “type” is addressed for the averaging period that is most representative of the exposure period.

2.5.1 Acute Aquatic Life

Continuous sensor results reported in **Section 3.2** demonstrated that the impacts of CSS discharges on receiving water quality are transient as they dissipate quickly downstream after the overflow discharge ends. For this reason, acute 1-hour (rather than 4-day) U.S. EPA water quality criteria were considered for protection of aquatic life.

2.5.2 Short Term Human Health

Some constituents, such as nitrate + nitrite and primary maximum contaminant level constituents, pose potential impacts to human health due to exposure over the course of several weeks. For these particular parameters, the Water Quality Assessment examined **average monthly concentrations** to determine if the CSS discharge was impacting the municipal and domestic water supply beneficial use with respect to these constituents.

2.5.3 Long Term Human Health

To assess other long-term drinking water (secondary maximum contaminant levels) and human health-based water quality objectives, **average annual values** were used to evaluate the impact of overflow discharges on the receiving water. Most drinking water objectives are compared to average annual concentrations and California Toxics Rule (CTR) human health objectives are based on 70 years of exposure to a particular constituent.

The assessment of beneficial use impacts was considered by conducting "near-field" (i.e., the reach of the Sacramento River downstream of the CSS discharge to the point where the discharge and receiving water are well-mixed) receiving water characterization of discharge impacts and by characterizing the annual, monthly or hourly loading for evaluated constituents. Sacramento River mass loading at assimilative capacity was estimated for evaluated constituents that have a relevant water quality objective using an appropriate objective and the volume of the Sacramento River water that is estimated to flow past the CSS over a particular averaging period (1- hour, 30 days, or one year). Comparisons of CSS effluent mass loadings with existing in-stream mass loadings upstream of the CSS and with estimated receiving water mass loadings if the Sacramento River reached full assimilative capacity for a particular constituent, were used to estimate the water quality impacts of CSS discharges with respect to available assimilative capacity in the Sacramento River downstream of the CSS. Beneficial use impacts are discussed in **Section** 5**.**

2.6 BENEFIT OF CSS COMPARED TO SEPARATE WASTEWATER AND STORMWATER SYSTEM

The CSS provides treatment year-round to stormwater and dry weather urban runoff flows in the CSS service area by diverting flows (up to 60 MGD) to SRWTP for secondary treatment. In order to quantify the benefit of providing this added treatment compared to a separate wastewater and stormwater system (where stormwater is typically discharged without treatment except in new development areas (a small fraction of the urban watershed) where stormwater management requirements have been in place since 2006), a comparison was conducted of estimated mass loadings of evaluated constituents from the existing CSS system and a hypothetical separate system. The results of this comparison are presented in **Section** 6**.**

2.7 BENEFICIAL USE EVALUATION CHECKLIST

Based on the Water Quality Assessment approach outlined above, a checklist was developed to assess whether evaluated constituents are a water quality issue for the receiving water downstream of the CSS discharge. As demonstrated in **Table 2-1**, the majority of evaluated constituents were determined not to impact applicable beneficial uses. Those constituents which are identified as potential water quality issues are discussed in **Section 8.**

Table 2-1. Water Quality Assessment Constituent Screening Checklist

☑ = Yes
☐ = No
NE = Loading Not Evaluated (See Explanation)
NEL= No Effluent Limit
NWQO = No Water Quality Objective
SR = Similar removal between CSS and Hypothetical Separate System

	Beneficial Use Impact Evaluation				
Evaluated Constituents	**Effluent Limit Not Exceeded**	**Concentration in Effluent <WQO[3]**	**Beneficial Use Not Impaired by CSS Loading**	**Removal Benefit of Combined Compared to Separate System (SS)**	**Explanation**
Routine Monitoring Constituents					
Total Suspended Solids	☑	NWQO	NE	☑	No WQO, therefore loading not evaluated
Settleable Solids	☑	NWQO	NE	NE	Effluent limit met; loading analysis unnecessary
Chlorine Residual	☐	☐	NE	NE	Insufficient data to evaluate loading impacts. No toxicity, presence of dechlorination residual, and analytical method interference cannot be retested.
pH	☐	☐	NE	NE	Loading of pH cannot be calculated. 2 excursions noted in effluent. Continuous sensor data demonstrate effect is transient; Monitoring shows no downstream receiving water limitation excursions.
Fecal Coliform	☑	☑	NE	☑	Loading not evaluated because concentrations are below WQO
Temperature	☑	☑	NE	NE	Loading cannot be calculated for temperature
Ammonia	NEL	☑	☑	☑	
Diazinon and Chlorpyrifos	☑	☑	☑	SR	Similar removal from CSS vs. SS
Mercury	NEL	☐	☑	SR	Similar removal from CSS vs. SS
Methylmercury	NEL	☑	☑	☑	
Annual Monitoring Constituents – Priority Pollutants[1]					
Nitrate plus Nitrite	NEL	☑	☑	☑	
Total Phosphorus	NEL	NWQO	NE	☑	No WQO, therefore loading not evaluated
Electrical Conductivity	NEL	☑	NE	NE	EC is similar to TDS, and evaluation results are equivalent

☑ = Yes
☐ = No
NE = Loading Not Evaluated (See Explanation)
NEL= No Effluent Limit
NWQO = No Water Quality Objective
SR = Similar removal between CSS and Hypothetical Separate System

	Beneficial Use Impact Evaluation				
Evaluated Constituents	**Effluent Limit Not Exceeded**	**Concentration in Effluent <WQO[3]**	**Beneficial Use Not Impaired by CSS Loading**	**Removal Benefit of Combined Compared to Separate System (SS)**	**Explanation**
TDS	NEL	☑	☑	☑	
Cyanide	NEL	☐	☑	SR	Similar removal from CSS vs. SS
MBAS	NEL	☐	☑	SR	Similar removal from CSS vs. SS
Aluminum	NEL	☐	☑	☑	
Copper	NEL	☐	☑	☑	
Iron	NEL	☐	☑	NE	Insufficient data for removal comparison.
Lead	NEL	☐	☑	☑	
Manganese	NEL	☐	NE	NE	Insufficient data to evaluate loading impacts. Expected to have a similar impact to other metals evaluated.
Silver	NEL	☐	☑	☑	
Zinc	NEL	☐	☑	☑	
2,3,7,8-TCDD	NEL	☐	NE	NE	Insufficient data to evaluate loading impacts. Chronic HH criterion - Not an issue due to event duration
Benzo(a)anthracene	NEL	☐	☑	SR	Similar removal from CSS vs. SS
Bis(2-ethylhexyl)phthalate	NEL	☐	☑	☑	
Carbon tetrachloride	NEL	☐	NE	NE	Insufficient data to evaluate loading impacts. Chronic HH criterion - Not an issue due to event duration
Chloroform	NEL	☐	☑	☐	Included in loading analysis of TTHMs
Chrysene	NEL	☐	☑	SR	Similar removal from CSS vs. SS
Tetrachloroethylene	NEL	☐	NE	NE	Insufficient data to evaluate loading impacts. Chronic HH criterion - Not an issue due to event duration
Total Trihalomethanes (TTHMs)[2]	NEL	☐	☑	NE	No data from stormwater runoff to perform comparison

☑ = Yes
☐ = No
NE = Loading Not Evaluated (See Explanation)
NEL= No Effluent Limit
NWQO = No Water Quality Objective
SR = Similar removal between CSS and Hypothetical Separate System

Evaluated Constituents	Beneficial Use Impact Evaluation				
	Effluent Limit Not Exceeded	Concentration in Effluent <WQO[3]	Beneficial Use Not Impaired by CSS Loading	Removal Benefit of Combined Compared to Separate System (SS)	Explanation
Pathogens					
Giardia	NEL	NWQO	NE	NE	No WQO, therefore loading not evaluated; No data from SRWTP to perform comparison; MUN Ben. use supported
Cryptosporidium	NEL	NWQO	NE	NE	No WQO, therefore loading not evaluated; No data from SRWTP to perform comparison; MUN Ben. use supported

Notes:
1. Table includes priority pollutants detected in effluent or receiving water
2. Total trihalomethanes represent the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane.
3. Water Quality Objective (WQO)

3 Discharge and Receiving Water Quality Characterization

CSS Discharge and receiving water are monitored to generate a constituent dataset to evaluate CSS impacts on receiving waters.

The discharge and receiving water quality were characterized through the City's water quality monitoring program. The monitoring program used to inform the Water Quality Assessment was conducted from October 2010 through December 2012, using a combination of grab samples and data collected through deployment of continuous sensors. Grab sample results from the CSS effluent and Sacramento River receiving waters were used to identify constituents of concern for the CSS, and to perform a near-field dilution analysis to further evaluate potentially problematic constituents. The following characterization steps are described in this section:

- Receiving water and effluent sampling;
- Continuous sensor monitoring;
- Identification of constituents of concern and beneficial use protection;
- Near-field water quality characterization.

3.1 RECEIVING WATER AND EFFLUENT SAMPLING

The City of Sacramento conducts a water quality monitoring program during CSS discharge events to assess effluent quality and receiving water impacts. Water quality monitoring has been conducted since 1991, with early monitoring results summarized in the Effluent and Receiving Water Quality and Toxicity Summary Report (Tomko, 1995). Under the current Permit, sampling was conducted for CSS influent, effluent, and receiving water upstream and downstream of the CSS discharge beginning in October 2010. Detailed sampling procedures are provided in the CSS Sampling and Analysis Plan (Appendix G). Sampling locations are described in **Table 3-1** and shown in **Figure 3-1** and schematized in Figure 3-2**.** The receiving water monitoring locations are located upstream and downstream of each discharge point. A dye dispersion study conducted in 1991 determined monitoring locations, which are located within the discharge plume for their respective upstream discharge locations, where the plume is mixed across the width of the Sacramento River and is relatively stable, and thus reflective of overall Sacramento River conditions (Christophel and Arsenault, 1991).

Table 3-1. Discharge and Receiving Water Monitoring Locations

Monitoring Site ID (Name)	Description
INF-001 (Sump 2A)	Sump 2A wet well's ISCO composite sampler.
EFF-002 (CWTP)	CWTP effluent sampling taps in the CWTP operator's lab labeled "Primary 2/Bacti" *for coliform samples only* and "Effluent 3" for all other analytes.
EFF-003 (CWTP Sump 104 inter-	Storm Sump 104 bypass, treated the same through CWTP. [NOTE: This is the same tap as for EFF-002.]

Monitoring Site ID (Name)	Description
connect)	
EFF-004 (Sump 2 Gate #4)	Sump 2 tap lines for Gate #4 in main Sump 2 pump house Stage 1 side.
EFF-005 (Sump 2 Gate #5)	Sump 2 tap lines for Gate #5 in main Sump2 pump house Stage 2 side. Backup sampling location is the corresponding flow control structure.
EFF-006 (Pioneer)	Pioneer Reservoir laboratory lab taps labeled “Basin 3 / Back-T” *for fecal coliform only* and “Outfall tap” for all other analytes.
EFF-007 (Sump 1A)	Sump 1A discharge at the wet well
RSW-001 (Delta King)	3700 feet upstream of EFF-006 and EFF-007. Downstream from the Delta King Hotel in Old Sac. 1000 Front Street, Sacramento
RSW-002 (Miller Park)	5600 feet downstream of Discharge Point Nos. 006 and 007. Sacramento Marina at Miller Park. 2710 Ramp Way, Sacramento
RSW-003 (La Rivage)	5000 feet downstream of EFF-004 and EFF-005. La Rivage Hotel Boat Ramp. 4800 Riverside Blvd, Sacramento
RSW-004 (Wooden Stairs)	1660 feet downstream of EFF-002 and EFF-003. Seymour Community park by 6011 Riverside Blvd., Sacramento

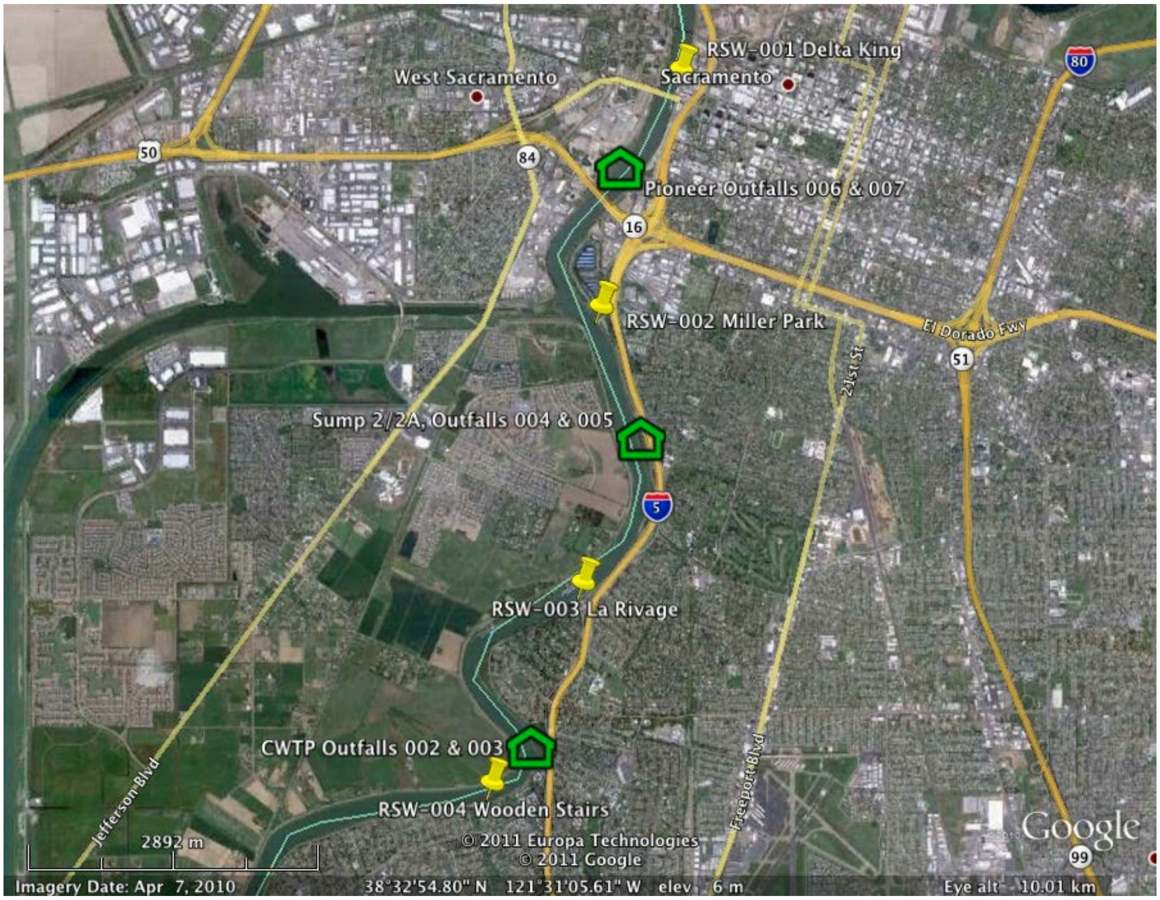


Figure 3-1. Satellite image identifying CSS outfalls (green buildings) and river monitoring (yellow pins) locations.

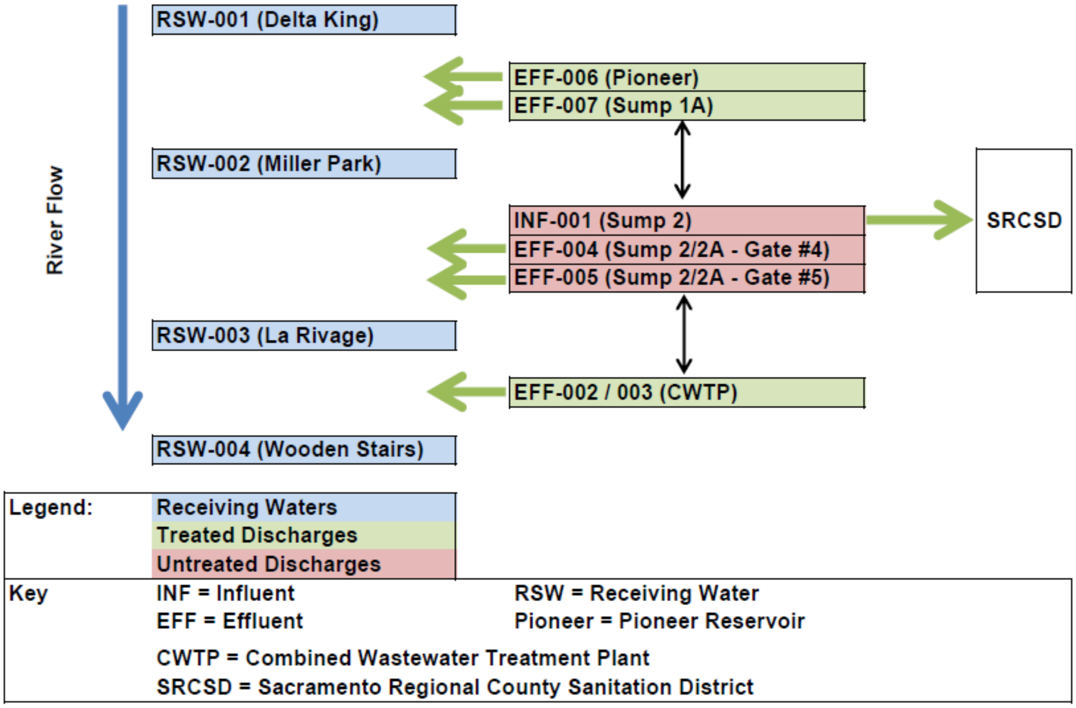


Figure 3-2. CSS Conceptual Flow Diagram and Sampling Locations

3.1.1 Monitored Constituents

The Permit specifies requirements for influent, effluent, and receiving water monitoring. The monitored constituents are summarized in **Table 3-2**. A “routine” set of constituents is monitored during each discharge event, and a more extensive “annual” set of constituents is monitored once per year when discharge occurs from an effluent site. In addition to the routine and annual constituents, protozoan pathogens *Cryptosporidium* and *Giardia* were monitored in the influent, effluent and downstream receiving water (RSW-004) locations during the first discharge event of the season during the 2010-2011 and 2011-2012 storm years. All constituents are analyzed using either EPA approved methods or standards methods.

Table 3-2. Constituents Monitored at Influent, Effluent, and Receiving Water Locations

Parameter	Sample Type	Sample Frequency	Influent	Effluent (EFF-002, -003, -006)	Effluent (EFF-004, -005, -007)	Receiving Water
Flow (mgd)	Meter	Continuous	X	X	X	
Total Flow (MG)	Meter	Continuous		X	X	
Flow Duration (hrs)	Calculated	Continuous		X	X	
TSS	Grab[1]	1/Discharge Event[2]	X	X	X	
Settleable Solids	Grab	1/Discharge Event	X	X	X	

pH	Grab	1/Discharge Event	X	X	X
Dissolved Oxygen	Grab	1/Discharge Event	X	X	X
Fecal Coliform	Grab	1/Discharge Event	X	X	X
Chlorine, total residual	Grab	1/Discharge Event	X		
Mercury, total	Grab	1/Discharge Event	X		
Methylmercury	Grab	1/Discharge Event	X		
Chlorpyrifos	Grab	1/Discharge Event	X		
Diazinon	Grab	1/Discharge Event	X		
Temperature	Grab	1/Discharge Event	X	X	X
Turbidity	Grab	1/Discharge Event			X
Ammonia Nitrogen, Total (as N)	Grab	1/Discharge Event	X	X	X
Priority Pollutants and Other Constituents of Concern[3]	Grab	1/Storm Year	X	X	
Whole Effluent Toxicity	Grab	1/Storm Year	X	X	

[1] Flow weighted composite required for influent sample

[2] Monitoring conducted within first 4 hours of the beginning of discharge, and daily if discharge event is greater than 24 hours.

[3] List of Priority Pollutants and Other Pollutants of Concern provided in Attachment I to the Permit

3.1.2 Discharge Event Summary

During the study period of December 2010 through December 2012, discharges occurred on thirteen occasions – Four during the 2010-2011 wet season; four during the 2011-2012 wet season; and five during the 2012-2013 wet season, as shown in **Table 3-3**. Twelve of those events were treated discharge events, with one untreated discharge event occurring on December 2, 2012. Treated discharges occurred most often at the Pioneer Reservoir (EFF-006) location.

The potential for CSS discharge is primarily based on available storage volume, storm intensity and total storm volume. As shown in **Table 3-3,** discharge events occurred during periods with high daily rainfall totals of approximately one inch or greater. During discharge events, the daily river flows were most often substantially higher than the average wet season (Oct-Apr) flow of 17,992 MGD[4] measured at the USGS Sacramento River gauge at Freeport.

---

[4] Based on available data from 1948-2011: http://nwis.waterdata.usgs.gov/nwis/monthly/?search_site_no=11447650&agency_cd=USGS&referred_module=sw&format=sites_selection_links

Table 3-3. Combined Sewer System Discharge Events from December 2010 to December 2012

Date	Discharge Location	24 hr Rainfall[1] (inches)	48 hr Rainfall (inches)	Daily River Flow[2] (MGD)	Discharge Duration (hours)	Discharge Volume (MG)
12/19/2010	Pioneer (EFF-006)	0.97	1.86	92,415	5:18	57
2/25/2011	Pioneer (EFF-006)	1.43	1.43	41,854	2:45	27.9
3/14/2011	Pioneer (EFF-006)	1.51	1.51	53,736	3:35	35
	CWTP (EFF-002)				3:30	25
3/24/2011	Pioneer (EFF-006)	1.07	1.35	125,836	4:25	56.5
	CWTP (EFF-002)				2:50	35
1/21/2012	Pioneer (EFF-006)	1.33	1.48	20,652	2:25	24.7
1/23/2012	Pioneer (EFF-006)	1.02	1.02	36,746	2:07	16.4
3/28/2012	Pioneer (EFF-006)	1.02	1.02	31,515	3:00	47.5
4/13/2012	Pioneer (EFF-006)	0.94	1.45	36,888	2:35	28.3
	Pioneer (EFF-006)	1.16	1.68		3:00	
11/30/2012	Pioneer (EFF-006)	1.21	1.68	22,990	8:00	37.6
	CWTP (EFF-002)	1.28	1.75		9:30	27.8
12/1/2012-12/2/2012	CWTP (EFF-002)	1.63	2.50	22,429	21:30	64.0
12/2/2012	Pioneer (EFF-006)	0.70	2.67	21,078	5:00	53.4
	Sump 2 (EFF-004)	1.69	2.54		3:20	3.8
12/22/2012	Pioneer (EFF-006)	1.10	1.14	21,932	2:10	17.7
12/23/2012	Pioneer (EFF-006)	0.90	1.88	20,849	2:15	42.6
12/25/2012	Pioneer (EFF-006)	0.78	0.80	19,110	4:05	23.5

Notes:
1 Rainfall totals from the California Data Exchange Center (CDEC) prior to the start of discharge at the CSU site
2 Daily average Sacramento River flow data from CDEC at Freeport (FPT)
NA not available

3.1.3 Grab Sample Results

The complete water quality analysis results for influent, effluent and receiving water sampling are provided in **Appendix A.** Summary statistics for constituents sampled during routine events, and data for selected constituents analyzed during each annual event, are provided for each monitoring location in **Appendix B**. Analysis of evaluated constituents is provided in **Section 3.4**.

3.1.3.1 Toxicity results

Acute toxicity testing was conducted using fathead minnows (*Pimephales promelas*) for effluent samples collected from each annual sampling event during the assessment period, in accordance with method EPA-821-R-01-012, Fifth Edition. River water collected from the upstream river location (RSW-001) was used as the control and for dilution. The acute toxicity results were reported as percent survival. Four replicates were performed, consistent with EPA protocol for stormwater toxicity testing.

All acute toxicity tests demonstrated that effluent samples were not acutely toxic to fathead minnows. Toxicity testing results are shown in **Table 3-4**.

