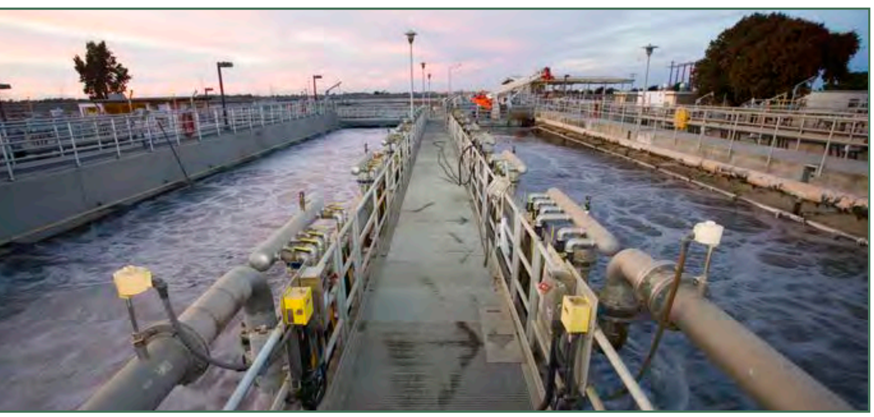

PROGRESS REPORT

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CENTRAL VALLEY CLEAN WATER ASSOCIATION
METHYLMERCURY SPECIAL PROJECT GROUP

Methylmercury Control Study
Progress Report

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Methylmercury Control Study Progress Report

Prepared for

Central Valley Clean Water Association Methylmercury Special Project Group

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October 2015

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List of Acronyms

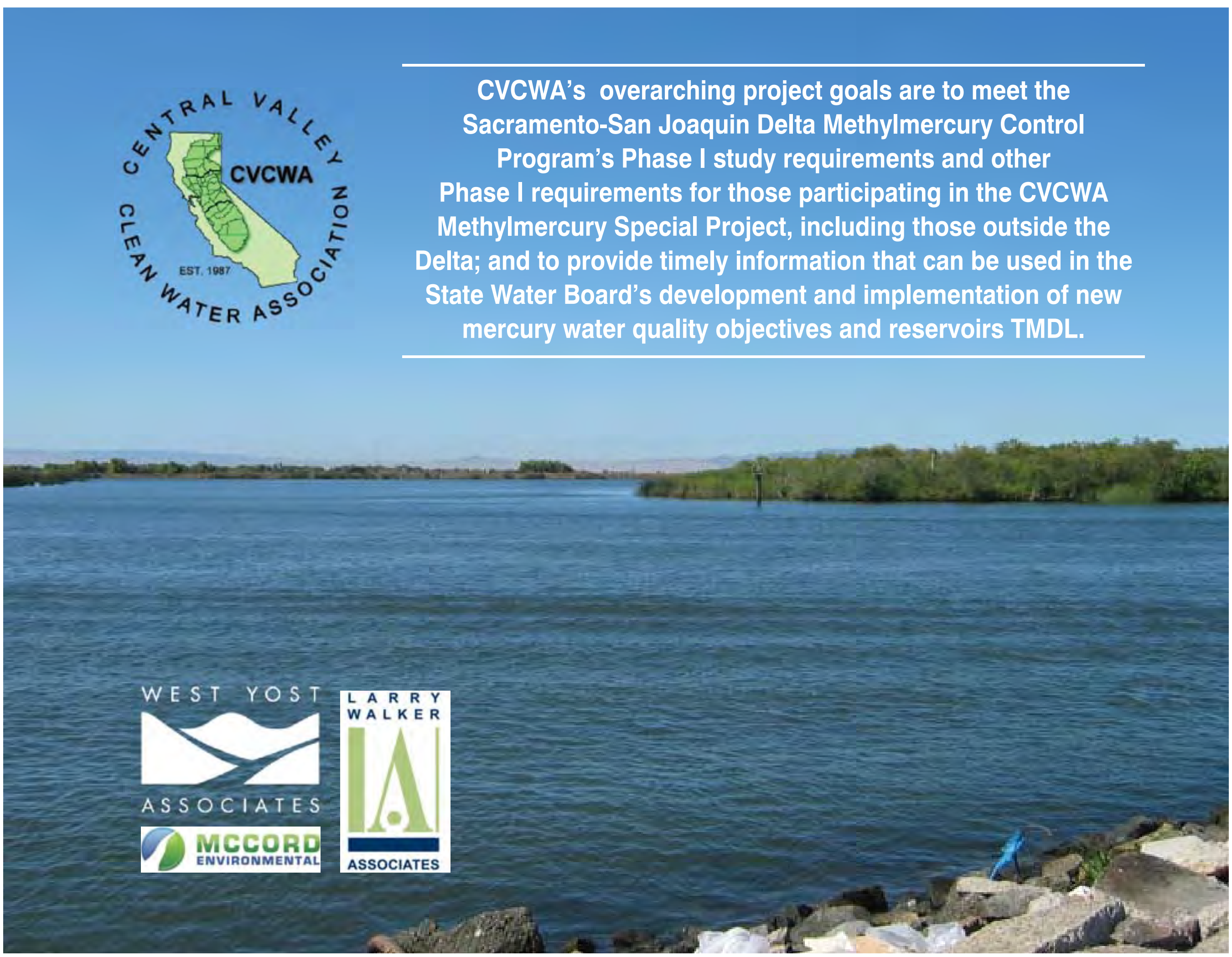
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
BOD	Biochemical Oxygen Demand
COC	Chain of Custody
CVCWA	Central Valley Clean Water Association
Delta	Sacramento and San Joaquin River Basins
D-MCM	Dynamic Mercury Cycling Model
DNQ	Detected, Not Quantified
DWR	Department of Water Resources
Hg	Mercury
MDL	Method Detection Limit
MeHg	Methylmercury
MeHg SPG	Central Valley Clean Water Association Methylmercury Special Project Group
MeHg TMDL Project Area	Methylmercury Total Maximum Daily Load Project Area
micrograms per liter	µg/L
milligrams per liter	mg/L
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N	Nitrification
nanograms per liter	ng/L
ND	Non-Detect
NDN	Nitrification and Denitrification
NO3-	Nitrate
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Units
ORP	Oxidation-Reduction Potential
POTW	Publicly Owned Treatment Works
QA/QC	Quality Assurance/Quality Control
Regional San	Sacramento Regional County Sanitation District
Regional Water Board	Central Valley Regional Water Quality Board
RL	Reporting Limit
RMP	Regional Monitoring Program
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SO_4^{2-}	Sulfate
SPG Facilities	MeHg SPG wastewater treatment facilities

State Water Board	State Water Resources Control Board
SVI	Sludge Volume Index
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TSS	Total Suspended Solids
USEPA	US Environmental Protection Agency
UV	Ultraviolet
WLA	Waste Load Allocations
WPCF	Water Pollution Control Facility
WQCF	Wastewater Quality Control Facility
WWCF	Wastewater Control Facility
WWCTS	Wastewater Collection and Treatment System
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant
WWTP (001)	City of Davis Wastewater Treatment Plant (001)
WWTP (002)	City of Davis Wastewater Treatment Plant (002)

Executive Summary

The purpose of this Methylmercury Control Study (MeHg Control Study) Progress Report is to summarize the methylmercury (MeHg) and total mercury data collection and evaluation efforts completed to date for the MeHg Control Study, being completed by the Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (MeHg SPG). The MeHg Control Study was developed in accordance with the Sacramento-San Joaquin River Delta Estuary Methylmercury Control Program Phase I Implementation requirements, hereinafter referred to as the Delta MeHg Control Program.

The Delta MeHg Control Program is administered and managed by the Central Valley Regional Water Quality Control Board (Regional Water Board) in accordance with the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Regional Water Board, 2010a). The purpose of the MeHg Control Study is to evaluate existing methods used to control MeHg discharges from the MeHg SPG wastewater treatment facilities (SPG Facilities) and to identify the effectiveness of applying additional MeHg control methods to meet prescribed Total Maximum Daily Load (TMDL) waste load allocations (WLAs) that have been prescribed for the Sacramento-San Joaquin Delta and Yolo Bypass, hereinafter referred to as the MeHg TMDL Project Area.



SPG Facilities Overview

The SPG Facilities include 14 of the 15 Publicly Owned Treatment Works (POTW) that discharge to the MeHg TMDL Project Area under National Pollutant Discharge Elimination System (NPDES) permits and are assigned WLAs under the Delta MeHg Control Program, plus six additional NPDES Facilities that discharge outside the boundary of the MeHg TMDL Project Area and have, therefore, not been assigned WLAs under the Delta MeHg Control Program. The SPG Facilities represent 99.5 percent of the total NPDES Facility WLA assigned under the Delta MeHg Control Program. **FIGURE ES-1** provides a map showing the locations of the SPG Facilities located both within and outside of the MeHg TMDL Project Area. **FIGURE ES-2**, provides a summary of the MeHg WLAs under the Delta MeHg Control Program. As shown, the NPDES Facility MeHg WLA represents 2.2 percent of the total MeHg WLA for the MeHg TMDL Project Area.

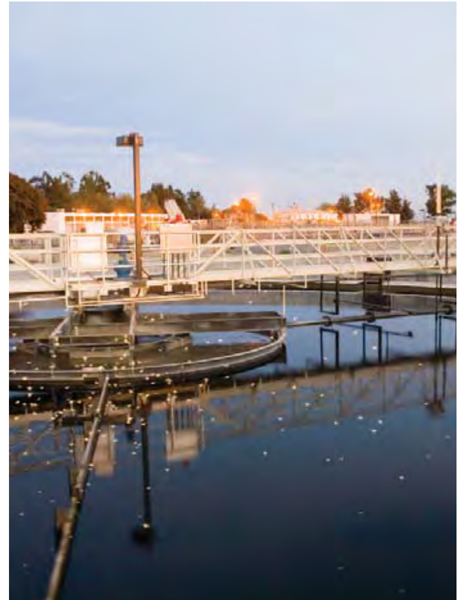
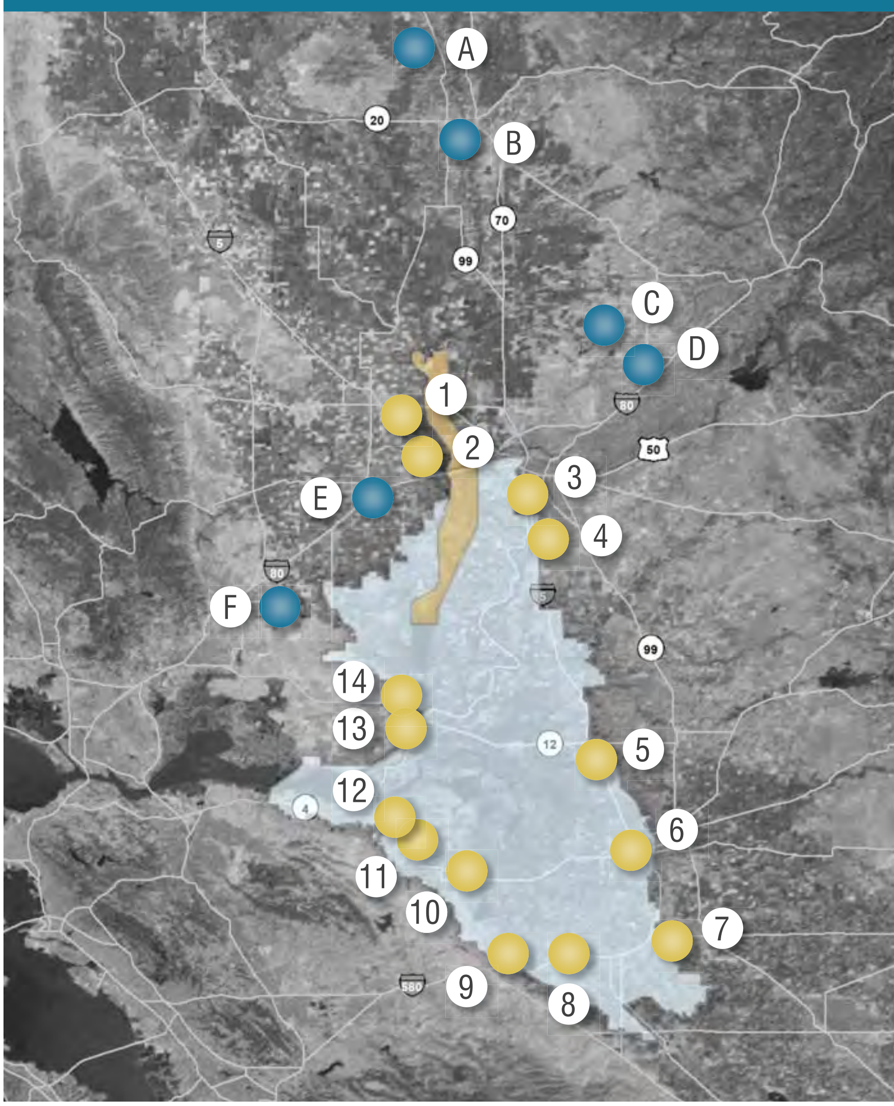


Figure ES-1 SPG Facility Location Map



Facilities Located Within the MeHg TMDL Project Area

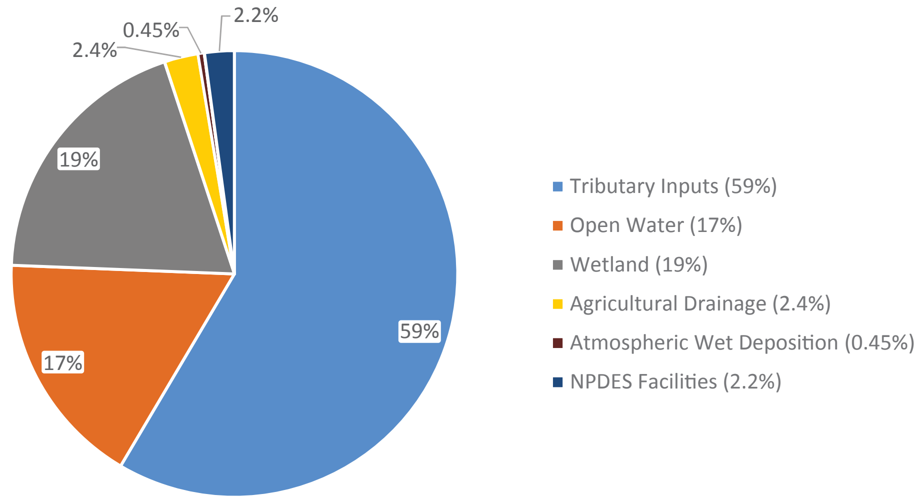
1. City of Woodland
2. City of Davis
3. Sacramento (Combined)
4. Sacramento Regional County Sanitation District
5. City of Lodi
6. City of Stockton
7. City of Manteca
8. City of Tracy
9. Mt. House CSD
10. Discovery Bay
11. City of Brentwood
12. Ironhouse SD
13. Rio Vista (Beach)
14. Rio Vista (Northwest)

Facilities Located Outside of the MeHg TMDL Project Area

A. City of Live Oak
B. City of Yuba City
C. City of Roseville (Pleasant Grove)
D. City of Roseville (Dry Creek)
E. UC Davis
F. City of Vacaville

Figure ES-2 Comparison of NPDES Facility MeHg WLA to the Total MeHg TMDL Project Area WLA

NPDES Dischargers have been assigned MeHg WLAs that collectively represent approximately 2.2 percent of the allowable MeHg load to the MeHg TMDL Project Area. For context, the current annual MeHg load to the MeHg TMDL Project Area is 5,220 g/yr and the total allowable load assigned under the Delta MeHg Control Program is 2,868 g/yr.



Note: Urban Runoff Point Sources represent 0.017% of the total WLA, and are not shown on this figure.

SPG Facility Control Strategies

Most of the SPG Facilities provide a very high level of wastewater treatment that includes nitrification, denitrification, tertiary filtration and ultraviolet disinfection. Eight of the SPG Facilities have completed major upgrades to achieve these high treatment levels since the Delta MeHg Control Program was developed in 2004-2005. In addition, five SPG Facilities are planning, or are in the process of implementing, upgrades. In total, the SPG Facilities that have completed and/or are planning changes represent approximately 96 percent of the total annual wastewater discharged from the NPDES Facilities that currently have WLAs assigned under the Delta MeHg Control Program. The costs associated with these upgrades is estimated to range between $2.7 and $3.2 billion.

Given the improvements made to date, the focus of the MeHg Control Study efforts has been to examine whether treatment process improvements that have recently been completed (and/or that will be made over the next 10-year period) provide effective control of MeHg discharges from POTWs.

Control Study Results to Date

TABLE ES-1 provides a comparison of the 2004-2005 MeHg loads reported in the *TMDL Staff Report* (Regional Water Board, 2010b) to the MeHg loads calculated using flow data collected between October 2012 and September 2014 and MeHg concentration data collected between October 2009 and September 2014 for the SPG Facilities that have WLAs under the Delta MeHg Control Program. Also shown are the combined WLAs for the applicable SPG Facilities and the total MeHg WLA for the MeHg TMDL Project Area. As shown, the loads calculated using the more recent data (shown as “Current” loads) are less than one-third of the 2004-2005 loads, and are approximately 56 percent of the assigned WLA for the SPG facilities and 1.2 percent of the total WLA for the MeHg TMDL Project Area.

TABLE ES-2 provides a comparison of the loads being discharged under the “Current” conditions (based on flow data collected between October 2012 and September 2014 and MeHg concentration data collected between October 2009 and September 2014), to loads that are expected to be discharged in 2030 given the

Table ES-1. Comparison Summary of 2004-2005 and Current MeHg Loads for SPG Facilities Within the MeHg TMDL Project Area

LOADING CONDITION	MEHG LOAD, GRAM/YEAR
2004-2005 Per TMDL Staff Report[(a)(b)]	204
TMDL MeHg WLA[(C)]	106.8
Current Conditions	60.1
Total WLA for MeHg TMDL Project Area	4,959

(a) The TMDL Staff Report load values cannot be verified with available data. Values were recalculated as part of this MeHg Control Study to be lower than the TMDL Staff Report Values.

(b) This load does not include discharges from the Ironhouse Sanitary District, Mountain House Community Services District, and Rio Vista Northwest facilities, because these facilities were not in operation during the 2004-2005 period.

(c) Total SPG Facility WLA shown is adjusted from the WLAs calculated in the Staff Report to account for errors identified in the calculation procedures.

facility changes that are planned and/or underway (i.e. "2030 Planned" loads). Also shown are the loads that are expected to be discharged when all of the SPG Facilities are discharging at their design average dry weather flow (ADWF) capacity (as defined in the current NPDES permits for each SPG Facility) and assuming the same effluent concentrations as the "2030 Planned" condition (i.e. "Design Capacity" loads). Also shown for comparison purposes is the WLA for the SPG Facilities within the MeHg TMDL Project Area and the total MeHg WLA for the MeHg TMDL Project Area. As shown, the combined loads predicted for "2030 Planned" and "Design Capacity" conditions from all SPG Facilities (not just those within the MeHg TMDL Project Area) are almost twenty times lower than the assigned WLA. The 2030 Planned loads of 6.17 grams/year shown in **TABLE ES-2** are equivalent to approximately ½ of a teaspoon of MeHg discharged to the MeHg TMDL Project Area each year.

A second goal of the MeHg Control Study efforts completed to date has been to identify the potential for load reduction benefits associated with blanket application of additional treatment control methods at individual NPDES Facilities beyond those that are already implemented and/or planned. The treatment control methods of interest for the MeHg Control Study are nitrification, denitrification and tertiary filtration. Therefore, the following three "plausible" minimum levels of treatment were applied to all the SPG Facilities:

- **PLAUSIBLE SCENARIO A**: Secondary plus ammonia removal (nitrification)
- **PLAUSIBLE SCENARIO B:** Secondary plus ammonia and nitrate removal (nitrification/denitrification)
- **PLAUSIBLE SCENARIO C:** Tertiary filtration plus ammonia and nitrate removal (nitrification/denitrification)

Table ES-2. Comparison of Current and Planned Discharge Period Loads to MeHg TMDL Project Area WLAs

SPG FACILITY LOCATION	WLA FOR MEHG TMDL PROJECT AREA	CALCULATED ASSIGNED MEHG WLA[(a)]	MEHG LOAD, GRAM/YEAR[(b)]		
			CURRENT	2030 PLANNED	DESIGN CAPACITY
Within the MeHg TMDL Project Area	4,959	106.8	60.1	3.67	5.02
Outside the MeHg TMDL Project Area	-		2.73	2.49	3.63
Total for all SPG Dischargers	**-**		**62.9**	**6.17**	**8.65**

(a) Total SPG Facility WLA shown is adjusted from the WLAs calculated in the Staff Report to account for errors identified in the calculation procedures.

(b) These annual average loads were calculated from data collected over a five year period between October 2009 and September 2014. Additional data collected between October 2014 and September 2017 will be evaluated and presented in the Final Report.

TABLE ES-3 provides a comparison of the calculated MeHg loads that are expected to occur in 2030 to MeHg loads that could occur in 2030 if one of the these minimum "plausible" treatment levels were applied. As shown, there would be a minor additional reduction in MeHg loads if an increased minimum level of treatment were applied to all SPG Facilities. However, the additional 20 to 35 percent reduction in MeHg loads associated with the blanket application of a prescribed treatment represents a decrease of only approximately 2 grams per year, or about 1.5 percent of the total 2004-2005 load of 5,220 g/yr calculated for all sources identified under the Delta MeHg Control Program. The cost to implement the additional treatment needed to achieve this additional reduction in MeHg load would be substantial without a measurable corresponding environmental benefit.

A final goal of the MeHg Control Study efforts to date has been to identify the potential for load reduction benefits associated with additional source control methods at individual NPDES Facilities given the high level of treatment that has already been implemented and/or is planned. To assess the benefits of source control, a comparison of the variances observed in the paired influent and effluent data (i.e., data that have been collected on the same day) to determine if a statistically significant difference in variances was demonstrated. If no treatment was provided, the variances of the influent and effluent would be the same, as they would represent a single population.

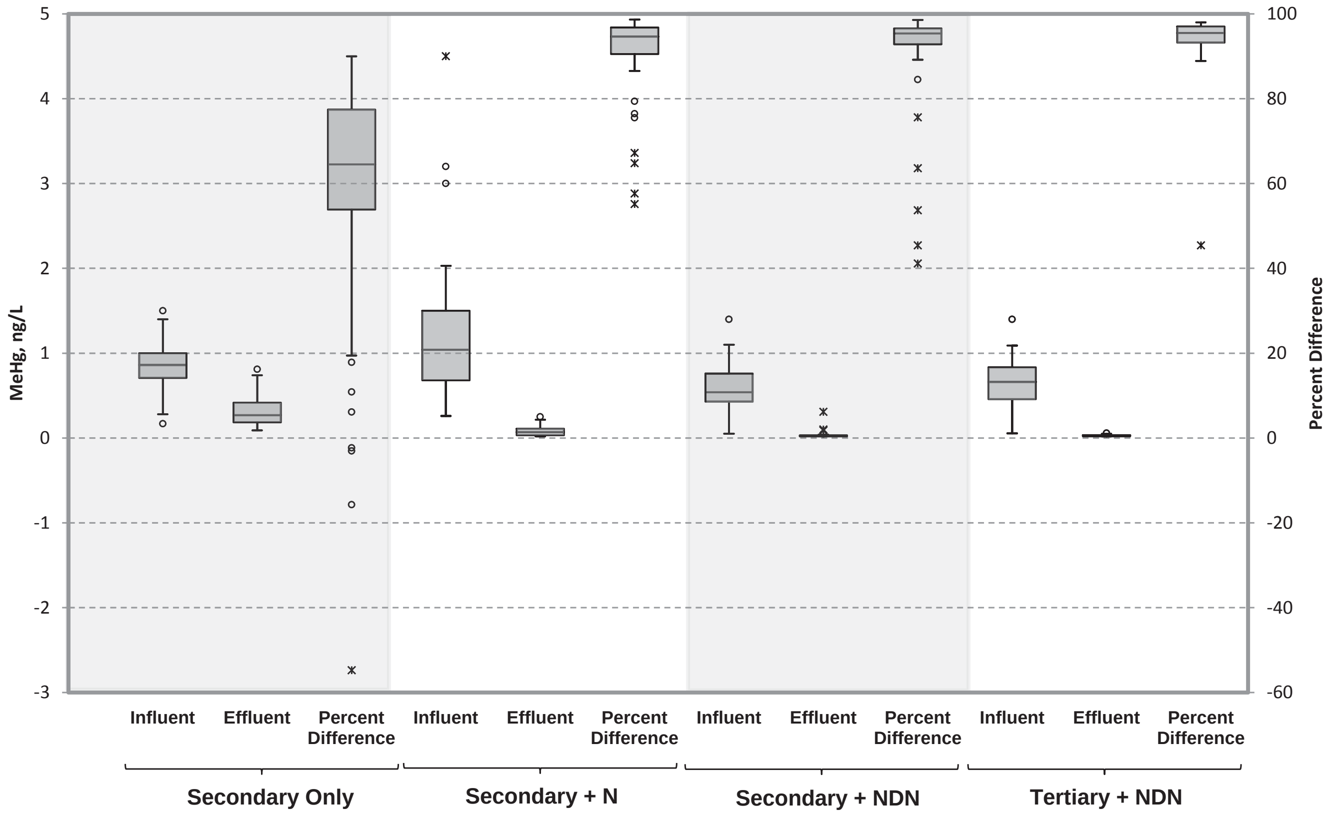
As to be expected, the variances were different between the influent and effluent MeHg data sets for all treatment levels evaluated. However, the relationship between the influent and effluent variances decreases with increasing treatment level. This trend is demonstrated on **FIGURE ES-3**, which provides a box plots of paired influent and effluent MeHg concentrations by treatment type along with the calculated percent reduction. As treatment levels increase from left to right, the spread in the calculated percent reduction decreases. In addition, at a treatment level beyond secondary only the median of the calculated percent reduction does not increase. In other words, increasing the treatment level beyond a secondary only treatment level (i.e. secondary without nitrification or denitrification) increases the differences between the influent and effluent MeHg in this sample set, but at higher treatment levels influent MeHg concentration appears to have less effect on effluent MeHg concentrations. Thus, when a high level of treatment is provided, reducing influent concentrations

Table ES-3. Comparison of 2030 Planned and 2030 Plausible Loads

SPG FACILITY LOCATION	2030 MEHG LOAD, GRAM/YEAR[(a)]			
	PLANNED	PLAUSIBLE A[(b)]	PLAUSIBLE B[(b)]	PLAUSIBLE C[(b)]
Within the MeHg TMDL Project Area	3.67	3.53	3.44	3.43
Outside the MeHg TMDL Project Area	2.49	1.16	0.798	0.747
Total for all SPG Dischargers	**6.17**	**4.69**	**4.24**	**4.18**

(a) These annual average loads were calculated from data collected over a five year period between October 2009 and September 2014. Additional data collected between October 2014 and September 2017 will be evaluated and presented in the Final Report.

(b) Although a decrease in load is observed under the Plausible scenarios evaluated, this decrease represent only a small fraction of the total WLA assigned to the MeHg TMDL Project Area.



is unlikely to provide additional reduction in effluent concentrations.