Table 3-4. Acute toxicity testing results using fathead minnow

Date	Sample	Mean % Survival
1/21/2012	RSW-001	100
	EFF-006	92.5
11/30/2012	RSW-001	100
	EFF-006	100
	EFF-002	100
12/2/2012	RSW-001	100
	EFF-004	100

3.2 CONTINUOUS SENSOR MONITORING

Beginning in January 2011, receiving waters upstream (at RSW-001, Delta King) and downstream (at RSW-002, Miller Park) of the Pioneer discharge were monitored with continuous remote sensing equipment. The sensors provide a continuous measure of selected water quality parameters over the duration of a discharge event, and thus provide additional information on the impact of combined sewer discharges on basic water quality. The Miller Park sensor was placed near-shore on a dock pier within the expected Pioneer (EFF-006) discharge plume. Sensor operation and results are discussed below.

3.2.1 Sensor Operation

Sensor systems were designed and assembled to monitor water temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), turbidity, and ammonium. Data are recorded at 5 to 15 minute intervals, transmitted periodically to a computer offsite by cellular telemetry, and displayed on a web site for use by the project team. The equipment is housed in non-descript 4-inch PVC pipe to reduce risk of theft and vandalism. The two sensor systems are installed at a depth of approximately 2 feet, 60 feet from the east bank, on floating docks upstream and downstream of the Pioneer discharge (**Figure 3-3)**. The Delta King unit is 2,700 feet upstream of Pioneer and serves as a control, recording background receiving water quality upstream of the discharge. The Miller Park unit is 2,300 feet downstream of Pioneer, at a location that prior modeling results indicated is within the Pioneer discharge plume (Christophel and Arsenault, 1991).

Figure 3-3. Location of continuous sensors at (A) Delta King (RSW-001) and (B) Miller Park (RSW-002) receiving water locations.

3.2.2 Sensor Results

An example of continuous sensor results is shown in **Figure 3-4,** which shows sensor data from the first 2011/2012 seasonal discharge event of 25 million gallons from Pioneer that occurred on January 21, 2012. This event is selected as an example event when the CSS overflow discharge “signal” was most evident through visual inspection. The same pattern of grab samples differing from the sensors was evident in all events. Equivalent graphs for all 12 discharge events captured by continuous sensors during the 2010/2011, 2011/2012 and 2012/2013 storm years are provided in **Appendix C**. **Figure 3-4** shows an example of the water quality results for sensor parameters measured at the Delta King and Miller Park locations, with the duration of the 2 hour 25 minute discharge outlined in green. In the absence of discharge, measurements at both sensor locations show similar values for some parameters (i.e. turbidity) or follow a parallel track for other parameters (such as pH). **Figure 3-4** illustrates the ability for continuous sensors to provide additional information on how a discharge from Pioneer impacts basic water quality of the receiving water. In general, the impacts are observed to be relatively small and of short duration. Additional conclusions from sensor data are discussed below.

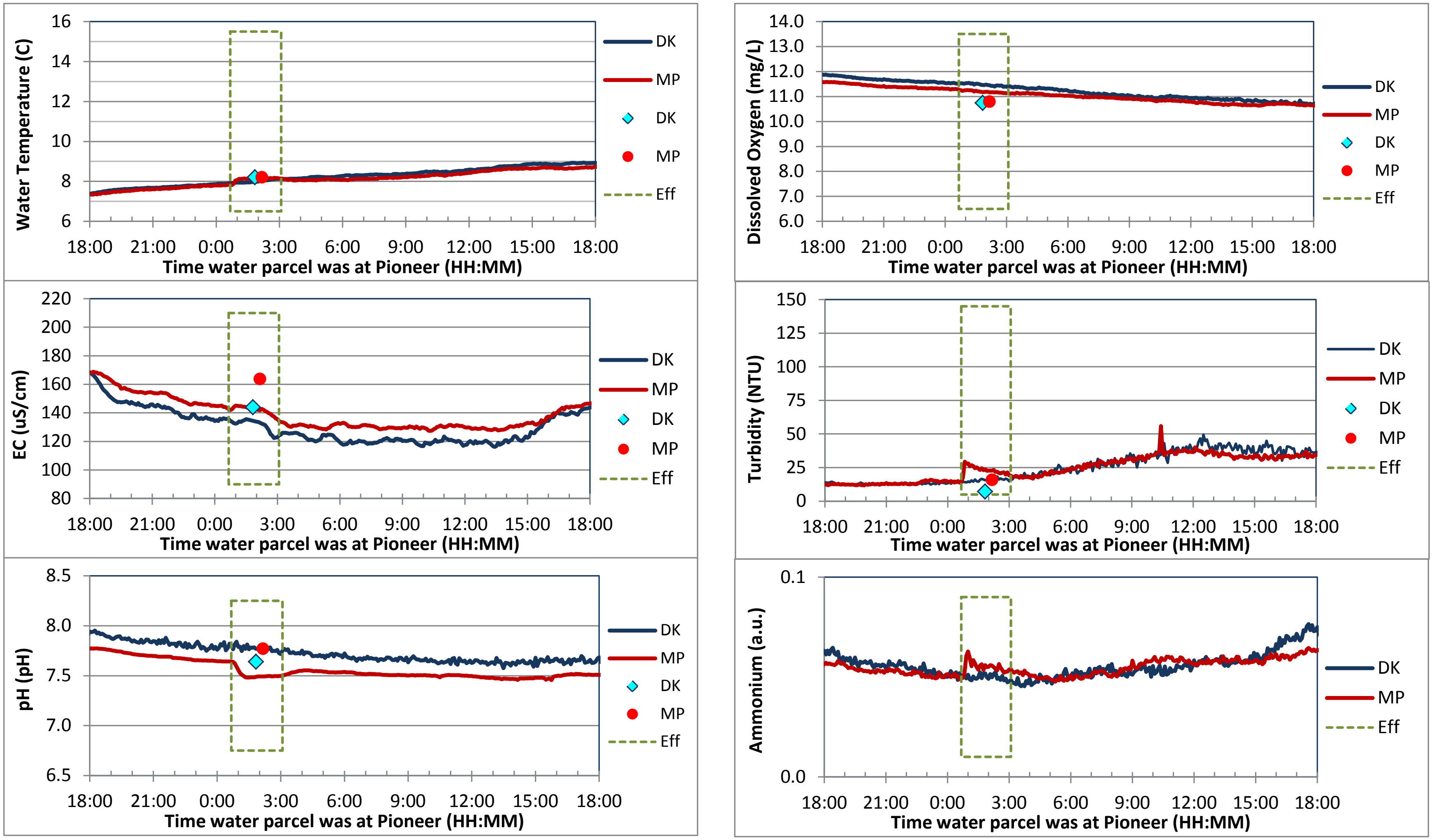


Figure 3-4. Continuous sensor and grab data from January 21, 2012 discharge event from Pioneer. Blue and red lines show the Delta King (upstream, DK) and Miller Park (downstream, MP) sensor readings, respectively. Blue and Red markers represent respective field grab measurements during the discharge. The green dashed box indicates the timing of the 2 hour 25 minute discharge event.

3.2.2.1 Water Quality Parameters

In general, the impacts of CSS discharge occur over a short duration and do not persist after discharge is discontinued. For the January 21, 2012, discharge event illustrated above in Figure 3-3, the largest change in water quality was observed for turbidity, where receiving water turbidity of 15 NTU initially increased to 30 NTU before dropping back down to near background levels. However, River turbidities seasonally fluctuate with algal growth and other (non-CSS) wet weather influences, including peaks above 200 NTU for short periods and increases above 30 NTU for more significant periods (see Figure 3-6). Data for this event also shows a small (average 0.18˚C) increase in water temperature, and a small (0.12 unit) decrease in pH. No detectable changes in EC or DO were observed.

Grab sample results for total ammonium are not shown in **Figure 3-4** where concentrations are generally either non-detect or below the 0.1 mg/L method reporting limit, and thus are not considered quantitative. Similarly, receiving water concentrations of ammonium are near the sensitivity limit of the deployed ion selective electrode (ISE) ammonium continuous sensors preventing quantitative calibration of the sensor data. For this reason, the total ammonium sensor data in figure 3-3 are presented in arbitrary units (a.u.); however, the sensors can provide useful information on any change in upstream to downstream ammonium concentrations during discharge[5] events. The comparison of upstream to downstream sensor data indicates that impact of the CSS discharges on background receiving water total ammonium concentration at the Miller Park sensor location is very small and of short duration. Background total ammonium concentrations are typically less than 0.1 mg/L. The changes observed during discharge range from non-detect to a very small increase in concentration, indicating that the impact of CSS discharges on receiving water total ammonium concentration is on the order of a few parts per billion.

3.2.2.2 Comparison with Field Readings

Figure 3-4 includes an overlay of handheld field meter readings and grab sample data over continuous sensor data. The overlay demonstrates that discrete field data during the discharge event does not fully characterize the impact of a discharge event on receiving water quality, and can in fact be misleading due to limitations in handheld field meter accuracy, sample timing, and inability to correct transient or unstable effects of the American River mixing with the Sacramento River at their confluence. **Figure 3-4** shows that field data falsely reported no change in water temperature, and increases in EC and pH. Timing of discrete data collection can also impact grab results, as exemplified by turbidity data in **Figure 3-4** where receiving water impact decreased from +15 to +5 NTU over 2 hours. In general, for characterization of the small changes in water quality typical of a CSS discharge event, positive and negative results based on field readings may not be representative of the true impact of a discharge on the receiving water.

---

[5] The deployed sensors detect ammonium (NH_4^+) concentration which is approximately equal to the total ammonia concentration at receiving water temperature and pH. Due to calibration drift over time, the sensors exhibited limited absolute accuracy (ability to report an ammonium value close to its true value); however, they exhibited high precision in their ability to detect small relative changes in ammonium concentration. This precision enabled the sensors to detect a small ammonium change, or absence of a small change, related to a discharge event. For this reason, while the ammonium graphs are plotted in arbitrary units, the relative change in downstream concentration provides information on any increase in total ammonium above the background receiving water concentration.

3.2.2.3 Water Quality Impact from CSS Discharge

The water quality impacts from CSS discharges are summarized in **Figure 3-5**, which shows the changes in receiving water quality for all 12 events monitored during the 2010/2011, 2011/2012 and 2012/2013 storm years. The graphs show the average change in parameters during the discharge events (which are represented in the green dashed boxes in **Figure 3-4** and in the figures in **Appendix C)**. The error bars represent the 95% confidence intervals determined based on twice the standard deviation of the error signal between upstream and downstream sensor readings over the 3 hour period prior to discharge.

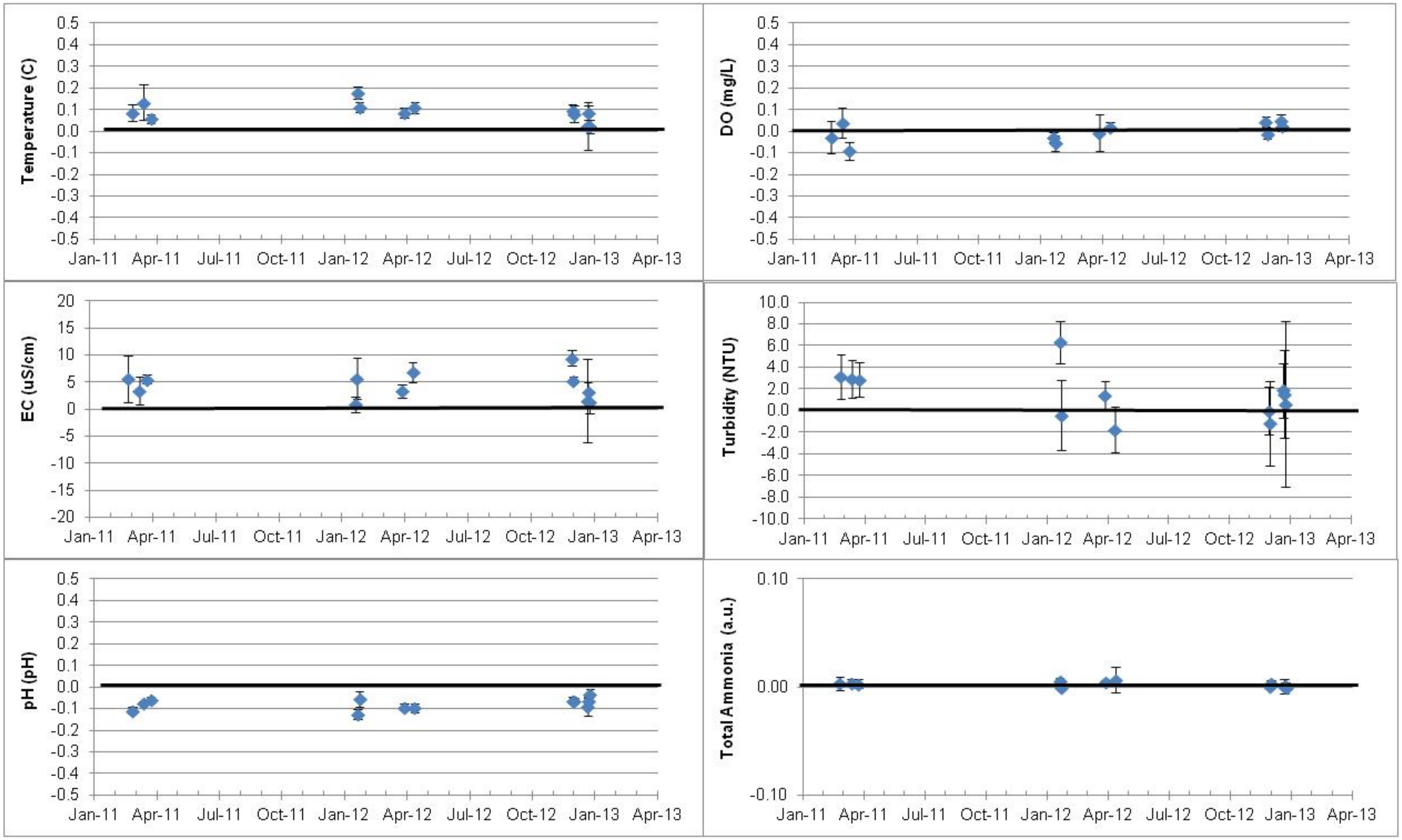


Figure 3-5. Impact of CSS discharge on receiving water based on continuous sensor data. Each data point represents the average increase or decrease in value at Miller Park (downstream) as compared to Delta King (upstream). The error bars represent the 95% confidence intervals.

The averages of the relative changes for each water quality parameter shown in **Figure 3-5** are summarized in **Table 3-5**. The observed impact of the CSS discharge on temperature and pH is relatively consistent at approximately +0.1˚C and -0.1 pH units, respectively. In addition, confidence in the temperature and pH results is high (indicated by error bars that are small compared to the observed impact). Sensor data for EC and turbidity indicate that the impact on receiving water quality shows larger variability between discharge events, and sensor results have somewhat lower confidence. Data for DO and total ammonium indicate that the impact of the CSS discharge was not discernible from sensor noise, and the impact was less than 0.1 mg/L and 0.01 mg/L respectively.

Table 3-5. Relative change in receiving water quality parameters during CSS discharge at Pioneer, observed using continuous sensors.

Water Quality Parameter	Average Change during CSS Discharge[1]
Temperature	+ 0.1 C
EC	+ 4 uS/cm
pH	-0.1 pH units
DO	< 0.1 mg/L
Turbidity	+ 2 NTU
Total Ammonium	< 0.1 mg/L

1. As discussed previously, ammonium levels in the Sacramento River are non-detect or close to the reporting limit (preventing calibration of the continuous sensors using grab sample data), so “arbitrary units” which approximately correspond to mg/L are used to quantify impacts of discharge.

In addition, the continuous sensor data also show that the impacts from the CSS discharge on receiving water quality are small compared to the general storm-related impacts on the receiving water. For example, **Figure 3-6** shows turbidity sensor data from the whole 2011/2012 wet season. In general, storms large enough to trigger a CSS discharge event typically cause highly elevated turbidity levels in the river for a week or more from both urban and non-urban stormwater runoff. Complete wet and dry weather sensor data for all parameters are provided graphically in **Appendix D**. In general, the natural variability of receiving water quality is significantly larger than the changes observed as a result of Pioneer discharge events.

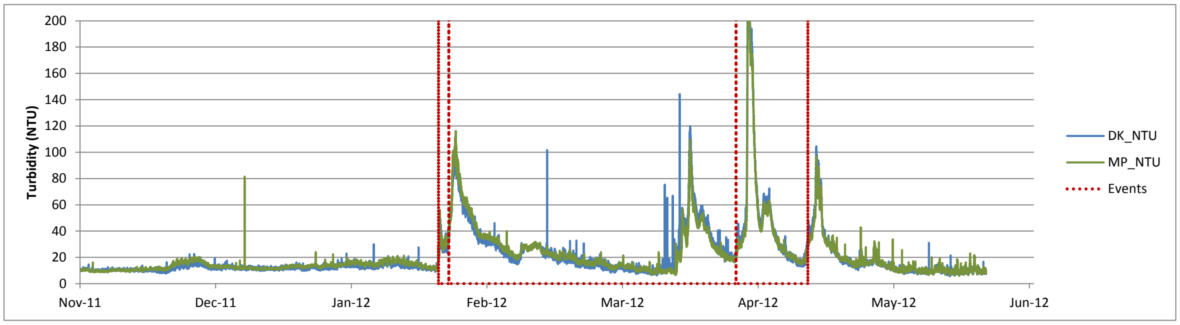


Figure 3-6. All Delta King (upstream) and Miller Park (downstream) turbidity data recorded for the 2011/2012 wet season, with red dashed lines indicating timing of Pioneer discharge events.

3.2.3 Continuous Sensor Findings

The results from continuous sensor monitoring show that::

- Changes in river water quality parameters due to CSS discharge are of a short duration and small compared to overall hydrologic changes in the larger tributary watershed; and
- Field measurements collected during the discharge event tended to be biased high when compared to the continuous sensor data and do not provide quantification of changes over time.

3.3 CONSTITUENT SCREENING

A screening analysis was conducted to select constituents of concern for further evaluation.

A constituent screening was conducted to identify selected constituents that may potentially impact beneficial uses in the Sacramento River from the larger list of all monitored constituents (Table I-1, Priority Pollutant, Permit). The following considerations were included in the screening assessment:

1. The constituent has a water quality objective or criterion applicable to the Sacramento-San Joaquin Delta;
2. The CSS received an effluent limitation in its Permit for a particular constituent;
3. The constituent was identified as a pollutant/stressor on the 2010 303(d) List;
4. The constituent is covered by an adopted TMDL downstream of the CSS discharge; and
5. The constituent was listed under “Specific Parameters of Concerns” in the Permit by the Central Valley Water Board.

As part of the constituent screening process, CSS monitoring data for CSS effluent and the Sacramento River were compared to relevant water quality objectives or criteria. The list of “evaluated constituents” – those constituents evaluated for their potential impacts on downstream receiving water quality – was developed for this Water Quality Assessment based on the availability of adequate detected data in CSS effluent and availability of Sacramento Stormwater Quality Partnership data collected at monitoring site Sump 111, which were used as surrogate data to characterize CSS influent quality. Stormwater data from Sump 111 were used as surrogate data because a very limited constituent set is analyzed in CSS influent (only TSS and settleable solids), and Sump 111 is located close to the CSS service area and collects separate storm sewer runoff. To verify whether Sump 111 data were comparable to CSS influent data, the constituents measured in CSS effluent from the single untreated discharge event (December 2, 2012) were compared to Sump 111 data. The comparison showed that the untreated discharge data were comparable to stormwater runoff data, and thus Sump 111 stormwater runoff data were sufficiently representative of CSS influent quality and could be used as a surrogate for CSS influent data.

The list of evaluated constituents for whom an exceedance of a water quality objective or criterion was observed in either CSS effluent or the receiving water from December 2010 to December 2012 is presented in **Table 3-6**. This table also shows the organism level effects, ecological properties, and beneficial uses that each constituent is known to impact. Because insufficient bromodichloromethane data were available in the Sump 111 data set to act as a surrogate for bromodichloromethane concentrations in CSS influent, chloroform and total trihalomethanes (see Section 5) were used to estimate potential disinfection byproduct impacts on the receiving water. Additionally, the assessment also evaluated potential water quality impacts from other constituents of regional concern that were not observed to exceed relevant water quality standards. These constituents and the organism level effects, ecological properties, and beneficial uses they are know to impact in receiving waters are presented in **Table 3-7**. In instances where the potential beneficial use impacts of one constituent is illustrative of other similar constituents (e.g., electrical conductivity and total dissolved solids; chlorpyrifos and diazinon), the loading calculation was performed for one representative constituent. The constituents shown in **Table 3-6** and **Table 3-7** collectively make up the evaluated constituents considered for analysis in the Water Quality Assessment.

Table 3-6: Constituents Observed to Exceed a Relevant Water Quality Standard and their Potential Impacts to Receiving Waters.

	Potential Constituent-Based Impacts to Receiving Waters					
Constituents	**Aquatic Toxicity**	**Bioaccum-ulation in Aquatic Organisms**	**Habitat and Ecosystem Integrity**	**Drinking Water Supply**	**Agricultural Water Supply**	**Contact Recreation**
Cyanide	☑					
MBAS				☑		
Aluminum	☑			☑		
Copper	☑					
Iron				☑		
Lead	☑					
Mercury		☑		☑		
Silver	☑					
Zinc	☑					
Benzo(a)anthracene		☑		☑		
Bis(2-ethylhexyl)phthalate		☑		☑		
Bromodichloromethane		☑		☑		
Chloroform		☑		☑		
Chrysene		☑		☑		
Total Trihalomethanes(1)		☑		☑		

Notes:

1. Total trihalomethanes represent the sum of bromodichloromethane, bromoform, chloroform, and dibromochloromethane.

Table 3-7: Constituents of Regional Water Quality Interest and their Potential Impacts to Receiving Waters.

	Potential Constituent-Based Impacts to Receiving Waters					
Constituents	**Aquatic Toxicity**	**Bioaccum-ulation in Aquatic Organisms**	**Habitat and Ecosystem Integrity**	**Drinking Water Supply**	**Agricultural Water Supply**	**Contact Recreation**
Ammonia	☑		☑			
Nitrate plus Nitrite			☑	☑		
Total Phosphorus			☑			
Electrical Conductivity				☑	☑	
Total Dissolved Solids				☑	☑	
Total Suspended Solids			☑			
Total Coliform				☑		☑
Cryptosporidium				☑		☑
Giardia				☑		☑
Methylmercury		☑		☑		
Chlorpyrifos	☑			☑		
Diazinon	☑			☑		

3.3.1 Data Sources

Water quality data were compiled for use in near-field water quality impact analyses. All effluent, stormwater runoff, and ambient water quality data were evaluated for duplicates and outlier values prior to use. Water quality data from the four monitoring programs shown in **Table 3-8** were used to perform near-field water quality impact analyses.

Table 3-8: Water Quality Monitoring Data Used in Near-Field Water Quality Impact Analyses.

Water Quality Monitoring Program	Data Type	Monitoring Location	Monitoring Data Date Range
City of Sacramento Combined Sewer System	Effluent, Receiving Water	Effluent: EFF-002, EFF-004, EFF-006; Receiving Water: RSW-001, RSW-003	Dec. 2010 – Dec. 2012
Sacramento Stormwater Quality Partnership	Stormwater Runoff(1)	Sump 111(1)	Feb. 1990 – Feb. 2012(2)
Sacramento Regional Wastewater Treatment Plant NPDES Self-Monitoring Data	Effluent	Effluent	Jun. 2005 – Aug. 2012(3)
Sacramento Coordinated Water Quality Monitoring Program (CMP)	Receiving Water	Sacramento River at Freeport	Feb. 2000 – Aug. 2012(4)

Notes:

1. Stormwater runoff data from Sump 111 were used as surrogate data to characterize CSS influent quality as the CSS Monitoring and Reporting Program is only required to collect total suspended solids and settleable solids measurements.
2. The 1990 – 2012 date range describes the overall period during which all data were collected; it does not reflect the date range of any single constituent.
3. Sacramento Regional Wastewater Treatment Plant data generally cover the period Aug. 2009 – Aug. 2012.
4. The monitoring date range specified above for the CMP Program is a maximum with most parameters evaluated having a data set that covers a smaller date range.

3.4 NEAR-FIELD WATER QUALITY CHARACTERIZATION

Median concentrations of evaluated constituents were calculated from the monitoring data described in **Table 3-8**. Because the CSS discharged effluent from three different locations (EFF-006, EFF-004, and EFF-002), and the effluent from each of these locations undergoes treatment from a unique, primary treatment and disinfection system, median concentrations were calculated for each of the three effluent discharge locations. Discharge location EFF-004 is represented by a single data point from the one untreated discharge event that occurred on December 2, 2012.

Median concentrations were determined for select constituents in CSS effluent and the receiving water in comparison with stormwater runoff and SRWTP effluent.

As described earlier, stormwater runoff data collected by the Sacramento Stormwater Quality Partnership at the Sump 111 monitoring site were used to represent CSS influent quality. Because of the connection between the CSS and SRWTP, effluent monitoring data from the Sacramento Regional County Sanitation District NPDES Self-Monitoring Program were used to characterize the quality of CSS wastewater and stormwater flows that are treated at the SRWTP and discharged to the Sacramento River just downstream of the Freeport Bridge.

For evaluated constituent data sets with more than 20% of the data measured above detection limits, a regression-on-order statistical method was used to generate median (as 50th percentile) values. For data sets with less than 20% of the data measured above detection limits, effluent and receiving water values below detection limits were assumed to be equal to the detection limit. Median concentration values calculated from data sets containing less than 20% detected data are described in **Table 3-9** with a less than sign (<) preceding the numeric concentration. The median concentrations shown in **Table 3-9** were used to estimate the mass loadings discussed in **Section** 4.

As shown in **Table 3-9**, CSS primary treated and disinfected effluent discharges at EFF-002 and EFF-006 have similar median constituent concentrations. Because there is only a single data point for effluent from the CSS untreated discharge event (EFF-004; December 2, 2012), only general observations can be drawn to compare constituent concentrations of primary treated and disinfected effluent with untreated effluent. Elevated concentrations of cyanide and chloroform are observed in the disinfected effluent, while elevated coliform levels are observed in the undisinfected effluent. The secondary treated and disinfected effluent discharged by the SRWTP to the Sacramento River just downstream of Freeport generally has lower median constituent concentrations than CSS effluent, as would be expected due to the higher level of treatment provided by the SRWTP as compared to the CSS. The higher median ammonia, total phosphorus, and total dissolved solids concentrations in SRWTP effluent, as compared to CSS effluent, are likely the result of the significant loads of these pollutants generated in the SRWTP service area, and the treatment plant's ability to remove these constituents.

Table 3-9: Comparison of Concentrations of CSS Effluent, CSS Influent/Sump 111 Stormwater Runoff, and SRWTP Effluent.

Constituent	**Median Concentration of CSS Primary Treated, Disinfected Effluent**		**Concentration of CSS Untreated Discharge (December 2, 2012)**	**Median Concentration of Sump 111 Stormwater Runoff Used as Surrogate for CSS Influent**	**Median Concentration of SRWTP Effluent Discharged to the Sacramento River Downstream of Freeport**
Discharge Location	***EFF-002***	***EFF-006***	***EFF-004***	***n/a***	***Sac River below Freeport***
Ammonia (mg/L as N)	0.28	0.25	0.63	0.44	24.9
Nitrate + Nitrite (mg/L as N)	0.26	0.33	0.29	0.53	<0.10
Phosphorus -- total (mg/L)	0.60	0.70	0.36	0.32	2.21
Cyanide (µg/L)	12.45	13.0	0.9	<3.0	3.4
MBAS (mg/L)	0.52	0.19	0.12	0.08	0.22
Total Dissolved Solids (mg/L)	155	120	42	45	388
Total Suspended Solids (mg/L)	78	62	82	83	6.6
Fecal Coliform (MPN/100 mL)	<1.8	<1.8	>16,000	8,000	no data
Total Coliform (MPN/100 mL)	9.4	4.5	>16,000	181,448	2
Cryptosporidium (oocysts/L)	no data	3	no data	0.6(1)	no data
Giardia (cysts/L)	no data	293	no data	1.15(1)	no data
Aluminum -- total (µg/L)	1,600	1,315	1,500	4,485	14
Copper -- dissolved (µg/L)	5.8	6.8	4.9	5.1	3.6
Copper -- total (µg/L)	19	22.5	18	20.8	3.7
Iron -- dissolved (µg/L)	65	100	290	63.6	no data
Iron -- total (µg/L)	2,500	2,100	2,200	2,030	no data
Lead -- dissolved (µg/L)	0.47	0.61	5.2	0.64	0.09
Lead -- total (µg/L)	17	18	21	20.3	0.13
Mercury -- total (ng/L)	42.5	51	28	27.1	3.4
Methylmercury -- total (ng/L)	0.27	0.29	0.15	0.31	0.34
Silver -- dissolved (µg/L)	<0.062	<0.060	<0.020	<0.035	0.021
Silver -- total (µg/L)	0.12	0.16	0.32	0.21	0.036

Constituent	Median Concentration of CSS Primary Treated, Disinfected Effluent		Concentration of CSS Untreated Discharge (December 2, 2012)	Median Concentration of Sump 111 Stormwater Runoff Used as Surrogate for CSS Influent	Median Concentration of SRWTP Effluent Discharged to the Sacramento River Downstream of Freeport
Discharge Location	***EFF-002***	***EFF-006***	***EFF-004***	***n/a***	***Sac River below Freeport***
Zinc -- dissolved (µg/L)	39	49	58	69	13.5
Zinc -- total (µg/L)	96	109	200	192	14
Benzo(a)anthracene (µg/L)	<0.03	<0.03	<0.03	0.024	<0.5
Bis(2-ethylhexyl)phthalate (µg/L)	3.3	3.0	3.2	2.5	1.6
Chloroform (µg/L)	147	88	0.7	<5.0	14
Chrysene (µg/L)	<0.03	<0.03	<0.03	0.07	<0.6
Diazinon (µg/L)	<0.008	<0.007	<0.007	0.072	<0.05
Total Trihalomethanes (µg/L)	149.07	89.32	1.18	no data	<15.6

Notes:

1. No stormwater data were available, and therefore the average concentration of average residential and commercial/light industrial estimated wet season pathogen concentrations were used in the assessment (WERF, 2011).

4 Discharge and Receiving Water Volume and Load Characterization

The mass loading of selected constituents from CSS discharges was characterized using the City's concentration data and discharge volume records. .

The mass loading of evaluated constituents from the CSS to the Sacramento River was estimated using CSS discharge event volumes and constituent concentrations, as described in the following sections. Mass loadings occur when flows from the CSS service area are discharged to the Sacramento River, either as a result of CSS discharge events or from flows treated by the SRWTP. As previously described in **Section 1**, pollutants generated in the CSS service area are discharged directly to the Sacramento River when CSS storage capacity is exceeded. Primary treated and disinfected effluent is discharged to the River at locations EFF-006 (Pioneer Reservoir) and/or EFF-002 (Combined Wastewater Treatment Plant, CWTP). Untreated effluent was discharged on one occasion from EFF-004 (Sump 2). The majority of CSS flows are directed to the SRWTP prior to, during, and after discharge events for secondary treatment and disinfection at rate up to 60 mgd.

4.1 HISTORICAL CSS DISCHARGE VOLUMES AND LOADS

The discharge volumes and pollutant loads for routine monitoring constituents discharged to the Sacramento River during CSS discharge events are reported annually by the CSS to the Central Valley Water Board. A summary of event loads is provided in **Table 4-1.**

Table 4-1. Historic CSS Discharge Loads

Monitoring Year	Date	Discharge Location	Estimated Event Loads (lb) TSS	Ammonia	Mercury	Methylmercury	Chlorpyrifos	Diazinon
2009/2010	10/13/2009	EFF-002 (CWTP)	16711	[a]	[a]	[a]	<0.18	<0.091
	10/13/2009	EFF-006 (Pioneer)	63533	[a]	[a]	[a]	<0.47	<0.24
	1/20/2010	EFF-002 (CWTP)	2070	[a]	[a]	[a]	<0.0061	<0.015
	1/20/2010	EFF-006 (Pioneer)	34723	[a]	[a]	[a]	<0.043	<0.12
	3/2/2010	EFF-006 (Pioneer)	10141	[a]	[a]	[a]	<0.016	<0.020
	3/3/2010	EFF-006 (Pioneer)	7994	[a]	[a]	0.00012	<0.033	<0.042
	4/4/2010	EFF-006 (Pioneer)	7481	37.43	<0.033	0.00012	<0.041	<0.041
2010/2011	10/24/2010	EFF-002, 003, 004, 005, 007	N/A	N/A	N/A	N/A	N/A	N/A
	12/19/2010	EFF-006 (Pioneer)	39006	76	0.021	<0.00143	<0.00143	<0.0043
	2/25/2010	EFF-006 (Pioneer)	14203	63	0.0077	<0.0021	<0.0007	<0.0021
	3/14/2010	EFF-002 (CWTP)	20446	50	0.015	<0.0019	<0.00063	<0.0019
	3/14/2010	EFF-006 (Pioneer)	19862	58	0.011	<0.0026	<0.0088	<0.0026
	3/24/2010	EFF-002 (CWTP)	7991	25	0.0039	<0.00094	<0.00032	<0.00094
	3/24/2010	EFF-006 (Pioneer)	38192	110	0.019	<0.0042	<0.0014	<0.0042
2011/2012	1/21/2012	EFF-006 (Pioneer)	25595	92.7	0.0247	0.00012	<1.03E-3	<0.00144
	1/23/2012	EFF-006 (Pioneer)	8459	20.5	0.0057	0.00004	<6.8E-4	<0.00096
	3/28 - 3/29/2012	EFF-006 (Pioneer)	21381	150.4	0.0475	0.00015	<1.98E-3	<0.00277
	4/13/2012	EFF-006 (Pioneer)	13224	179.5	0.0123	0.00009	<1.18E-3	<0.00165

Notes:

[a] Ammonia,mercury and methylmercury were not sampled, as documented in the April 2010 Discharge Monitoring Report dated May 27, 2010.
“<” denotes loading estimates where underlying sample results were reported below their detection limits.

Table 4.1 (continued). Historic CSS Discharge Loads

Monitoring Year	Date	Discharge Location	Estimated Event Loads (lb)					
			TSS	Ammonia	Mercury	Methylmercury	Chlorpyrifos	Diazinon
2012/2013	11/30/2012	EFF-002 (CWTP)	12527	99.7	0.0093	0.00006	<1.16E-3	<0.00162
		EFF-006 (Pioneer)	15060	81.6	0.0160	0.00013	<1.57E-3	<0.00220
	12/1/2012-12/2/2012	EFF-002 (CWTP)	42216	165.7	0.0240	0.00014	<2.67E-3	<0.00374
	12/2/2012	EFF-004 (Sump 2)	2600	20.0	0.0009	0.00000	<1.59E-4	<0.000222
	12/2/2012	EFF-006 (Pioneer)	40133	138.2	0.0241	0.00012	<2.23E-3	<0.00312
	12/22/2012	EFF-006 (Pioneer)	9453	31.0	0.0095	0.00006	<7.38E-4	<0.00103
	12/23/2012	EFF-006 (Pioneer)	38747	88.9	0.0782	0.00010	<1.78E-3	<0.00249
	12/25/2012	EFF-006 (Pioneer)	11570	41.2	0.0076	0.00005	<9.80E-4	<0.00137

Notes:

[a] Ammonia, mercury and methylmercury were not sampled, as documented in the April 2010 Discharge Monitoring Report dated May 27, 2010.
"<" denotes loading estimates where underlying sample results were reported below their detection limits.

4.2 ESTIMATE OF CSS VOLUME AND LOAD DIRECTLY TO SACRAMENTO RIVER

The CSS mass loading to the Sacramento River during the Water Quality Assessment study period of December 2010 through December 2012 was estimated using CSS discharge event flow volumes (see **Table 3-3**) and measured or estimated median constituent concentrations. Because most CSS discharge events were monitored for routine constituents, with annual constituent monitoring occurring only during the first discharge event each year, a number of constituents were only analyzed for a small number of the 13 total CSS discharge events that occurred from December 2010 through December 2012. In order to estimate annual mass loading from the CSS to the Sacramento River, it was necessary to (1) use measured concentrations directly, where available, and (2) use the measured concentrations from each of the effluent discharge locations to calculate an estimated, median surrogate concentration that could be applied to a particular effluent discharge location when event-based data were not available. In this way, event mass loading (lbs/event) was calculated for each of the 13 CSS discharge events. It should be noted that during some discharge events CSS effluent is discharged from more than one location. **Table 4-2** provides an example of how measured total aluminum concentrations for specific CSS discharge events were used to calculate estimated, median surrogate concentrations for those discharge events lacking total aluminum data. Because the December 2010 through December 2012 analysis period includes a total of 25 months, and a limited number of events occurred during that period, the analysis period was divided into two calendar years (2011 and 2012) to evaluate mass loadings. Since there was available data from the end of December 2010 (December 19), that event was considered for the 2011 mass loading estimates along with the data collected during 2011 discharge events. Inclusion of the December 2010 event with the 2011 event data provides a conservative overestimate of the 2011 mass loading, and allows the available event data to be divided roughly equally into one 13 month period and one 12 month period. Data from this event are used in other parts of this assessment as an expanded constituent list was monitored.

An estimated average annual mass loading from the CSS directly to the Sacramento River was then calculated from the individual 2011 and 2012 mass loading estimates for each constituent, as shown in **Table 4-3.** Event-based annual and average annual mass loading estimates are provided for each evaluated constituent in **Appendix E, Section 1**. Some parameters selected as evaluated constituents for this assessment are monitored during every CSS discharge event, and therefore, did not require the generation of a median surrogate concentration for one or more CSS discharge events.

Table 4-2: Example of How Measured Total Aluminum Concentrations Were Used to Estimate Median Concentrations for CSS Discharge Events Where Total Aluminum Was Not Measured.

Effluent Discharge Location	Date	Total Aluminum (µg/L)[(1)(2)(3)]	CSS Discharge (MG)	Event Mass Loading (lbs/event)	Estimate Annual Mass Loading (lbs/yr)
EFF-006	12/19/2010	**1330**	57	632	
EFF-006	02/25/2011	1315	27.9	306	
EFF-002	03/14/2011	**1850**	25	386	
EFF-006	03/14/2011	1315	35	384	
EFF-002	03/24/2011	1600	12.6	168	
EFF-006	03/24/2011	1315	56.5	620	2,496
EFF-006	01/21/2012	**2330**	24.7	480	
EFF-006	01/23/2012	1315	16.4	180	
EFF-006	3/27-28/2012	1315	47.5	521	
EFF-006	4/13/2012	1315	28.3	310	
EFF-002	11/30/2012	**960**	27.8	223	
EFF-006	11/30/2012	**960**	37.6	301	
EFF-002	12/1-2/2012	**1600**	64.04	855	
EFF-004	12/2/2012	**1500**	3.8	48	
EFF-006	12/2/2012	**1300**	53.44	579	
EFF-006	12/22/2012	1315	17.7	194	
EFF-006	12/23/2012	1315	42.6	467	
EFF-006	12/25/2012	1315	23.5	258	4,415
		Estimated Average Annual Mass Loading (lbs/yr)			3,455

Notes:

1. Blue, bold values denote measured concentrations.
2. The estimated median surrogate total aluminum concentration at discharge location EFF-006 is 1315 µg/L.
3. The estimated median surrogate total aluminum concentration at discharge location EFF-002 is 1600 µg/L.

Table 4-3: Estimated Average Annual CSS Mass Loadings Discharged Directly to the Sacramento River as a Result of CSS Discharge Events.

Constituent	Estimated Average Annual Mass Loading (lbs/yr)
Ammonia (as N)	748
Nitrate + Nitrite (as N)	900
Phosphorus – total	1,598
Cyanide	<33
Methylene Blue Active Substances	662
Total Dissolved Solids	319,320
Total Suspended Solids	189,267
Aluminum – total	3,455
Copper – dissolved	16.1
Copper – total	54
Iron – dissolved	230
Iron – total	5,392
Lead – dissolved	1.54
Lead – total	45
Mercury – total	0.169
Methylmercury – total	0.338(1)
Silver – dissolved	<0.14
Silver – total	0.40
Zinc – dissolved	114
Zinc – total	272
Benzo(a)anthracene	<0.08
Bis(2-ethylhexyl)phthalate	8.0
Chloroform	298
Chrysene	<0.09
Diazinon	<0.019
Total Trihalomethanes	302

Notes:

1. Methylmercury mass loading presented in grams/year (g/yr).

“<” denotes loading estimates where a large percentage of sample results in the underlying data set were reported below a detection limit.

4.3 ESTIMATE OF CSS VOLUME AND LOAD THROUGH SRWTP DISCHARGE TO SACRAMENTO RIVER

As shown in **Figure 1-2**, a substantial volume of CSS effluent (up to 60 mgd) flows to the SRWTP for treatment and disinfection prior to discharge to the Sacramento River just downstream of the Freeport Bridge. In order to characterize the entirety of the CSS impact to downstream receiving waters, it is important to account for the CSS mass loading that is discharged to the Sacramento River via the SRWTP diffuser. Generally, median SRWTP effluent concentrations and estimated annual CSS event-based flows to the SRWTP were used to estimate annual and average annual mass loading to the Sacramento River as discharged by the SRWTP, as shown in **Table 4-4**. For ammonia, total phosphorus, and total dissolved solids, the median concentrations presented in **Table 4-4** and used to estimate mass loadings are actually CSS effluent concentrations. Median CSS effluent concentrations were used for these three parameters because the median concentrations discharged by the SRWTP are significantly higher than those discharged directly to the Sacramento River by the CSS and are not representative of effluent quality produced by the CSS. With regard to these three constituents, SRWTP removal ability and loading are very different from those observed for the CSS. Annual storm event-based effluent flows from the CSS to the SRWTP were calculated from the summation of volumetric flow measurements made during each CSS discharge event for a particular calendar year.

Table 4-4: Estimated Annual and Average Annual CSS Mass Loadings Discharged by SRWTP.

Constituent	Median SRWTP concen.	Year(2)(3)	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
Ammonia (mg/L as N)	0.63(1)	2011	41,624	38,915
		2012	36,207	
Nitrate + Nitrite (mg/L as N)	<0.1	2011	<6,607	<6,177
		2012	<5,747	
Phosphorus – total (mg/L)	0.6(1)	2011	39,642	37,062
		2012	34,483	
Cyanide (µg/L)	3.4	2011	225	210
		2012	195	
MBAS (mg/L)	0.22	2011	14,535	13,589
		2012	12,644	
Total Dissolved Solids (mg/L)	155(1)	2011	10,240,769	9,574,383
		2012	8,907,996	
Total Suspended Solids (mg/L)	6.6	2011	436,059	407,683
		2012	379,308	
Aluminum – total (µg/L)	14	2011	925	865
		2012	805	
Copper – dissolved (µg/L)	3.6	2011	238	222
		2012	207	
Copper – total (µg/L)	3.7	2011	244	229
		2012	213	
Lead – dissolved (µg/L)	0.09	2011	6.0	5.6
		2012	5.2	
Lead – total (µg/L)	0.13	2011	8.6	8.0
		2012	7.5	
Mercury – total (ng/L)	3.44	2011	0.23	0.21

Constituent	Median SRWTP concen.	Year(2)(3)	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
		2012	0.20	
Methylmercury – total (ng/L)	0.34	2011	0.022	
		2012	0.020	0.021
Silver –dissolved (µg/L)	0.021	2011	1.4	
		2012	1.2	1.3
Silver – total (µg/L)	0.036	2011	2.4	
		2012	2.1	2.2
Zinc – dissolved (µg/L)	13.5	2011	892	
		2012	776	834
Zinc – total (µg/L)	14	2011	925	
		2012	805	865
Benzo(a)anthracene (µg/L)	<0.5	2011	<33.0	
		2012	<28.7	<30.9
Bis(2-ethylhexyl)phthalate (µg/L)	1.63	2011	108	
		2012	94	101
Chloroform (µg/L)	14	2011	925	
		2012	805	865
Chrysene (µg/L)	<0.6	2011	<39.6	
		2012	<34.5	<37.1
Diazinon (µg/L)	<0.05	2011	<3.3	
		2012	<2.9	<3.1
Total Trihalomethanes (µg/L)	<15.6	2011	<1,031	
		2012	<897	<964

Notes:

1. Median CSS effluent concentration used instead of median SRWTP effluent concentration.
2. 2011 annual stormwater and wastewater event-based effluent flows to SRWTP equaled 7922 MG.
3. 2012 annual stormwater and wastewater event-based effluent flows to SRWTP equaled 6891 MG.

"<" denotes loading estimates where a large percentage of sample results in the underlying data set were reported below a detection limit.

5 Beneficial Use Impact Assessments From CSS Mass Loading

Mass loadings were compared with the River assimilative capacity to assess beneficial use impacts.

CSS discharge events are short in duration, and thus have a transient impact on beneficial uses in the Sacramento River. From December 2010 through December 2012, the average discharge duration was approximately five hours. To evaluate the beneficial use impact of an individual pollutant discharged directly to the Sacramento River in CSS effluent, the mass load of the constituent in CSS effluent was compared to the mass load estimated to be present in the upstream receiving water, and the CSS effluent mass load was also compared to the allowable mass load in the receiving water if in-stream concentrations existed at a relevant water quality objective or criterion for a given pollutant. This latter mass loading describes the assimilative capacity (i.e., the total mass the River can carry and still meet water quality objectives and protect beneficial uses) of the receiving water for a particular constituent. Because water quality parameters have been determined to exert impacts on beneficial uses over certain time periods – from acute 1-hour impacts to long-term, multi-year impacts – the appropriate averaging period was identified for each evaluated constituent to assess the impact of a given constituent on beneficial uses. **Table 5-1** lists the averaging periods, water quality objectives, and objective sources for each of the constituents considered in this assessment. For constituents that have both 1-hour acute and 4-day chronic objectives, the analysis focused on the 1-hour acute objective since CSS discharge events do not extend past one day in length. Due to the absence of multi-year data sets for those constituents most appropriately evaluated for their long-term impacts on beneficial uses, the comparison of mass loading presented in Section 5.1.2.1 evaluated annual impacts to the receiving water.

Table 5-1: Relevant Water Quality Objectives for Combined Sewer System Constituents of Concern.