Additional Evaluations

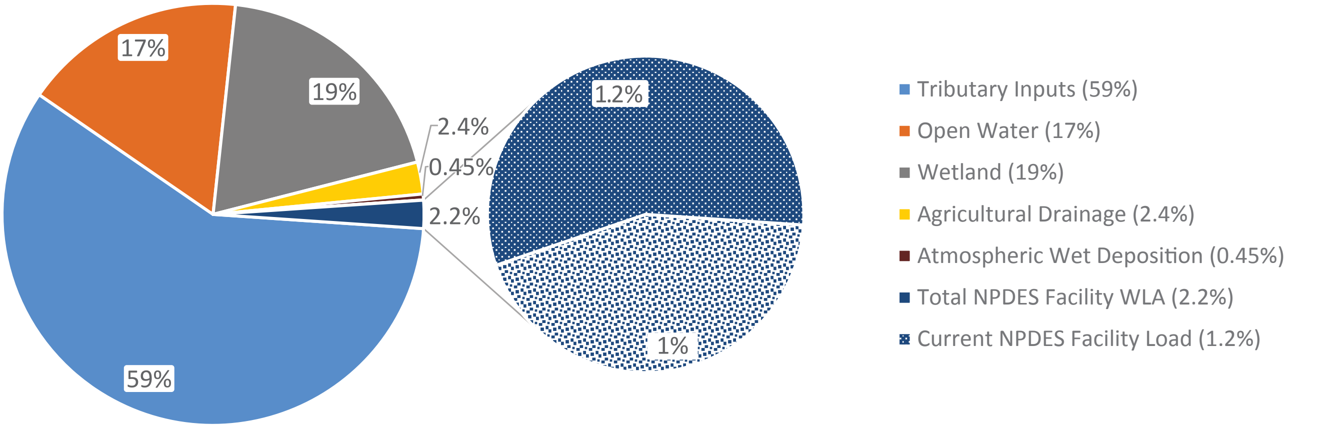
Two additional data collection and evaluation efforts have been identified as next potential steps to help assess the impacts of the following two SPG Facility conditions: more stringent nutrient removal requirements and drought impacts. The first effort would involve collecting MeHg data from four biological nutrient removal treatment plants in the Tampa Bay, Florida region that provide a higher level of nutrient removal than the SPG Facilities. This data could be used to determine if higher levels of nutrient removal result in effluent MeHg levels that are different from the SPG Facilities. A second effort would involve comparing data collected during the MeHg Control Study monitoring period, which generally represents drought conditions, to data collected under the SPG Facility NPDES monitoring programs over the next two year period (through September 2017) to determine if influent and effluent water quality is impacted significantly by drought conditions. In addition, a collaborative modeling effort by stakeholders or the Regional Water Board would be beneficial in developing a holistic understanding of present and future MeHg loads in the MeHg TMDL Project Area.

WLA Achievement Summary

FIGURES ES-4 AND ES-5 show the current NPDES Facility MeHg loads and MeHg loads anticipated in 2030 with respect to all WLAs for the MeHg TMDL Project Area. As shown on these figures, the SPG Facilities' WLAs are currently being satisfied, and by 2030 the MeHg loads are estimated to be 0.074 percent of the total MeHg TMDL Project Area WLA. Based on this estimated information, our conclusion is that the implementation of the planned treatment plant upgrades will be an adequate MeHg loading control method. Furthermore, the significant costs and lack of corresponding environmental benefit associated with implementing additional plausible controls are not justified, given that WLA requirements are satisfied under planned conditions for SPG Facilities. Finally, implementing source controls at facilities that provide a high level of treatment will not reduce effluent loads.

Figure ES-4 Comparison of Current NPDES Facility MeHg Loads to the MeHg TMDL Project Area WLA

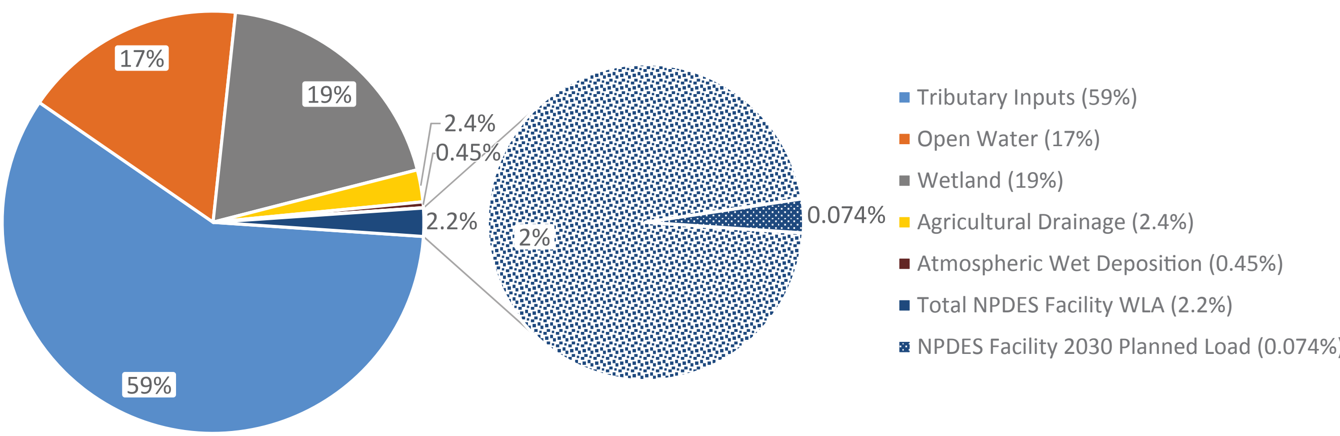
The current SPG Facility load of 60.1 g/year represents 1.2% of the total MeHg TMDL Project Area WLA and is approximately half of the allocation that has been assigned to NPDES Facilities.



Note: Urban Runoff Point Sources represent 0.017% of the total WLA and are not shown on this figure.

Figure ES-5 Comparison of Planned 2030 NPDES Facility MeHg Loads to the MeHg TMDL Project Area WLA

Due to planned improvements at several SPG Facilities, the 2030 Planned loads are expected to be lower than current SPG Facility loads. These 2030 Planned loads of 3.7 g/year for the SPG Facilities within the MeHg TMDL Project Area represent 0.074% of the total MeHg TMDL Project Area WLA.



Note: Urban Runoff Point Sources represent 0.017% of the total WLA and are not shown on this figure.

1.0 INTRODUCTION

The purpose of this Methylmercury Control Study Progress Report (Progress Report) is to summarize the methylmercury (MeHg) and total mercury (Hg) data collection and evaluation efforts completed to date for the Methylmercury Control Study (MeHg Control Study) that is being completed by the Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (MeHg SPG). The MeHg Control Study was developed in accordance with the Sacramento-San Joaquin River Delta Estuary (Delta) Methylmercury Control Program Phase I Implementation requirements, hereinafter referred to as the Delta MeHg Control Program. The Delta MeHg Control Program is administered and managed by the Central Valley Regional Water Quality Control Board (Regional Water Board) in accordance with the MeHg Total Maximum Daily Load (TMDL) control requirements detailed in the *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins* (Basin Plan) (Regional Water Board, 2010a). The Delta MeHg Control Program provides a range of strategies for managing MeHg and total Hg loads within the Delta and the Yolo Bypass (about two thirds of which is within the legal Delta boundary). The area addressed by the Delta MeHg Control Program is referred to herein as the MeHg TMDL Project Area.

This Progress Report, which must be submitted to the Regional Water Board by October 20, 2015, documents the MeHg Control Study progress made to date, in accordance with the strategy provided in the *CVCWA MeHg Control Study Work Plan* (Larry Walker Associates et al. 2013), hereinafter referred to as the Control Study Work Plan. A copy of the Control Study Work Plan has been included as **Appendix A** to this Progress Report. The information provided herein will also guide in the preparation of the MeHg Control Study Final Report that will be submitted to the Regional Water Board by October 20, 2018. This Progress Report, and the subsequent Final Report, must meet the requirements outlined in the *Methylmercury Control Study Guidance for the Delta MeHg Control Program Implementation Phase I* (Regional Water Board, 2012), hereinafter referred to as the Guidance Document.

This Progress Report includes the following major sections:

- Background Information
- MeHg Control Study Overview
- Data Evaluation
- Hypothesis Testing Results
- Compliance Plan
- Potential Additional MeHg SPG Evaluations
- Recommended MeHg TMDL Project Area-Wide Studies

The concentration and loading information presented in the body of this Progress Report has been summarized for all of the MeHg SPG wastewater treatment facilities (SPG Facilities) as a whole. Detailed discharger-specific information is presented in **Appendix B – Discharger Specific Tables**.

2.0 BACKGROUND INFORMATION

This section presents the following background information:

- Purpose of the Study
- Publicly Owned Treatment Works (POTW)-Specific Problem Statement
- Literature Review
- SPG Facility Information

2.1 Purpose of the Study

The purpose of the MeHg Control Study is to evaluate existing methods used to control MeHg discharges from the SPG Facilities and to identify the effectiveness of applying additional MeHg control methods for meeting the Delta MeHg Control Program waste load allocations (WLAs) that have been assigned to the SPG Facilities. All of the SPG Facilities discharge effluent to surface waters via existing National Pollutant Discharge Elimination System (NPDES) permits.

The MeHg Control Study is specifically intended to examine whether treatment process improvements that have recently been completed (and/or that will be made over the next ten-year period) have resulted (or will result) in significant reductions in the MeHg loads discharged to the MeHg TMDL Project Area from the SPG Facilities relative to the loads that were being discharged in 2004-2005 when the data collection and evaluations used to support the Delta MeHg Control Program findings were developed. The requirements of the Delta MeHg Control Program and estimated loads for 2004-2005 period are discussed in detail in the *Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury, Staff Report* (Regional Water Board, 2010b) - hereinafter referred to as the TMDL Staff Report. The MeHg Control Study also considers potential added benefits of additional source and/or treatment controls at the SPG Facilities beyond those already planned.

2.2 POTW-Specific Problem Statement

Several SPG Facilities have made significant treatment process improvements since the WLAs were developed as a result of a series of water quality-related policies implemented by US Environmental Protection Agency (USEPA) and the State Water Resources Control Board (State Water Board). These polices include the National Toxics Rule, the California Toxics Rule, and the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (also known as the State Implementation Plan). These policies have resulted in the application of water quality standards for a wide range of trace toxics to all NPDES discharges in the state.

In addition, beginning in the late 1990s, the Regional Water Board began interpreting narrative water quality standards in the Basin Plan as a basis for applying other numeric water quality criteria to surface water dischargers. Such applied water quality criteria include: water quality standards for water recycling as defined under Title 22, Division 4, Chapter 3 of the California Code of Regulations; USEPA National Recommended Ambient Water Quality Criteria for ammonia and other constituents; and drinking water Maximum Contaminant Level criteria defined under Title 22, Division 4, Chapter 15 of the California Code of Regulations.

The policy changes discussed above have resulted in NPDES permit requirements for many publicly owned treatment works (POTW) which, depending on the location and receiving water condition, have necessitated the construction and operation of treatment processes not previously required of POTWs including: tertiary filtration, ultraviolet (UV) disinfection, nitrification and denitrification. Thus, unlike other entities regulated under the Delta MeHg Control Program, treatment upgrades that may impact MeHg loads have already been implemented and/or are planned for future implementation. The POTW-specific problem statement therefore centers on the question of whether the treatment process upgrades that have already been implemented (or are planned) are sufficient to control MeHg discharges from POTWs.

2.3 Literature Review

The MeHg Control Study is intended to build upon findings presented in the Regional Water Board staff report titled *A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley* (Regional Water Board, 2010d), which provides an evaluation of effluent data from Central Valley POTWs, grouped based on their treatment type, to determine if trends existed between treatment processes and effluent methylmercury concentrations. The major conclusions drawn from that study were as follows:

- Facilities that use treatment pond systems (oxidation, facilitative, settling or stabilization ponds) had the highest effluent MeHg concentrations, with one exception being the City of Stockton facility (classified as a "Pond + Filtration + Chlorination/Dechlorination"), which did not have significantly higher effluent methylmercury concentrations than the "Secondary + Chlorination/Dechlorination" (i.e. secondary treatment without nitrification/denitrification and filtration) category.
- WWTPs that use one or more advanced treatment processes, such as nitrification/denitrification, filtration, and UV disinfection, had statistically lower effluent methylmercury concentrations than both the pond-based treatment and "Secondary + Chlorination/Dechlorination" categories.
- Seasonal variability was observed in effluent methylmercury concentrations at several facilities, particularly when treatment ponds are used, where effluent concentrations were higher in the warm season (e.g., May through November) than the cool season However, there was no observed trend between the type of treatment process and seasonality.

The 2010 Regional Water Board study called for additional analyses "*to continue the evaluation of potential relationships between [municipal wastewater] treatment processes, mercury minimization measures for mercury sources to [municipal wastewater treatment facilities] influent, and effluent MeHg levels*." This MeHg Control Study builds upon these efforts by evaluating and comparing effluent MeHg levels from the SPG Facilities that have different types of treatment processes. An understanding of the mechanisms that affect methylation and demethylation of mercury in the natural environment, and how these mechanisms are influenced in a municipal wastewater treatment facility system, is helpful in understanding what treatment processes should be evaluated through this effort.

The concentration of MeHg in any system depends on the amount of total mercury available for methylation and the relative rates of methylation and demethylation of this mercury. Both chemical and physical conditions can affect the methylation and demethylation of mercury in natural environments. These factors include: salinity, pH, dissolved oxygen, oxidation-reduction potential (ORP), organic carbon concentrations, and concentrations of elements that are important to mercury cycling (such as the activity of sulfur and iron reducing bacteria). Moreover, several studies have demonstrated relationships between the methylation of mercury in aquatic environments and sulfate-reducing bacteria and other anaerobes (Alpers *et al*., 2008). Of these factors, dissolved oxygen, ORP, and organic carbon are modified differently for facilities at the different treatment levels evaluated under this MeHg Control Study.

Municipal wastewater treatment facilities that provide nitrification maintain the wastewater under aerobic conditions (where dissolved oxygen levels are typically maintained in the range of 1 to 3 mg/L) for longer periods than facilities that do not provide nitrification. This extended aeration period increases the oxidation state of the wastewater, potentially supporting oxidative demethylation processes.

In addition, the nitrification process results in the formation of nitrate (NO_3^-). The sequence of organic matter degradation processes is generally controlled according to the highest free energy yields of various electron acceptors, where these energy yields decrease progressively in the order $O_2 > NO_3 - > Mn^{4+} > Fe^{3+} > SO_4^{2-} > CO_2$ (Stumm and Morgan, 1996). ORP is a measure of the energy yield state of a given water body. Accordingly, because sulfate (SO_4^{2-}) reduction generally will only proceed in the absence of energetically favorable electron acceptors, the presence of nitrate may inhibit methylation processes that would otherwise occur in a municipal wastewater treatment environment by sulfate-reducing bacteria. Scientific justification for the use of nitrate to control MeHg production has been presented in a number of studies conducted in Onondaga Lake, where the findings suggest that the presence of nitrate may have abated sulfate reduction and associated MeHg production in the lake sediments (Upstate Freshwater Institute and Syracuse University Center for Environmental Systems Engineering, 2007).

No specific research has been identified that links demethylation of mercury to denitrification processes. However, such linkages cannot be ruled out. Denitrification also has the potential to produce a better settling secondary sludge, and settling of particles has been identified as a significant MeHg loss mechanism in aquatic system such as the Delta (Foe *et al*., 2008). Thus, lower effluent MeHg levels in denitrified effluent could potentially be attributed to better settling of sludge in the secondary clarification process. Conversely, denitrification is an anaerobic process. Thus, it is possible that methylation will take place in these anaerobic conditions.

Finally, filtration processes result in greater solids (and therefore organic carbon) removal than facilities that do not provide filtration. Thus filtration processes may also influence Hg and MeHg removal in POTWs.

2.4 SPG Facility Information

The SPG Facilities include 14 of the 20 facilities that have been assigned WLAs under the Delta MeHg Control Program and that also have existing NPDES permits for discharges within the MeHg TMDL Project Area. These 20 facilities are referred in the TMDL documents (and herein) as NPDES Facilities. The 14 SPG Facilities comprise all of the municipal wastewater treatment facilities that have been assigned WLAs under the Delta MeHg Control Program, with the exception of the Deuel Vocational Institute Wastewater Treatment Plant. The remaining NPDES Facilities consist of groundwater treatment and industrial facilities and therefore may not have the same types of treatment or control mechanisms. In addition, one or more of the SPG Facilities is located in each of the MeHg TMDL Project Area hydrologic Subareas identified under the Delta MeHg Control Program, with the exception of the Mokelumne/Cosumnes River Subarea, where no NPDES Facilities were identified for the Delta MeHg Control Program. The SPG Facilities also include six existing NPDES Facilities that discharge outside the boundary of the MeHg TMDL Project Area and, therefore, have not been assigned WLAs under the Delta MeHg Control Program. Finally, the City of Davis contains two effluent discharge points. Discharge point 001 is outside the MeHg TMDL Project Area, while discharge point 002 is inside the MeHg TMDL Project Area. MeHg discharges associated with these two discharge locations are addressed separately. A map showing the location of each of the SPG Facilities is provided as **Figure 1**.

As detailed in the Control Study Work Plan (**Appendix A**), the range of treatment levels achieved by the SPG Facilities is typical for municipal wastewater treatment plants. The treatment level achieved at each SPG Facility was determined from a combination of process information combined with effluent data to demonstrate the ability to reliably meet specific criteria for ammonia, nitrate, bio-chemical oxygen demand (BOD), total suspended solids (TSS), and turbidity (measured as Nephelometric Turbidity Units or NTU). Specific characteristics associated with the SPG Facility treatment levels are described in **Table 1**.

Since the data was compiled for the Delta MeHg Control Program in 2004–2005, eight of the SPG Facilities have made plant upgrades (six of these facilities are subject to the Delta MeHg Control Program). Two additional SPG Facilities (both of which are subject to the Delta MeHg Control Program) are also planning, or in the process of implementing, upgrades. Finally, three SPG Facilities (two of which are subject to the Delta MeHg Control Program) previously upgraded their plants, and are now planning, or in the process of implementing, further upgrades. All of these planned upgrades will be operational by 2030.

Table 1. Characteristics of the Treatment Levels Represented by the SPG Facilities

Treatment Level	Symbol Used for the SPG Control Study	Secondary Treatment Process	Tertiary Filtration Process	Effluent Water Quality			
				Ammonia as N < 2 mg/L	Nitrate as N < 10 mg/L	TSS < 5 mg/L	Turbidity < 2 NTU
Primary Treatment Only[(a)]	p	—	—	—	—	—	—
Secondary Only	a	✓	—	—	—	—	—
Secondary plus Nitrification (N)	b	✓	—	✓	—	—	—
Secondary plus Nitrification and Denitrification (NDN)	c	✓	—	✓	✓	—	—
Pond-based Secondary plus NDN	g	✓ (b)	—	✓	✓	—	—
Tertiary Only	d	✓	✓	—	—	✓	✓
Tertiary Plus N	e	✓	✓	✓	—	✓	✓
Tertiary plus NDN	f	✓	✓	✓	✓	✓	✓

(a) There is one Primary Only facility wihtin the SPG, the City of Sacramento Combined Wastewater Collection and Treatment System (Combined WWCTS). This complex of facilities, which serves the downtown Sacramento area, is designed to collect both wastewater and stormwater in a single collection system (i.e. combined sewer system), and convey the flow to the Sacramento Regional County Sanitation District Wastewater Treatment Plant for treatment and disposal. The maximum allowed conveyance capacity to SRCSD is 60MGD, which is roughly four times the average daily flow. The system is designed to store and attenuate the peak flows above 60 MGD in a storm event. When storm events have excessive intensity and/or duration and the system reaches storage capacity, the flow id directed to two treatment plants that provide primary treatment, chlorine disinfection, and dechlorination. Discharges from this system to receiving waters occurs only for a few hours a day, three to five days each year (if at all). Because of the unique storm dependent and intermittent operation of the treatment facilities, these facilities cannot rely on the biological treatment processes that are being evaluated under this study for the remaining SPG Facilities. Therefore, control strategies for discharges from the City of Sacramento CWCTS are not likely to be the same as the other SPG Facilities. Nevertheless, the majority of flows in the City of Sacramento's combined system are routed to and treated at the Sacramento Regional County Sanitation District Wastewater Treatment Plant , which is also part of the MeHg Control Study. In addition, the City of Sacramento is preparing a MeHg control study specific to the CWCTS and is also participating in addition to MeHg control studies being completed by the stormwater dischargers under the Delta MeHg Control Program.

(b) For these facilties, the majority of secondary treatment occurs in a pond facility.

Table 2 summarizes the treatment levels employed at each of the SPG Facilities, as follows: in 2004-2005 when the TMDL Staff Report was developed, in 2013 when the Control Study Work Plan (**Appendix A**) was submitted, and as anticipated in 2030 (based on information available). As shown, (with the exception of the Rio Vista Beach facility and City of Live Oak facility) all of the completed/planned plant upgrades (eight in total) have, or will, result in treatment trains that provide nitrification, denitrification and filtration (i.e. a Tertiary plus NDN treatment level). In total, the SPG Facilities that have completed and/or are planning changes to achieve a Tertiary plus NDN treatment level represent approximately 96 percent of the total annual wastewater discharged from the SPG Facilities that currently have WLAs assigned under the Delta MeHg Control Program. The Rio Vista Beach facility has been upgraded to a Secondary plus N treatment level, and the City of Live Oak facility has a Tertiary plus N treatment level.

Table 2. SPG Facility Treatment Level Summary

Treatment Level[a] 2004-2005	Treatment Level[a] Current (2013)	Treatment Level[a] Future (2030)	Agency	Facility
SPG Facilities Within the MeHg TMDL Project Area				
f	f	f	Brentwood, City of	Wastewater Treatment Plant (WWTP)
g	g	f	Davis, City of	WWTP
b	b	b	Discovery Bay, Town of	WWTP
(b)	f	f	Ironhouse Sanitary District	WWTP
b	f	f	Lodi, City of	White Slough Water Pollution Control Facility (WPCF)
b	f	f	Manteca, City of	Wastewater Quality Control Facility (WQCF)
(b)	f	f	Mountain House Community Services District	WWTP
a	b	b	Rio Vista, City of	Beach Wastewater Treatment Facility (WWTF)
(b)	f	f	Rio Vista, City of	Northwest WWTF
p	p	p	Sacramento, City of	Combined Wastewater Collection and Treatment System (Combined WWCTS)
a	a	f[c]	Sacramento Regional County Sanitation District	Sacramento Regional WWTP
d	e	f[c]	Stockton, City of	Regional WWCF
a	f	f	Tracy, City of	WWTP
b	e	f	Woodland, City of	WPCF
SPG Facilities Outside of the MeHg TMDL Project Area				
g	e	e	Live Oak, City of	WWTP
f	f	f	Roseville, City of	Dry Creek WWTP
f	f	f	Roseville, City of	Pleasant Grove WWTP
f	f	f	UC Davis	Main WWTP
b	c	f[d]	Vacaville, City of	Easterly WWTP
a	a	a	Yuba City, City of	WWTF

[a] Treatment Level Categories:

p = Primary Only (Combined stormwater and wastewater facility with primary settling and disinfection used only in peak wet weather flow events)

a = Secondary Only

b = Secondary plus Nitrification (N)

c = Secondary plus Nitrification/Denitrification (NDN)

d = Tertiary Only

e = Tertiary plus N

f = Tertiary plus NDN

g = Pond-Based Secondary plus NDN

[b] Facility was not online in 2004-2005.

[c] Although an “e” treatment level was identified for these facilities in the Control Study Work Plan, Regional San has decided to adopt an "f" treatment level, and the City of Stockton's recently adopted NPDES permit requires an "f" treatment level.

[d] Vacaville Easterly WWTP upgraded to an "f" treatment level as of January 2015.

As noted in **Table 2**, at the time the Control Study Work Plan (**Appendix A**) was developed, the City of Stockton and Sacramento Regional County Sanitation District facilities (also referred to as Regional San) were expected to reach a Tertiary plus N treatment level by 2030. However, since that time, Regional San has moved forward to construct a Tertiary plus NDN treatment facility and City of Stockton has been required in its renewed NPDES permit to denitrify. Therefore, in this Progress Report, it is assumed that the Regional San and the City of Stockton Facilities will obtain a Tertiary plus NDN treatment levels by 2030.

3.0 METHYLMERCURY CONTROL STUDY OVERVIEW

In accordance with the Delta MeHg Control Program requirements, the MeHg SPG developed the Control Study Work Plan (**Appendix A**) to direct the analysis completed to date. In accordance with the Guidance Document, the Control Study Work Plan summarized the following three aspects of the MeHg Control Study efforts to date:

- Control methods (or treatment levels) being evaluated;
- Monitoring and data collection plan and associated quality assurance/quality control (QA/QC) procedures; and
- MeHg Control Study Objectives, along with the hypotheses testing procedures to be used to evaluate these objectives.

Each of these aspects of the Control Study Work Plan is summarized below.

3.1 Control Methods (Treatment Levels)

As discussed previously, the control methods of interest for this MeHg Control Study are nitrification, denitrification and filtration. To help understand the relative importance of each of these processes on MeHg control in municipal wastewater treatment plants, effluent data from the SPG Facilities that provide the same treatment level were combined and compared to effluent data from the SPG Facilities that represent other treatment levels. Inter-process data was collected after the secondary process at treatment plants with tertiary filtration, which provided information for two treatment levels. The five treatment levels of interest for this study are as follows:

- **Secondary Only:** Secondary treatment processes provided to achieve BOD reduction only, so average effluent ammonia concentrations are greater than 10.0 mg-N/L (mg as Nitrogen per liter).
- **Secondary plus N**: Secondary treatment with nitrification, where the average effluent ammonia concentrations are consistently less than 2.0 mg-N/L.
- **Secondary plus NDN:** Secondary treatment with nitrification and denitrification (NDN), where average effluent ammonia concentrations are consistently less than 2.0 mg-N/L and average effluent nitrate concentrations are consistently less than 10 mg-N/L.

- **Tertiary plus N**: Secondary treatment with nitrification, followed by filtration, where average effluent ammonia concentrations are less than 1.5 mg-N/L, average effluent TSS concentrations less than 5 mg/L, and average turbidity of 2 NTU or less.
- **Tertiary plus NDN:** Secondary treatment with nitrification and denitrification, followed by filtration, where average effluent ammonia concentrations are less than 1.5 mg-N/L, average effluent nitrate concentrations are 1-10 mg-N/L, average effluent TSS concentrations less than 5 mg/L, and average turbidity of 2 NTU or less.

3.2 Monitoring Data Collection

The MeHg Control Study analyses utilizes data collected by the SPG Facilities between October 2013 and September 2014, hereinafter referred to as the Control Study monitoring period, and data previously collected by the SPG Facilities in accordance with their NPDES permit requirements. A summary of the Control Study monitoring period data collection procedures, along with associated quality assurance/quality control procedures, is provided below followed by a summary of the historic data used under this evaluation. Quality assurance/quality control procedures associated with these historic data collection efforts were provided in the Control Study Work Plan (**Appendix A**).

3.2.1 Control Study Monitoring Period Data

The MeHg Control Study monitoring, following associated quality assurance/quality control procedures, were completed over a twelve-month period from October 2013 through September 2014. During the Control Study monitoring period, concurrent (on the same day) influent and final effluent Hg and MeHg samples were collected monthly in accordance with sampling procedures described in the Control Study Work Plan (**Appendix A**). In addition, secondary effluent samples were collected monthly on the same day as the influent and effluent samples at SPG Facilities with cloth and/or granular media filtration processes. A summary of the data collection QA/QC efforts and results for the Control Study monitoring period is provided in **Appendix C**.

As outlined in the Control Study Work Plan (**Appendix A**), all of the SPG Facilities completed monthly monitoring unless the prescribed Control Study Work Plan monitoring was not consistent with the individual facilities' NPDES permit requirements for MeHg monitoring. The following specific SPG Facilities did not complete monthly monitoring:

- Ironhouse Sanitary District collected samples only during months when surface water discharge occurs.
- Mountain House Community Services District collected samples at a minimum quarterly frequency.
- City of Sacramento Combined Wastewater Collection and Treatment System (Sacramento Combined WWCTS) collected samples only during its episodic discharges from three system facilities/outfalls.

The MeHg and Hg samples were collected as either grab or composite samples at each SPG Facility as specified in the Control Study Work Plan (**Appendix A**) procedures, which were tailored for each SPG Facility in accordance with their respective NPDES permit monitoring requirements. However, there were some minor variations from these Control Study Work Plan procedures, as follows:

- City of Roseville PG and DC facilities each collected twelve grab and twelve composite secondary effluent MeHg and Hg samples, whereas only twelve grab samples were specified for each parameter. Similarly, eleven and twelve final effluent Hg composite samples were collected at the City of Roseville DC and PG facilities, respectively, in addition to the twelve final effluent Hg and MeHg grab samples prescribed.
- Sacramento Combined WWCTS collected four grab and two composite final effluent samples whereas grab samples were specified in the Control Study Work Plan.
- Mountain House Community Service District collected two MeHg and Hg final effluent composite samples in addition to the four prescribed grab samples for each parameter. However, only two MeHg and Hg secondary effluent grab samples were collected whereas four quarterly samples were prescribed.
- City of Live Oak and City of Yuba City collected grab samples whereas they were originally specified to collect composite samples.