Constituent (unit)	Appropriate Averaging Period	Relevant Water Quality Objective	Objective Source
Fecal Coliform (MPN/100 mL)	30-day geometric mean	200	Basin Plan
Total Coliform (MPN/100 mL)	n/a	n/a	No objective
Ammonia (mg/L as N)	1-hour acute	Various – pH dependent	U.S. EPA 1999 Update of Ambient WQ Criteria for Ammonia, acute objective (1-hour avg.)
Nitrate + Nitrite (mg/L as N)	Running 30-day average	10	Title 22 Primary MCL/Basin Plan
Phosphorus – total (mg/L)	n/a	n/a	No objective
Cyanide (µg/L)	1-hour/4-day	22/5.2	CTR (acute & chronic FW, aquatic life)
MBAS (mg/L)	Annual average	0.5	Title 22 Secondary MCL
Total Dissolved Solids (mg/L)	Annual average	500(2)	Title 22 Secondary MCL/Basin Plan(1)
Total Suspended Solids (mg/L)	n/a	narrative	Basin Plan narrative

Constituent (unit)	Appropriate Averaging Period	Relevant Water Quality Objective	Objective Source
Aluminum – total (µg/L)	Annual average	200[3]	Title 22 Secondary MCL/Basin Plan[1]
Copper – dissolved (µg/L)	1-hour/4-day	Various – hardness dependent	CTR (acute & chronic FW, aquatic life)
Copper – total (µg/L)	Annual average	1000	Title 22 Secondary MCL
Iron – dissolved (µg/L)	n/a	n/a	No objective
Iron – total (µg/L)	Annual average	300	Title 22 Secondary MCL
Lead – dissolved (µg/L)	1-hour/4-day	Various – hardness dependent	CTR (acute & chronic FW, aquatic life)
Lead – total (µg/L)	n/a	n/a	Title 22 Secondary MCL Rescinded
Mercury – total (µg/L)	Long-term average	0.05	CTR (human health, water & organisms)
Methylmercury – total (g)	year	0.53	MeHg TMDL wasteload allocation for CSS
Silver – dissolved (µg/L)	1-hour average	Various – hardness dependent	CTR (acute FW, aquatic life)
Silver – total (µg/L)	Annual average	100	Title 22 Secondary MCL
Zinc – dissolved (µg/L)	1-hour/4-day	Various – hardness dependent	CTR (acute & chronic FW, aquatic life)
Zinc – total (µg/L)	Annual average	5000	Title 22 Secondary MCL
Benzo(a)anthracene (µg/L)	Long-term average	0.0044	CTR (human health, water & organisms)
Bis(2-ethylhexyl)phthalate (µg/L)	Long-term average	1.8	CTR (human health, water & organisms)
Chrysene (µg/L)	Long-term average	0.0044	CTR (human health, water & organisms)
Diazinon (µg/L)	1-hour/4-day	0.16/0.10	Basin Plan[1]
Total Trihalomethanes (µg/L)	Annual average	80	EPA Drinking Water Regulations for Disinfection Byproducts

Notes:

1. Incorporated into the Basin Plan by reference (CVRWQCB, 2009).
2. 500 mg/L is the low end of the acceptable Title 22 Secondary MCL recommended range for TDS.
3. The Secondary MCL for aluminum has been determined to be the controlling water quality objective for the discharge to the Sacramento River and downstream Delta. The determination is made through evaluation of available aluminum toxicity bioassay results performed in the Central Valley (e.g., City of Manteca, City of Yuba City, and City of Modesto) which resulted in adjusted chronic criteria more than an order of magnitude greater than the 1988 U.S. EPA ambient water quality chronic criterion of 87 µg/L (U.S. EPA, 1988), and generally exceeding the Secondary MCL concentration of 200 µg/L. Previously, the 304(a) 87 µg/L aquatic life criterion has been selected based on best professional judgment utilizing available information for use in Central Valley permits as an interpretation of the narrative toxicity objective in the Basin Plan. Considering the new information regarding the low aluminum toxicity in Central Valley waters provided by the bioassays, the fact that the Secondary MCL concentration is an order of magnitude less than the bioassay effects levels, and the fact that the U.S. EPA criteria document acknowledges many high quality waters with aluminum concentrations exceeding 87 µg/L and recommends consideration of the site specific waters in determining the appropriate aquatic life criterion, the use of the 200 µg/L Secondary MCL value is deemed appropriate.

5.1.1 Mass Loading Estimation Methodology

The CSS mass loading to the Sacramento River was compared with in-stream River loading upstream of the CSS discharge and with River loading at assimilative capacity. The mass loading comparison methodology is described in the following section. In this way, the CSS overflow's loading is put into context with the total River load observed at the time of the discharge event and the available assimilative capacity in the River. Event-based, monthly, or annual mass loadings were estimated for each of the three load types depending on the appropriate averaging period of the constituent under consideration based on protection of the beneficial use.

Event-based CSS mass loading was estimated using one of the following: 1-hour average loading (lbs/hour) for parameters with 1-hour acute averaging periods, 30-day average loading (lbs/month) for nitrate + nitrite, or annual average loadings for parameters with annual average or long-term, multi-year averaging periods. Estimated annual CSS mass loadings are included in **Appendix E, Section 1**. Estimated 1-hour average and 30-day average CSS mass loadings are provided in **Appendix E, Section 2** and **Section 3**, respectively.

Average hourly CSS mass loading estimates were only calculated for CSS discharge events where a particular constituent was monitored in the effluent. Median "surrogate" values generated for estimating average annual CSS mass loadings were only used when effluent concentrations were monitored at only one outfall (e.g., EFF-002) during a storm event where the CSS discharged from more than one outfall. These surrogate values were generated by calculating the median of the CSS effluent data from a particular outfall for a particular constituent.

To conservatively estimate average monthly mass loading for nitrate + nitrite, the month of December 2012 was selected because it included the largest volume of CSS effluent discharged to the Sacramento River during the period 2011 – 2012. A nitrate + nitrite (as N) concentration measured in the Sacramento River during the January 21, 2012, CSS discharge event was used as a surrogate concentration to calculate a 30-day average in-stream mass loading for the month of December 2012. The January 21, 2012, nitrate + nitrite (as N) measurement (0.552 mg/L as N) was the highest measured in the receiving water from December 2010 through December 2012, and therefore provides a conservative, upper limit estimate for *monthly* nitrate + nitrite mass loading in the Sacramento River upstream of the CSS discharge during this time period. With regard to all averaging periods, CSS discharges from more than one outfall that occurred during the same storm event (e.g., discharge from EFF-002 and EFF-006) were summed to calculate the mass per averaging period discharged by the CSS for a particular event.

Event-based receiving water mass loading upstream of the CSS was estimated for the various constituents that have a relevant water quality objective using CSS receiving water monitoring data and Sacramento River flow measurements at Freeport as reported by CDEC (FPT). River flows for each discharge event were first adjusted by subtracting CSS discharge flows. Estimated receiving water mass loadings upstream of the CSS discharge were calculated as either 1-hour average loadings (lbs/hour), a 30-day average loading for nitrate + nitrite (lbs/month), or annual loadings (lbs/year) as described in **Table 5-1**. Estimated event-based annual Sacramento River mass loadings upstream of the CSS discharge are included in **Appendix E, Section 4**. Estimated 1-hour average and 30-day average CSS mass loadings are provided in **Appendix E, Section 5** and **Section 6**, respectively.

Similar to the methodology used to calculate CSS mass loadings, the estimation of receiving water mass loadings used median surrogate values for discharge events where the CSS Monitoring and Reporting Program did not collect receiving water data for a particular discharge event. These surrogate values were generated by calculating the median of the receiving water data for a particular constituent. Sacramento River mass loading upstream of the CSS discharge for nitrate + nitrite was only estimated for the month of December 2012 for the reason stated above. All event-based receiving water mass loading estimates are meant to provide a sense of the amount of a particular constituent over some averaging period that exists in the River upstream of the CSS during the time that the CSS discharges.

Sacramento River mass loading at assimilative capacity was estimated for constituents that have a relevant water quality objective using the appropriate objective (see **Table 5-1**) and the volume of River water that was estimated to flow past the CSS over a particular averaging period (1-hour, 30 days, or one year). Flow data were measured at Freeport as reported by CDEC (FPT). In this way, the averaging period of a particular water quality objective was appropriately linked to the volume of receiving water estimated to be present to dilute a pollutant during that same averaging period. Where necessary, receiving water pH (ammonia acute criteria) and hardness (California Toxics Rule (CTR) trace metals objectives) were used when calculating specific water quality objectives to be used in the assimilative capacity mass loading estimates. These assimilative capacity mass loading estimates, which describe the amount of loading of a constituent to the receiving water that could occur over a particular averaging period and still be protective of beneficial uses, provide a benchmark by which to compare existing in-stream loads upstream of the CSS discharge and the mass loading contributed by the CSS discharge. The difference between the loading estimate at 100% or full assimilative capacity and the sum of existing in-stream loads and CSS discharge loads provides a measure of the available assimilative capacity in the receiving water for a particular constituent. Sacramento River mass loading at full assimilative capacity estimates are provided in **Appendix E, Section 7** (annual and 30-day loadings at full assimilative capacity) and **Section 8** (1-hour average loadings at full assimilative capacity).

Since pathogens levels are typically expressed as concentrations (counts of an organism per a specific volume of water), no mass loadings of pathogens were estimated. However, a comparison of pathogen concentrations is provided in **Table 6-4**.

5.1.2 Comparison of Mass Loadings

An estimate of the water quality impacts of CSS discharges, with respect to available assimilative capacity in the Sacramento River downstream of the CSS, can be achieved by comparing CSS mass loadings to existing in-stream mass loadings upstream of the CSS and to estimate receiving water mass loadings if the River reached full assimilative capacity for a particular constituent. As described above, the calculation of receiving water mass loadings at 100% assimilative capacity is based on the appropriate water quality objective and averaging period for the pollutant of interest. In order to make the appropriate mass loading comparison, estimated mass loadings from the three load types must be normalized to the same unit of measure (e.g., lbs/hour, lbs/month, or lbs/year) based on the averaging period of the parameter under consideration.

5.1.2.1 Annual and Monthly Load Comparisons

Some of the constituents evaluated in this assessment have been determined to have longer term impacts on beneficial uses. These longer term impacts are evaluated by comparing average annual or average multi-year concentrations or mass loadings to a water quality objective or mass loading derived from that objective, respectively. Because the CSS lacks multiple years worth of data for the various constituents identified in **Table 5-1**, the current analysis focuses on the comparison of estimated annual mass loadings to the Sacramento River for the years 2011 and 2012. **Figure 5-1** through **Figure 5-13** present these annual mass loading comparisons for constituents with annual or longer term averaging periods. In instances where CSS discharge and/or receiving water concentrations were non-detect, mass loading estimates were calculated using the detection limit for the non-detect parameter. **Figure 5-14** presents estimated monthly mass loadings for nitrate + nitrite. The estimated CSS mass loadings described by this figure represents "worst case" conditions as the highest nitrate + nitrite concentration measured in CSS effluent during 2011 – 2012 was used to calculate a daily mass loading that was summed for each of the 31 days of December 2012. This month was chosen because it had the greatest number of CSS discharges (four) on any month during 2011 – 2012.

In the following bar plots, the estimated, existing in-stream mass loadings are added to the estimated discharge contributions from the CSS to provide a sense of how existing ambient mass loadings compare to mass loadings that would exist for a constituent if it used the full assimilative capacity available in the receiving water. With the exception of the total trihalomethanes (TTHMs) bar plot, the plots describing annual mass loadings use Sacramento River at Freeport data collected by the Sacramento Coordinated Water Quality Monitoring Program (CMP) for estimating in-stream annual mass loadings because the CSS Monitoring Program does not collect the necessary receiving water data on a year round basis needed to calculate an annual mass load. The bar plots describing TTHMs annual mass loading and nitrate + nitrite average monthly mass loading use receiving water data collected upstream of the CSS discharge in calculating existing in-stream mass loadings. Additionally, the TTHMs plot describes the upstream receiving water mass loading as "storm-based upper limit" because the concentration data used to calculate the mass loading were all derived from storm events and included a large percentage of results reported as non-detect; no dry season TTHM data were available for inclusion in the data set. Finally, some in-stream receiving water mass loadings are described in the plots as "upper limit – ND data." These mass loadings represent an upper limit estimate because they are based on data sets that include a large percentage of non-detect (ND) results.

For all parameters evaluated, CSS mass loadings on an annual basis were less than existing in-stream annual mass loadings in the Sacramento River. For parameters such as TTHMs, chrysene, benzo(a)anthracene, nitrate+nitrite, and bis(2-ethylhexyl)phthalate, the sums of annual CSS mass loadings and existing in-stream annual mass loadings were significantly below the estimated Sacramento River mass loadings at full assimilative capacity, indicating that CSS loadings do not impact beneficial uses in the Sacramento River. For all but two metals examined (total aluminum and total lead), the sums of annual CSS mass loadings and existing in-stream annual mass loadings were also significantly below the estimated Sacramento River mass loadings at full assimilative capacity. Median concentrations of total aluminum and total iron in the Sacramento River at Freeport measured by the CMP currently exceed their Title 22 Secondary MCLs of 200 µg/L and 300 µg/L, respectively. Additionally, storm-based concentrations of these two parameters measured by the CSS Monitoring Program were also observed to exceed their MCLs both upstream and downstream of the CSS discharge. It should be noted that while regulation of these two parameters in surface waters considers the total fraction of each metal, the Safe Drinking Water Act regulates the dissolved fraction of each metal for the purpose of ensuring a safe potable water supply for domestic consumption. During both 2011 and 2012, the annual CSS mass loading of total methylmercury to the Sacramento

River was below the 0.53 g wasteload allocation imposed upon the facility by the Sacramento-San Joaquin Delta Methylmercury TMDL. The bar plot for total methylmercury is formatted differently from the other plots presented below to allow for easy comparison of CSS mass loading for total methylmercury and the facility's annul wasteload allocation.

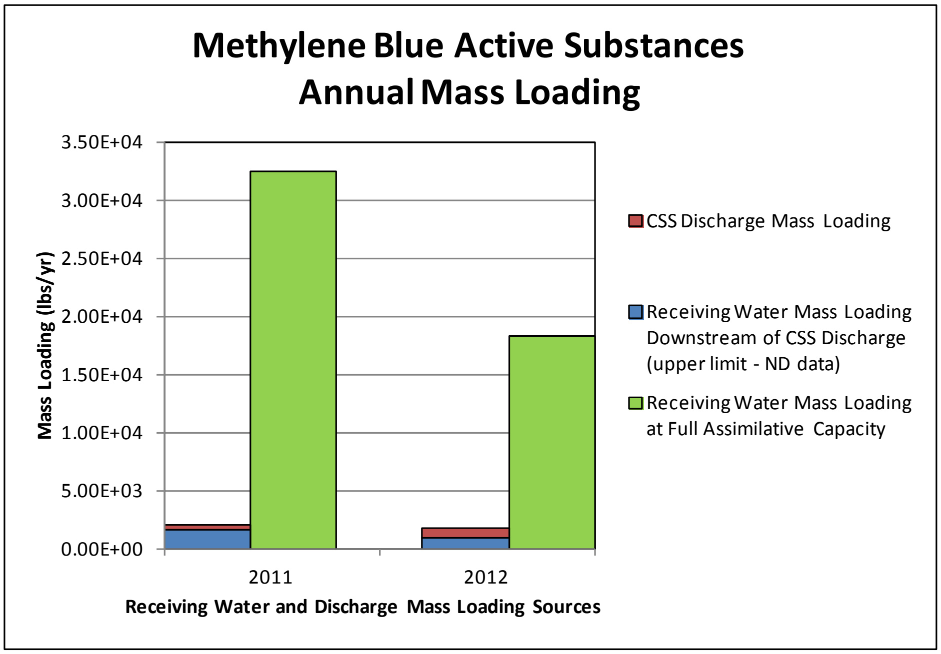


Figure 5-1: Comparison of Annual CSS Mass Loadings for MBAS to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

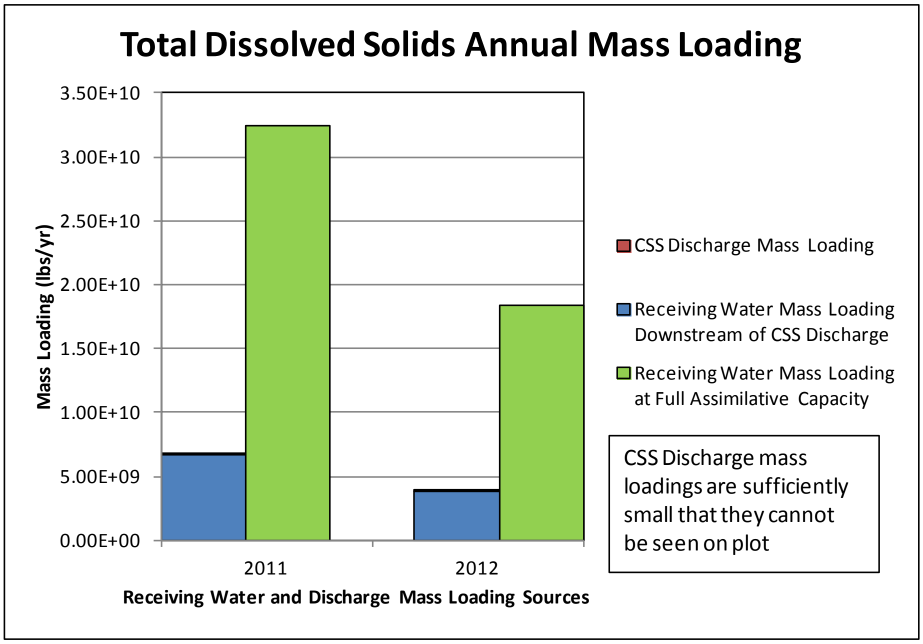


Figure 5-2: Comparison of Annual CSS Mass Loadings for Total Dissolved Solids to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

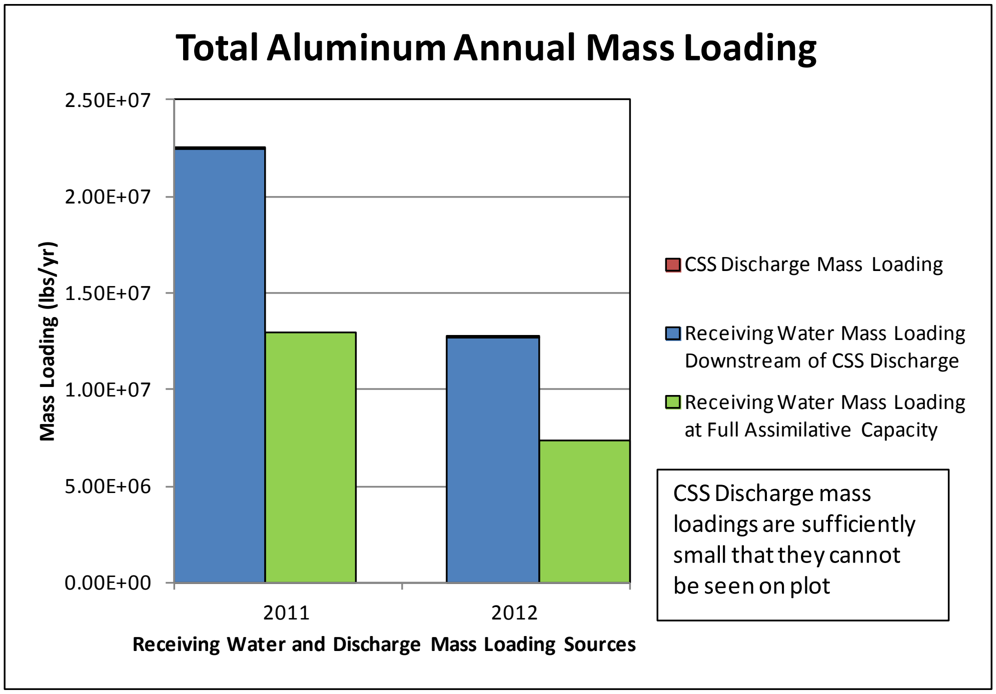


Figure 5-3: Comparison of Annual CSS Mass Loadings for Total Aluminum to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

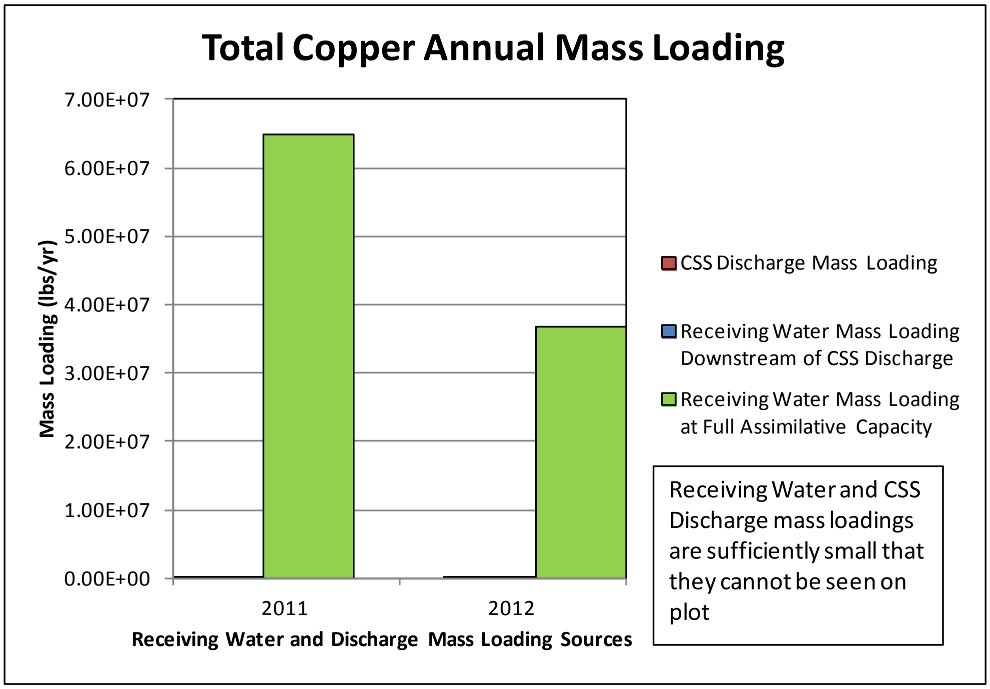
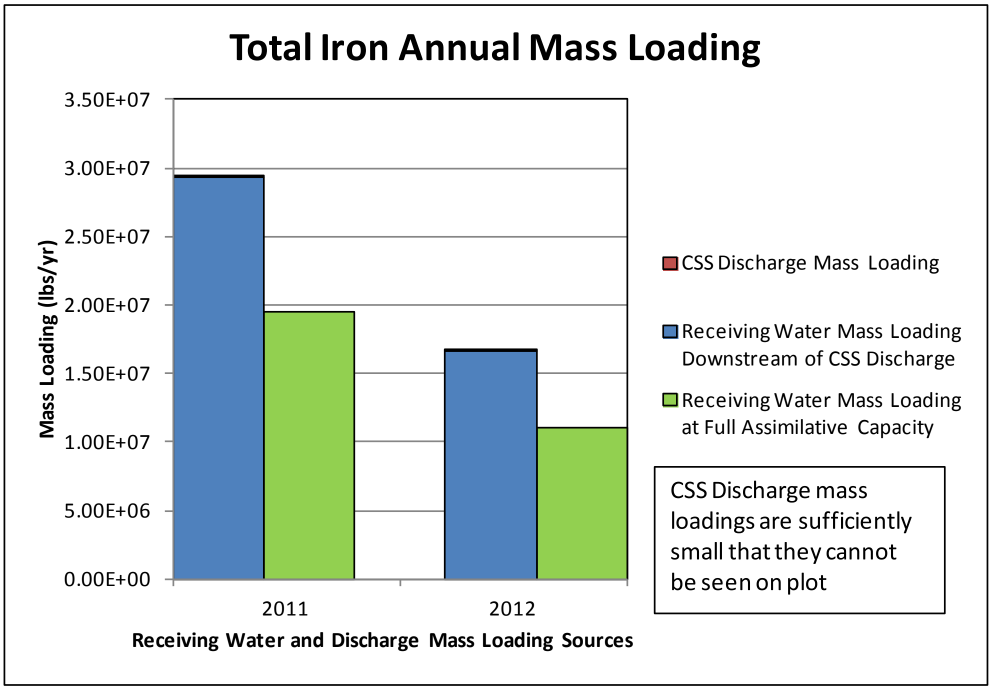
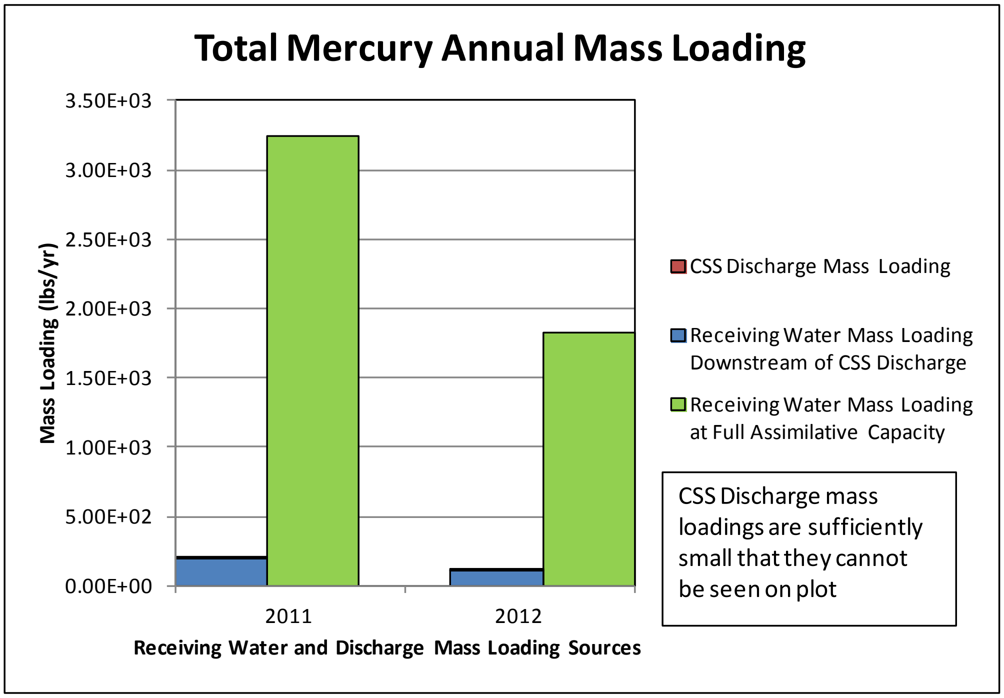


Figure 5-4: Comparison of Annual CSS Mass Loadings for Total Copper to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.