As discussed in the Control Study Work Plan, the grab samples were to be collected over a range of time periods and days to represent the possible range of influent concentrations and loads – with an emphasis on the peak flow period. In general, this protocol was followed with some exceptions. A detailed discussion of the grab sampling variability is provided in **Appendix D**.

All samples were analyzed unfiltered, following USEPA methods 1630 for MeHg and 1631e for Hg (or equivalents). All analytical labs were Environmental Laboratory Accreditation Program -certified. A desired maximum method detection limit (MDL) of 0.02 nanograms per liter (ng/L) was specified in the Control Study Work Plan for all MeHg samples. Within the Control Study monitoring period, the only deviations from the desired MDL were as follows:

- Discovery Bay WWTP had an MDL of 0.026 ng/L for each of the twelve final effluent samples collected, and
- Mountain House WWTP had an MDL of 0.026 ng/L for each of the six final effluent and two secondary effluent samples collected.

3.2.2 Previously Collected Data

Data collected in 2004-2005 and data collected in 2009-2013 were used in addition to the Control Study monitoring period data to complete the MeHg Control Study analyses. A summary of the previously collected data that were used in the MeHg Control Study evaluations is provided below under the following headings:

- 2004 – 2005 Concentration Data
- 2004 – 2005 Flow Data
- 2009 – 2013 Concentration Data
- 2012 – 2013 Flow Data

3.2.2.1 2004 – 2005 Concentration Data

To simplify the analysis and eliminate possible errors with attempting to re-create the Regional Water Board's calculation of 2004-2005 MeHg loads presented in the TMDL Staff Report, data collected between October 2004 and September 2005, which mirrors the date range used to develop the TMDL Staff Report as much as possible, was used to represent the MeHg concentrations and flows during the 2004-2005 discharge period. The use of quality control/quality assurance procedures associated with the MeHg sampling conducted between October 2004 and September 2005, including the use of the "clean hands/dirty hands" techniques data, cannot be confirmed.

Effluent MeHg concentration data collected between October 2004 and September 2005 were obtained from each SPG facility addressed in the TMDL Staff Report with the following exceptions:

- 2004-2005 MeHg effluent concentration data for the City of Rio Vista Beach facility are not available. MeHg concentration data for the Current discharge period are assumed to adequately represent the 2004-2005 condition for this facility.
- The City of Rio Vista Northwest, Ironhouse Sanitary District, and Mountain House Community Service District facilities were not in operation in 2004-2005. Therefore, effluent concentrations cannot be defined for this period.

3.2.2.2 2004 – 2005 Flow Data

Effluent flow data collected between October 2004 and September 2005 were obtained from each SPG Facility addressed in the TMDL Staff Report with the following exceptions:

- August 2004 through August 2005 data were used for the City of Brentwood and City of Tracy facilities, as these were the data available.
- Monthly flow data was used for the Town of Discovery Bay facility since daily data were not available.
- For the Rio Vista Beach facility flow rate data for the Current discharge period (discussed below) are assumed to adequately represent the 2004-2005 condition.
- The City of Rio Vista Northwest, Ironhouse Sanitary District, and Mountain House Community Service District facilities were not in operation in 2004-2005. Therefore, effluent flows are equal to zero for this period.

3.2.2.3 2009 – 2013 Concentration Data

Influent and effluent MeHg concentration data collected between October 2009 and September 2013 (i.e. the beginning of the Control Study monitoring period) were used in addition to the Control Study monitoring period data to characterize the water quality currently associated with each SPG Facility. As detailed in the Control Study Work Plan (**Appendix A**), MeHg and Hg data collected between October 2009 and September 2013 generally included appropriate quality control/quality assurance procedures, including the use of the "clean hands/dirty hands" sampling techniques.

Influent and effluent MeHg concentration data collected between October 2009 and September 2013 adequately represents the current water quality for each SPG facility, with the following exceptions:

- The City of Vacaville had a major process changes between October 2009 and September 2013. Therefore effluent data from before and after the process changes are considered separately.
- For the City of Davis facility, there are two discharge locations (001 and 002). Location 001, which is to a tributary to the Yolo Bypass, is not given a WLA under the Delta MeHg Control Program. Location 002, which discharges after the effluent has passed through a wetland receiving other water sources, is given a WLA under the Delta MeHg Control Program, but will be abandoned in 2017. Due to differences in effluent quality between these locations associated with the wetland facility, effluent data from each discharge location are considered separately.

Graphical summaries of influent and effluent MeHg data from October 2009 through the end of the Control Study monitoring period for each SPG Facility (grouped by treatment level) are provided on **Figure 2** and **Figure 3**, respectively.

Scatter plots showing paired daily effluent and influent concentrations for each treatment level of interest are also provided on **Figure 4** through **Figure 8**. Also shown on these plots are the results of a linear regression analysis, along with associated r^2 values. As shown, there is little to no statistically significant linear relation between influent and effluent concentrations. In addition, the linear correlation between influent and effluent MeHg data appears to decrease with increasingly higher treatment levels.

3.2.2.4 2012 – 2013 Flow Data

Effluent flow data collected more than three years ago is not likely to be representative of current conditions. Therefore, only effluent flow data collected over the two-year period from September 2012 through September 2014 are assumed to represent current flows.

3.3 MeHg Control Study Objectives

The three MeHg Control Study Objectives, along with their specific null hypothesis statements from the Control Study Work Plan (**Appendix A**), are summarized below.

3.3.1 Objective 1

The first Study Objective involves determining whether treatment improvements made since 2004-2005 at the SPG Facilities that have WLAs assigned under the Delta MeHg Control Program, along with the changes planned by 2030, will result in statistically significant reductions in MeHg loads such that the WLAs are met. The specific null hypothesis that was tested under Objective 1 is as follows:

> **Planned Scenario:** By 2030, by which time all Delta MeHg Control Program WLAs must be met, there will not be a statistically significant reduction in MeHg loads to the MeHg TMDL Project Area from SPG Facilities (as compared to the WLAs and the 2004-2005 load estimates presented in the TMDL Staff Report) assuming the SPG Facilities implement the treatment process changes required under their current NPDES permits.

To evaluate this Objective, the annual average loads anticipated in 2030 for each SPG Facility with WLAs under the Delta MeHg Control Program were compared to both the average discharge loads calculated for the 2004–2005 timeframe and to the Delta MeHg Control Program WLAs.

3.3.2 Objective 2

The second Study Objective involves determining whether blanket application of a specific "plausible" treatment level on all SPG Facilities would result in statistically lower MeHg loads relative to loads that would be discharged under the Planned Scenario discussed above. The specific null hypotheses that were tested under Objective 2 were as follows:

> **Plausible Scenarios:** In 2030 by which time all WLAs must be met, there will not be a statistically significant reduction in MeHg loads to the MeHg TMDL Project Area (as compared to the Planned Scenario described above) if all SPG Facilities provide at least the following levels of treatment:

- Plausible Scenario A: Secondary plus N
- Plausible Scenario B: Secondary plus NDN
- Plausible Scenario C: Tertiary plus NDN

Each Plausible Scenario was evaluated by comparing the annual average load anticipated under the Planned Scenario discussed under Study Objective 1 to the anticipated annual average load assuming blanket application of the given Plausible Scenario treatment level.

3.3.3 Objective 3

The third Study Objective involves determining whether the variability in influent MeHg concentrations have a potential to impact the variability in effluent MeHg concentrations at the different treatment levels being considered under this study. The specific null hypotheses that were tested under Objective 3 are as follows:

> **Influent Conditions:** The variance of influent MeHg concentrations is equal to the variance of effluent MeHg concentrations for the following levels of treatment:

- Secondary Only
- Secondary plus N
- Secondary plus NDN
- Tertiary plus NDN

This Objective was tested by comparing the variances observed in the influent and effluent concentration data (i.e., for data that has been collected on the same day) for SPG Facilities that provide the treatment level being considered to determine if a statistically a significant difference in variances was demonstrated. Not rejecting the null hypothesis indicates that source control efforts do not impact effluent MeHg loads.

4.0 DATA EVALUATION

This section provides a characterization of the MeHg concentrations, flows, and loads under a range of discharge periods of interest. The following specific topics are addressed:

- Discharge Periods of Interest
- Average MeHg Concentrations
- Discharge Volumes
- Average MeHg Effluent Loads

A summary of the Hg data collected under the MeHg Control Study is provided in the *Mercury Data Summary Technical Memorandum*, which is provided in **Appendix E**.

4.1 Discharge Periods of Interest

The discharge periods of interest for the data evaluations presented in this section are as follows:

- **2004-2005:** The discharge period represented by the 2004-2005 effluent flow rate and concentration data used in the development of the Delta MeHg Control Program. Only data from the SPG Facilities that discharge to the MeHg TMDL Project Area are of interest for this discharge period, as these are the only facilities that were evaluated in the TMDL Staff Report.
- **Current:** The discharge period characterized by flow rate data collected between October 2012 and September 2014 and by representative influent and effluent MeHg concentration data collected between October 2009 and September 2014 (i.e. the end of the Control Study monitoring period) is assumed to represent the concentration for the Current discharge period conditions.
- **2030 Planned:** The discharge period represented by predicted 2030 effluent flow rate and anticipated 2030 effluent MeHg concentration, where 2030 effluent concentrations are assumed to equal the concentrations for the Current conditions unless treatment improvements are planned. In the latter case, concentrations are based on the calculated average concentration for the planned treatment level.
- **Design Capacity:** The discharge period represented by the permitted ADWF design capacity specified in the current NPDES permits for each SPG Facility[1] and the anticipated 2030 effluent MeHg concentration, where the same concentrations used for the 2030 Planned discharge period are applied. Note that the timing for when each SPG Facility reaches this condition will vary.

[1] Note that although the current NPDES permit for the City of Davis WWTP identified a design capacity ADWF of 7.5 mgd, the current upgrade project for the City will results in a lower ADWF design capacity of 6.0 mgd. Nevertheless, the 7.5 mgd ADWF capacity is used in calculated the "Design Capacity" loads for the City of Davis WWTP.

- **2030 Plausible:** The discharge period represented by the 2030 Planned discharge period flow conditions and by effluent MeHg concentrations that represent the blanket application of one treatment method to all SPG Facilities that do not already plan to meet or exceed the prescribed treatment level of interest. Consistent with Study Objective 3, the treatment levels of interest are as follows:
  - 2030 Plausible Scenario A: All SPG Facilities implement (as a minimum) the treatment process changes required to meet a Secondary plus N treatment level.
  - 2030 Plausible Scenario B: All SPG Facilities implement (as a minimum) the treatment process changes required to meet a Secondary plus NDN treatment level.
  - 2030 Plausible Scenario C: All SPG Facilities implement the treatment process changes required to meet a Tertiary plus NDN treatment level.

4.2 Average MeHg Concentrations

Effluent data collected from all of the SPG Facilities that provide a specific treatment level were combined to calculate a representative average effluent MeHg concentration for a given treatment level, where the treatment levels of interest are:

- Secondary Only
- Secondary plus N
- Secondary plus NDN
- Tertiary plus N
- Tertiary plus NDN

Because non-detect values comprise up to 85 percent of the available effluent data – regardless of treatment level, a log-normal probability distribution of detected and non-detected data was used to calculate estimated averages using the "Robust Method" (Helsel and Cohn, 1988). This method is described in detail in the Control Study Work Plan (**Appendix A**). These log plots are shown on **Figure 9** through **Figure 13**. A summary of calculated average concentrations for each treatment level is shown in **Table 3**.

As shown in **Table 3**, the average effluent MeHg concentration is decreased significantly as the treatment level increases above Secondary Only. However, there is no difference between the Secondary plus N treatment level and the Tertiary plus N treatment level – suggesting that tertiary filtration does not improve removal. Conversely, the average effluent concentrations for the Secondary plus NDN treatment plants are less than half of the average effluent concentrations for the Secondary plus N treatment plants. A similar relationship is observed between the Tertiary plus N and Tertiary plus NDN facilities. The observed relationship between the facilities that provide the same level nitrogen removal – regardless of whether filtration is applied - suggests that nitrification/denitrification is more effective for MeHg removal than tertiary filtration.

Table 3. SPG Facility MeHg Effluent Concentrations by Treatment Level

Treatment Level	Calculated Average Effluent Concentration[(a,b)], ng/L	Number of SPG Facilities	Data Points	
			Total Number	Percent ND
Secondary Only	0.27	2	120	1
Secondary plus N	0.05	6	137	23
Secondary plus NDN	0.02	9	147	67
Tertiary plus N	0.05	3	120	23
Tertiary plus NDN	0.01	10	448	85

(a) All values were calculated using a log-normal distribution in accordance with the "Robust Method."
(b) These average concentrations were calculated from data collected over a five year period between October 2009 and September 2014. Additional data collected between October 2014 and September 2017 will also be evaluated and presented in the MeHg Control Study Final Report.

Average influent, secondary effluent, and final effluent concentrations calculated for each SPG Facility for the Current discharge period are provided in **Table B-1** in **Appendix B**. In addition, **Table B-1** provides a comparison of the calculated average 2004-2005 effluent MeHg data to the 2004-2005 averages reported in the TMDL Staff Report. (Note that 2004-2005 average concentrations are only calculated for the SPG Facilities that discharge to the MeHg TMDL Project Area.) These average MeHg concentrations were calculated using the following procedures:

- If all values were detected (whether a quantified or estimated concentration) the averages were directly calculated from the data.
- When there were at least 5 detected values, but non-detect values made up some portion of the data set (up to 90 percent), a log-normal probability distribution of detected and non-detected data was used to calculate estimated averages using the "Robust Method" (Helsel and Cohn, 1988). This method is described in detail in the Control Study Work Plan (**Appendix A**).
- When there were less than 5 reported detected or estimated values, or when the non-detect data are greater than 90 percent of the total data set, a meaningful statistical analysis of the data using the "Robust Method" cannot be performed. Under this case, the average concentration was directly calculated assuming all non-detect values are equal to half the MDL.

Table B-1 also indicates the methodology used to calculate the average values in accordance with the above-described procedures. As indicated, the majority of the influent MeHg averages are directly calculated because all available data was reported as either a detected or estimated concentration, and the majority of the effluent MeHg data averages are calculated using the "Robust Method". Graphs showing the results of the "Robust method" calculations identified by the red-colored font in **Table B-1** are provided in **Appendix F**.

4.3 Discharge Volumes

This section provides a summary of the effluent flow data evaluations completed for this study. The following topics are addressed:

- 2004-2005 and Current Discharge Period Annual Average Effluent Flows
- Future Annual Average Effluent Flows
- Total Annual Discharge Volumes

4.3.1 2004-2005 and Current Discharge Period Annual Average Effluent Flows

The calculated average flow rates for both the Current and 2004-2005 discharge periods are presented in **Table 4**. (Note that 2004-2005 flow rate averages are only calculated for the SPG Facilities that discharge to the MeHg TMDL Project Area.) As shown, total effluent flow rates from SPG Facilities within the Delta MeHg Control Program Area have decreased since 2004-2005, despite service area growth over this period.

Table 4. SPG Facility Average Surface Water Discharge Flow Rates

SPG Facility Location	Flows, mgd	
	TMDL Staff Report Data Collection Period[a,b] (Oct 2004-Sep 2005)	Current (Sep 2012-Oct 2014)
Within the MeHg TMDL Project Area	237	209
Outside the MeHg TMDL Project Area	—	31.5
Total for all SPG Dischargers	—	240

(a) This number does not include flows from the Ironhouse Sanitary District, Mountain House Community Services District, and Rio Vista Northwest facilities, because these facilities were not in operation during the 2004-2005 period.

(b) Current flow rates are used for City of Rio Vista Beach 2004-2005 calculations because 2004-2005 data was not provided for this facility.

For many of the SPG Facilities, reductions in effluent flows may be associated with water conservation efforts that have occurred since 2005. Specifically, in 2008 California established an initiative "to achieve a 20 percent reduction in per capita water use statewide by 2020." This initiative, which has been emboldened by the stresses from the current four-year drought, has resulted in significant reductions in both individual water usage and per capita wastewater generation rates throughout the state. Households that exhibit extensive levels of conservation can reduce their wastewater flow rates by as much as 30 percent as compared to average consumption rates (Metcalf & Eddy et al 2014). While some of this reduction has likely already occurred for most California communities, continued reductions are expected. In addition, some of the SPG Facilities have increased their recycled water production rates and/or have made significant collection system improvements that have resulted in reductions in year-round base infiltration.

The Current and 2004-2005 discharge period annual average effluent flow rates calculated for each SPG Facility are presented in **Table B-2** of **Appendix B**.

4.3.2 Future Annual Average Effluent Flows

The 2030 Planned discharge period annual average effluent flow rates were determined for all of the SPG Facilities, except the Cities of Davis and Sacramento, using the annual average effluent flow rate value determined for the Current discharge period and a predicted annual service area growth rate for each SPG Facility, as follows:

$$\begin{aligned} &\mathit{Projected\ Annual\ Average\ Discharge\ Flow}\ (mgd) = \\ &\quad \mathit{Current\ Annual\ Average\ Discharge\ Flow}\ (mgd) \\ &\quad \times (1 + \mathit{Annual\ Service\ Area\ Growth\ Rate})^{YYYY-2014} \\ &\quad \times (1 - \mathit{Water\ Conservation\ Adjustment\ Factor}) \end{aligned}$$

The following exceptions were applied in the use of the above equation:

- For the City of Davis 001 discharge location, 2030 effluent flow rates are based on the annual average influent flow rate value determined for the Current discharge period and the predicted annual service area growth rate. This is because the City of Davis will be switching from a pond-based treatment system to an activated sludge process in 2017. Therefore, losses that occur in the current treatment system (resulting in effluent flow rates that are lower than the influent flow rates) will be reduced. In addition, all effluent flows will be discharged at 001 after this date. Thus, for City of Davis 002 discharge location, 2030 effluent flow rates will be zero.
- Sacramento Combined WWCTS facility treats a combination of wastewater and stormwater flows only during peak flow events for the City's combined collection system. Therefore, flows to this facility are not expected to be impacted significantly by water conservation efforts. In addition, there is no growth or expansion expected to the facility's service area. Therefore, flows for the Current discharge period are assumed to adequately represent flows under the future conditions of interest for this MeHg Control Study.

The Annual Service Area Growth Rate value shown in the equation above was either provided by the SPG Facilities, or was calculated using California Department of Finance historic population data. Specifically, the historic 10-year average annual growth rates for communities within the SPG Facility's service area were calculated for the 1991-2000 and 2001-2010 periods. (Note that this approach was a slight deviation from the Control Study Work Plan (**Appendix A**), which called for long term averages to be determined using the date range from 1971-2010. This is because the 1971-1991 period was determined to not be adequately representative of likely future growth conditions.) The average of these annual growth rates for each decade was assumed to be the long term growth rate. The Annual Service Area Growth Rates identified for each SPG Facility and the associated basis for the growth rate estimates for each SPG Facility is provided in **Table B-3** of **Appendix B**.

The Water Conservation Adjustment Factor shown in the equation above is intended to account for further reductions in discharge volumes due to ongoing conservation efforts and/or future recycling efforts. Note that the application of a Water Conservation Adjustment Factor in the calculation of 2030 effluent flows is a deviation from the Control Study Work Plan (**Appendix A**), where a Water Conservation Adjustment Factor was not identified. However, this reduction factor is appropriate given the indoor use reductions called for in the State's 20x2020 Water Conservation Plan (California Department of Water Resources et al., 2010) and the many drought-driving water recycling initiatives currently underway or planned. For purposes of the MeHg Control Study, a relatively low five percent Water Conservation Adjustment Factor has been conservatively applied.

The annual average effluent flow rates for each SPG Facility predicted for the 2030 Planned discharge period using Water Conservation Adjustment Factor values ranging from zero to ten percent are provided in **Table B-4** of **Appendix B**. The SPG Facilities' Design Capacity flow is also shown in **Table B-4**. As shown, only one of the SPG Facilities, City of Tracy, is projected to reach its Design Capacity Flow by 2030.

Table 5 provides a sum of the total Design Capacity and 2030 Planned flow rates for the SPG Facilities. As shown, the combined SPG Facility discharge flow rates in 2030 are expected to be approximately 70 percent of the total Design Capacity flow rates.

Table 5. Summary of Design Capacity and Predicted 2030 SPG Facility Surface Water Discharge Flow Rates

SPG Facility Location	Flows, mgd	
	Design Capacity	2030 Planned[(a)]
Within the MeHg TMDL Project Area	332	242
Outside the MeHg TMDL Project Area	68.0	42.2
Total for all SPG Dischargers	400	284

(a) Assumes a five percent water conservation adjustment factor.

4.3.3 Total Annual Discharge Volumes

The total annual discharge volumes from all of the SPG Facilities for the 2004-2005, Current, 2030 Planned, and Design Capacity discharge periods were calculated by multiplying the calculated annual average flow rate for each SPG Facility by the average number of discharge days per year for each SPG Facility.

The total annual discharge volumes from all of the SPG Facilities for the 2004-2005, Current, 2030 Planned, and Design Capacity discharge periods are presented in **Table 6**. As shown, discharge volumes under the Current discharge period are lower than those that occurred in 2004-2005 and the Current discharge period effluent volumes are expected to increase by 23 percent by 2030 and by 76 percent by the time the Design Capacity condition is reached for each SPG Facility.

Table 6. Summary of SPG Facility Annual Total Flows at Various Discharge Conditions

SPG Facility Location	Total Annual Flows, million gallons per year			
	2004 - 2005[a,b]	Current	2030 Planned	Design Capacity[c]
Within the MeHg TMDL Project Area	77,500	61,300	74,700	104,000
Outside the MeHg TMDL Project Area	—	11,300	15,500	24,900
Total for all SPG Dischargers	—	72,600	90,200	128,900

(a) This number does not include flows from the Ironhouse Sanitary District, Mountain House Community Services District, and Rio Vista Northwest facilities, because these facilities were not in operation during the 2004-2005 period.
(b) Current flow rates are used for City of Rio Vista Beach 2004-2005 calculations because 2004-2005 data was not provided for this facility.
(c) For the City of Sacramento discharge, the Current flow rate is used for Design Capacity flow (in lieu of the maximum allowable discharge flow included in the NPDES permit) because a future flow rate increase is not anticipated.

The total annual discharge volumes for each respective discharge period and SPG Facility were determined as follows:

- The Current and 2004-2005 discharge period annual average flow rates for each facility were shown in **Table B-2** of **Appendix B**, the 2030 Planned, and Design Capacity discharge period annual average flow rates for each facility were shown in **Table B-4** of **Appendix B**.
- The number of discharge days per year for the 2004-2005 discharge period was directly calculated from the 2004-2005 effluent flow data sets described above.
- For the Current discharge period, the number of discharge days per year of 365 days was used for all SPG Facilities that are known to discharge year-round.
- Because the Sacramento Combined WWCTS facility treats a combination of wastewater and stormwater flows only during peak flow events for the City's combined collection system, the number of discharge days is correlated with rainfall. To better reflect the range of possible number of discharge days per year, annual days of discharge were calculated from September 2001 through September 2014 for the Sacramento Combined WWCTS facility and averaged to estimate the number of discharge days per year.
- For SPG Facilities that receive influent flows daily but discharge intermittently, the number of discharge days per year under the Current discharge period is assumed to equal the average of the annual number of discharge days per year over the three-year period from September 2011 through September 2014. The SPG Facilities that receive influent flows daily but have intermittent discharges are as follows:
  - — City of Lodi WPCF
  - — Ironhouse Sanitary District WWTP
  - — City of Manteca WQCF
  - — City of Stockton Regional WWCF
  - — City of Davis WWTP (001 and 002)

- For all three future discharge periods (2030 Planned, and Design Capacity), the average number of discharge days per year were assumed to remain the same as the Current discharge period with the exception of the City of Davis. As noted previously, after 2017 the City of Davis will discharge year-round to discharge point 001 and will cease discharge to point 002.

The individual SPG Facility total annual discharge volumes are shown in **Table B-5** of **Appendix B**.

4.4 MeHg Effluent Loads

This section provides a summary of the MeHg load evaluation methodologies and results used for the MeHg Control Study. The topics addressed include:

- Load Calculation Overview
- Waste Load Allocations
- Potential Waste Load Allocation Increases
- 2004-2005 versus Current Discharge Period Loads
- Current versus Planned Discharge Period Loads
- 2030 Planned versus 2030 Plausible Discharge Period Loads
- Overall MeHg TMDL Project Area Loads

4.4.1 Load Calculation Overview

Loads have been calculated for each condition of interest using the following equation:

$$Total\ Annual\ Load\ Discharged\ \left(\frac{g}{year}\right) = Average\ Effluent\ Concentration\ \left(\frac{mg}{L}\right) \times Total\ Annual\ Discharge\ Volume\ (million\ gallons) \times 8.34\left(\frac{lb/million\ gallons}{mg/L}\right) \times 453.6\ \left(\frac{g}{lb}\right)$$

4.4.2 Waste Load Allocations

As discussed in the Control Study Work Plan (**Appendix A**), some discrepancies were identified in a review of the calculation procedures in the TMDL Staff Report. **Table 7** provides a comparison of the total SPG Facility WLA provided in the TMDL Staff Report and the TMDL WLA values calculated in accordance with this MeHg Control Study. (The MeHg WLA shown in **Table 7** includes the allocation increases that have been assigned to Brentwood, Rio Vista Northwest and City of Woodland.) As shown in **Table 7**, the calculated WLA values are slightly higher than those detailed in the TMDL Staff Report. Although the difference between the total WLA provided in the TMDL Staff Report and the calculated TMDL WLA values are small, the adjustments to the SPG Facility WLAs are important for individual facility compliance.

Table 7. Comparison of 2004-2005 TMDL Staff Report MeHg WLAs and Calculated MeHg WLAs for SPG Facilities Within the MeHg TMDL Project Area

Parameter	MeHg WLA, gram/year[a]
TMDL Staff Report	106.3
Calculated Value	106.8

(a) WLAs are calculated here and in the TMDL Staff Report as follows: Average Concentration (ng/L) ÷ 1,000,000 (ng/mg) x Average Effluent Flow (mgd) x 8.34 (lb/gallon) x 453.6 (g/lb), rounded to two significant figures.

A comparison of the WLA values provided in the TMDL Staff Report to the values calculated for the MeHg Control Study are shown for each SPG Facility in **Table B-6** of **Appendix B**. This table also notes the specific errors identified in the TMDL Staff Report for the WLA calculations.

4.4.3 2004-2005 Versus Current Discharge Period Loads

The TMDL staff report did not include the flows information that was used to estimate the 2004-2005 MeHg loads. In addition, the MeHg concentration values used to calculate the 2004-2005 loads could not be replicated as part of this evaluation. Therefore, to ensure an accurate comparison to the 2004-2005 loads is being presented, the 2004-2005 loads were recalculated for this MeHg Control Study. **Table 8** provides a comparison of the total SPG Facility Delta MeHg Control Program WLAs to: the 2004-2005 MeHg loads reported in the TMDL Staff Report, the 2004-2005 MeHg loads calculated using the measured 2004-2005 flows and the MeHg concentration values presented in the TMDL Staff Report, and the 2004-2005 MeHg loads calculated using the individual SPG Facility 2004-2005 flow and concentration data. Also shown are the MeHg loads calculated for the Current discharge period. This information is presented graphically on **Figure 14.** (Note that *only* the SPG Facilities located within the MeHg TMDL Project Area are included in these summaries.)

Table 8. Comparison Summary of 2004-2005 and Current MeHg Loads for SPG Facilities within the MeHg TMDL Project Area

Loading Condition	MeHg Load, gram/year
2004-2005 TMDL Staff Report Value[a]	204
2004-2005 Value Using SPG Facility Flows and TMDL Concentrations[b,c]	194
2004-2005 Value Using SPG Facility Flows and Concentrations[b,c]	131
Calculated TMDL MeHg WLA[d]	107
Current Conditions[e]	60.1

(a) TMDL Staff Report Value cannot be verified with available data.
(b) Current loads are used for City of Rio Vista Beach 2004-2005 load calculations because 2004-2005 data was not provided for this facility.
(c) This load calculation does not include flows from the Ironhouse Sanitary District, Mountain House Community Services District, and Rio Vista Northwest facilities, because these facilities were not in operation during the 2004-2005 period.
(d) WLA assigned to the SPG Facilities only. WLA shown is adjusted from the WLAs calculated in the TMDL Staff Report to account for error identified in the calculation procedures, as documented in the Control Study Work Plan (**Appendix A**).
(e) This current load value was calculated from data collected over a five year period between October 2009 and September 2014. Additional data collected between October 2014 and September 2017 will also be evaluated and presented in the MeHg Control Study Final Report.