CSS Discharge mass loadings are sufficiently small that they cannot be seen on plot

Figure 5-5: Comparison of Annual CSS Mass Loadings for Total Iron to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.



CSS Discharge mass loadings are sufficiently small that they cannot be seen on plot

Figure 5-6: Comparison of Annual CSS Mass Loadings for Total Mercury to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

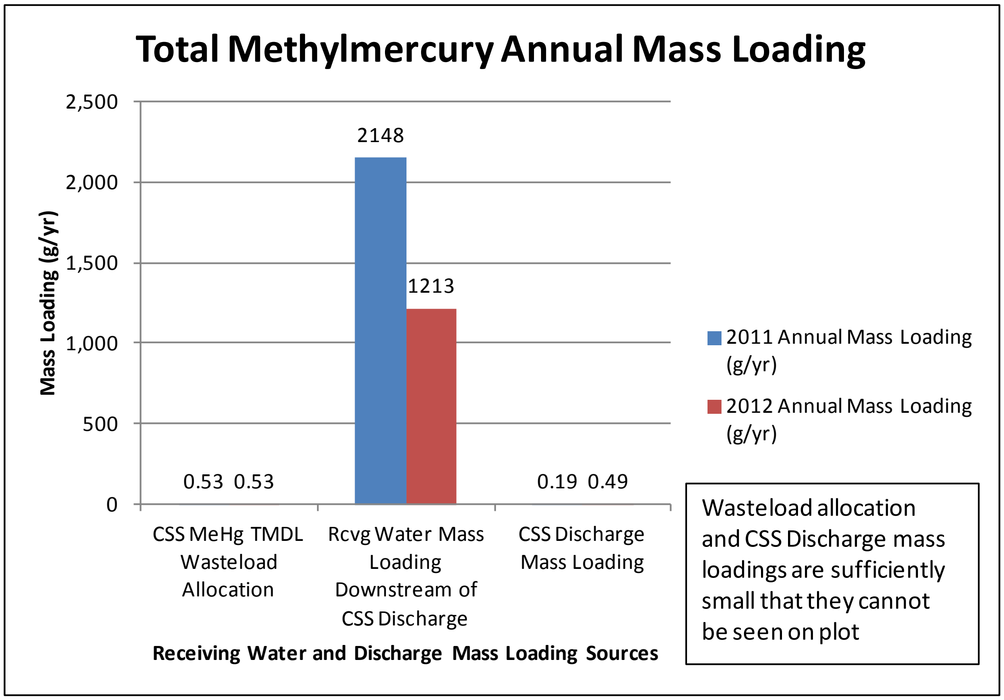


Figure 5-7: Comparison of Annual CSS Mass Loadings for Total Methylmercury to Existing Downstream Sacramento Mass Loadings and Delta Methylmercury TMDL Wasteload Allocation.

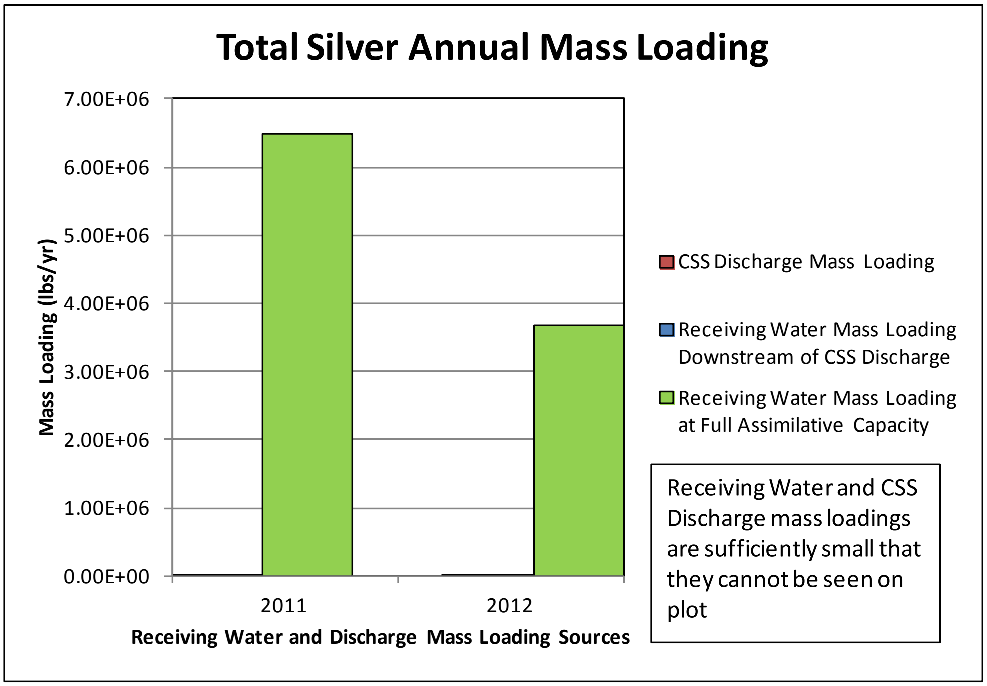


Figure 5-8: Comparison of Annual CSS Mass Loadings for Total Silver to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

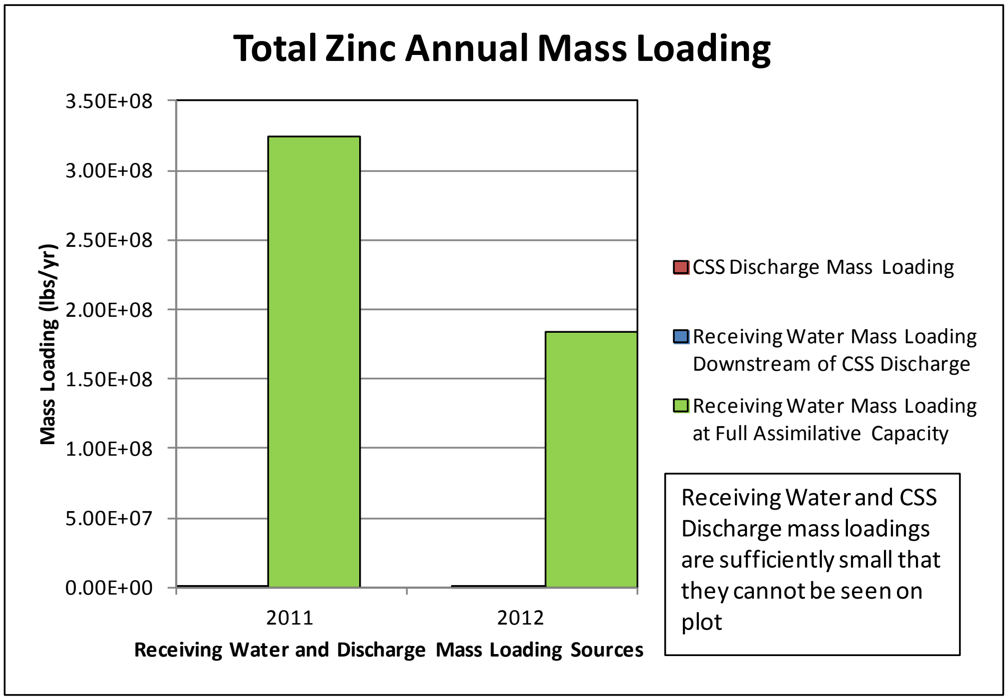


Figure 5-9: Comparison of Annual CSS Mass Loadings for Total Zinc to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

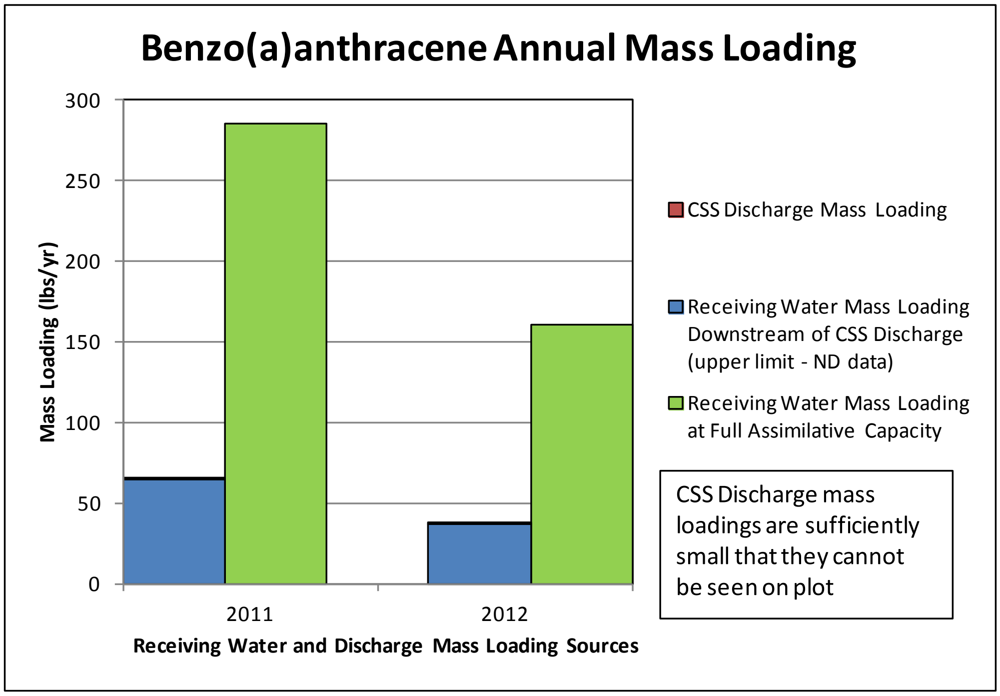
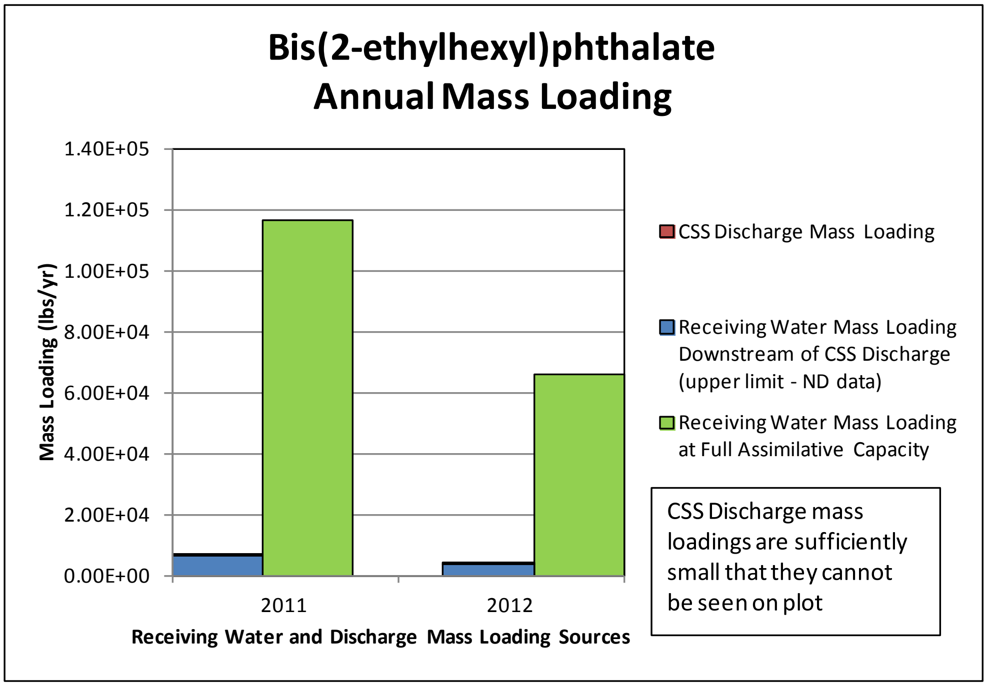
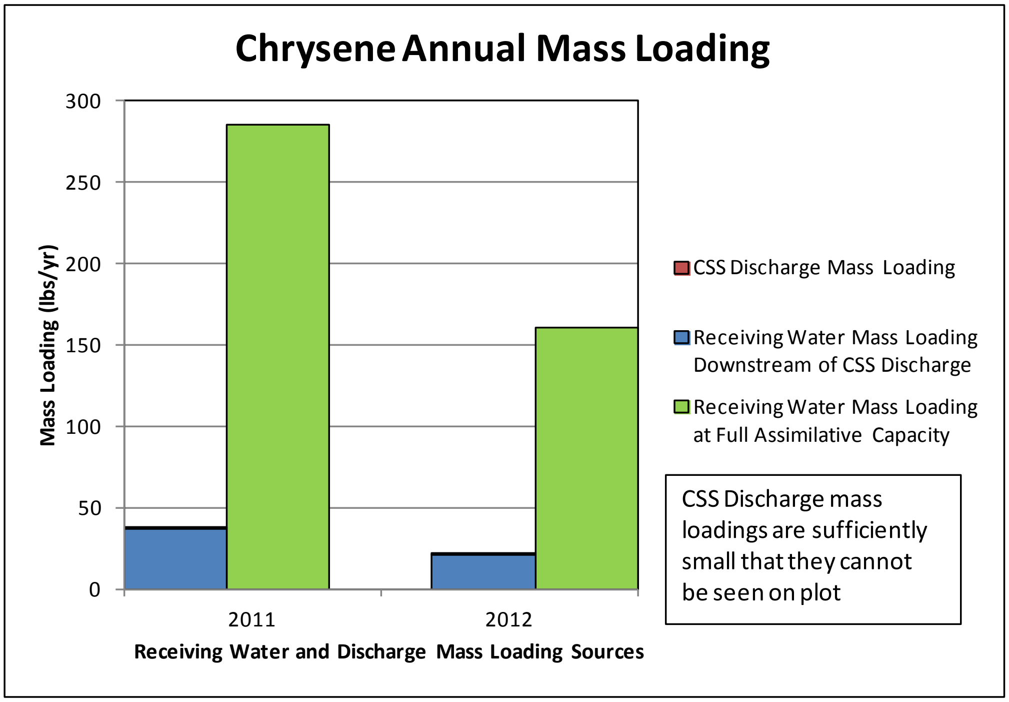


Figure 5-10: Comparison of Annual CSS Mass Loading for Benzo(a)anthracene to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.



CSS Discharge mass loadings are sufficiently small that they cannot be seen on plot

Figure 5-11: Comparison of Annual CSS Mass Loading for Bis(2-ethylhexyl)phthalate to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.



CSS Discharge mass loadings are sufficiently small that they cannot be seen on plot

Figure 5-12: Comparison of Annual CSS Mass Loadings for Chrysene to Existing Downstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

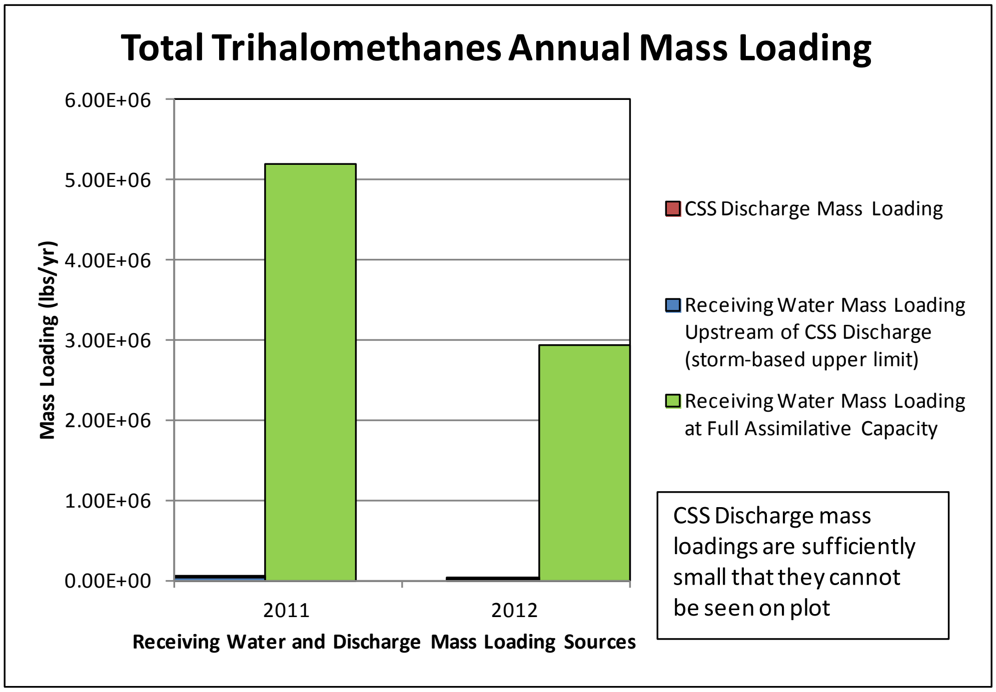


Figure 5-13: Comparison of Annual CSS Mass Loadings for Total Trihalomethanes to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

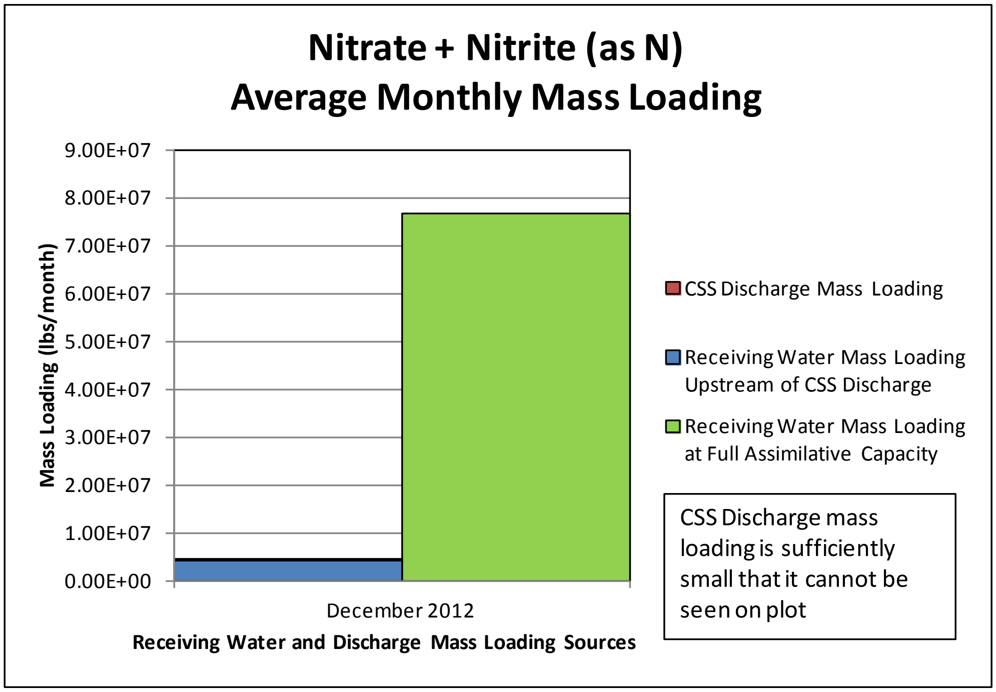


Figure 5-14: Comparison of Average Monthly CSS Mass Loadings for Nitrate + Nitrite to Existing Upstream Sacrament River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

5.1.2.2 Hourly Load Comparisons

Similar to the annual and monthly load comparisons presented above, comparisons of estimated hourly mass loadings can be made for those constituents determined to have acute impacts on aquatic life beneficial uses. **Figure 5-15** through **Figure 5-21** present these hourly mass loading comparisons for constituents with 1-hour acute water quality objectives. The number of events considered for a particular parameter varies based on how frequently the CSS is required to monitor for a constituent. Full assimilative capacity mass loading estimates (lbs/hour) for ammonia were calculated using pH measured in the upstream receiving water during CSS discharge events, and full assimilative capacity mass loading estimates for trace metals having CTR hardness-based criteria were calculated using hardness measured in the upstream receiving water.

For all parameters evaluated, CSS average hourly mass loadings were less than existing in-stream average hourly mass loadings in the Sacramento River upstream of the CSS discharge. Furthermore, the sums of average hourly CSS mass loadings and existing in-stream average hourly mass loadings were significantly below the estimated Sacramento River average hourly mass loadings at full assimilative capacity. All upstream and downstream receiving water concentrations were observed to exist below their respective 1-hour acute water quality objectives.

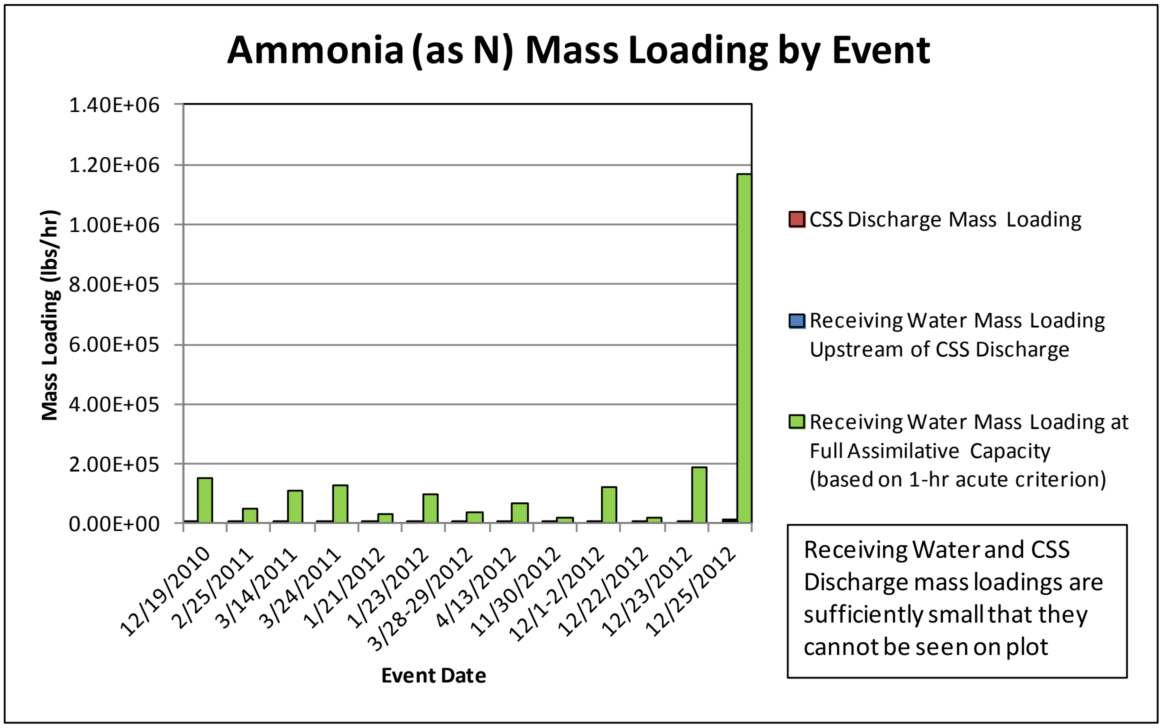


Figure 5-15: Comparison of Hourly CSS Mass Loadings for Ammonia to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

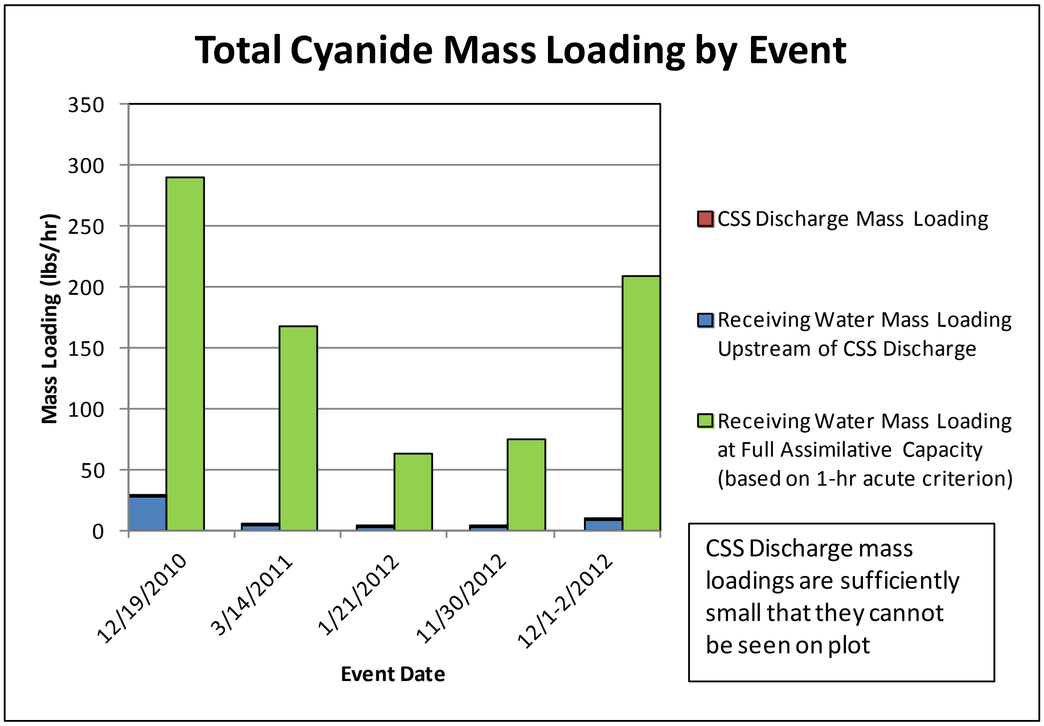


Figure 5-16: Comparison of Hourly CSS Mass Loadings for Cyanide to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

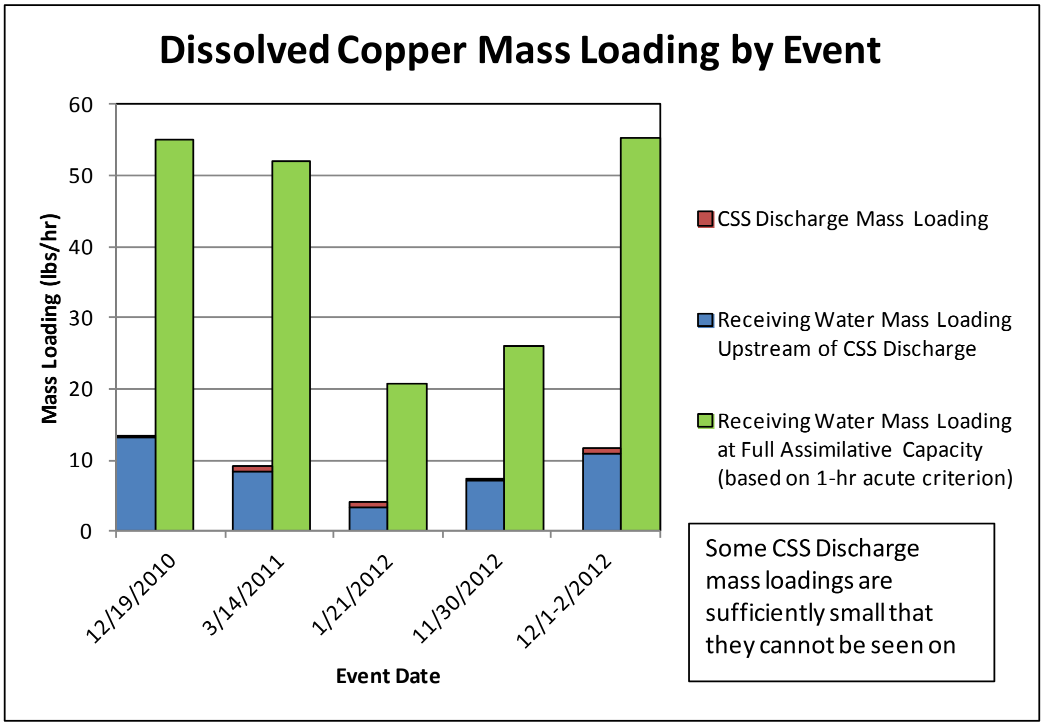


Figure 5-17: Comparison of Hourly CSS Mass Loadings for Dissolved Copper to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

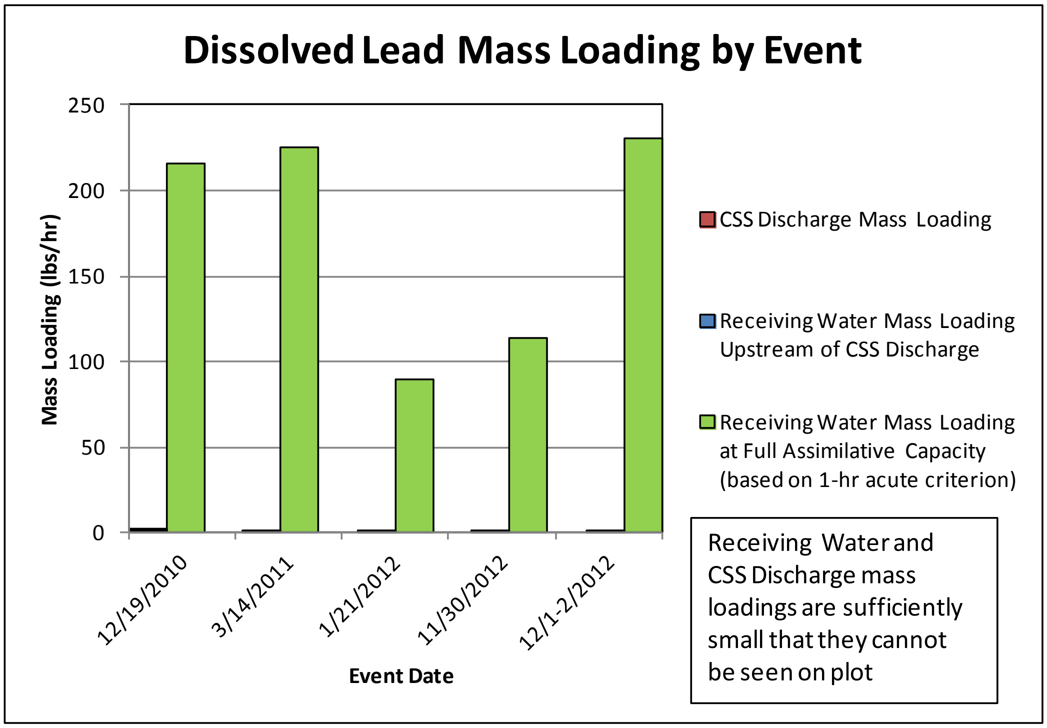


Figure 5-18: Comparison of Hourly CSS Mass Loadings for Dissolved Lead to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

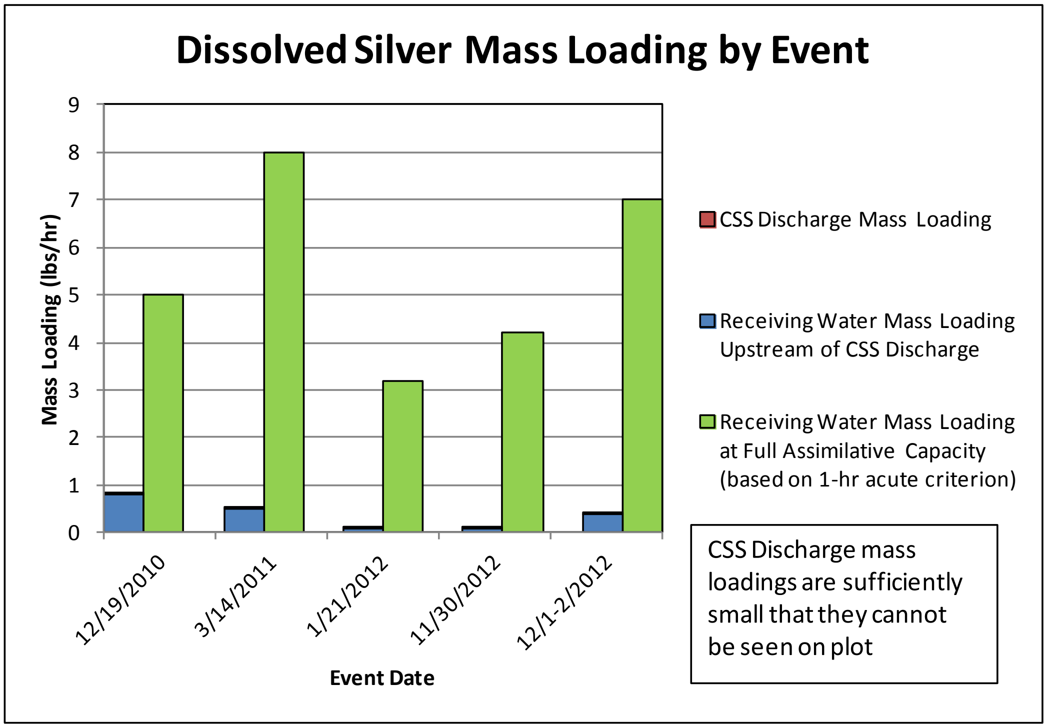


Figure 5-19: Comparison of Hourly CSS Mass Loadings for Dissolved Silver to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

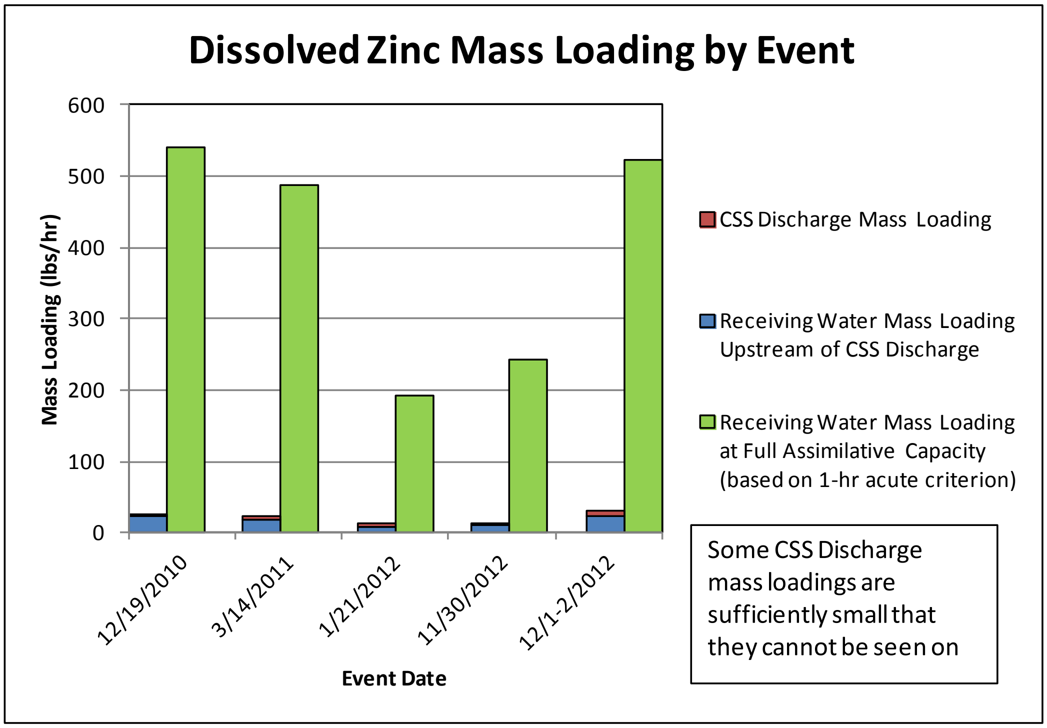


Figure 5-20: Comparison of Hourly CSS Mass Loadings for Dissolved Zinc to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

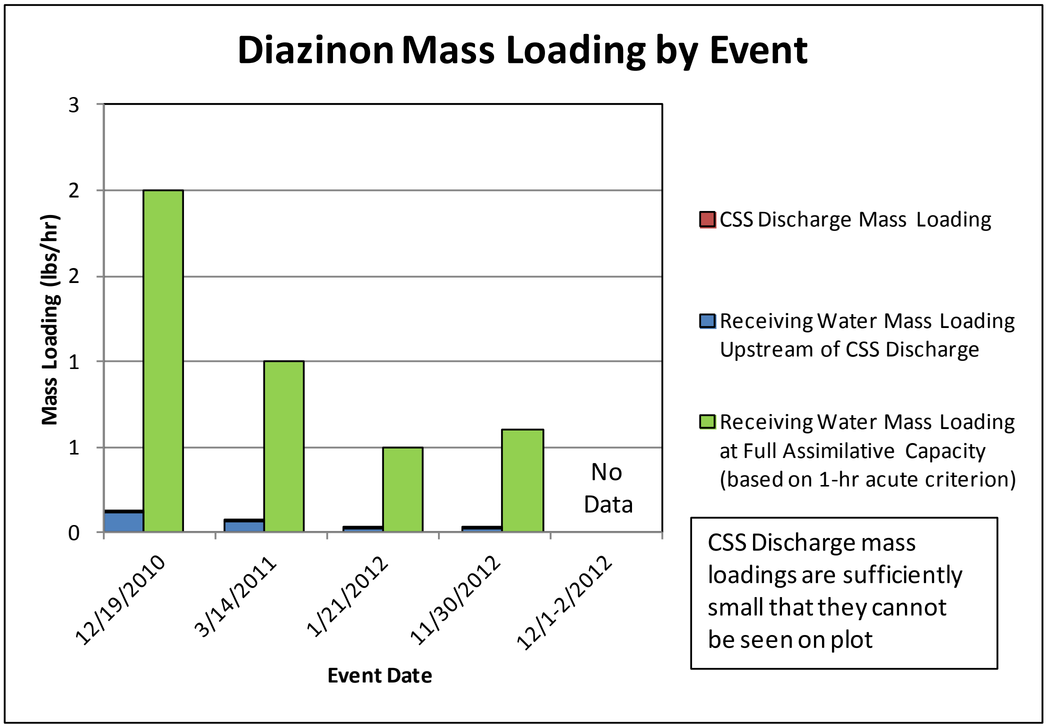


Figure 5-21: Comparison of Hourly CSS Mass Loadings for Diazinon to Existing Upstream Sacramento River Mass Loadings and Mass Loadings at Full Assimilative Capacity.

6 Benefit of Combined Sewer System as Compared to Separate Wastewater and Storm Sewer System

The benefit that the CSS provides to receiving water quality can be estimated by comparing the existing system – Combined Sewer System + Sacramento Regional Wastewater Treatment Plant – to a hypothetical separate wastewater and stormwater (WW + SW) system. As described above, the existing system operates throughout most of the year by directing domestic wastewater and base flow from the CSS collection system to the SRWTP. During storm events where the total flow into the CSS exceeds both the 60 mgd that can be directed to the SRWTP for treatment and the storage capacity of the CSS, the existing system discharges primary treated and disinfected effluent to the Sacramento River for brief durations (~2 – 21 hours per event). Throughout the duration of a CSS discharge event, 60 mgd of combined wastewater and stormwater is sent to the SRWTP for treatment. The flows sent to the SRWTP for treatment during the event are composed primarily of stormwater, based on observed dry weather wastewater flow.

The benefit of the CSS system over a separate system was illustrated by comparing the water quality data of the existing CSS to that from a hypothetical separate storm sewer system.

An alternate strategy for meeting the wastewater treatment needs of the CSS service area would be a separate WW + SW system. Under this hypothetical scenario, all wastewater flows that entered the CSS collection system would be directed to the SRWTP for treatment – exactly as happens under the existing system except during high, stormwater-produced influent flows. Under the hypothetical separate system, urban runoff flows would be captured by a stormwater collection system and discharged directly to the Sacramento River.

6.1.1 Methodology for Calculating Mass Loading for Existing CSS System and a Hypothetical Separate System

The comparison of the CSS and a hypothetical separate WW + SW system was conducted by first accounting for the component flows attributable to both the existing and hypothetical systems, and then estimating mass loadings for each system. The total average annual mass loading from the existing CSS was estimated by calculating the average annual mass loading from the CSS to the Sacramento River that occurs during CSS discharge events (see **Table 4-3**), and adding this load to the average annual CSS-attributable mass load discharged by the SRWTP to the Sacramento River below Freeport Bridge (see **Table 4-4**). On an annual basis, this latter mass loading is the sum of the load attributable to the CSS that is discharged daily by the SRWTP (non-CSS discharge days), and the WW + SW load from the CSS that is treated and discharged by the SRWTP during a CSS discharge event (i.e., the 60 MGD limit to SRWTP). The average annual mass loading of the existing system is described by the following equation:

$$Mass\ Loading_{existing} = Mass\ Loading_{CSS} + Mass\ Loading_{CSS\_All\_SRWTP}$$

Where:

$Mass\ Loading_{existing}$ = estimated avg. annual mass loading produced by the CSS

$Mass\ Loading_{CSS}$ = estimated avg. annual CSS mass loading discharged directly to the Sac. River

Mass Loading $_{CSS\_All\_SRWTP}$ = est. avg. annual SRWTP mass loading attributable to CSS flows

The total average annual mass loading from a hypothetical separate WW + SW system can be estimated by calculating the average annual mass loading generated by stormwater runoff in the CSS service area (see **Table 6-1**) added to the average annual CSS service area-attributable wastewater mass loading discharged by the SRWTP (see **Table 6-2**). As described earlier, due to the lack of a robust CSS influent data set, Sacramento Stormwater Quality Partnership Sump 111 stormwater runoff data were used as surrogate data for the purposes of estimating CSS service area stormwater runoff quality. The average annual mass loading of a hypothetical separate WW + SW system is described by the following equation:

$$Mass\ Loading_{hypothetical} = Mass\ Loading_{CSS\_SW} + Mass\ Loading_{CSS\_WW\_SRWTP}$$

Where:

Mass Loading $_{hypothetical}$ = estimated avg. annual mass loading produced by a separate WW + SW system

Mass Loading $_{CSS\_SW}$ = estimated avg. annual stormwater mass loading from the CSS service area discharged to the Sacramento River.

Mass Loading $_{CSS\_WW\_SRWTP}$ = est. avg. annual SRWTP mass loading attributable to CSS service area WW flows

Table 6-1: Estimated Annual and Average Annual Stormwater Mass Loadings from the CSS Service Area Discharged to the Sacramento River with a Hypothetical Separate Wastewater and Storm Sewer System.

Constituent	Median Sump 111 concen.	Year[(1)(2)]	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
Ammonia (mg/L as N)	0.44	2011	6,719	5,614
		2012	4,510	
Nitrate + Nitrite (mg/L as N)	0.53	2011	8,093	6,763
		2012	5,432	
Phosphorus – total (mg/L)	0.32	2011	4,887	4,083
		2012	3,280	
Cyanide (µg/L)	<`3.0	2011	<45.8	<38
		2012	<30.8	
MBAS (mg/L)	0.08	2011	1,222	1,021
		2012	820	
Total Dissolved Solids (mg/L)	45.5	2011	693,283	579,313
		2012	465,344	
Total Suspended Solids (mg/L)	82.8	2011	1,264,401	1,056,545
		2012	848,688	
Aluminum – total (µg/L)	4485	2011	68,488	57,229
		2012	45,971	
Copper – dissolved (µg/L)	5.14	2011	78.5	66
		2012	52.7	

Constituent	Median Sump 111 concen.	Year(1)(2)	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
Copper – total (µg/L)	20.8	2011	318	265
		2012	213	
Iron – dissolved (µg/L)	63.6	2011	971	812
		2012	652	
Iron – total (µg/L)	2030	2011	30,999	25,903
		2012	20,807	
Lead – dissolved (µg/L)	0.64	2011	9.8	8.2
		2012	6.6	
Lead – total (µg/L)	20.3	2011	310	259
		2012	208	
Mercury – total (ng/L)	27.1	2011	0.414	0.346
		2012	0.278	
Methylmercury – total (ng/L)	0.31	2011	0.00473	0.00396
		2012	0.00318	
Silver –dissolved (µg/L)	<0.035	2011	<0.53	<0.45
		2012	<0.36	
Silver – total (µg/L)	0.21	2011	3.2	2.7
		2012	2.2	
Zinc – dissolved (µg/L)	69	2011	1,054	880
		2012	707	
Zinc – total (µg/L)	192	2011	2,932	2,450
		2012	1,968	
Benzo(a)anthracene (µg/L)	0.024	2011	0.37	0.31
		2012	0.25	
Bis(2-ethylhexyl)phthalate (µg/L)	2.53	2011	38.6	32
		2012	25.9	
Chloroform (µg/L)	<5	2011	<76.4	<64
		2012	<51.3	
Chrysene (µg/L)	0.067	2011	1.02	0.85
		2012	0.69	
Diazinon (µg/L)	0.072	2011	1.10	0.92
		2012	0.74	
Total Trihalomethanes (µg/L)	No data	2011	---	---
		2012	---	

Notes:

1. 2011 estimated annual CSS service area stormwater runoff equaled 1831 MG.
2. 2012 estimated annual CSS service area stormwater runoff equaled 1229 MG.

"<" denotes concentrations and loading estimates where a larger percentage of sample results in the data set were below a detection limit.

Table 6-2: Estimated Annual and Average Annual SRWTP Mass Loadings Attributable to CSS Service Area Wastewater Flows with a Hypothetical Separate Wastewater and Storm Sewer System.

Constituent	Median SRWTP concen.	Year(1)(2)	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
Ammonia (mg/L as N)	24.9	2011	1,360,628	427,377
		2012	1,308,296	
Nitrate + Nitrite (mg/L as N)	<0.1	2011	<5,464	<1,716
		2012	<5,254	
Phosphorus – total (mg/L)	2.21	2011	120,763	37,932
		2012	116,118	
Cyanide (µg/L)	3.4	2011	186	58
		2012	179	
MBAS (mg/L)	0.22	2011	12,022	3,776
		2012	11,559	
Total Dissolved Solids (mg/L)	388	2011	21,201,748	6,659,523
		2012	20,386,296	
Total Suspended Solids (mg/L)	6.6	2011	360,648	1,334,462
		2012	346,777	
Aluminum – total (µg/L)	14	2011	765	<5,359
		2012	736	
Copper – dissolved (µg/L)	3.6	2011	197	118,440
		2012	189	
Copper – total (µg/L)	3.7	2011	202	182
		2012	194	
Lead – dissolved (µg/L)	0.09	2011	4.92	11,790
		2012	4.73	
Lead – total (µg/L)	0.13	2011	7.10	20,794,022
		2012	6.83	
Mercury – total (ng/L)	3.44	2011	0.188	353,713
		2012	0.181	
Methylmercury – total (ng/L)	0.34	2011	0.01858	750
		2012	0.01786	
Silver –dissolved (µg/L)	0.021	2011	1.15	193
		2012	1.10	
Silver – total (µg/L)	0.036	2011	1.97	198
		2012	1.89	
Zinc – dissolved (µg/L)	13.5	2011	738	4.82
		2012	709	
Zinc – total (µg/L)	14	2011	765	6.97

Constituent	Median SRWTP concen.	Year(1)(2)	Estimated Annual Mass Loading (lbs/yr)	Est. Average Annual Mass Loading (lbs/yr)
		2012	736	
Benzo(a)anthracene (µg/L)	<0.5	2011	<27.3	0.184
		2012	<26.3	
Bis(2-ethylhexyl)phthalate (µg/L)	1.63	2011	89.1	0.01822
		2012	85.6	
Chloroform (µg/L)	14	2011	765	1.13
		2012	736	
Chrysene (µg/L)	<0.6	2011	<32.8	1.93
		2012	<31.5	
Diazinon (µg/L)	<0.05	2011	<2.73	724
		2012	<2.63	
Total Trihalomethanes (µg/L)	<15.6	2011	<852	750
		2012	<820	

Notes:

1. 2011 estimated annual CSS service area wastewater flows directed to the SRWTP equaled 6552 MG.
2. 2012 estimated annual CSS service area wastewater flows directed to the SRWTP equaled 6300 MG.