The following conclusions can be drawn from the information provided in **Table 8** and **Figure 14**:

- MeHg loads given in the TMDL Staff Report are greater than those calculated here for approximately the same 2004-2005 period. **Tables B-1**, **B-6** and **B-7** in **Appendix B** include details regarding the differences identified for each SPG Facility with respect to the concentration data and how this impacts the load calculations.
- Current discharge period loads are less than half of the 2004-2005 loads (calculated using flow and concentration data from the SPG facilities) for both MeHg.
- Current discharge period loads are less than one third of the 2004-2005 loads presented in the TMDL Staff Report and calculated using the concentrations presented in the TMDL Staff Report.
- Current discharge period loads are approximately 56 percent of the WLA assigned to the SPG Facilities.

A comparison of the 2004-2005 MeHg loads to the Delta MeHg Control Program WLAs and the Current discharge period MeHg loads for each SPG Facility is provided in **Table B-7** of **Appendix B**. The individual SPG Facility MeHg loads summarized in **Table 8** and **Figure 14** for 2004-2005 discharge period were calculated using the actual 2004-2005 total annual discharge volumes (from **Table B-5** of **Appendix B**) and either the concentrations provided in the TMDL Staff Report or the 2004-2005 annual average concentrations reported in **Table B-1** of **Appendix B**. MeHg loads presented in **Table 8** and **Figure 14** for the Current discharge period were calculated using the Current discharge period annual average concentrations (presented in **Table B-1** of **Appendix B**), and the Current discharge period total annual discharge volume (presented in **Table B-5** of **Appendix B)**.

4.4.4 Current versus Planned Discharge Period Loads

A comparison of the calculated MeHg WLA to the MeHg loads for the Current discharge period and the MeHg loads at the 2030 Planned and Design Capacity discharge periods is presented in **Table 9** and is displayed graphically on **Figure 15.** As shown, the combined loads from *all* SPG Facilities for the 2030 Planned and Design Capacity discharge periods are two orders of magnitude lower than the assigned WLA.

Table 9. Comparison Summary of Current and Planned Discharge Period Loads

SPG Facility Location	Calculated Assigned MeHg WLA	MeHg Load, gram/year		
		Current	2030 Planned	Design Capacity
Within the MeHg TMDL Project Area	107	60.1	3.67	5.02
Outside the MeHg TMDL Project Area	—	2.73	2.49	3.63
Total for all SPG Dischargers	—	62.9	6.17	8.65

The 2030 Planned and Design Capacity MeHg loads presented in **Table 9** and **Figure 15** are based on the assumption that each of the SPG Facilities will implement the treatment process upgrades required under the NPDES permits that are currently effective. These loads were quantified using the total annual effluent flow rate for the period of interest (2030 Planned or Design Capacity, as shown in **Table B-4** of **Appendix B**) and the “planned” average annual effluent concentration as follows:

- For the 15 SPG Facilities that are not planning additional major process changes, effluent concentrations calculated for the Current discharge period (from **Table B-1** of **Appendix B**) were used.
- For the five SPG Facilities still planning major process changes, the calculated average treatment level effluent concentration value for the planned level of treatment (as presented in **Table 3**) was used.

A comparison of the MeHg WLA to the MeHg loads for the Current discharge period and the MeHg loads at the 2030 Planned and Design Capacity discharge periods for each SPG Facility is provided in **Table B-8** of **Appendix B**.

4.4.5 2030 Planned versus 2030 Plausible Discharge Period Loads

Table 10 provides a comparison of the calculated MeHg loads for the 2030 Planned discharge period and calculated MeHg loads for the following three 2030 Plausible discharge periods:

- 2030 Plausible Scenario A: Minimum Secondary plus N treatment level
- 2030 Plausible Scenario B: Minimum Secondary plus NDN treatment level
- 2030 Plausible Scenario C: Minimum Tertiary plus NDN treatment level

The information provided in **Table 10** is shown graphically on **Figure 16**, along with the loads being discharged under the Current discharge periods for comparison.

Table 10. Comparison of 2030 Planned and 2030 Plausible Loads

SPG Facility Location	2030 MeHg Load[a], gram/year			
	Planned	Plausible A	Plausible B	Plausible C
Within the MeHg TMDL Project Area	3.67	3.53	3.44	3.43
Outside the MeHg TMDL Project Area	2.49	1.16	0.78	0.75
Total for all SPG Dischargers	6.17	4.69	4.22	4.18

[a] Although a decrease in loads is observed under the various Plausible conditions, any reductions in MeHg loads that may be associated with a given treatment level need to be considered in the context of the overall loads within the waterbody in question. The load reductions shown for the MeHg TMDL Project Area represent only a small fraction of the total loads to the MeHg TMDL Project Area. See Figure 16 for additional information regarding the total MeHg loads within the MeHg TMDL Project Area.

As shown in **Table 10** and **Figure 16**, the MeHg loads under the 2030 Plausible discharge periods are lower than MeHg loads under the 2030 Planned discharge periods, with the blanket application of Tertiary plus NDN treatment level resulting in the smallest MeHg loads. Specifically, a 20 to 35 percent reduction in MeHg loads discharged from the SPG Facilities is realized for the 2030 Plausible discharge period scenarios relative to the 2030 Planned discharge periods. However, ***planned improvements will already result in a greater than 95 percent reduction in MeHg loads discharged to the MeHg TMDL Project Area among the Delta MeHg Control Program Dischargers, relative to 2004-2005 levels (131 g/year in 2004-2005 vs. 3.7 g/year under 2030 Planned discharge periods).*** The additional 20 to 35 percent reduction in MeHg loads associated with the blanket application of a prescribed treatment level represents a decrease of approximately 2 g/year, or about 1.5 percent of the total 2004-2005 loads from all of the MeHg sources identified under the MeHg MeHg Control Program. The cost to implement the additional treatment need to achieve this additional reduction would likely be substantial.

The MeHg loads summarized in **Table 10** for the three 2030 Plausible discharge period scenarios were calculated for each SPG Facility as follows:

- For facilities that are already meeting or exceeding the treatment level being considered for each 2030 Plausible discharge period scenario, annual average effluent concentrations calculated for the Current discharge period (from **Table B-1** of **Appendix B**) were used.
- For Facilities planning major process changes to meet the treatment level being considered under each 2030 Plausible discharge period scenario (or better), the calculated treatment level average effluent concentration value for the 2030 Planned discharge period (as presented in **Table 3**) was applied.
- For Facilities not planning new major process changes (or those planning changes that will not result in the water quality expected from the treatment level being considered), the calculated treatment level average effluent concentration value for the Plausible discharge period scenario level of treatment under consideration (as presented in **Table 3**) was applied. It should be noted that the hypothetical application of the "plausible" treatment scenarios to the Sacramento Combined WWCTS facility may not be realistic. This plant is of intermittent and short-term operation and, thus, would not be able to obtain biological treatment at these flows.

The calculated MeHg loads for the 2030 Planned discharge periods and the three 2030 Plausible discharge periods for each SPG Facility are presented in **Table B-9** of **Appendix B**.

5.0 HYPOTHESIS TESTING

This section presents an overview of the hypothesis testing methodology and a summary of the hypothesis testing results for each of the three MeHg Control Study Objectives.

5.1 Null Hypothesis Approach

In accordance with the Guidance Document, the three Study Objectives are expressed as null hypotheses. A null hypothesis typically corresponds to a general or default position and is commonly used in scientific evaluations as the basis for statistical analysis of study results. In the cases presented, the null hypothesis states that a potential treatment or influent condition has no effect. The data collected and/or evaluated under the MeHg Control Study are used to either reject, or fail to reject, these null hypotheses. For example, if the comparison of two groups (e.g., Secondary Only treatment level versus Tertiary plus NDN treatment level) reveals no statistically significant difference between the two groups, it means that there is not enough evidence to reject the null hypothesis that the treatment level has no effect.

For purposes of simplifying the discussion presented this Progress Report, a "failure to reject" the null hypothesis will be presented as an acceptance of the null hypothesis. Nevertheless, regardless of how the results are presented herein, it is recognized that the MeHg Control Study is not adequately robust to reach a conclusion that a given null hypothesis is true.

5.2 Study Objective 1

The first Study Objective involves determining whether planned treatment improvements would result in reductions in MeHg loads such that Delta MeHg Control Program WLAs for SPG Facilities are met by 2030. To evaluate this Objective, the 2030 Planned discharge period MeHg loads were compared to the 2004-2005 discharge period MeHg loads and to the MeHg WLAs for each SPG Facility assigned WLAs under the Delta MeHg Control Program.

5.2.1 Methodology

A one-tailed Wilcoxon Signed-Rank test was used to compare for similarity, with a 95 percent confidence level, of the 2030 Planned discharge period MeHg loads and 2004-2005 discharge period MeHg loads. The Wilcoxon Signed-Ranked test is a non-parametric test that can be used as an alternative to a t-test when the population cannot be assumed to be normally distributed. P-values were calculated and used to evaluate the test hypothesis that the two sample sets are the same, as follows:

- P-Value < 0.05 → reject the hypothesis that loads are the same (*i.e.*, there is a statistical difference in loads)
- P-Value ≥ 0.05 → accept that loads are the same (*i.e.*, there not is a statistical difference in loads)

For this analysis, the 2030 Planned discharge period was compared to the following three representations of the 2004-2005 discharge period load scenarios:

- 2004-2005 loads presented in the TMDL Staff Report
- 2004-2005 loads using SPG flow data and TMDL Staff Report concentrations
- 2004-2005 loads using SPG flow and concentration data

The Control Study Work Plan (**Appendix A**) called for a test procedure that assumed the loads for the 2030 Planned period should be used for the Facilities that were not yet discharging during the 2004-2005 period. However, using the same values for both sets of paired data sets can skew the results of the Wilcoxon Signed-Ranked test by artificially creating paired data points that remain the same overtime. Thus, the 2030 Planned discharge period loads were compared to the 2004-2005 discharge period loads (using both the TMDL Staff Report concentrations and the SPG concentrations) assuming the SPG Facilities that were not yet discharging during the 2004-2005 period had a discharge load of zero.

5.2.2 Hypothesis Testing Results

A summary of the p-values calculated for each of the Wilcoxon Signed-Rank test described above is provided in **Table 11**. As shown, the null hypothesis should be rejected for all scenarios evaluated. Thus, an alternative hypothesis that 2030 Planned MeHg load conditions are less than the 2004-2005 discharge period MeHg loads should be accepted.

Table 11. Statistical Comparison of 2004-2005 Loads to 2030 Planned Loads for SPG Facilities within the MeHg TMDL Project Area

Condition Evaluated		Loading, g/yr	Comparison with Planned Scenario	
			One-tailed P-value (Wilcoxon signed-rank test)	Conclusion
2030 Planned		3.67		
All TMDL Facilities	Using TMDL Staff Report Loads	204	0.001	Should reject the null. Should accept that the outcomes are different.
Existing TMDL Facilities Only	Using 2004-05 TMDL Staff Report Concentrations	194	0.009	Should reject the null. Should accept that the outcomes are different.
	Using 2004-05 Actual SPG Concentrations	131	0.009	Should reject the null. Should accept that the outcomes are different.

5.2.3 Hypothesis Testing Conclusions

Based on the analysis presented above, it is concluded that the hypothesis that the MeHg loads discharged under the 2004-2005 are the same as MeHg loads discharged under the 2030 Planned conditions should be rejected. In other words, the combined MeHg load from SPG Facilities to the MeHg TMDL Project Area that are expected to occur in 2030 are significantly lower than the 2004-2005 loads. In addition, as shown in **Figure 15**, the 2030 Planned MeHg loads are almost twenty times lower than the Delta MeHg Control Program WLA.

5.3 Study Objective 2

Objective 2 involves determining whether the blanket application of three "plausible" treatment levels (Secondary plus N, Secondary plus NDN, Tertiary plus NDN) by 2030 would result in MeHg loads discharged from the SPG Facilities that are lower than the loads that will be discharged under the 2030 Planned discharge period condition.

5.3.1 Methodology

Statistical similarity was determined in the same manner described for Objective 1. Specifically, a one-tailed Wilcoxon Signed-Rank test was used to compare for similarity, with a 95 percent confidence level, the loads that are expected under the 2030 Planned discharge period conditions and the loads that would be discharged under the 2030 Plausible discharge period condition scenarios (minimum of Secondary plus N, Secondary plus NDN, or Tertiary plus NDN). P-values were calculated and used to evaluate the hypothesis that the two sample sets are the same as follows:

- P-Value < 0.05 → reject the hypothesis that loads are the same (*i.e.*, there is a statistical difference in loads)
- P-Value ≥ 0.05 → accept that loads are the same (*i.e.*, there is not a statistical difference in loads)

5.3.2 Hypothesis Testing Results

A summary of the p-values calculated for each of the Wilcoxon Signed-Rank test described above is provided in **Table 12**.

Table 12. Statistical Comparison of SPG Facility 2030 Planned Loads with 2030 Plausible Loads

Scenarios	2030 Loading, g/yr	Comparison with Planned Scenario	
		One-tailed P-value (Wilcoxon signed-rank test)	Conclusion
2030 Planned	6.17		
Min. Secondary plus N	4.69	0.186	Cannot reject the null. Accept that the loads are the same under both conditions.
Min. Secondary plus NDN	4.24	0.030	Should reject the null. Accept that the outcomes are different.
Min. Tertiary plus NDN	4.18	0.030	Should reject the null. Accept that the outcomes are different.

As shown in **Table 12**, there is not adequate evidence available to suggest the null hypothesis is false at a 95% confidence level when comparing the 2030 Planned discharge period to the 2030 Plausible Scenario A discharge period (minimum of Secondary plus N). However, the null hypothesis should be rejected at a 95% confidence level when comparing the 2030 Planned discharge period to the 2030 Plausible Scenario B discharge period (minimum of Secondary plus NDN) and 2030 Plausible Scenario C discharge period (minimum of Tertiary plus NDN). Thus, the alternative hypothesis that the loads are different should be accepted. Note, however, that the calculated p-value is the same for Scenario B and Scenario C indicating that added load reductions that would occur at a Tertiary plus NDN treatment level versus a Secondary plus NDN treatment levels are very minor. As discussed previously, there is very little difference in average effluent concentrations calculated for Secondary plus NDN treatment facilities and Tertiary plus NDN treatment facilities.

5.3.3 Hypothesis Testing Conclusions

Based on the information presented above, the hypothesis that the MeHg loads discharged under the 2030 Planned discharge period conditions are the same as MeHg loads that would be discharged under a 2030 Plausible discharge period scenario where all treatment facilities must meet a minimum treatment level of Secondary plus N should *not* be rejected. In other words, the application of additional regulatory requirements for SPG Facilities to achieve a Secondary plus N treatment level will not provide a statistically significant reduction in MeHg loads beyond what is expected to occur.

In contrast, the hypothesis that the MeHg loads discharged under the 2030 Planned discharge period conditions are the same as MeHg loads that would be discharged under a 2030 Plausible discharge period scenario where all treatment facilities must meet a minimum treatment level of Secondary plus NDN or Tertiary plus NDN should be rejected (with a 95 percent confidence level). In other words, the application of additional regulatory requirements for SPG Facilities to achieve a Secondary plus NDN or Tertiary Plus NDN treatment levels will provide a significant reduction in MeHg loads beyond what is expected to occur. However, it must be stated that regardless of its “significance,” the magnitude of the load reduction that would occur under the Plausible B and Plausible C scenarios is very small (<2g/yr) – particularly when considering that the overall loads within the MeHg TMDL Project Area exceed 4,800 g/yr. Therefore, any consideration of the benefits associated with the application of a minimum Secondary plus NDN or Tertiary Plus NDN treatment level must also account for the expense that would be associated with requiring such treatment levels.

It is also important to note that the hypothesis that the MeHg loads discharged under the 2030 Planned discharge period are the same as MeHg loads that would be discharged under the 2030 Plausible discharge period scenario where all treatment facilities must meet a minimum treatment level of Secondary plus NDN or Tertiary plus NDN would *not* be rejected if the confidence level is increased to 97 percent. In other words, if a higher confidence level is applied, it cannot be shown that the application of additional regulatory requirements for all SPG Facilities to achieve a Secondary plus NDN or Tertiary Plus NDN treatment level would provide a statistically significant reduction in MeHg loads beyond what is expected to occur.

Finally, as noted previously, the differences between the loads discharged under the Secondary plus NDN and Tertiary plus NDN is insignificant. This further demonstrates that the application of NDN treatment (regardless of filtration) is a more important factor than filtration with respect to control of MeHg discharges from municipal wastewater treatment facilities.

5.4 Study Objective 3

Objective 3 involves determining whether variances in influent MeHg concentrations result in the same variation in effluent MeHg concentrations at facilities that provide different treatment levels (Secondary Only, Secondary plus N, Secondary plus NDN, Tertiary plus NDN). Variance measures how far a set of values is spread out. (A variance of zero indicates that all the values are identical.) If the variance of the influent concentration data is the same as the variance of the effluent concentration data, this would suggest that the treatment had no effect on the concentrations.

5.4.1 Methodology

The null hypotheses were tested by comparing the variances observed in the influent and effluent data (i.e., data that have been collected on the same day) for SPG Facilities that provide the treatment level being considered to determine if a statistically significant difference in variances was demonstrated. The Brown-Forsythe test was used to compare the variances observed in the influent and effluent data to determine if they are statistically the same with a 95 percent confidence level. F-statistics were calculated for the two data sets and used to determine if the variations in the samples sets are considered to be the same by comparing these F-statistics to the F-critical value, as follows:

- F-statistic > 3.9 (F-critical, 95 percent confidence) → reject the hypothesis that the variances are the same (*i.e.*, there is a statistical difference in variances)
- F-statistic ≤ 3.9 (F-critical, 95 percent confidence) → accept that the variances are the same (*i.e.*, there is not a statistical difference in variances)

Moreover, a higher the F-statistic value indicates a higher significance of the difference between the influent data variance and the effluent data variance – thus indicating a stronger influence of the treatment being applied.

5.4.2 Hypothesis Testing Results

A summary of the F-statistic values calculated for each of the Brown-Forsythe tests described above is provided in **Table 13**. As shown, all of the F-statistic values are greater than the F-critical value; therefore, the null hypothesis that the influent and effluent variances are equal should be rejected for all treatment levels evaluated. However, the F-statistic values increase with increasing treatment level, suggesting that increased treatment level further reduces the relationship between the influent and effluent variances. Indeed, the Brown-Forsythe test would fail to reject the null hypothesis that the variances between the influent and effluent data are equal for Secondary Only facilities if the confidence level was set at 99.98 percent. (The F-critical value for a 99.98 percent confidence level is 9.6.)

Table 13. Statistical Comparison of Influent/Effluent Variances at Different Treatment Levels

Treatment Level	Statistical Results		Conclusion
	F-Statistic	F-Critical, 95%	
Secondary Only	9.6	3.9	Reject the null hypothesis. Variances are not the same.
Secondary plus N	42		Reject the null hypothesis. Variances are not the same.
Secondary plus NDN	127		Reject the null hypothesis. Variances are not the same.
Tertiary plus NDN	296		Reject the null hypothesis. Variances are not the same.

5.4.3 Hypothesis Testing Conclusions

The hypothesis that the influent and effluent variances are equal should be rejected for all treatment levels evaluated. In other words, all treatment levels evaluated provide some removal such that the influent and effluent data cannot be considered to be the same.

It is important to note, however, that the relationship between the influent and effluent variances decreases with increasing treatment level. In other words, increasing the treatment level beyond the Secondary Only treatment level increases the differences in the variances between the influent and effluent data, suggesting that at higher treatment levels the influent has less of an influence on the effluent data. Thus, at higher treatment levels reducing influent concentrations is less likely to result in a change in effluent concentrations.

6.0 COMPLIANCE PLAN

This section presents a summary of the MeHg WLA compliance plan for the SPG Facilities. The topics addressed are as follows:

- WLA Achievement Summary
- Relationship to Overall MeHg TMDL Project Area MeHg Compliance Strategy
- WLA Compliance Costs
- Potential Redirected Impacts
- Potential Impacts of Changing Conditions

6.1 WLA Achievement Summary

As shown in **Table 9**, MeHg WLA requirements have already been achieved under the Current discharge condition when all SPG Facilities are considered as a whole. Moreover, the MeHg loads are projected to *decrease* relative to the Current discharge conditions under both the 2030 Planned and Design Capacity discharge conditions. Under the 2030 Planned condition, annual average discharge loads are expected to be approximately 6.2 grams per year, which is equivalent to approximately ½ of a teaspoon of MeHg discharged to the MeHg TMDL Project Area each year. This load is expected to increase to by approximately 40 percent (to 8.7 grams per year) under the Design Capacity conditions. Therefore, the WLA requirements will be satisfied when all of the SPG Facilities are considered as a whole under both of these two anticipated conditions.

A comparison of the individual SPG Facility MeHg WLA to the MeHg loads for the Current, 2030 Planned, and Design Capacity discharge periods is provided in **Table B-8** of **Appendix B**. As shown, all of the SPG Facilities effluent loads under Current and 2030 Planned discharge conditions are expected to be lower than their individual WLA requirements. In addition, each SPG Facility is projected to meet individual WLA requirements under Design Capacity discharge conditions, with the only exception being the Rio Vista Beach facility. However, as discussed in the paragraphs below, the Rio Vista Beach facility could meet its WLA if the allocation is adjusted to allow for growth in accordance with the procedures identified in the TMDL Staff Report. In addition, any increase in load allowed for the Rio Vista Beach facility is significantly offset by the reductions in loads provided by the other SPG Facility discharger within the Central Delta Subarea.

The Delta MeHg Control Program provides for a 120 percent increase in MeHg loads from NPDES Facilities to allow for population growth in the region (where a portion of this increase has already been assigned to Brentwood, Rio Vista Northwest and City of Woodland). The TMDL Staff Reports states that new NPDES Facilities would be allotted a portion of the unassigned allocation for the MeHg TMDL Project Area hydrologic Subarea where their discharges are located, and that “new” facilities could include:

- Newly built facilities that have not previously discharged to land or water,
- Existing facilities that previously discharged to land that begin to discharge to surface water, and/or
- Existing facilities that start to receive flow that was previously sent to another facility as part of a regionalization effort.

Existing facilities that do not satisfy the criteria above also may be allotted a portion of the unassigned allocations in the Subareas where they discharge if they expand beyond their allocations listed in Table 8.4 of the TMDL Staff Report *so long as the additional allocation does not exceed the product of the net increase in flow volume and 0.06 ng/l methylmercury*. In addition, the sum of all new and/or expanded methylmercury discharges from NPDES Facilities within each MeHg TMDL Project Area Subarea must not exceed the MeHg TMDL Project Area Subarea-specific WLA listed for NPDES Facilities. This allocation approach was determined to be fair and equitable as a part of the stakeholder process conducted during the TMDL development period.

In the WLA calculation procedure defined in the TMDL Staff Report, the Rio Vista Beach facility is assumed to have an average flow of 0.47 mgd. Under the Design Capacity discharge period conditions, the Rio Vista Beach facility flow would be 0.65 mgd. Therefore, assuming a concentration of 0.06 ng/l, the Rio Vista Beach facility’s WLA may be increased by an additional 0.015 g/year. With this increase, the total WLA for the Rio Vista Beach facility would be 0.073 g/year, which is higher than the predicted Design Capacity discharge period MeHg effluent load of 0.068 g/year. The recommended increase in the assigned WLA to the Rio Vista Beach facility represents approximately 2 percent of the 8.5 g/year unassigned NPDES Facility allocation for the Sacramento River Subarea shown in Table 8.4 of the TMDL Staff Report.

6.2 Relationship to Overall MeHg TMDL Project Area MeHg Compliance Strategy

This section evaluates the implications of the SPG Facility control strategy on the overall MeHg TMDL Project Area loading conditions through comparison with MeHg contributions from all MeHg TMDL Project Area sources.

6.2.1 Relationship to Other NPDES Facility Dischargers

The SPG Facilities represent all of the municipal wastewater treatment facilities (or municipal wastewater treatment NPDES Facilities) that have been assigned WLAs under the Delta MeHg Control Program, with the exception of the Deuel Vocational Institute WWTP. Deuel Vocational Institute WWTP provides a Tertiary plus NDN treatment level and has a permitted ADWF design capacity of 0.62 mgd. This flow constitutes 0.19 percent of the total Design Capacity flow rate capacity for SPG Facilities within the MeHg TMDL Project Area. Assuming the average effluent MeHg concentration of 0.012 ng/L calculated under this MeHg Control Study for Tertiary plus NDN Facilities (see Table 3), the total load contribution from the Deuel Vocational Institute WWTP, the overall MeHg load contribution from this facility is expected to be approximately 0.01 g/year, a small fraction of the overall load from the SPG Facilities.

6.2.2 Relationship to Other MeHg TMDL Project Area Methylmercury Sources

As indicated by Table 8.5 in the TMDL Staff Report, NPDES Facilities are responsible for approximately four percent of the total MeHg load entering the MeHg TMDL Project Area. Given the low percentage of the MeHg loads from NPDES Facilities as compared to overall loads, it is prudent to consider the potential reductions in total MeHg loads discharged to the MeHg TMDL Project Area that would occur under the discharge periods discussed above. To provide this analysis, graphs were developed comparing the overall MeHg loading to the MeHg TMDL Project Area from all sources in 2004 to 2005 (As provided in Table 8.5 of the TMDL Staff Report) given the following potential NPDES Facility discharge conditions: the calculated WLA, Current discharge period, 2030 Planned discharge period, and the three 2030 Plausible discharge period scenarios. Similar graphs were developed for each MeHg TMDL Project Area Subarea identified under the Delta MeHg Control Program.

A comparison of the NPDES Facilities MeHg loads to the overall MeHg loads discharged within the MeHg TMDL Project Area is shown on **Figure 17** through **Figure 23**, as follows:

- **Figure 17**: Comparison of Entire MeHg TMDL Project Area MeHg Loads
- **Figure 18**: Comparison of Central MeHg TMDL Project Area Subarea MeHg Loads for Varying SPG Facility Scenarios
- **Figure 19**: Comparison of Marsh Creek Subarea MeHg Loads for Varying SPG Facility Scenarios
- **Figure 20**: Comparison of Sacramento Subarea MeHg Loads for Varying SPG Facility Scenarios
- **Figure 21**: Comparison of San Joaquin Subarea MeHg Loads for Varying SPG Facility Scenarios

- **Figure 22**: Comparison of West MeHg TMDL Project Area Subarea MeHg Loads for Varying SPG Facility Scenarios
- **Figure 23**: Comparison of Yolo Subarea MeHg Loads for Varying SPG Facility Scenarios

For the loading analysis presented in the above-listed figures, MeHg loads for the non-NPDES Facility source categories were assumed to remain the same as the 2004-2005 levels identified in the TMDL Staff Report under all future discharge conditions. The information provided on these figures further demonstrates that additional control methods (beyond the controls anticipated for the 2030 Planned discharge period) would not measurably reduce overall MeHg loads to the MeHg TMDL Project Area.

6.3 WLA Compliance Costs

As discussed in Section 2.4 of this Progress Report, eight SPG Facilities have provided (or will provide) upgrades to achieve a Tertiary plus NDN treatment level since the 2004-2005 period. These eight facilities represent approximately 78 percent of the total annual flow that would be discharged by all of the SPG Facilities at their design capacities, and 95 percent of the total annual flow that would discharged by the all of SPG Facilities within the MeHg TMDL Project Area at their design capacities.

The improvements that have been, or will be, completed would not result directly from the need to comply with the MeHg WLA. Therefore, this MeHg Control Study does not provide a detailed evaluation of the costs that are assumed to be associated with the 2030 Planned discharge scenario. Nevertheless, the costs expended by the eight facilities that have upgraded (or are expected to upgrade) to provide nitrification, denitrification and filtration is estimated to range between $2.7 and $3.2 billion. This estimated range of costs for the improvements completed to provide a Tertiary plus NDN treatment level at eight of the SPG Facilities is based on the application of following assumptions:

- An estimated cost of $7.4 per gallon of ADWF capacity, which was calculated for the *Wastewater Control Measures Study* (West Yost, 2011) using actual or estimated per gallon costs for twelve known nitrification, denitrification and filtration upgrade projects) to seven of the eight facilities,
- An estimated cost of $1.8 billion for the Regional San WWTP upgrade that is currently underway, and
- Applying a potential 20 percent estimating contingency to calculate the upper end of the range.