"<" denotes concentrations and loading estimates where a large percentage of sample results in the data set were below a detection limit.

6.1.2 Comparison of Existing CSS Mass Loadings to those of a Hypothetical Separate System

A comparison of estimated mass loadings to the Sacramento River from the existing CSS system and the hypothetical separate wastewater and storm sewer system is provided in **Table 6-3**. A graphical representation of the total mass loadings presented in **Table 6-3** is provided in **Figure 6-1**. Due to the large range in data values, **Figure 6-1** is presented using logarithmic scale. To illustrate the relative benefit of the existing CSS and hypothetical separate system, the comparison for selected constituents is shown using a linear scale in **Figure 6-2.** A comparison of the median pathogen concentrations attributable to the existing CSS and hypothetical separate system is provided in **Table 6-4**.

The estimated total mass loadings and concentrations for the existing CSS and a hypothetical separate system shown in **Table 6-3** and **Table 6-4**, respectively, reveal that the existing CSS contributes smaller mass loadings of nutrients and several trace metals than would otherwise be discharged to the receiving water by a hypothetical separate system. The CSS also discharges lower levels of coliform bacteria than a hypothetical separate system due to the untreated stormwater component that would receive no disinfection; although the CSS disinfection process generates more disinfection byproducts than would be produced if all CSS wastewater flows were treated at the SRWTP. While no definitive comparisons can be made for most trace organic compounds examined due to the non-detects contained in their data sets, it appears that the existing CSS system is more efficient at removing such compounds as bis(2-ethylhexyl)phthalate, a compound with sufficient detections in both the CSS and SRWTP effluents to allow a comparison.

6.1.3 Findings from the Comparison of Existing CSS to Hypothetical Separate System

The comparison of mass loadings to the Sacramento River from the current CSS system to a hypothetical separate wastewater and storm sewer system provided the following findings:

- The existing CSS system provides a benefit in pollutant mass removal for most all constituents (nutrients, trace metals, bacteria) examined due to treatment of urban runoff dry and wet weather flows;
- The approach did not consider the added benefit of treatment of the "first flush" portion of stormwater events that is treated by the SRWTP;
- The existing CSS system disinfection process may generate more disinfection byproducts than a hypothetical separate system. However, as indicated in the mass loading comparisons presented in **Section** 5**,** disinfection byproduct mass loadings by the CSS do not impact beneficial uses in the Sacramento River;
- In some cases non-detect values only allow calculation of an upper limit loading and differences in these upper limits is not necessarily due to actual differences between the combined and hypothetical separate sewer systems;
- The existing CSS system may discharge more MBAS than the hypothetical system, although calculation of the existing combined system loading is heavily influenced by two data points from the EFF-002.

Table 6-3: Tabular Comparison of Estimated Average Annual Mass Loadings to the Sacramento River from the Existing CSS and a Hypothetical Separate Wastewater and Storm Sewer System.

	Existing CSS System			***Hypothetical Separate System (serving existing CSS area)***		
Constituent	**Estimated CSS Mass Loadings Directly to Sacramento River (lbs/yr)**	**Estimated Mass Loadings to Sacramento River via SRWTP (lbs/yr)**	**Estimated Total Mass Loadings to Sacramento River (lbs/yr)**	**Estimated Mass Loading to Sacramento River from Stormwater Runoff (lbs/yr)**	**Estimated Mass Loadings to Sacramento River from WW Flows Treated by SRWTP (lbs/yr)**	**Est. Total Mass Loadings to Sacramento River (lbs/yr)**
Ammonia	750	39,000	**40,000**	5,600	1,300,000	1,300,000
Nitrate + Nitrite	900	<6200	*<7,100*	6,800	<5,400	*<12,000*
Phosphorus – total	1,600	37,000	**39,000**	4,100	120,00	120,000
Cyanide	<33	210	*<240*	<38	180	*<220*
MBAS	660	14,000	14,000	1,000	12,000	**13,000**
Total Dissolved Solids	320,000	9,600,000	**9,900,000**	580,000	21,000,000	21,000,000
Total Suspended Solids	190,000	410,000	**600,000**	1,100,000	350,000	1,400,000
Aluminum – total	3,500	870	**4,300**	57,000	750	58,000
Copper – dissolved	16	220	**240**	66	190	260
Copper – total	54	230	**280**	270	200	460
Iron – dissolved	230	No data	---	810	No data	---
Iron – total	5,400	No data	---	26,000	No data	---
Lead – dissolved	1.5	5.6	**7.0**	8.2	4.8	13
Lead – total	45	8.0	**53**	260	7.0	270
Mercury – total	0.17	0.21	**0.38**	0.35	0.18	0.53
Methylmercury – total	0.00074	0.021	**0.022**	0.0040	0.018	0.022
Silver – dissolved	<0.14	1.3	*<1.4*	<0.45	1.1	*<1.60*
Silver – total	0.40	2.2	**2.6**	2.7	1.9	4.6
Zinc – dissolved	110	830	**950**	880	720	1,600

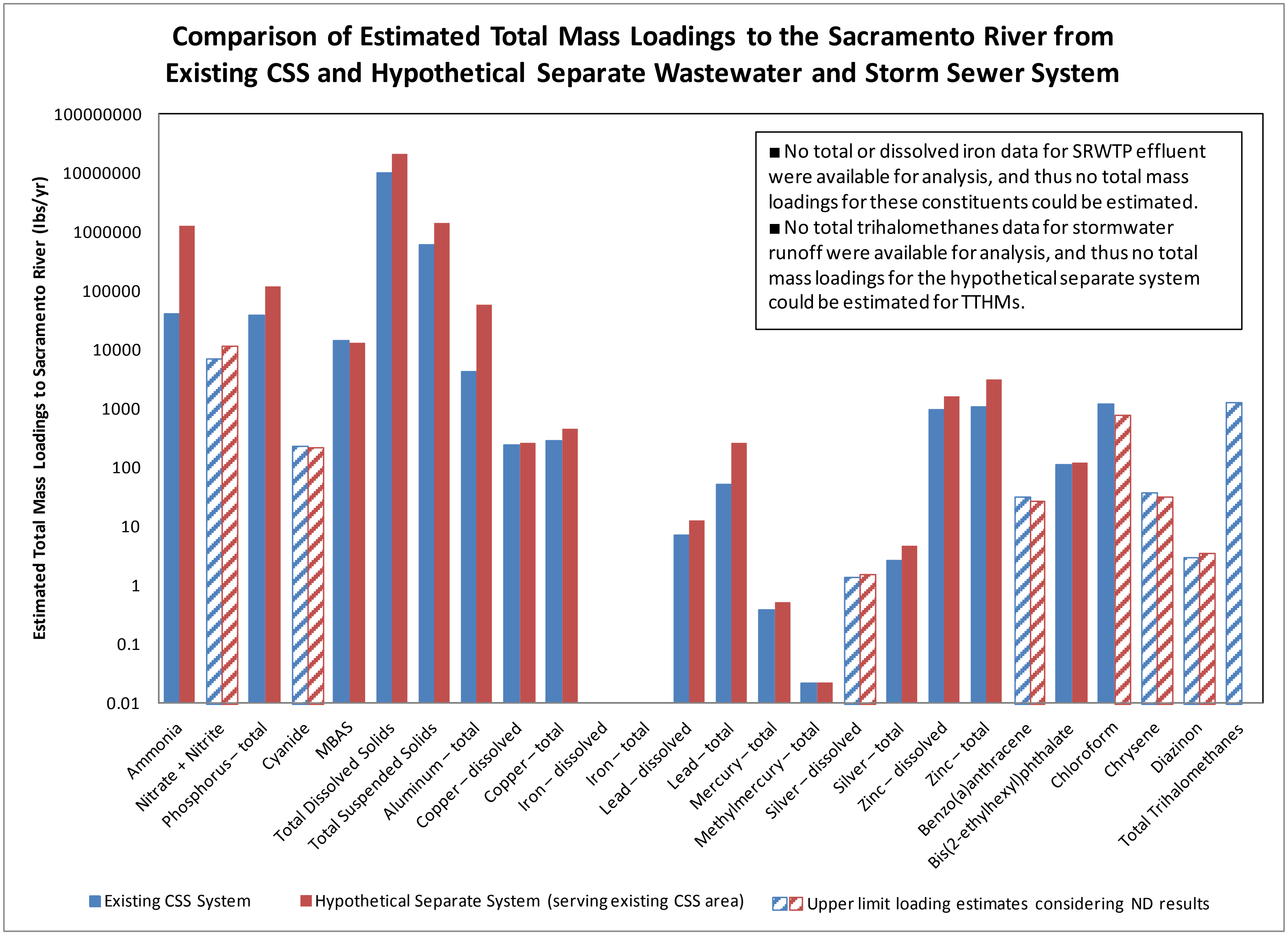
	Existing CSS System			***Hypothetical Separate System (serving existing CSS area)***		
Constituent	**Estimated CSS Mass Loadings Directly to Sacramento River (lbs/yr)**	**Estimated Mass Loadings to Sacramento River via SRWTP (lbs/yr)**	**Estimated Total Mass Loadings to Sacramento River (lbs/yr)**	**Estimated Mass Loading to Sacramento River from Stormwater Runoff (lbs/yr)**	**Estimated Mass Loadings to Sacramento River from WW Flows Treated by SRWTP (lbs/yr)**	**Est. Total Mass Loadings to Sacramento River (lbs/yr)**
Zinc – total	270	870	**1,100**	2,500	750	3,200
Benzo(a)anthracene	<0.080	<31	*<32*	0.31	<27	*<27*
Bis(2-ethylhexyl)phthalate	8.0	100	**110**	32	87	120
Chloroform	300	870	1,200	<64	750	***<810***
Chrysene	<0.090	<37	*<39*	0.85	<32	*<33*
Diazinon	<0.019	<3.1	*<3.1*	0.92	<2.7	*<3.6*
Total Trihalomethanes	300	<960	*<1300*	No data	<840	---

Notes:

Total mass loadings in *italics* were derived from data sets that include non-detects (detection limits were used for calculations), and therefore, no definitive comparisons can be made between the existing and hypothetical mass loads values provided.

Blue bolded text denotes that difference between existing and hypothetical mass loadings is less than or equal to 20% (lower mass loading in bold).

Brown bolded text denotes that difference between existing and hypothetical mass loadings is greater than 20% (lower mass loading in bold).



- No total or dissolved iron data for SRWTP effluent were available for analysis, and thus no total mass loadings for these constituents could be estimated.
- No total trihalomethanes data for stormwater runoff were available for analysis, and thus no total mass loadings for the hypothetical separate system could be estimated for TTHMs.

Figure 6-1: Graphical Comparison of Estimated Total Mass Loadings to the Sacramento River from the Existing CSS and a Hypothetical Separate Wastewater and Storm Sewer System

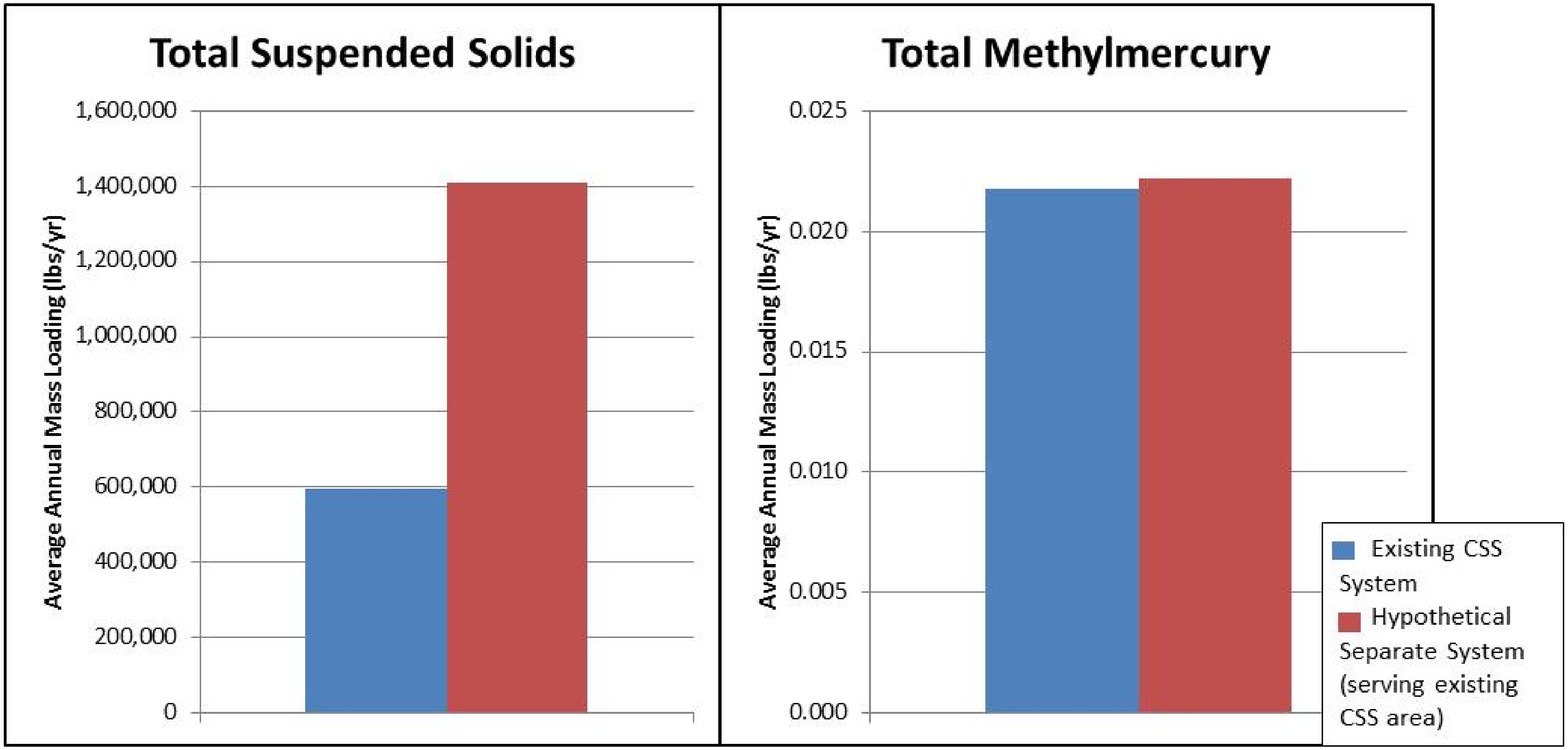


Figure 6-2. Graphical Comparison Using a Linear Scale for Select Constituents of Estimated Total Mass Loadings to the Sacramento River from the Existing CSS and a Hypothetical Separate System

Table 6-4: Comparison of Estimated Median Pathogen Concentrations Discharged to the Sacramento River from the Existing CSS and a Hypothetical Separate Storm Sewer System.

	Existing CSS System		***Hypothetical Separate System(serving existing CSS area)***	
Constituent	**Estimated Median Concentration Discharged Directly to the Sacramento River**	**Estimated Median Concentration Discharged to the Sacramento River via SRWTP**	**Estimated Median Concentration Discharged to the Sacramento River from Stormwater Runoff**	**Estimated Median Concentration Discharged to the Sacramento River from WW Flows Treated by SRWTP**
Fecal Coliform (MPN/100 mL)	<1.8	No data	8,000	<2
Total Coliform (MPN/100 mL)	5.7	2	181,448	2
Cryptosporidium (oocysts/L)	3	No data	0.6(1)	No data
Giardia (cysts/L)	293	No data	1.15(1)	No data

Notes:

1. Stormwater data is not available and the data is the average concentration of average residential and commercial/light industrial estimated wet season pathogen concentrations (WERF, 2011).

7 Long Term Control Plan Performance Evaluation

Performance and discharge modeling was conducted for the CSS to analyze discharges to the Sacramento River under existing conditions and under conditions for proposed LTCP projects. The modeling was conducted using a hydrologic and hydraulic (H&H) numerical model for the CSS. The model evaluation is described in detail in the *CSS Performance and Discharge Modeling Technical Memorandum*, included as **Appendix F**, and summarized below.

7.1 SYSTEM MODEL DEVELOPMENT AND CAPABILITIES

The H&H model was developed using InfoWorks. The H&H model includes all major large pipes within the CSS and a detailed representation of the special structures including pump stations, storage and combined sewer discharge locations. The model also includes the operational control logic for the hydraulic representation of the different treatment paths during a wet weather event. Since 2008, the City has refined the model to allow better analysis of design storms for flooding events and develop projects to address the flooding issues. The most recent model refinement was released in July 2012. The model was validated using intensive flow and rainfall monitoring data from the 2008-2009 wet weather season at several depth and flow monitoring locations. However, to analyze CSS discharge events, it was necessary to calibrate and validate the model using data from recent discharge locations to improve the model's capability to simulate discharge events.

7.2 EVALUATION OF OBSERVED EVENTS

Eight discharge events that occurred during the 2010/2011 and 2011/2012 seasons were evaluated using the H&H model. Rainfall data for the storms causing discharge were used as an input to the model simulation. The modeling included percent wastewater in the discharge for each of the discharge events.

7.3 TYPICAL YEAR DEVELOPMENT

The model evaluation used long term historical rainfall records to develop a typical year rainfall dataset to establish the baseline conditions for comparison with the impact of proposed CSS projects. A "typical" rainfall year can be used to analyze how a collection system will perform on an annual basis in conjunction with a model. A typical rainfall year was used to estimate average annual overflow frequency and volume in Sacramento, as well as provide other annual performance statistics. Development of the typical period involved selecting a year that closely resembles the long-term average in terms of number and distribution of storms. Based on evaluation using a scoring system to rank years based on how well the year matched the average for the period of record, 2008 was selected as the most typical year. Though 2008 statistics are relatively close to annual averages, there were too few storms with large intensities and depths; thus, a single storm was added to "typicalize" the rainfall and make the year match long term averages more closely. Using the typical year rainfall developed in the evaluation, the H&H model simulated the typical year rainfall dataset. The performance of the current system for a typical rainfall year was evaluated. Model calibration was considered good for planning purposes, and can be used with good confidence for CSS ouflow and discharge analysis.

7.4 EVALUATION OF LTCP PROJECTS

The H&H model can be used to evaluate how current and future LTCP projects could (a) reduce the risk of flooding and (b) control outflows to maintain/improve the impact of CSS discharges to the Sacramento River for the 5-year and 10-year storms. To perform the evaluation, the impacts of a potential project can be modeled and compared to the baseline conditions determined in the typical year analysis. The analysis of discharge frequency compares the baseline conditions with future planning projects to evaluate the impact of the future projects on the water quality of the Sacramento River. The discharge frequency analysis is divided into four project scenarios:

1. Baseline discharge frequency, volume, and percent wastewater;
2. Project Scenario I discharge frequency, volume, and percent wastewater for funded or planned projects since January 2010 and through January 2015;
3. Project Scenario II discharge frequency, volume, and percent wastewater for projects necessary to protect from the 5-year storm in the six areas of worst flooding; and
4. Project Scenario III discharge frequency and volume for projects necessary to protect from the 10-year storm throughout CSS.

The evaluation of the baseline discharge was performed, and is summarized in **Appendix F.** The modeling analysis for CSS discharges during a typical year provided a prediction of two discharge events from CWTP (EFF-002) and six discharge events from Pioneer (EFF-006). The annual average observed discharge events from October 2001-September 2008 were two from CWTP, two from EFF-004, and 3.4 from Pioneer. Since most years in that timeframe had annual rainfall lower than the average typical year rainfall, the higher number of modeled discharge events at Pioneer is within the acceptable range for a typical year.

The H&H model was used to evaluate Project Scenario I by calculating discharge frequency, volume, and percent wastewater for a typical year rainfall period for funded or planned projects from January 2010 through January 2015. The projects include:

- Project 1 - S Street Brick Sewer Main Replacement, 14th to 17th Street (constructed in October 2012);
- Project 2 - 7th Street Sewer Replacement, P to K Street: (planned for construction in 2014);
- Project 3 - 9th Street Sewer Replacement, G to L Street: (planned for construction in 2014);
- Project 4 - P Street Sewer Improvements, between 5th and 7th Streets (under construction); and
- Project 5 - Oak Park Regional Storage Project: (under construction).

The model analysis showed that the Scenario I projects provide flood reduction benefit in wet areas, cause a minor increase in treated CSS discharges (CSS discharges at CWTP increase from 2 to 3 events, and CSS volume increases by 1% at CWTP and Pioneer), but do not impact CSO discharges from EFF-004.

The model will continue to be used to evaluate future projects in the next year once a set of projects are finalized for Scenarios II and III. The City is currently developing and refining those projects, and the technical memorandum will be updated, to include the project evaluations, and submitted with the July 2014 Report of Waste Discharge.

8 Constituents of Concern

The constituent evaluations are summarized in (**Table 2-1**). The findings of beneficial use supported in this Water Quality Assessment are based on 1) compliance with technology based effluent limitations, 2) concentrations below relevant water quality objectives, 3) lower or equal loading rates for the CSS compared to a separated system for selected constituents, and 4) support of aquatic life as evaluated by toxicity tests and field observations. **Table 2-1** includes a few constituents where potential impacts should be more thoroughly evaluated because there was insufficient information to perform a complete assessment (e.g., no applicable numerical water quality objective, insufficient reliable data, etc.) or effluent limitations were exceeded. The following three constituents or groups of constituents require follow-up assessment.

- Pathogens - While the CSS discharge has complied with disinfection and pathogen indicator effluent limitations, the City detected *Giardia* and *Cryptosporidium* in the effluent and downstream receiving waters.
- Methylmercury -The City is currently evaluating the feasibility of compliance with Delta Methylmercury TMDL wasteload allocation.
- TSS, Chlorine Residual and pH - Operational considerations and field observations should also be considered when assessing effluent limitation violations for total suspended solids removal percentage, pH, and chlorine residual.

8.1 PATHOGENS

The Central Valley Regional Water Quality Control Board based the proposed Basin Plan Amendment on the work performed the Central Valley Drinking Water Policy Workgroup. The expected July 2013 amendments will include a narrative objective for *Cryptosporidium* and *Giardia*. However, the Workgroup concluded that existing conditions, including consideration of the CSS overflow discharges, are currently supportive of the MUN beneficial use. Because CSS discharges are not expected to increase due to operational or system changes, impacts to MUN beneficial uses are not expected. As discussed in the NPDES permit, because of the short duration and timing of CSS overflow discharges, the recreational beneficial uses do not apply and are not considered in this Water Quality Assessment. However, further evaluation of pathogens with the Central Valley Drinking Water Group is necessary to better establish existing levels, sources, and the relative contributions to downstream levels.

8.1.1 Detection in Combined Sewer System Overflow Discharge

Giardia was detected in effluent from Pioneer and CWTP. Protozoan pathogens, *Cryptosporidium* and *Giardia* can be present in wastewater influent depending on their presence in the contributing community. Furthermore, limited studies in other regions have detected pathogens in urban runoff (WERF, 2011). Protozoa, which are resistant to conventional wastewater treatment processes, and infectious at low doses, are of particular concern where dilution and decay processes in discharge receiving waters are limited. Protozoan pathogens are a concern for recreational users, and for downstream drinking water supply. As discussed previously, discharges from the CSS occur during winter months when river flows are high, and recreational use is not occurring. Thus, the main concern for pathogens is drinking water supply.