6.4 Potential Redirected Impacts

The potential redirected impacts associated with the control strategies evaluated to date under the MeHg Control Study are increased energy usage and potential for cross-media impacts.

6.4.1 Increased Energy Usage

There is a significant amount of energy used for wastewater treatment, including the energy required to construct facilities, operate facilities and produce and deliver materials and supplies for operations. The addition of the nitrification, and to a lesser extent denitrification and filtration, would significantly increase the overall energy demand from wastewater dischargers in the MeHg TMDL Project Area (as well as increase the associated greenhouse gas emissions from the power plants providing the electricity).

For example, nitrification, denitrification and filtration technologies require an input of energy beyond that needed for conventional municipal treatment for processes such as:

- Additional aeration demand for nitrification,
- Additional pumping for internal recycle flows (often required for denitrification),
- Additional pumping for filtration, and
- Potential chemical addition facilities operations, including the energy needed to generate the chemicals associated with chemical addition.

6.4.2 Cross Media Impacts

Cross media transfer (i.e. the removal of a pollutant from one medium and its transfer to one or more other media) associated with the control strategies evaluated involve a potential increase in Hg levels in the biosolids that are generated at the SPG Facilities. Specifically, Hg that is removed from wastewater entering the SPG Facilities is transferred into the biosolids generated from these facilities. However, because Hg levels entering the SPG Facilities are not expected to be elevated with respect to a typical municipal wastewater (as the sources of Hg in the MeHg TMDL Project Area are predominantly attributable to natural, legacy, and external sources), the Hg in the biosolids produced at the SPG Facilities are also not expected to be elevated above typical levels. The fate of these biosolids varies for each SPG Facility and the disposal practices include: land application on agricultural properties; disposal in landfills (often used as alternative daily cover); subsurface injection on dedicated land disposal sites; composting with other materials for use as a soil amendment; and recycling into a dry, pelletized fertilizer and sold commercially.

The USEPA established regulations governing the use/disposal of biosolids in 1993 in the Code of Federal Regulations, Title 40 (Part 503), under Section 405 (d). As part of the USEPA's regulation strategy, appropriate biosolids Hg concentration and loading limits for land application that adequately protect human health and the environment were determined (National Research Council, 2002). The USEPA developed these limitations through an extensive risk-assessment approach and was developed such that "the repeated application of biosolids in accordance with the regulations will not result in land becoming unsuitable for any existing or future use" (USEPA).

The USEPA has also conducted extensive research over many years on the fate of land applied metals in biosolids. This research has indicated that unless soils are extremely acidic (pH<5.5) trace metals in biosolids strongly adsorb or cling to soil and organic matter that is present in native soils (USEPA). Furthermore, this metal-binding capacity of soils that have been mixed with biosolids has been shown to last for decades after biosolids application has ceased (USEPA). Thus, increased concentrations of Hg in stormwater runoff from sites that have applied biosolids is not likely as long as Hg loadings are within the acceptable ranges identified by the USEPA.

6.5 Potential Impacts of Changing Conditions

Two factors have been identified that may impact long-term MeHg WLA compliance: more stringent nutrient removal requirements, and impacts due to drought and/or high inflows. These factors are discussed below.

6.5.1 More Stringent Nutrient Removal Requirements

As discussed in Section 2.3, the SPG Facilities that provide nitrification maintain the wastewater under aerobic conditions for longer periods than treatment plants that do not provide nitrification, and these aerobic conditions can support the oxidative demethylation process. In addition, the denitrification process that occur in the SPG Facility treatment plants generally take place under anoxic conditions, where the presence of nitrate inhibits competition from the sulfur and iron reducing bacteria that are known to contribute to mercury methylation.

However, if more stringent nitrogen limitations are applied to the SPG Facilities such that all of the nitrate must be removed from the wastewater, an anaerobic process would need to be located at the tail end of the treatment train (i.e. at some point after the ammonia has been converted to nitrate in a nitrification processes). Under this treatment scenario, the activity of the sulfur and iron reducing bacteria would no longer be inhibited by the presence of nitrate in the anaerobic zones – potentially resulting in increased mercury methylation.

Similarly, biological phosphorus removal involves placing an anaerobic process at the head of a treatment plant's biological process. To encourage anaerobic conditions, nitrate-laden wastewater is not allowed to enter this zone. Therefore, sulfur and iron reducing bacteria present in this anaerobic zone could result in increased methylation. Nevertheless, because the anaerobic zone would be followed by an aerated zone that is operating to achieve nitrification, it is possible that the methylated mercury could be de-methylated through oxidative demethylation processes that occur in the aerated biological reactors downstream of the anaerobic process area.

6.5.2 Drought and Water Conservation Effects

The data used for this MeHg Control Study to describe the Current discharge period has all been collected during a period of relative to extreme drought in the MeHg TMDL Project Area region (i.e. October 2009 through September 2014). As noted previously, this has resulted in decreased flows being discharged to the SPG Facilities. However, because Hg and MeHg sources are not expected to be impacted by drought conditions, it is likely that the decreased flows have resulted in increased Hg and MeHg concentrations entering the SPG Facilities during the "Current" discharge period.

As documented herein, the influent MeHg concentrations are not shown to be highly correlated to effluent MeHg concentrations. Moreover, as documented in the Mercury Data Summary Technical Memorandum provided as **Appendix E**, there is little-to-no correlation between influent and effluent Hg concentrations collected for this MeHg Control Study. Nevertheless, the impacts of the drought conditions should be investigated, by comparing wet-year to dry-year data, if possible.

7.0 POTENTIAL ADDITIONAL SPG EVALUATIONS

Two additional assessments are being considered to further characterize the impacts of the following two changing conditions discussed in the previous section: more stringent nutrient removal requirements and drought impacts. These potential efforts are further described below. Data and results from these assessments would be described in the MeHg Control Study Final Report that is due October 20, 2018. In addition to the two potential studies described below, the total Hg data presented in Appendix E of the Progress Report may be further evaluated to provide additional information regarding the relationships between the removal of Hg and MeHg at POTWs.

7.1 Evaluation of Treatment Plants with More Stringent Nitrogen Removal Requirements

The MeHg SPG is considering funding a Hg and MeHg sampling study at four biological nutrient removal treatment plants in the Tampa Bay, Florida Region, which treat influent total nitrogen (TN) to low levels (less than 3 mg/L as N). The goal of the sampling would be to understand the impact of TN removal pm low levels on Hg and MeHg speciation, which addresses the potential impact identified in Section 6.5.1.

Four treatment plants in the Tampa Bay Region with differing process configurations have been identified. All of these WWTPs have an effluent permitted TN concentration of less than 3 mg/L on an annual average basis, and typically have effluent TN concentrations of between 2 and 3 mg/L on average. All of the WWTPs have industrial pretreatment programs and municipal flow makes up the large majority of flow to the plants.

Sampling for Hg and MeHg would follow the "clean hands/dirty hands" protocols, and samples would be analyzed at the Eurofins Frontier Global Sciences Laboratory in Bothell, Washington, which is the same laboratory used by many of the SPG Facilities. (See the Control Study Work Plan, **Appendix A,** for additional information regarding this laboratory.) There would be five separate sampling events for each treatment plant being evaluated, with each sampling event separated by one month. Hg and MeHg grab samples would be collected from influent and effluent locations at each wastewater treatment facility.

One field blank and one field duplicate sample would also be collected per month (five total) also using the "clean hands/dirty hands" technique, and a field blank and field duplicate would be taken at least once from each treatment plant.

WWTP operations staff would collect their usual composite samples of the plant effluent on the morning of sample collection for this study. Additional wastewater would be collected, as needed, to provide sufficient samples for the following parameters:

- Total Suspended Solids
- Dissolved Organic Carbon
- Nitrate
- Total Kjeldahl Nitrogen
- Total Phosphorus

These data would be used to confirm plant performance during the study period.

7.2 Evaluation of Drought Impacts

The potential for impacts on influent and effluent Hg and MeHg concentrations associated with the drought conditions could be evaluated using data collected under the SPG Facility NPDES monitoring programs. Specifically, data collected under the SPG Facility NPDES monitoring programs between October 2014 and September 2017 could be compared to the data presented in this Progress Report to determine if there are changes in influent or effluent Hg and MeHg levels that may be associated with the current drought conditions. Should drought conditions continue, water conservation efforts are likely to increase, and influent Hg and MeHg concentrations would likely rise. Conversely, if the drought conditions subside, water conservation efforts may be reduced, and the Hg and MeHg concentrations in the wastewater influent could decrease. Data representing varying rainfall periods could be compared statistically to determine if there are differences in either influent or effluent Hg/MeHg concentrations that may be attributable to these changing climatic conditions.

8.0 RECOMMENDED MEHG TMDL PROJECT AREA-WIDE ASSESSMENTS

In addition to the SPG-specific evaluations that are planned over the next three year period as described in Section 7.0, there are several other collaborative, MeHg TMDL Project Area-wide assessments/efforts that may provide additional, valuable knowledge for the Delta MeHg Control Program. These key efforts, described below, are consistent with the Guiding Principles developed by stakeholders during the development of the Delta MeHg Control Program. To the extent that the MeHg SPG participates in these efforts, the corresponding data and results will be described in the MeHg Control Study Final Report that is due October 20, 2018.

8.1 Open Water Workgroup – TMDL Project Area-Wide Mercury Modeling

The Delta MeHg Control Program's open water WLAs apply to MeHg load fluxes from the sediment to the water column in both open water habitat in Delta channels and lands immersed by managed flood flows. The Open Water Workgroup, which consists of the California State Lands Commission, Central Valley Flood Protection Board, Department of Water Resources (DWR), US Army Corps of Engineers, and US Bureau of Reclamation, are participating in a collaborative effort to assess control strategies associated with MeHg load fluxes to the water column. The Open Water Workgroup is developing a modeling approach to test the impacts of different proposed operational scenarios (for example installation of an alternate conveyance or gating of Fremont Weir) on the predicted MeHg levels in target fish populations. The model will also be used to complete a sensitivity analyses to help understand the important processes governing MeHg production in the open waters of the MeHg TMDL Project Area.

The modeling approach involves enhancement of the DSM-2 hydrodynamic and water quality model by DWR to add a new mercury cycling sub-model based on the dynamic mercury cycling model (D-MCM). For the Yolo Bypass, D-MCM will be applied to simulate mercury cycling among sediment, water column, and food web compartments, with hydrodynamic input from the TUFLOW model. DWR expects that the modeling results will provide a qualitative understanding of the important factors affecting mercury cycling, identify likely trends in MeHg production under various scenarios, and identify key data and knowledge gaps.

Depending on how these models are developed and implemented, they could be useful for predicting the effectiveness of various integrated management scenario "bundles" in reducing MeHg concentrations in the MeHg TMDL Project Area's waters and fish. However, the complete model set is unlikely to be available to other stakeholders before October 2018. The MeHg SPG will continue to coordinate with the Open Water Workgroup to identify if there are opportunities for collaboration, such as developing input files for the different wastewater effluent scenarios described in this Progress Report.

8.2 Mercury Offsets Program

The Delta MeHg Control Program provides an opportunity for the development and adoption of a mercury/methylmercury offsets program. If there are dischargers who cannot meet their load or WLAs after implementing all reasonable load reduction strategies, such a program may be initiated. If an offset program is initiated, the MeHg SPG may identify opportunities for collaboration. The Regional Water Board will consider adoption of a mercury offset program on or before October 20, 2020.

8.3 Delta Regional Monitoring Program

Mercury in sediments, water, and fish in the MeHg TMDL Project Area's open waters has not been monitored in over a decade. Consequently, there are no new ambient data by which to assess the effects of reductions in MeHg loads, wetland restoration projects, the current drought, food web changes, and/or other potential drivers of MeHg cycling. The *Delta Regional Monitoring Program's (RMP) Monitoring Design Summary* (Aquatic Science Center, 2014) describes the initial monitoring design for four priority constituents: pathogens, current use pesticides, mercury, and nutrients. Each constituent's design summary includes assessment questions, study design elements, monitoring sites, example data products, and target parameters. As described in the *Delta Regional Monitoring Program FY 15-16 Detailed Workplan and Budget* (Aquatic Science Center, 2015), mercury will not be monitored in the 2015-2016 fiscal year. However, the Steering Committee and Technical Advisory Committee will reconsider its priorities for fiscal year 2016-2017. The MeHg SPG will continue to track the implementation of the Delta RMP and members will participate, as needed, to encourage ambient mercury monitoring.

8.4 Statewide Mercury Water Quality Control Program

State Water Board and Regional Water Board staffs are developing a statewide water quality control program for mercury that will include: 1) mercury control program for impaired reservoirs and other water bodies (separately); and 2) mercury fish tissue objectives. This program will address mercury sources in MeHg TMDL Project Area tributaries. Although the statewide mercury fish tissue objective will not apply directly to the MeHg TMDL Project Area, it may influence the water quality objectives within the MeHg TMDL Project Area. The MeHg SPG will continue to track and participate in the development of the statewide control program and fish tissue objectives, as appropriate.

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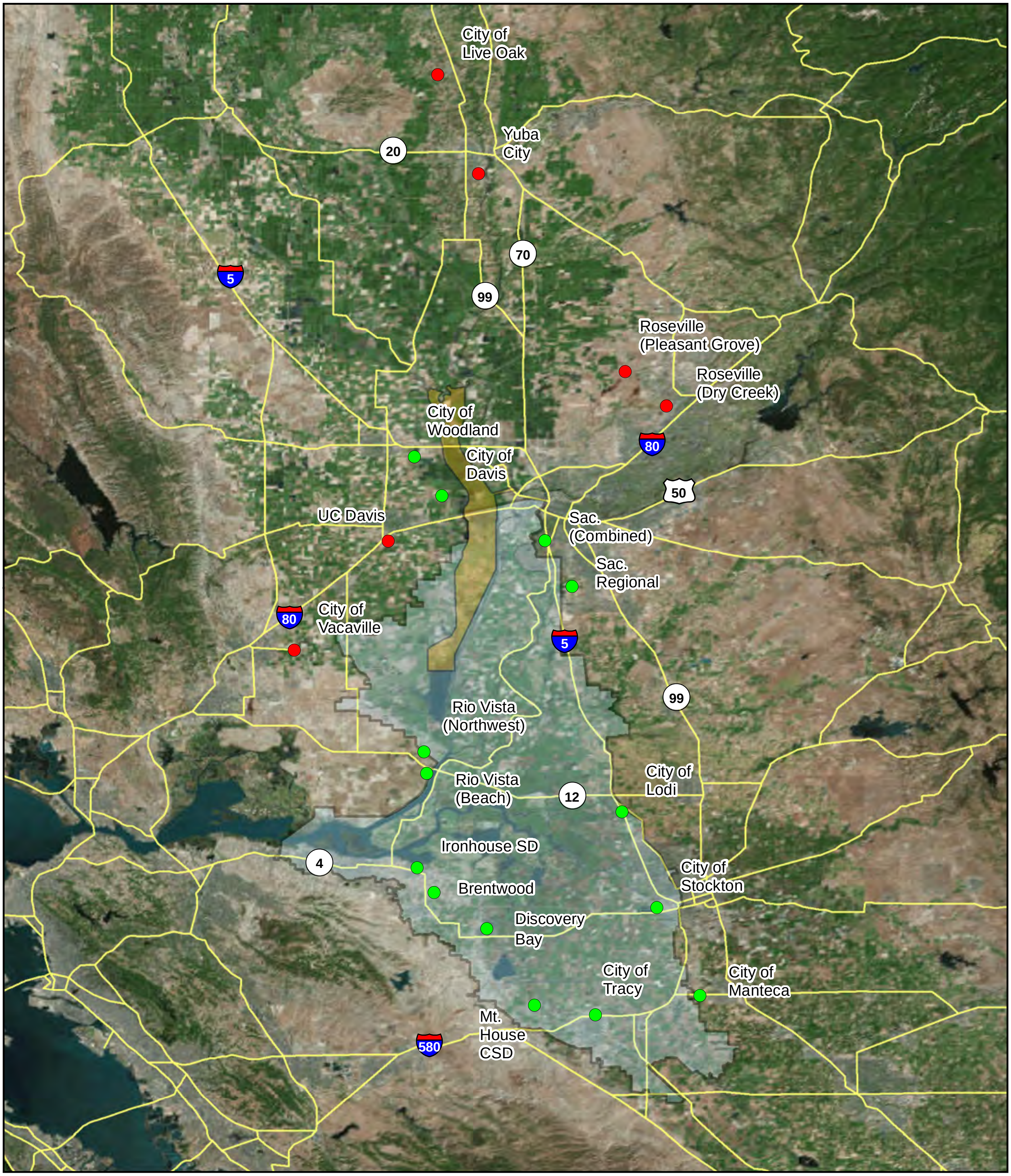


Located Outside of the MeHg TMDL Project Area

Located Within the MeHg TMDL Project Area

Yolo Bypass Boundary

Delta Boundary

N

0 40,000 80,000

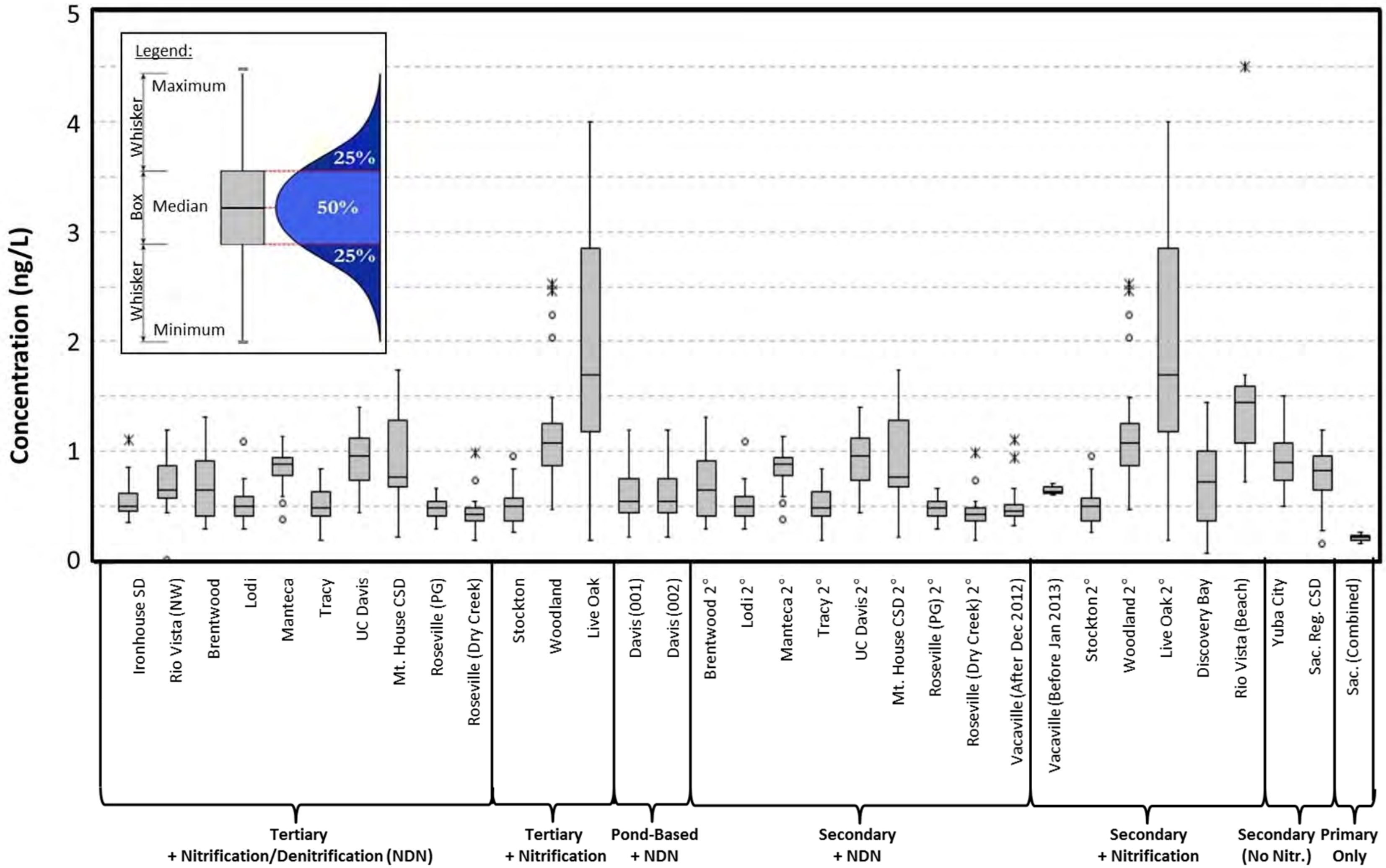
Feet

Notes:
1. City of Davis Discharge Location 001 is located outside of the Delta MeHg Control Program Area. City of Davis Discharge Location 002 is located within the Delta MeHg Control Program Area.

Figure 1

SPG Facility Location Map

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report



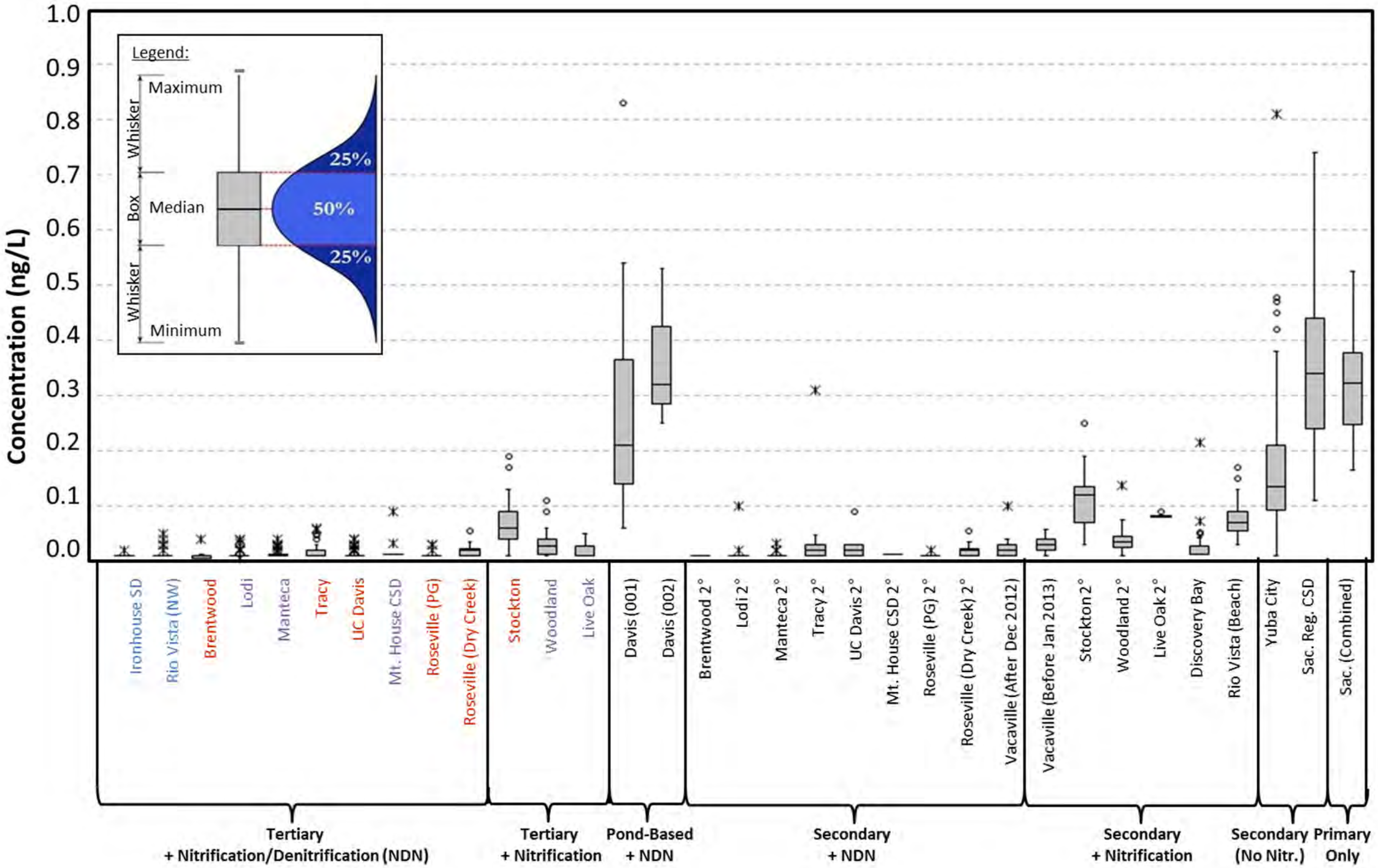
Notes:

1. Circles indicate possible outliers, which are outside the box by between 1.5 and 3 times the box size. Stars indicate probable outliers, which are outside the box by more than 3 times the box size.
2. Non-detect data is assumed to be equal to one half the reported method detection limit.
3. 2° refers to effluent sampled after secondary treatment and before tertiary treatment at a tertiary facility.

Figure 2

SPG Facility Influent MeHg Data Summary

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report



Notes:

1. City of Vacaville has the only nitrification facility with an anoxic selector.
2. City of Roseville's Dry Creek WWTP has an undersized anoxic selector for denitrification, limiting its denitrifying capacity.
3. Circles indicate possible outliers, which are outside the box by between 1.5 and 3 times the box size. Stars indicate probable outliers, which are outside the box by more than 3 times the box size.
4. Non-detect data is assumed to be equal to one half the reported method detection limit.
5. Filtration facilities are color-coded, as follows, to indicate the type of filtration media: Membranes, Granular Media Filtration, Cloth (UC Davis has primarily sand, but also a cloth filter.).
6. 2° refers to effluent sampled after secondary treatment and before tertiary treatment at a tertiary facility

Figure 3

SPG Facility Effluent MeHg Data Summary

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

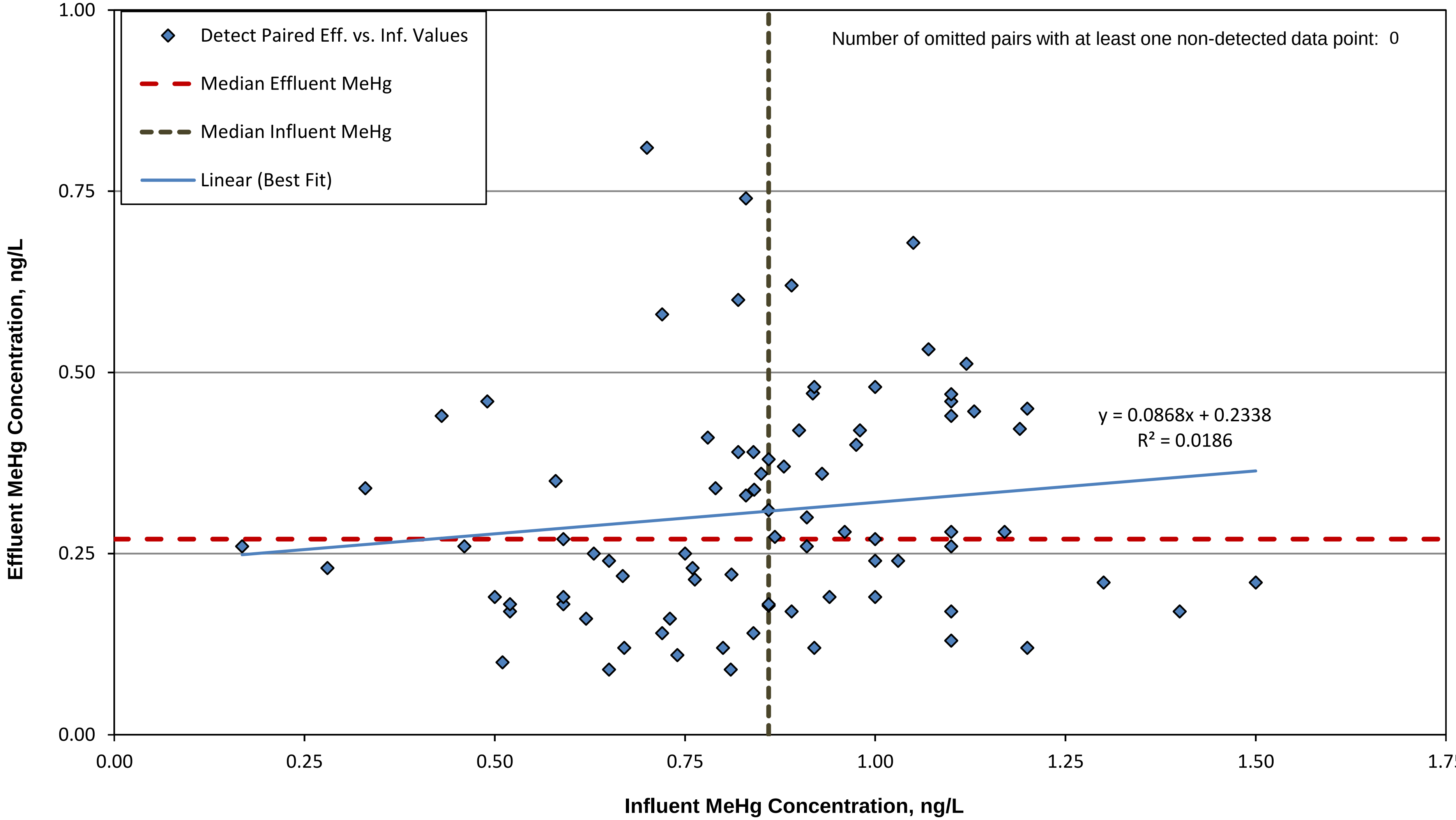


Figure 4

Comparison of Paired Influent vs. Effluent MeHg Concentrations for Secondary Only Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

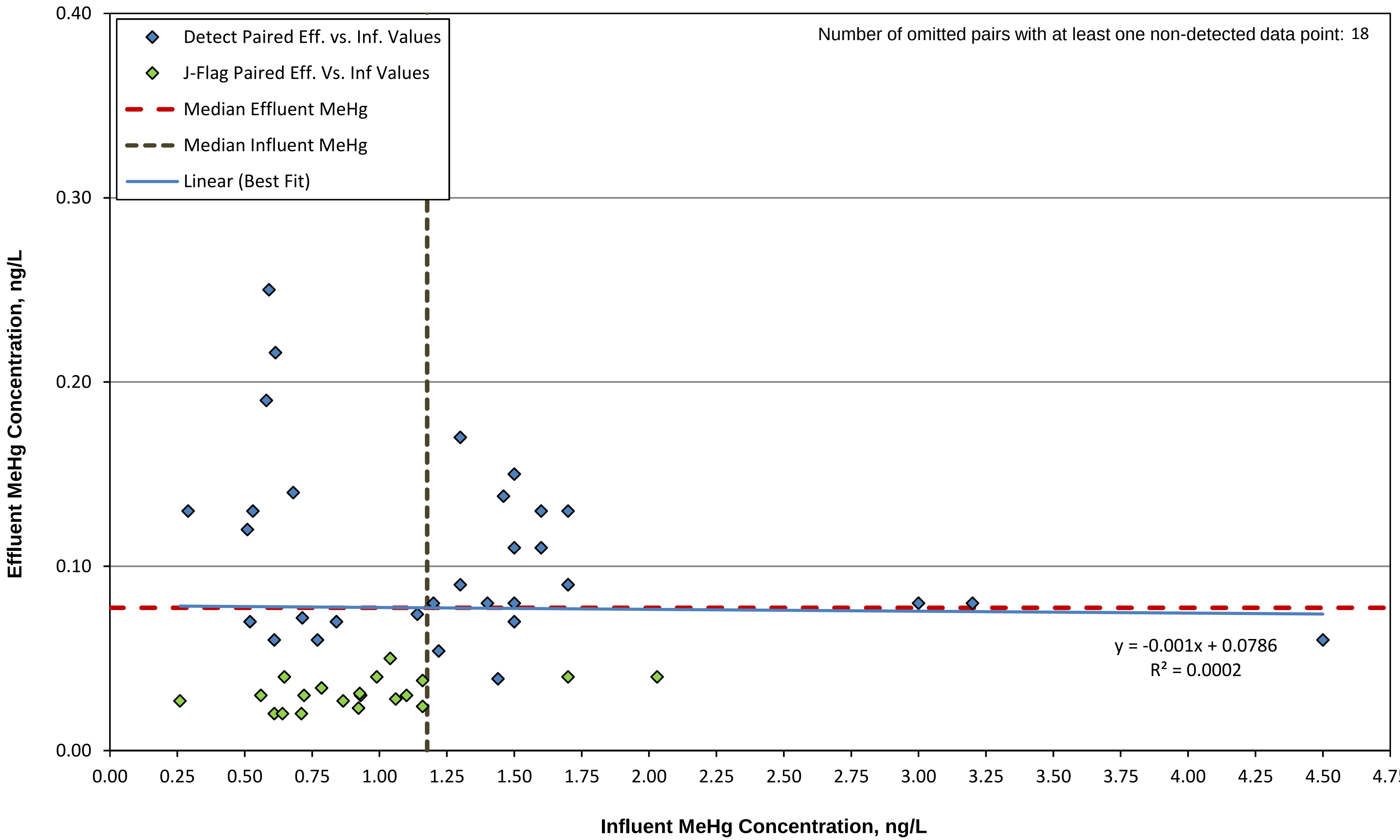


Figure 5

Comparison of Paired Influent vs. Effluent MeHg Concentrations for Secondary plus N Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

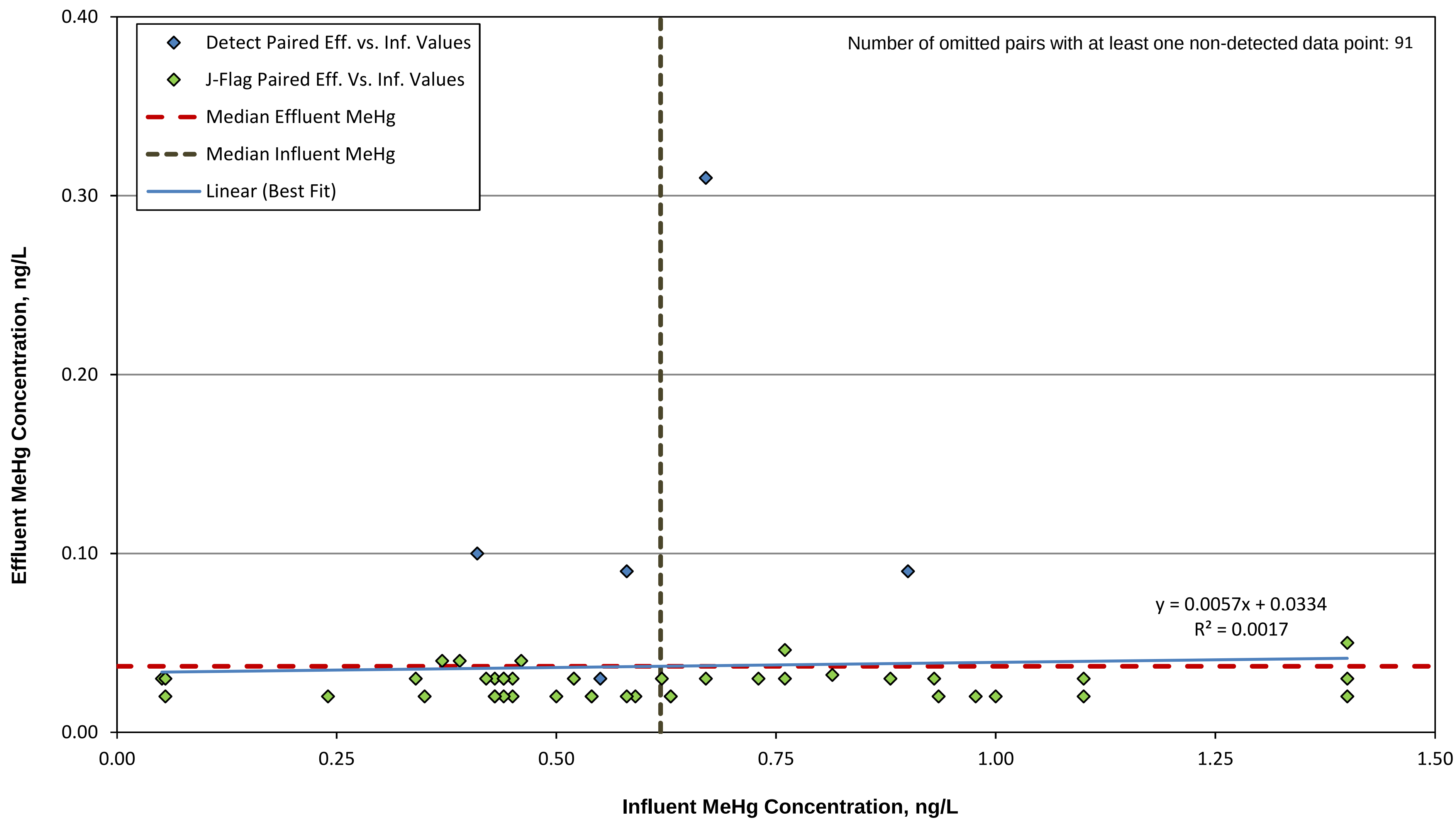


Figure 6

Comparison of Paired Influent vs. Effluent MeHg Concentrations for Secondary plus NDN Facilities

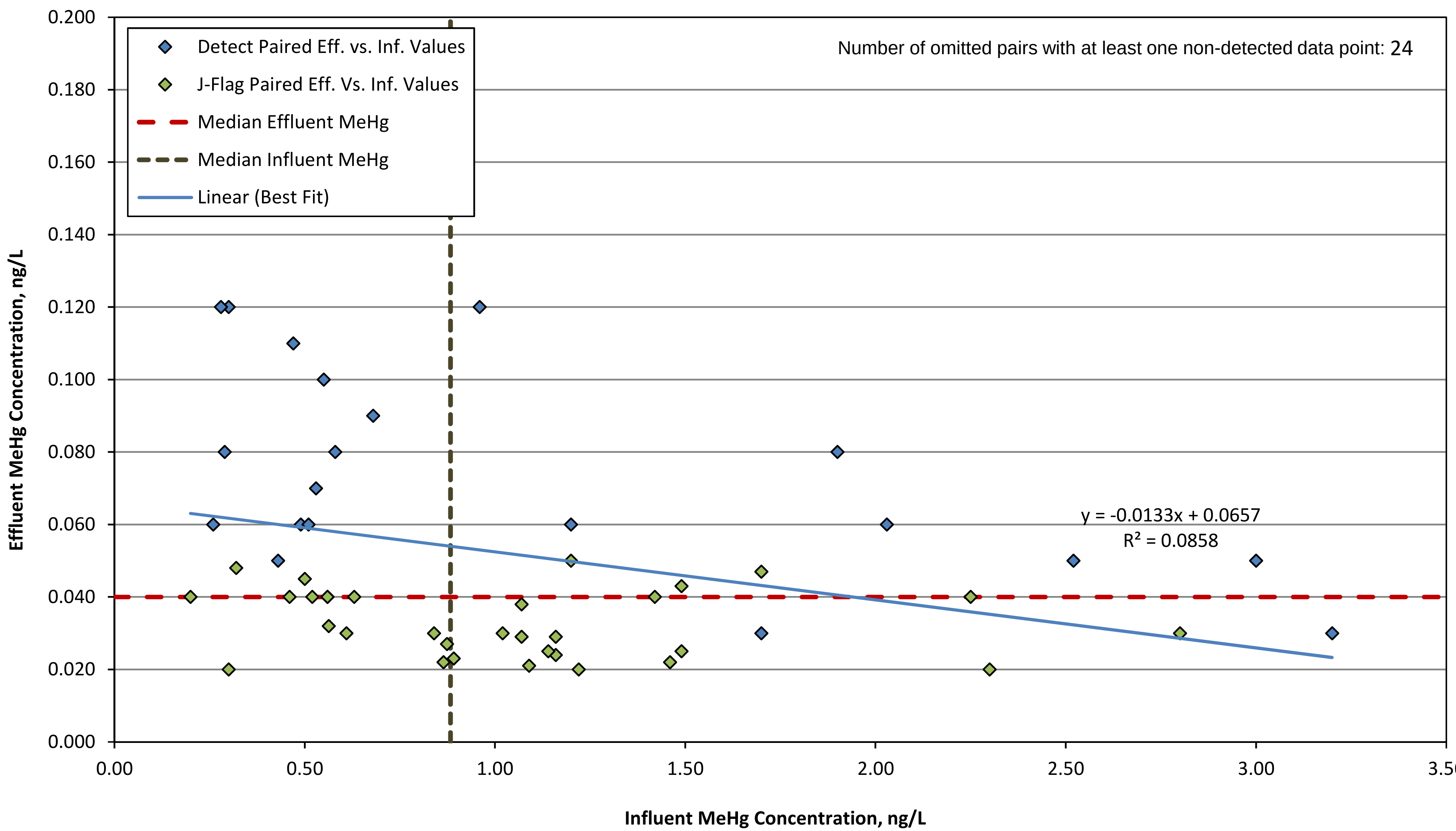


Figure 7

Comparison of Paired Influent vs. Effluent MeHg Concentrations for Tertiary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

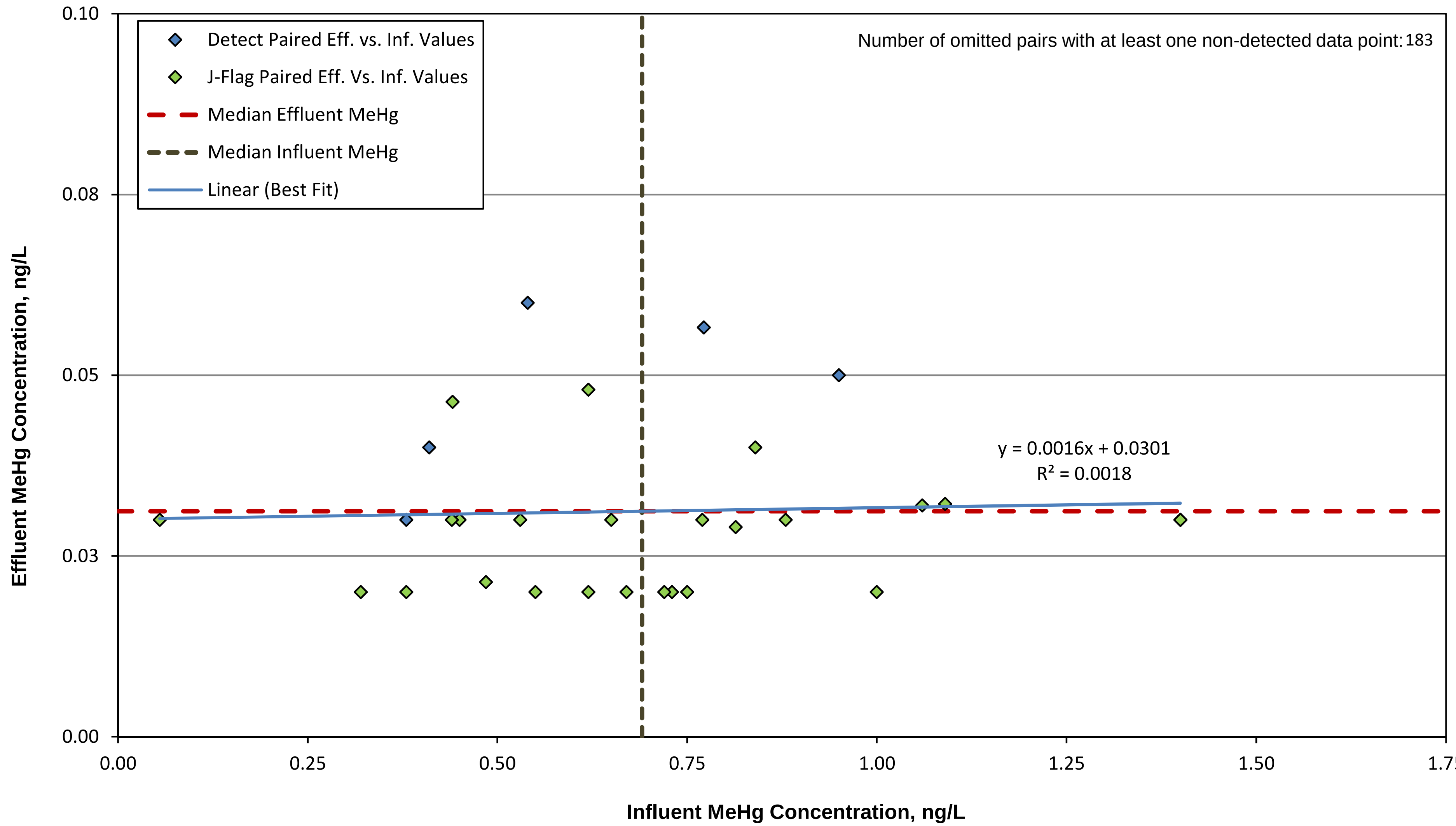


Figure 8

Comparison of Paired Influent vs. Effluent MeHg Concentrations for Tertiary plus NDN Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

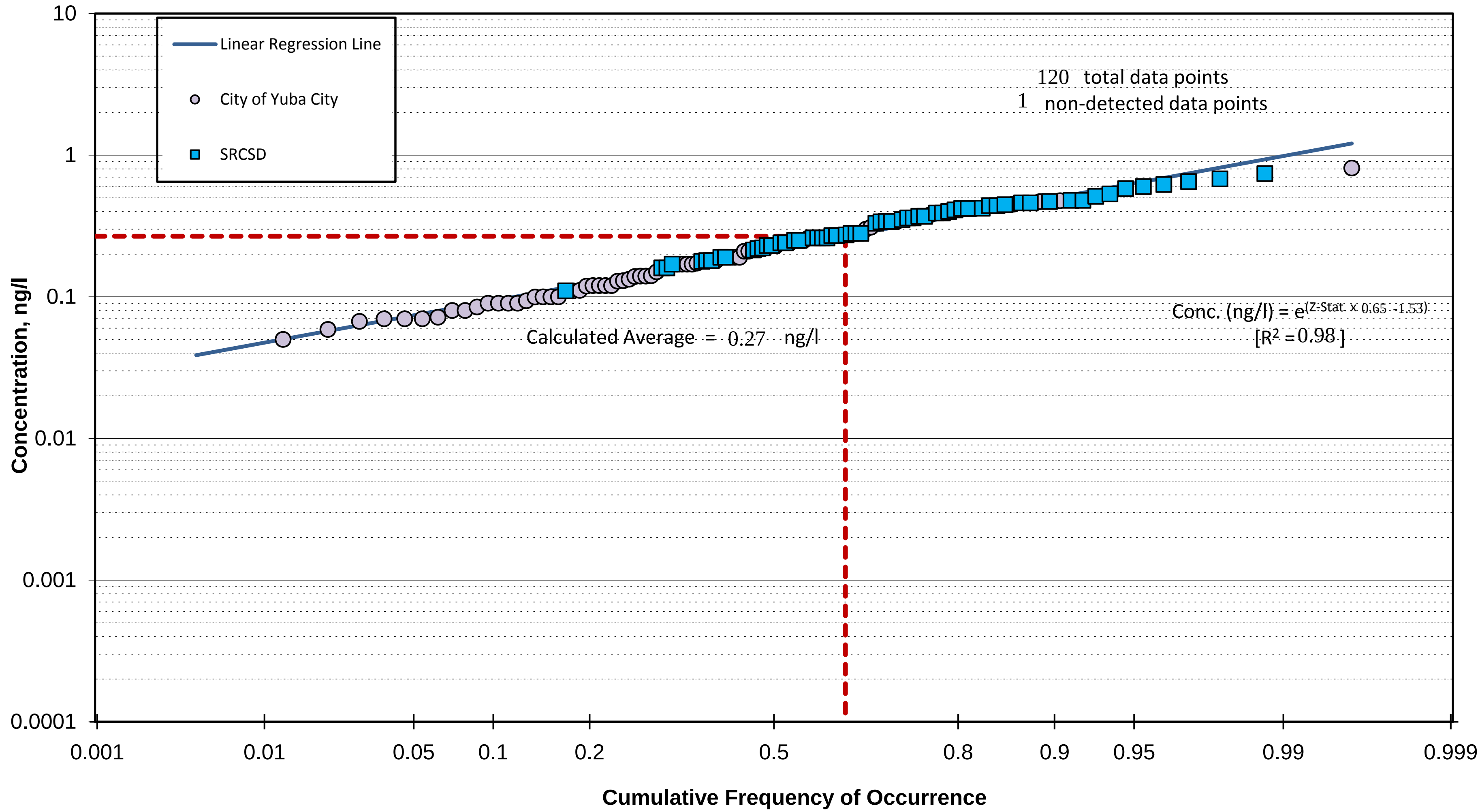


Figure 9

MeHg Concentration Probability Plot for Secondary Only Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

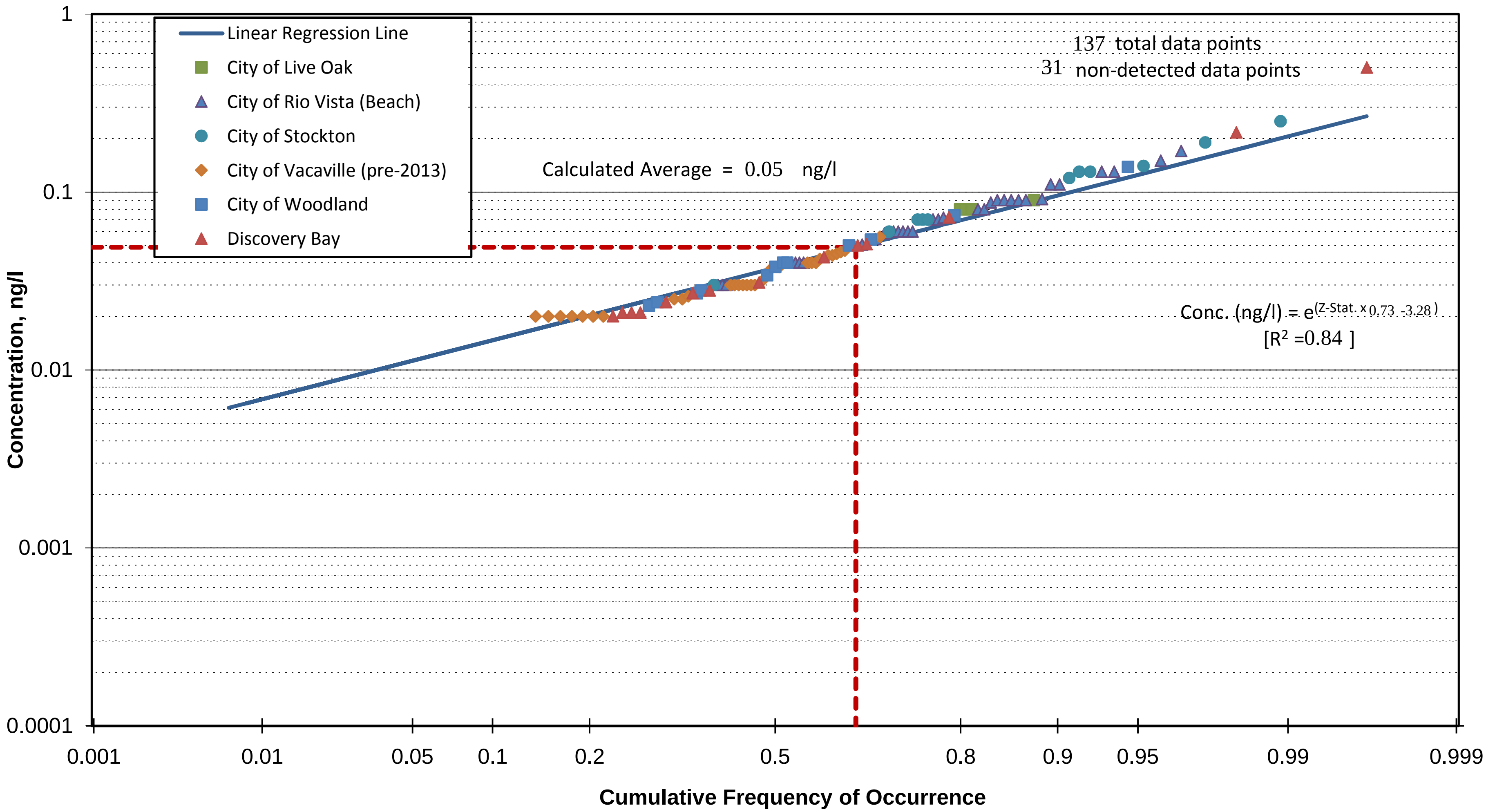


Figure 10

MeHg Concentration Probability Plot for Secondary plus N Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

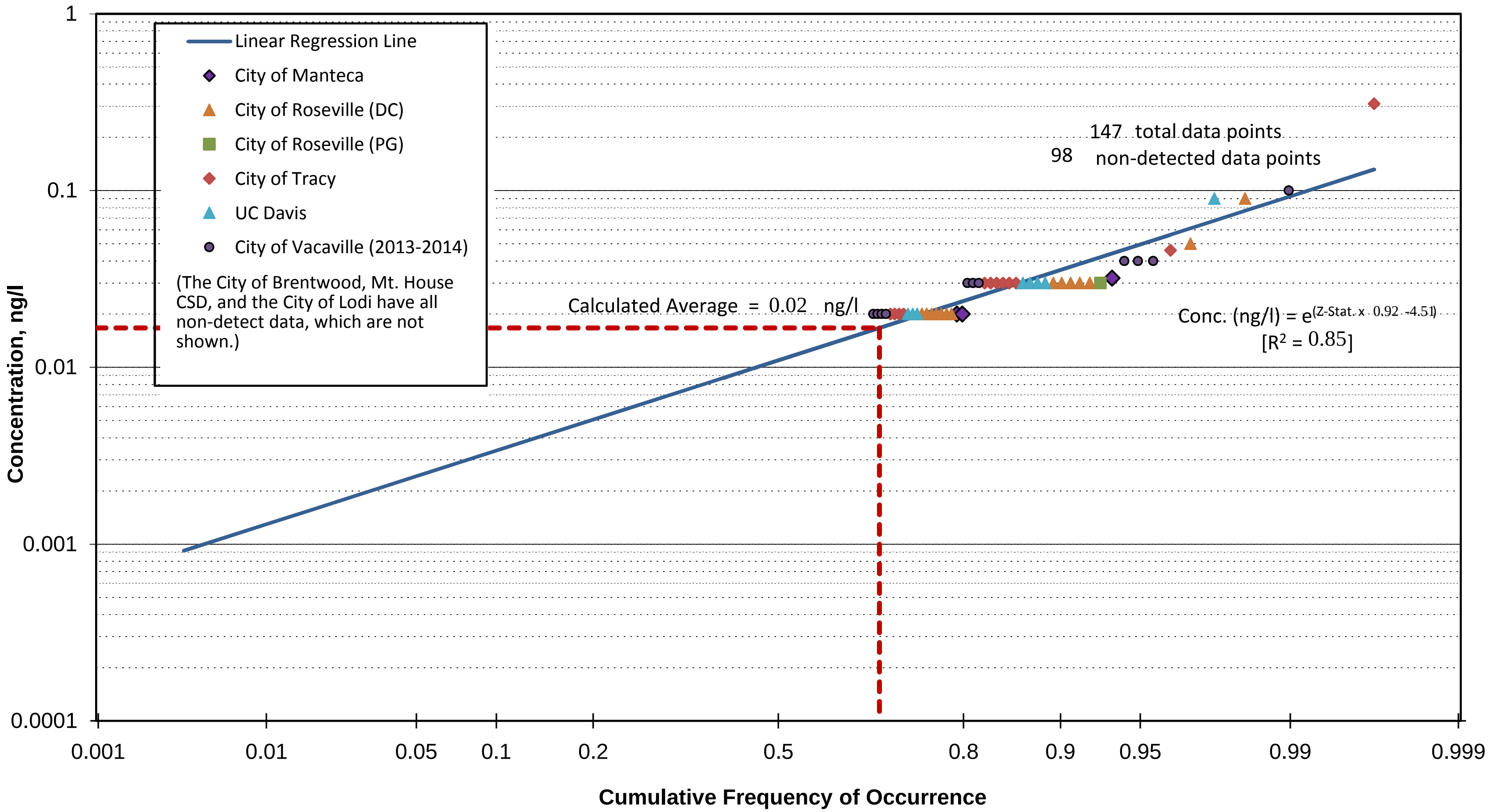


Figure 11

MeHg Concentration Probability Plot for Secondary plus NDN Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