8.1.2 Analytical Methodology

The method for enumerating cysts and oocysts does not distinguish between organisms that were inactivated during disinfection processes, and organisms that are viable and capable of causing an infection. It has been estimated that approximately 35-40% of the *Cryptosporidium* oocysts detected by USEPA analytical methods 1622 or 1623 are capable of causing infection (USEPA, 2006).

8.1.3 Protection of Beneficial Use

Numeric water quality standards have been established for levels of *Cryptosporidium* and *Giardia* in drinking water, but have not been developed for ambient levels in surface waters. The maximum contaminant level goal (MCLG) is zero for *Cryptosporidium* and *Giardia* in public drinking water supplies. Goals have not been set for ambient surface waters and pathogenic microorganisms are not generally monitored in surface waters. The proposed Basin Plan Amendment, expected to be adopted in July 2013, will include narrative water quality objectives for *Cryptosporidium* and *Giardia* and the Central Valley Drinking Water Policy Workgroup will develop a monitoring program to evaluate sources, fate and transport, and drinking water intake concentrations. The monitoring program will be performed in coordination with the next round of Long Term 2 Enhanced Surface Water Treatment Rule (LT2) monitoring expected in 2015.

The LT2 requires source water monitoring to determine the requisite degree of treatment for public water systems that use surface or groundwater under direct influence of surface water. Drinking water systems are classified into a “bin” based on the results of the source water monitoring, and the bin levels determine whether further treatment of *Cryptosporidium* is required (see **Table 8-1**). Under the LT2, public water systems are classified in treatment bins according to the annual average of the total number of oocysts counted, without further adjustment for recovery or fraction of infectious oocysts. Currently nearly all Central Valley water agencies are in the highest water quality bin (Bin No. 1). The expected Basin Plan Amendment also includes trigger values, based on the bin levels and water intake sample collection, that could initiate an evaluation process to determine the cause of increases in pathogen levels. The trigger values are not water quality objectives, but are intended to identify changes in water quality before it requires additional water supply treatment (i.e., a change in bin classification).

Table 8-1. LT2 Bin Classification.

Bin	*Cryptosporidium* Annual Average Concentration (oocysts/L)	Treatment Requirements
1	oocysts < 0.075	No additional treatment
2	0.075 ≤ oocysts < 1.0	Additional treatment required such that the total *Cryptosporidium* removal and inactivation is at least 4-log
3	1.0 ≤ oocysts < 3.0	Additional treatment required such that the total *Cryptosporidium* removal and inactivation is at least 5-log
4	oocysts ≥ 3.0	Additional treatment required such that the total *Cryptosporidium* removal and inactivation is at least 5.5-log

The California State Water Project Sanitary Survey reported protozoan pathogens measured in source waters by a combination of different monitoring programs, including SWP Contractors and the Department of Water Resources (SWP, 2006). The Survey reported protozoan pathogens detected statewide at locations in the South Bay Aqueduct, North Bay Aqueduct, San Luis Reservoir, and East, West and San Joaquin divisions of the California Aqueduct. The Sanitary Survey reported that *Giardia* and *Cryptosporidium* are not detected frequently in SWP waters, despite being detected in treated wastewater. The source waters for all of the drinking water treatment plants analyzed were classified as Bin No. 1 (no additional treatment required under LT2, see **Table 8-1**), with the annual average *Cryptosporidium* level less than detection at all locations except the North Bay Aqueduct, which is uniquely impacted by local nonpoint source contributions.

8.1.4 Recommended Future Evaluations

It is recommended that the City participate in the source, fate and transport, and municipal water intake study that is referenced in the forthcoming Central Valley Drinking Water Policy Basin Plan Amendment. This study could evaluate some of the analytical issues and unknown fate and transport processes to better evaluate the protection of the municipal water supply beneficial use.

8.2 METHYLMERCURY

Further evaluation of methylmercury is necessary as part of the Delta Methylmercury TMDL Phase I assessment, however, the overall load from the CSS is small compared to upstream loading. Although it is expected that the CSS will be able to comply with the proposed TMDL wasteload allocation, this cannot be statistically confirmed.

8.2.1 Detection in Combined Sewer System Overflow Discharge

Effluent methylmercury data collected from December 2010 to March 2013 at various discharge locations is provided in **Figure 8-1**. Methylmercury concentrations are consistently within the 0.1 to 0.6 ng/L (nanograms per liter or parts per trillion) range.

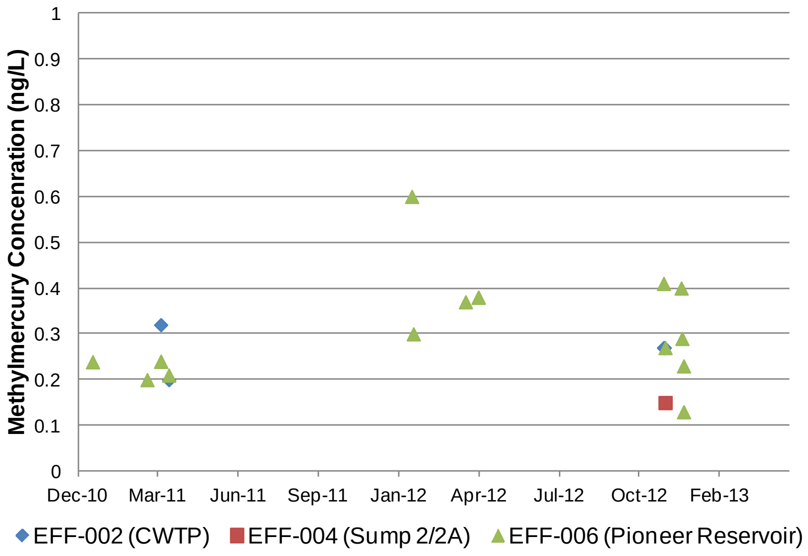


Figure 8-1. Historic (December 2010 – March 2013) Methylmercury Effluent Concentrations (ng/L)

During the 2012/2013 storm year (October 2012 to September 2013), the City conducted influent and effluent monitoring to further characterize the influent methylmercury at the two treated discharge locations (EFF-002 and EFF-006). The results of sampling are provided in **Figure 8-2** and indicate increases at Pioneer Reservoir (EFF-006) and decreases to no change at CWTP (EFF-002). The samples were collected as grab samples. Effluent samples are collected at the beginning of a discharge event, just after influent sample collection. Additional sampling will be conducted in future wet seasons that may further evaluate the time variation of effluent concentrations.

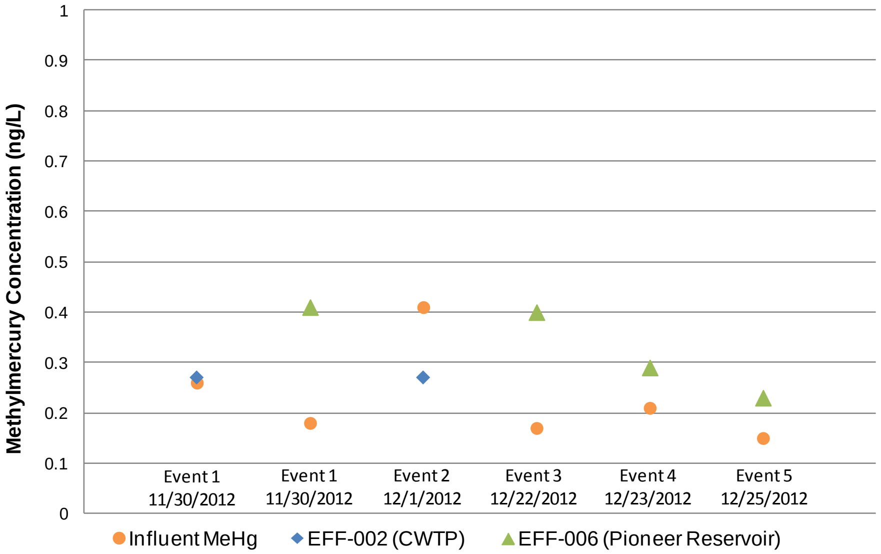


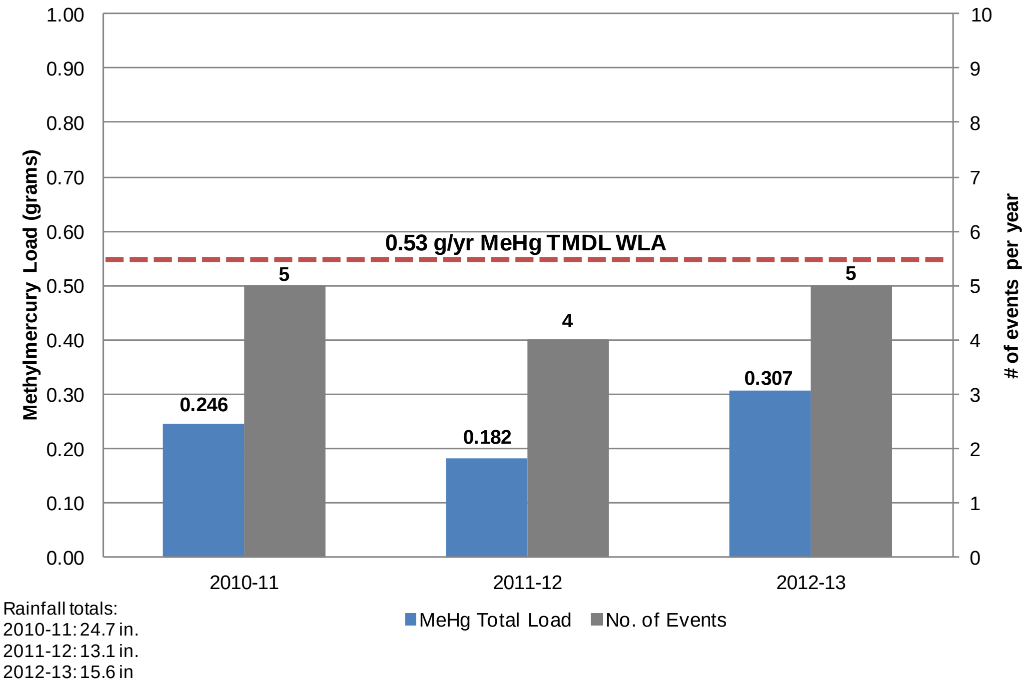
Figure 8-2. Influent and Effluent Methylmercury Concentrations (ng/L)

8.2.2 Analytical Methodology

The City collected limited methylmercury samples in 2004/2005 and 2005/2006 storm years. Since the 2010/2011 storm season, the City has collected regular methylmercury effluent samples as part of the CSS NPDES permit requirements. The analytical methods used for total mercury and methylmercury are base on cold vapor atomic fluorescence spectroscopy (CV-AFS), however, specialized methods (EPA 1631 and EPA 1630, respectfully) are required to meet the low level detection limits necessary to evaluate concentration data against the relevant water quality objectives. These analytical methods also require specialized “clean hands” collection and handling methods (EPA 1669). Quality control samples and documentation of collection methods are available prior to 2010 and these data were not used in this analysis.

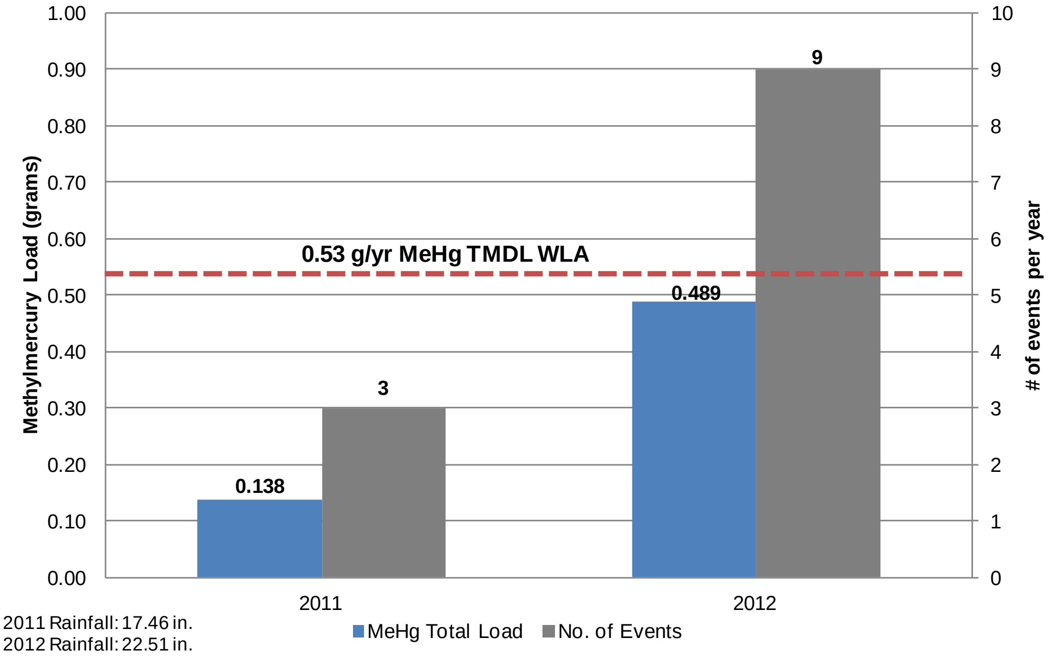
8.2.3 Protection of Beneficial Use

For the storm seasons 2010/2011, 2011/2012 and 2012/2013, the CSS would have complied with the current TMDL waste load allocation (WLA) of 0.53 g/year (see **Figure 8-3**). However, the WLA is based on the calendar year instead of the storm year. **Figure 8-4** presents the observed discharged loads on a calendar year basis. There is year-to-year variability in the discharged load based on rainfall patterns and it is possible the WLA could be exceeded in years with more frequent large events. Long term averages would likely not exceed the WLA.



Note: For the 2012/2013 season, the data is preliminary and is current as of April 2013. The number of events refers to the occurrence of river discharge events that may include multiple sites (i.e., a discharge from Pioneer Reservoir and CWTP occurring on the same day is considered one event.)

Figure 8-3. Methylmercury CSS Loading and Number of Events per Storm Year (grams)



Note: The number of events refers to the occurrence of river discharge events that may include multiple sites (i.e., a discharge from Pioneer Reservoir and CWTP occurring on the same day is considered one event.)

Figure 8-4. Methylmercury CSS Loading and Number of Events per Calendar Year (grams)

8.2.4 Recommended Future Evaluations

Compliance with the final 2030 WLA may require further reductions of CSS discharges to the Sacramento River. Due to the sporadic nature of CSS discharges, the primary reductions in methylmercury loading from the CSS will be focused on reducing methylation potential from the treatment and conveyance processes and reducing the discharge volumes to the Sacramento River using a combination of Low Impact Development (LID) strategies and continuing Capital Improvement Plan (CIP) projects described in the Long Term Control Plan (LTCP).

The specific control mechanisms to be evaluated are discussed in the Work Plan. These mechanisms are expected to reduce methylmercury production and discharge to the Sacramento River.

8.3 TOTAL SUSPENDED SOLIDS, CHLORINE RESIDUAL, AND PH

Total suspended solids (TSS), pH, and chlorine residual, provide information on general water quality, aquatic life protection, and the potential for nuisance in overflow discharges. TSS, pH, and chlorine residual are indicators of treatment performance and can pose aquatic life threats and/or lead to nuisance discharges.

8.3.1 Detection in Combined Sewer System Overflow Discharge

Over the last three years there have been effluent limitation violations for TSS percent removal, chlorine residual, and pH. These parameters are measures of treatment performance and do not necessarily directly impact downstream beneficial uses. The exceedances for each of the three are affected by sample collection requirements, interference in the analytical method, and influent quality and process control limitations, respectively.

8.3.2 Sample Collection and Analytical Methodology

TSS influent samples are collected as composite samples and effluent samples are collected as grab samples, which may bias the calculation of percent removal. Moreover, concentrations of TSS are generally low, compared to typical wastewater, after the first flush portion of the storm event and higher percent removals are not necessary to protect water quality. Chlorine is removed from the system prior to discharge with sodium bisulfite and complete dechlorination is confirmed with detection of sodium bisulfite residual, which is also measured. Effluent limitation violations were isolated and potentially caused by method interference. Influent pH can be low and is typically further reduced by the treatment processes and chemical addition.

8.3.3 Protection of Beneficial Use

Overflow discharge TSS concentrations did not exceed the effluent limitations and do not pose a threat to beneficial uses. Lower percent removals may be a result of sample collection timing and relatively low TSS influent concentrations during the later parts of the storm.

Adjustment to chemical additions could help manage pH and chlorine residual within the system. However, because of the short nature of discharge events and the unexpected flow conditions, it can be difficult to reach equilibrium conditions with chemical additions (disinfectant and chlorine removal) while still maintaining sufficient disinfectant dosing. Moreover, interference with chlorine residual analytical methods is possible and reanalysis is not always possible because of the short discharge periods. The potential threat to aquatic life from these constituents is minimal based on the high survival rate of the acute toxicity tests, the infrequent and short duration of CSS overflow discharges, and the highly buffered pH of the receiving water. Operations staff will continue to closely monitor influent pH conditions and dechlorination dosages to manage pH in the overflow discharge.

8.3.4 Recommended Future Evaluations

The City continues to evaluate TSS removal sample collection as well as chemical additions as part of operations and to ensure compliance with effluent limitations. The City will continue to investigate the logic and physical sampling of the chemical feed system to evaluate the balance of chlorine dose with residual bisulfite feed. Additional assessments of recommended sampling and analysis methods will be prepared as part of the Report of Waste Discharge.

9 Conclusions and Action Items

The Water Quality Assessment demonstrated that the City's CSS complies with the presumptive approach through capture and treatment of more than 85% of combined flows. Furthermore, the short duration of CSS overflow discharges does not result in water quality impairments when the appropriate "exposure" periods are considered on a constituent-by-constituent basis. Finally, the CSS provides load removal benefits over a separate system for a number of key constituents. Further improvements to the system through the LTCP Combined Sewer Improvement Program projects, expected integration of low impact development practices, and potential operational optimization should reduce from or maintain at the current frequency and volume of CSS overflow discharges.

The current Water Quality Assessment confirmed the previous Water Quality Assessment finding that there are no significant impacts to Sacramento River beneficial uses downstream of the CSS discharge during the infrequent and short duration of CSS overflow discharges. However, follow-up activities could further investigate pathogen and methylmercury impacts of planned LTCP projects that seek to reduce discharge frequency and volume. The activities shown in **Table 9-1** are recommended for consideration with updates submitted as part of the Report of Waste Discharge due to the Central Valley Regional Water Quality Control Board in July 2014. While these efforts should be acknowledged in the next NPDES permit, the permit should also allow some flexibility based on outcomes and the evolving policies, evaluations, and physical changes in the Delta.

Table 9-1: Proposed Action Items

Name	**Description**	**Expected Timeframe**
Central Valley Drinking Water Policy Workgroup study on pathogens	Participation in this planned study to evaluate the sources of *Giardia* and *Cryptosporidium* and the fate and transport between the sources and drinking water intakes. The expected sampling of sources would be concurrent with sampling at drinking water intakes.	July 2013 – June 2016
Delta Methylmercury Phase 1 Control Study	The City has submitted the Work Plan to the Central Valley Water Board and has already initiated sample collection to study potential methylation in the collection and treatment systems.	July 2013 – October 2016
Continued development of collection and treatment system model scenarios	The hydrologic and hydraulic model will be further refined to better simulate and predict the impact of changes to the CSS on the frequency, duration, and quality of CSS overflow discharges. LTCP projects will be assessed over appropriate planning horizons so that individual projects, which are designed to reduce flooding and minimize risk to life and property damage, can be considered in balance with projects intended to reduce CSS overflow discharges.	Status reported annually. Updated Combined Sewer Improvement Plan expected January 2014
Sacramento – San Joaquin River Delta modeling and monitoring programs	The City has participated in regional modeling and monitoring efforts through the Sacramento Stormwater Quality Partnership and the Central Valley Clean Water Association (CVCWA). Continued development of the Watershed Analysis Risk Management Framework (WARMF) and Delta Simulation Model II (DSM2) to incorporate CSS overflow discharges would be useful in gaining a better understanding of the impacts of the CSS on the Delta. These models were used in the Central Valley Drinking Water Policy development and could also be applied to the Delta Methylmercury Phase I implementation evaluation, the Delta nutrient policy, and would be useful as a planning tool for the Delta Regional Monitoring Program (RMP). The City will continue participation in the Delta RMP through the Sacramento Stormwater Quality Partnership and the Central Valley Clean Water Association.	July 2013 – ongoing

Based on this Water Quality Assessment the following specific changes are recommended for the next NPDES permit.

- **Reduce monitoring frequency of organic constituents with long-term water quality objective averaging periods** – Annual sample collection at each discharge and receiving water location for constituents with long-term exposure water quality objectives is not useful to treatment operations and is not relevant to the short duration of CSS discharge events. Dioxins, polycyclic aromatic hydrocarbons, disinfection byproducts, and semi- and non-volatile organics (e.g., plasticizers) all pose complications and risks to sampling crews due to the intensive sampling required, require large sample volumes, and are costly. These constituents have water quality objectives based on cancer risk that assumes daily consumption for 70 years. The infrequent, short, and relatively small volume of CSS overflow discharges do effectively increase the dilution of these trace organic compounds over the exposure period to mitigate any possible risk, even if concentrations were to unexpectedly change. *It is recommended that these constituents be collected no more than twice per permit term from the effluent locations, if an overflow discharge occurs.*

- **Allow calculation of percent removal using composite samples –** *It is recommended that the City should have the option of collecting samples (where appropriate) as composites or using continuous sensors and using these more representative samples for calculation of percent removal.* The current NPDES permit specifies that percent total suspended solids removal be calculated using grab samples.
- **Collection of receiving water samples –** The City successfully deployed continuous sensors at locations upstream and downstream of the Pioneer Reservoir treated overflow discharge location (EFF-006). Dissolved oxygen, turbidity, pH, electrical conductivity, temperature, and ammonium (indicator) were collected throughout 2011-2013. *Routine sample collection for ammonium and field measurements should be allowed using these continuous sensors to reduce risks to field sampling crews and provide more robust water quality data sets for these parameters.* Bacteriological samples in the receiving water may still be required if overflow discharge events are longer than two hours and conditions are safe. Continuous sampling and modeling also indicates that the downstream locations are influenced by overflow discharge events up to one hour after the end of the overflow discharge.
- **Chlorine Residual and pH management** – The NPDES permit should specifically allow compliance with chlorine residual effluent limitations through detection of dechlorination agents in the overflow discharge and should allow resampling even after overflow discharge has stopped to allow retesting for false positives or averaging of results. Further pH adjustment to meet the effluent limitation range would require addition of chemicals. Before requiring pH control, the City should perform an evaluation of the feasibility and potential operational and water quality impacts of any changes. *It is recommended that the allowable overflow discharge pH range be based on the receiving water limitation that the pH should not change more that 0.5 standard units from the upstream measurement.*

10 References

California Regional Water Quality Control Board, Central Valley Region (CVRWQCB). 2009. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board: Central Valley Region, the Sacramento River Basin and the San Joaquin River Basin (Fourth Edition, Revised). September.

California State Water Project (SWP). 2006. California State Water Project watershed sanitary survey 2006 update. The State Water Project Contractors Authority.

Christophel, D. and P. Arsenault. 1991. Results of the Dye Dispersion Zone Study, Technical Memorandum for the City of Sacramento Combined Sewer Improvement and Implementation Plan.

Tomko, J. and J. Baumgardner. 1995. City of Sacramento Combined Sewer System Effluent and Receiving Water Quality and Toxicity Summary Report for 1991-1995 and Proposed Sampling Program for 1995/1996. Submitted to California Regional Water Quality Control Board Central Valley Region. August.

United States Environmental Protection Agency (USEPA). 1991. Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources.

United States Environmental Protection Agency (USEPA). 2006. National recommended water quality criteria: 2006. Office of Water, Office of Science and Technology. January.

United States Environmental Protection Agency (USEPA). 2006. National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule. March.

Water Environmental Research Foundation (WERF). 2011. Quantification of Pathogens and Sources of Microbial Indicators for QMRA in Recreational Waters, Final Report. Alexandria, VA.