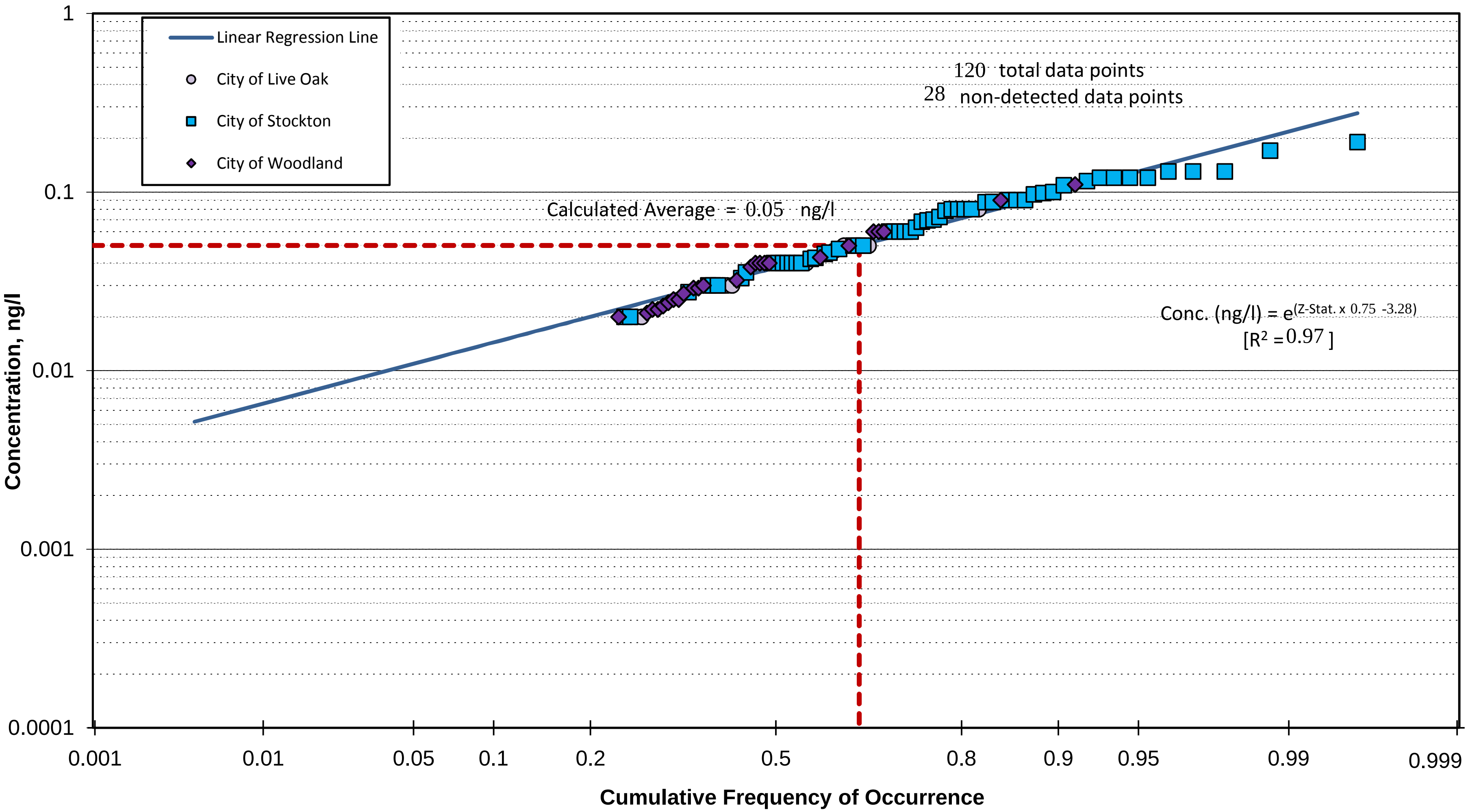


Figure 12

MeHg Concentration Probability Plot for Tertiary plus N Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

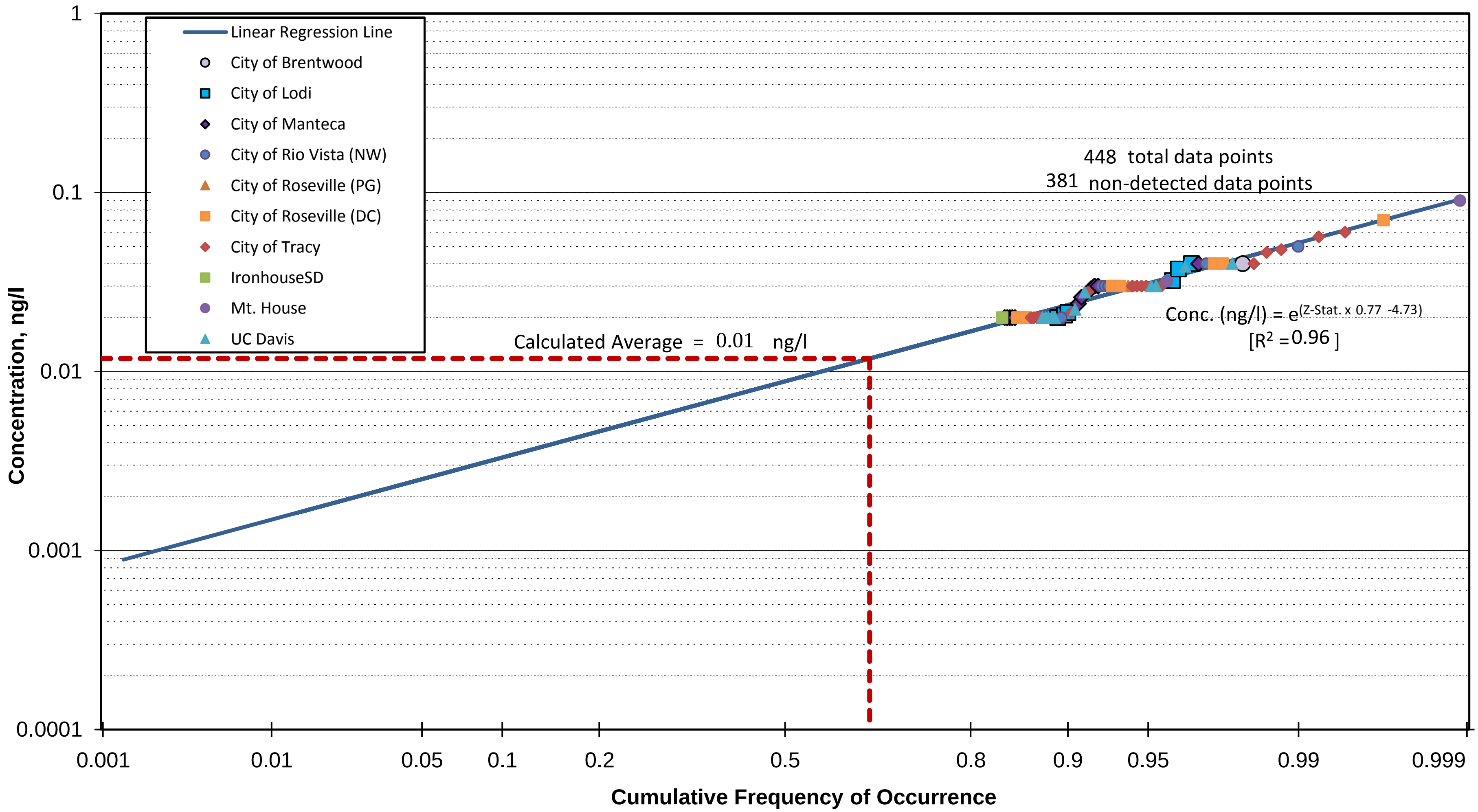


Figure 13

MeHg Concentration Probability Plot for Tertiary plus NDN Facilities

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

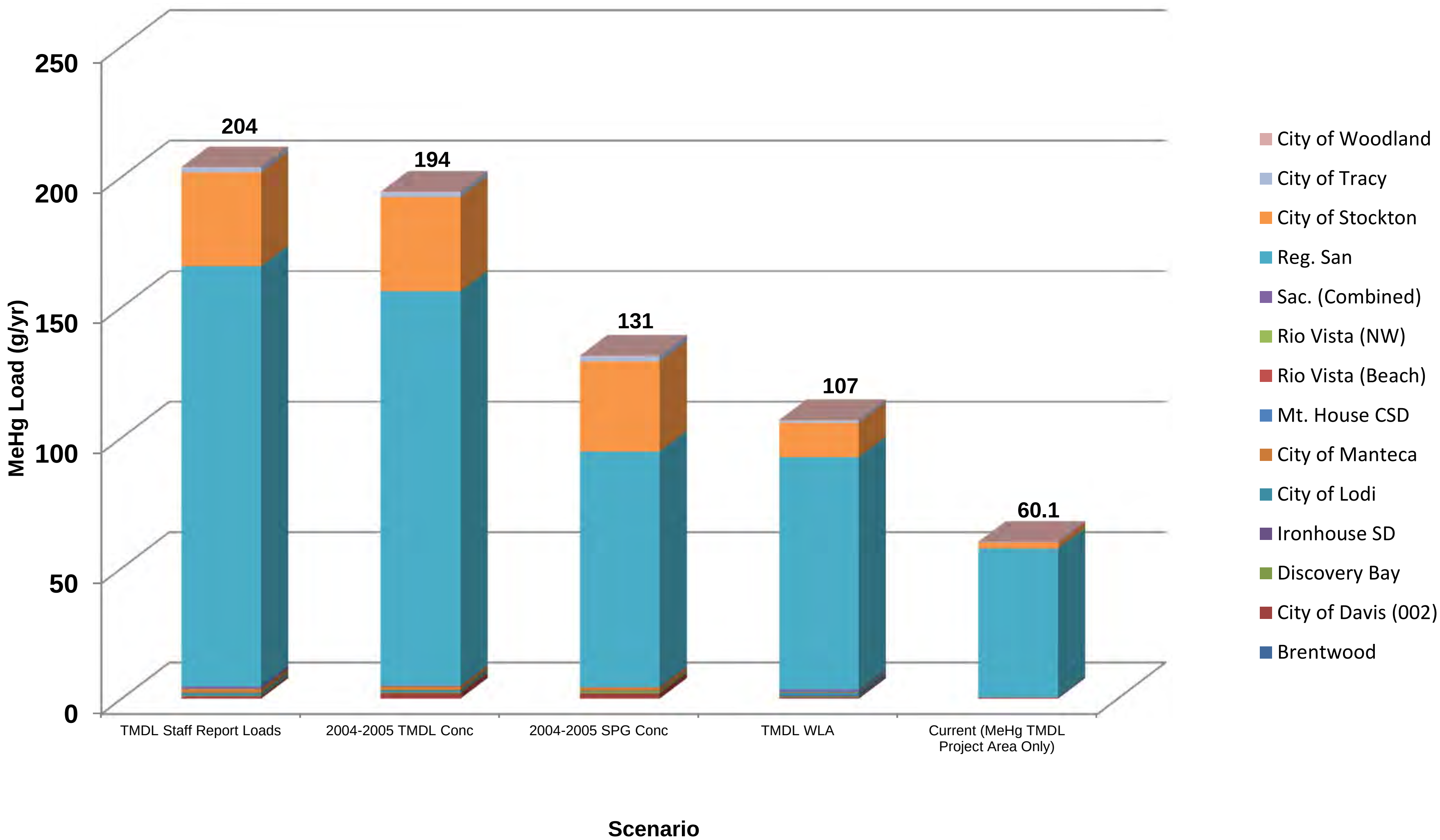


Figure 14

Comparison of 2004-2005 MeHg Loads and Current MeHg Loads

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

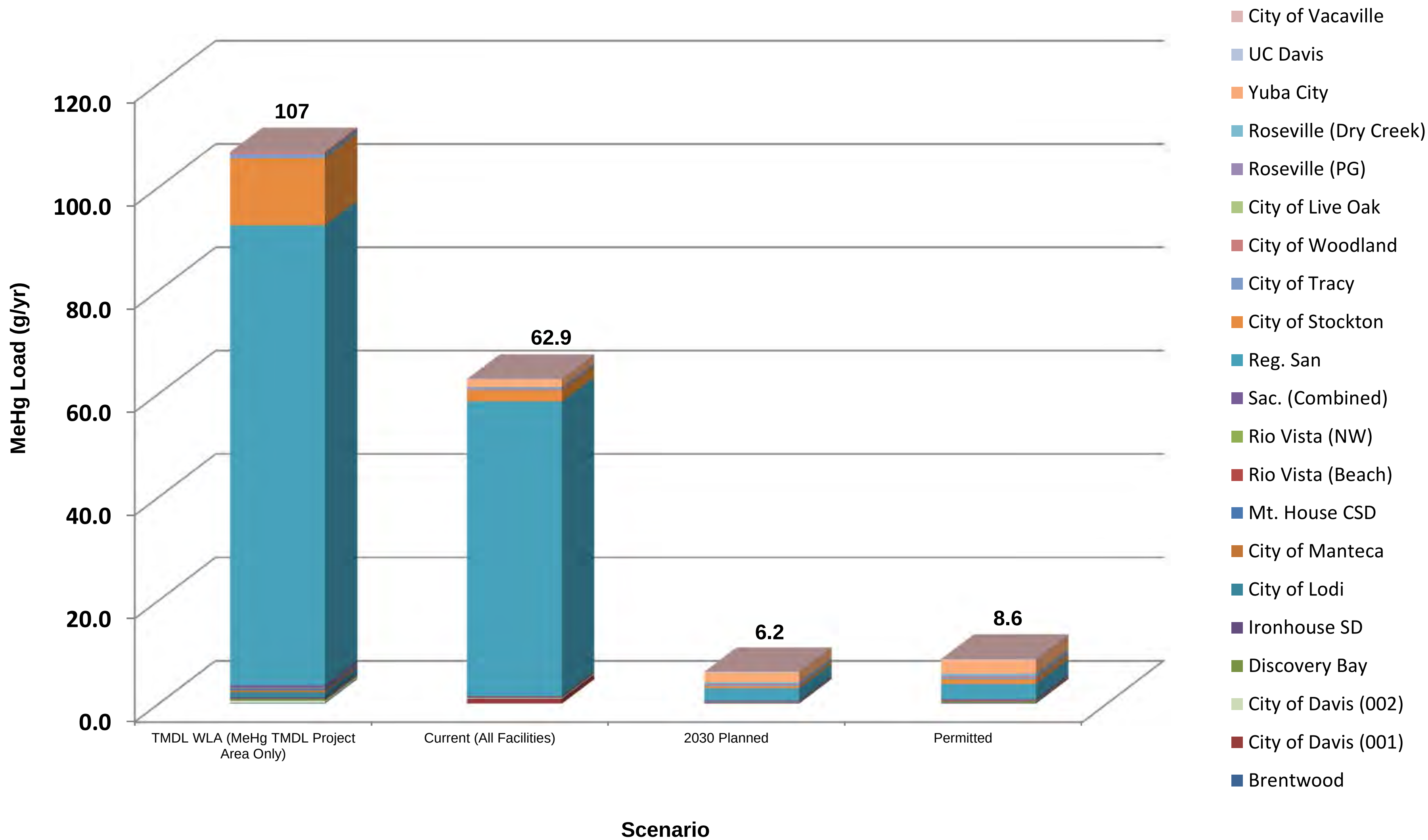


Figure 15

Comparison of TMDL MeHg WLA to Current and Planned MeHg Loads

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

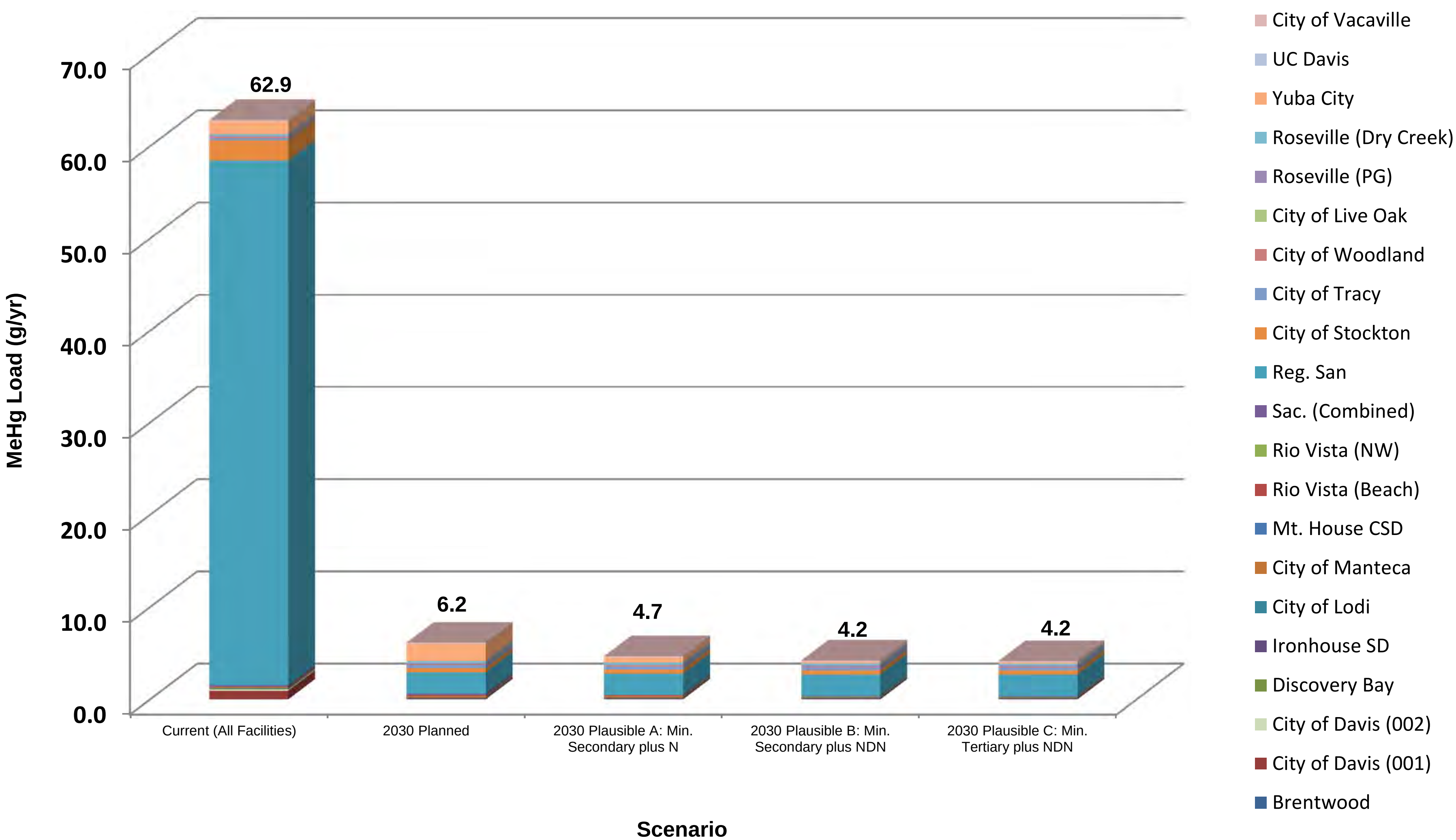
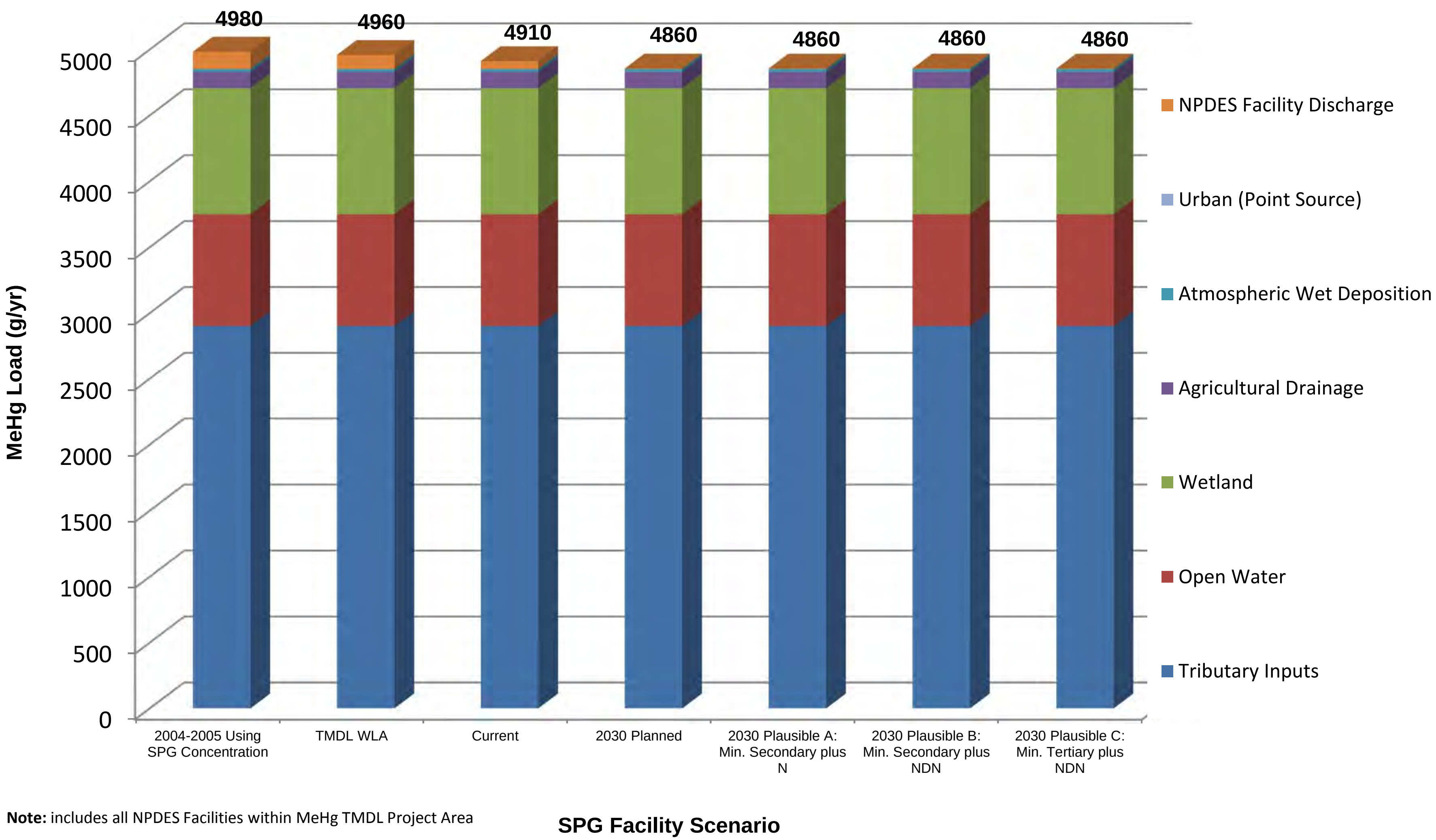


Figure 16

Comparison of Current and 2030 Planned MeHg Loads to 2030 Plausible MeHg Loads

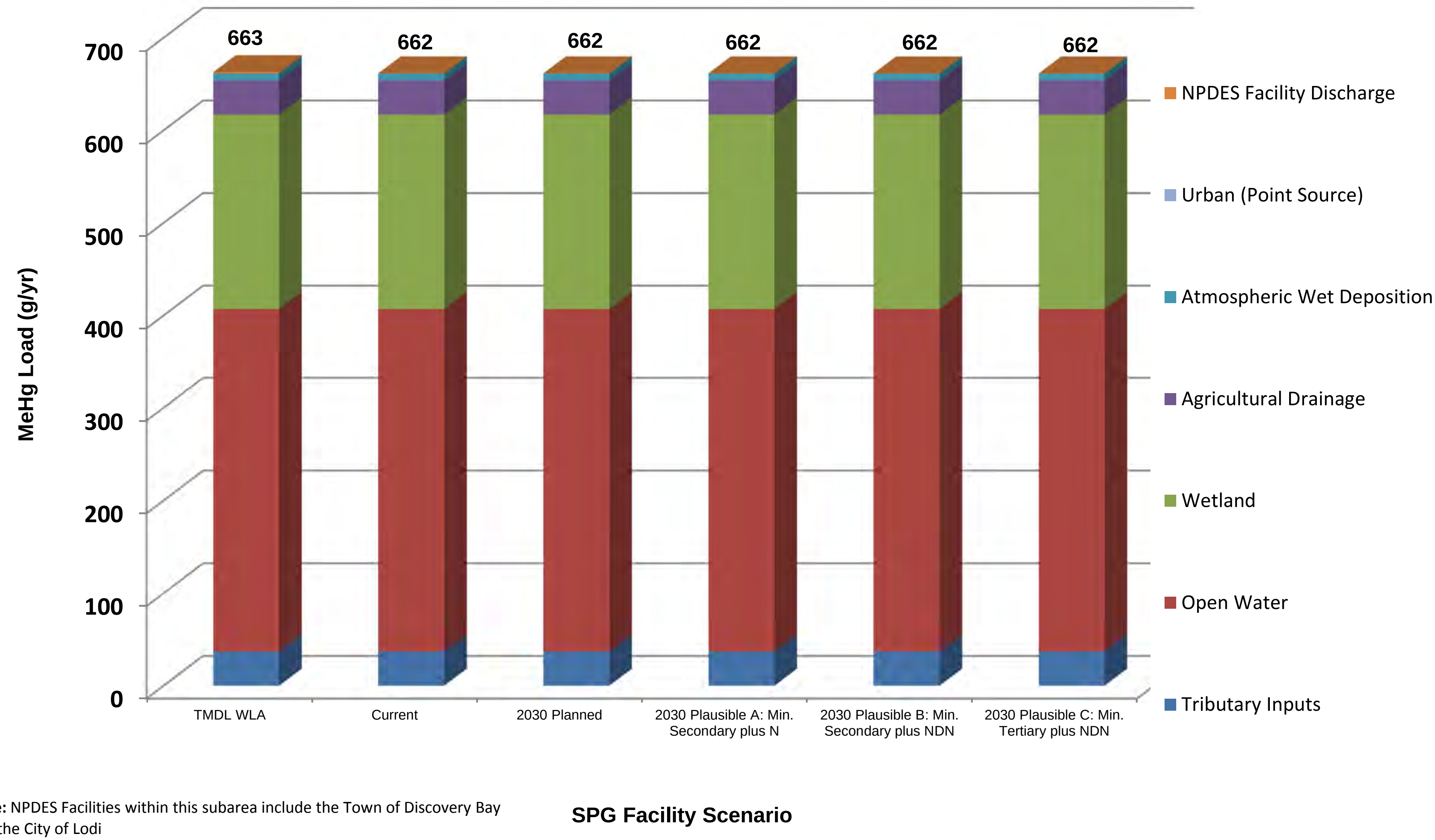


Note: includes all NPDES Facilities within MeHg TMDL Project Area

Figure 17

Comparison of MeHg TMDL Project Area MeHg Loads at Varying SPG Facility Scenarios

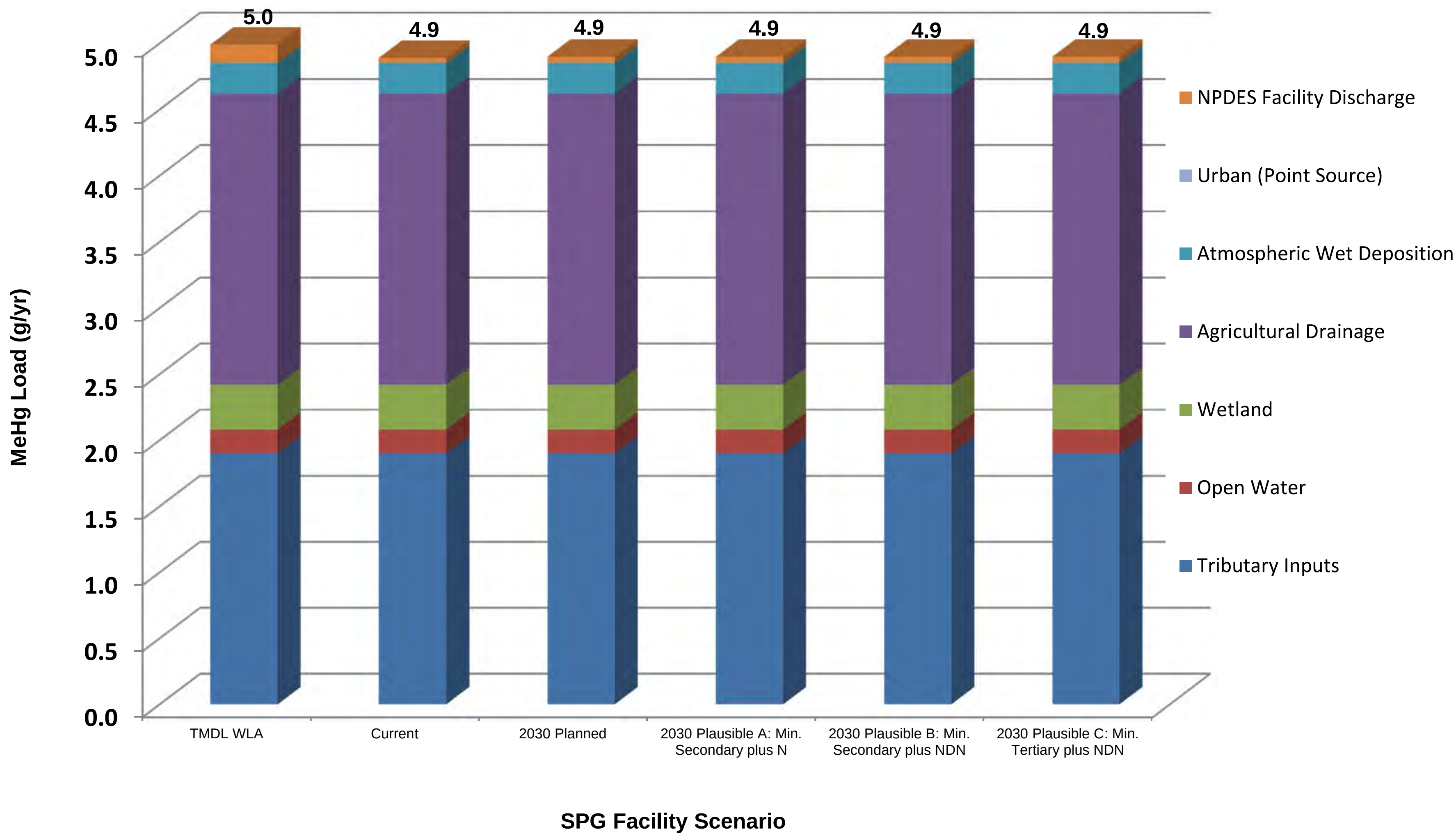
CVCWA MeHg Special Project Group
MeHg Control Study Progress Report



Note: NPDES Facilities within this subarea include the Town of Discovery Bay and the City of Lodi

Figure 18

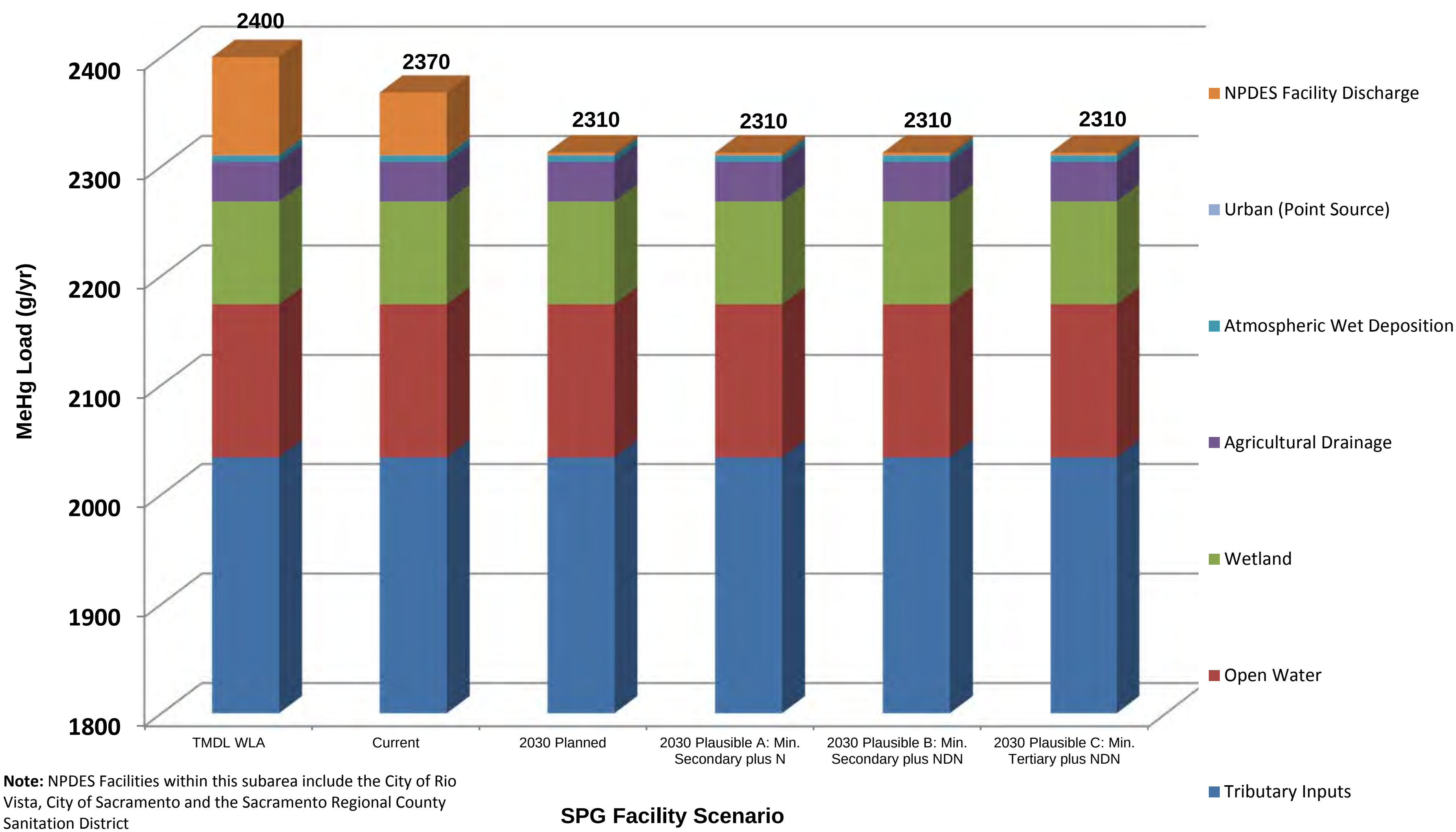
Comparison of Central Delta Subarea MeHg Loads for Varying SPG Facility Scenarios



Note: NPDES Facilities within this subarea include the City of Brentwood

Figure 19

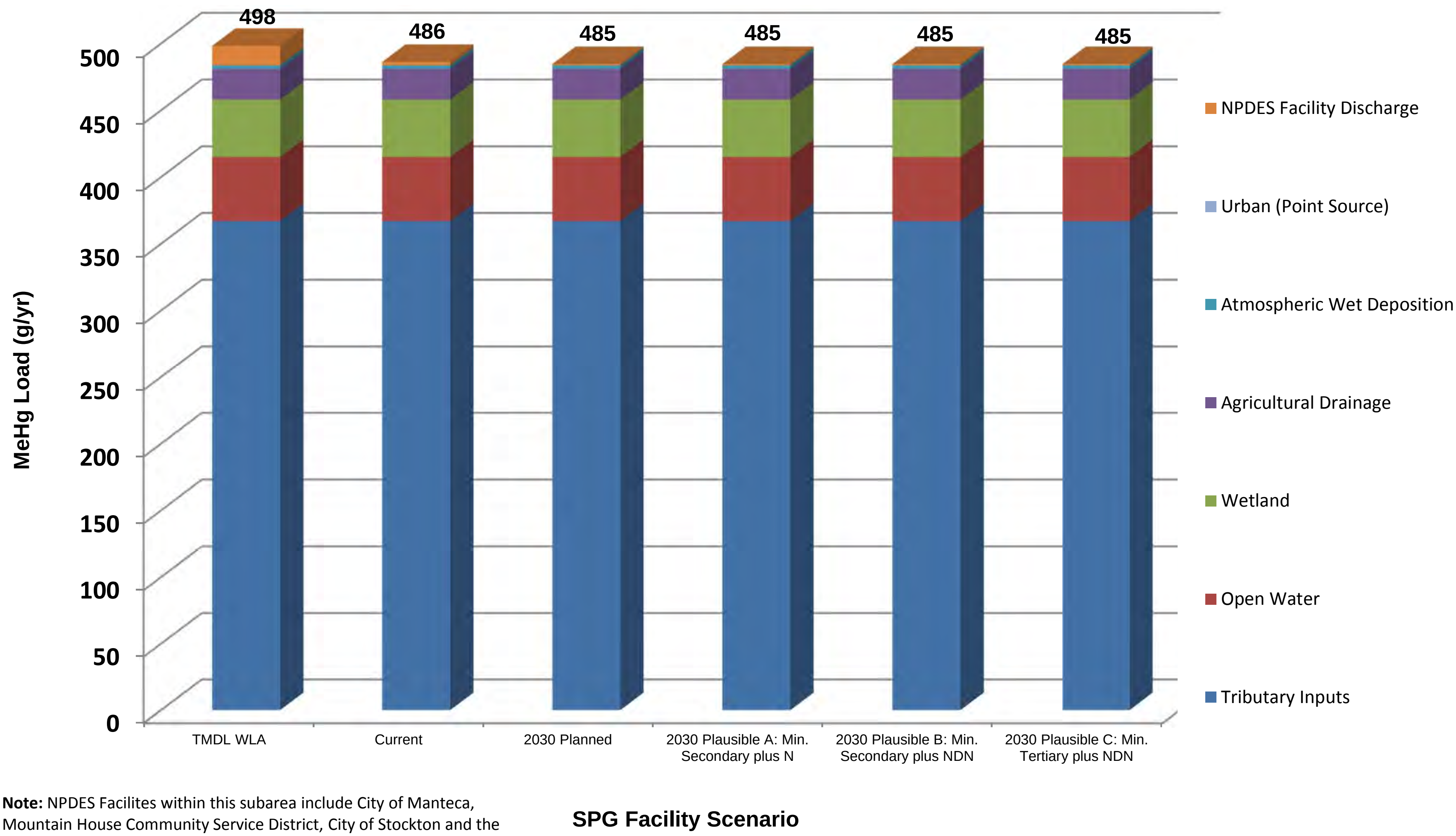
Comparison of Marsh Creek Subarea MeHg Loads for Varying SPG Facility Scenarios



Note: NPDES Facilities within this subarea include the City of Rio Vista, City of Sacramento and the Sacramento Regional County Sanitation District

Figure 20

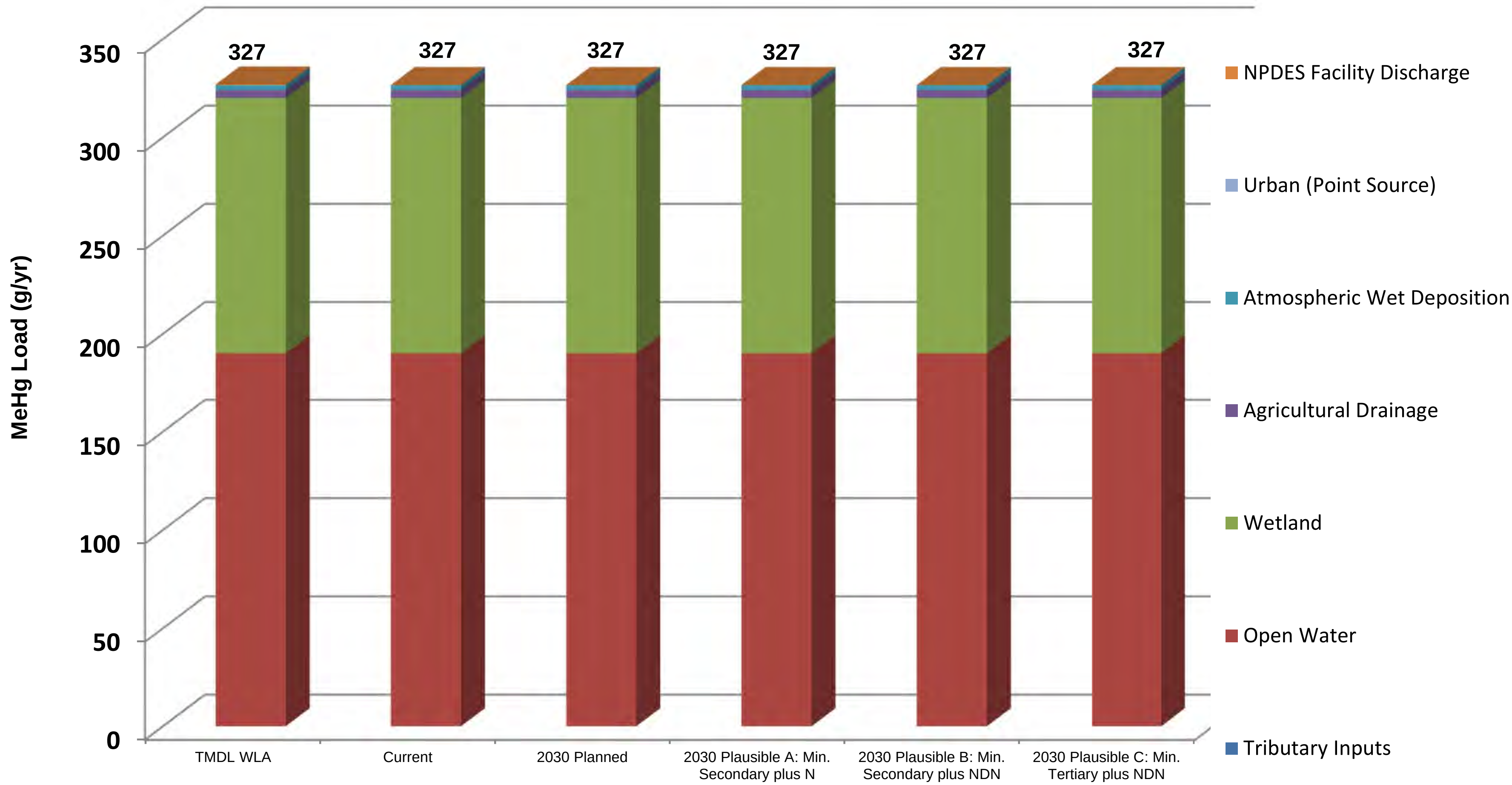
Comparison of Sacramento Subarea MeHg Loads for Varying SPG Facility Scenarios



Note: NPDES Facilites within this subarea include City of Manteca, Mountain House Community Service District, City of Stockton and the City of Tracy

Figure 21

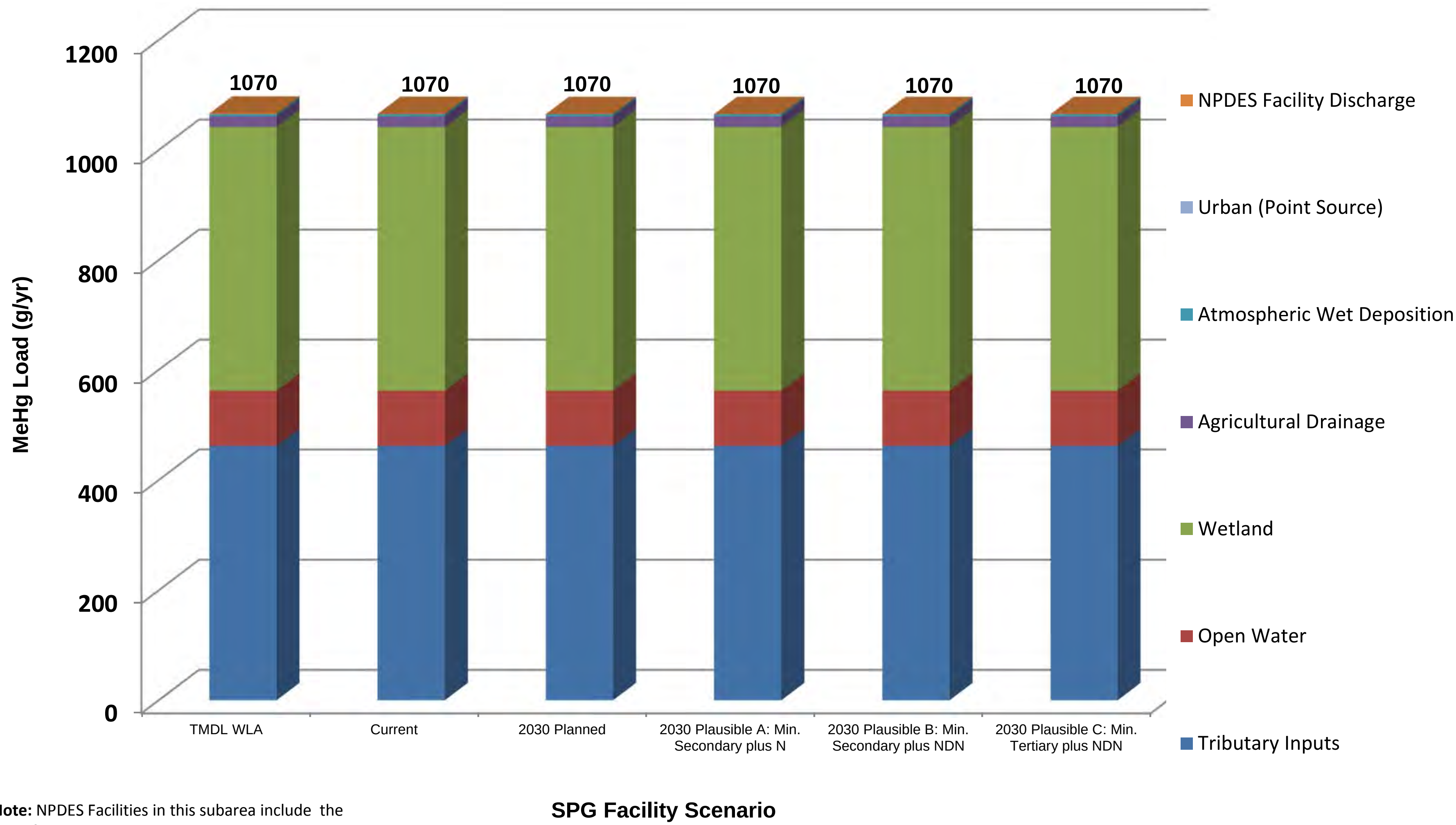
Comparison of San Joaquin Subarea MeHg Loads for Varying SPG Facility Scenarios



Note: NPDES Facilities within this subarea include the Ironhouse Sanitary District

Figure 22

Comparison of West Delta Subarea MeHg Loads for Varying SPG Facility Scenarios



Note: NPDES Facilities in this subarea include the City of Davis, UC Davis and Woodland

Figure 23

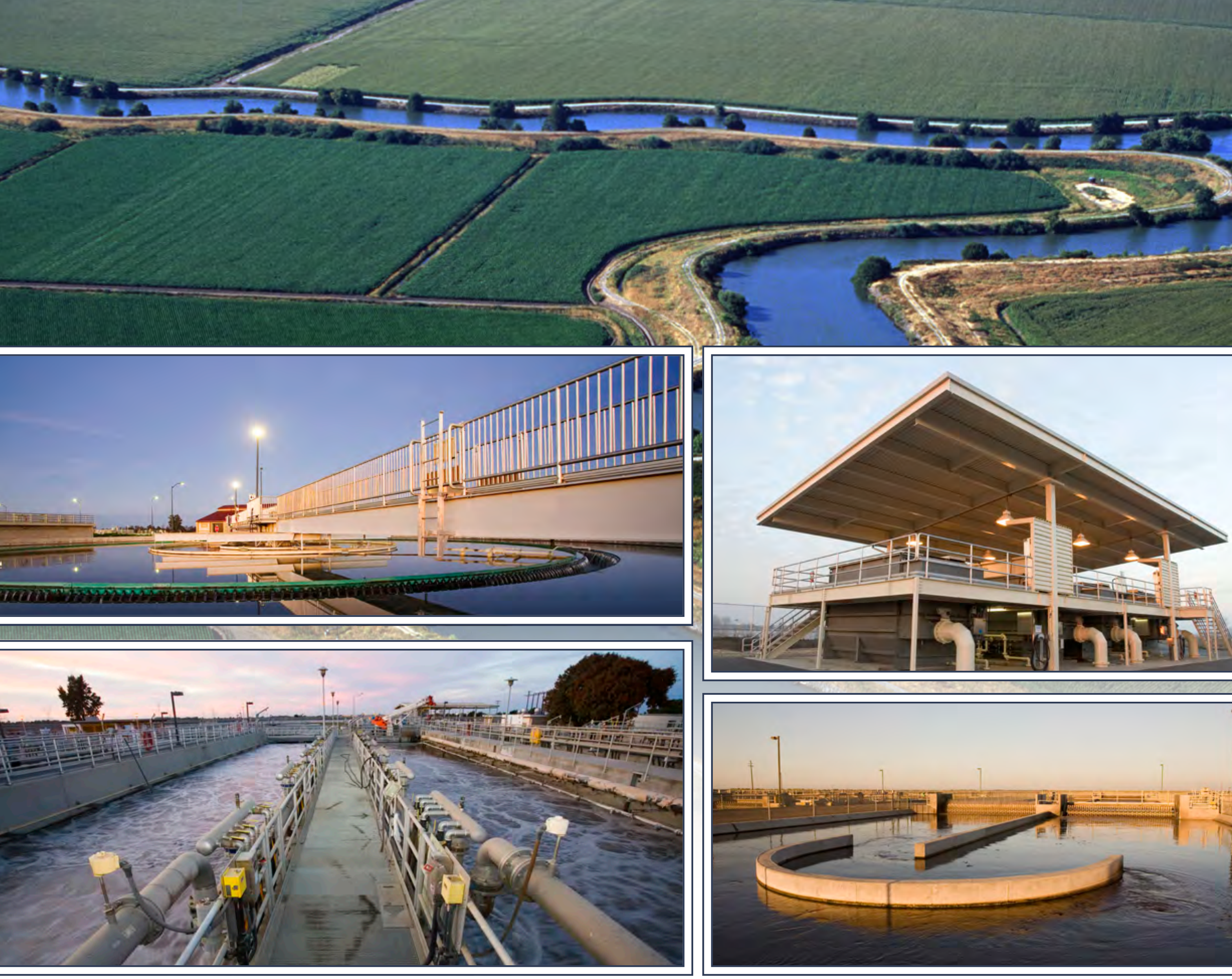
Comparison of Yolo Subarea MeHg Loads for Varying SPG Facility Scenarios

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

MeHg CONTROL STUDY PROGRESS REPORT

APPENDIX A

Control Study Work Plan



WORK PLAN

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Sacramento Regional County Sanitation District

Mark Severeid
City of Woodland

CENTRAL VALLEY CLEAN WATER ASSOCIATION
METHYLMERCURY SPECIAL PROJECT GROUP

Methylmercury Control Study
Work Plan

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Methylmercury Control Study Work Plan

Prepared for

Central Valley Clean Water Association Methylmercury Special Project Group

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203-06-12-04

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List of Acronyms

CWIQS	California Integrated Water Quality System
CVCWA	Central Valley Clean Water Association
Delta	Sacramento River and San Joaquin River Basins
DNQ	Detected, Not Quantified
DOF	California Department of Finance
ELAP	Environmental Laboratory Accreditation Program
MDL	Method Detection Limit
mg/L	Milligrams per Liter
MeHg	Methylmercury
MeHg SPG	Central Valley Clean Water Association Methylmercury Special Project Group
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N	Nitrogen (*e.g.,* “Nitrate as N”)
ND	Non-Detect
NDN	Nitrification/Denitrification
NELAP	National Environmental Laboratory Accreditation Program
NTU	Nephelometric Turbidity Units
ORP	Oxidation-Reduction Potential
PMP	Pollutant Minimization Plan
QA/QC	Quality Assurance/Quality Control

Regional Board	Central Valley Regional Water Quality Control Board
RL	Reporting Limit
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
SVI	Sludge Volume Index
TAC	Regional Board Methylmercury TMDL Technical Advisory Committee
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
UV	Ultraviolet (light)
WLA	Waste Load Allocation
WPCF	Water Pollution Control Facility
WQCF	Wastewater Quality Control Facility
WWCF	Wastewater Control Facility
WWCTS	Wastewater Collection and Treatment System
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant
µg/L	Micrograms per Liter

1.0 INTRODUCTION

The Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (MeHg SPG) is developing and implementing a collaborative Methylmercury Control Study (MeHg Control Study)[1], as required under the Delta Mercury Control Program (TMDL Program) detailed in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (Regional Board, 2010a).

In accordance with the *Methylmercury Control Study Guidance for the Delta Methylmercury Control Program Implementation Phase I* (Guidance Document) provided by the Central Valley Regional Water Quality Control Board (Regional Board), the MeHg SPG has developed this CVCWA MeHg Control Study Work Plan (Work Plan). This Work Plan specifically addresses the following seven elements:

- Problem Statement (Section 2.0)
- Objectives (Section 3.0)
- Mechanisms Underlying the Study (Section 4.0)
- Proposed Control Measures (Section 5.0)
- Monitoring and Data Collection Plan (Section 6.0)
- Quality Assurance Procedures (Section 7.0)
- Project Evaluation and Data Sharing Plan (Section 8.0)

The requirements for each element, as spelled out in the Guidance Document, are identified in each section followed by the requested information. In accordance with the Guidance Document, this Work Plan is due to the Regional Board by April 20, 2013.

In addition, as an optional preliminary step in preparing this Work Plan, the Regional Board allowed for concept proposals describing collaborative studies to be submitted in August 2012. The Concept Proposals needed to briefly address the first five Work Plan elements listed above. Accordingly, in August 2012 a *Methylmercury Control Study Concept Proposal* (Concept Proposal) was prepared on behalf of CVCWA and provided to staff of the Regional Board and their Technical Advisory Committee (TAC) for review. Comments on the Concept Proposal that were received from the Regional Board and TAC are provided in **Appendix A**.

This Work Plan has been expanded from what was presented in the Concept Proposal to fully address the Guidance Document requirements, provide additional details, and to address the comments received from the Regional Board and TAC. Finally, additional data were collected following completion of the Concept Proposal to support the MeHg SPG study objectives. These data have also been incorporated into this Work Plan.

[1] As conveyed in an April 20, 2012 letter from CVCWA to Ms. Pamela Creedon, CVCWA Coordinated Methylmercury Control Study and Request for Extension to Submit Methylmercury Control Plan.

The findings and conclusions related to municipal wastewater treatment plants that are presented in the *Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury, Staff Report* (Regional Board, 2010b) - hereinafter referred to as the TMDL Staff Report - and the corresponding Delta Mercury TMDL section of the Basin Plan are based on MeHg effluent data collected in 2004-2005. A number of changes have occurred at the individual municipal wastewater treatment facilities since this timeframe, which in many cases have resulted in improved effluent water quality for MeHg.

The MeHg Control Study will evaluate existing MeHg control methods used at the SPG municipal wastewater treatment facilities (SPG Facilities) and identify the effectiveness of applying additional control methods for reducing MeHg loads to the Delta from these facilities. In that regard, the MeHg Control Study is intended to build upon the findings presented in the March 2010 Regional Board Staff Report titled *A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley* (MeHg Staff Report), which called for additional analyses "to continue the evaluation of potential relationships between [municipal wastewater] treatment processes, mercury minimization measures for mercury sources to [municipal wastewater treatment facilities] influent, and effluent MeHg levels."

The results of the efforts outlined in this Work Plan will be used to inform the process of determining what (if any) additional MeHg control methods should be applied at individual NPDES Facilities. A MeHg Control Study Progress Report will be submitted following the completion of the Control Study that summarizes the results of the study and identifies a proposed approach to the process of evaluating what control methods can and/or should be applied.

2.0 PROBLEM STATEMENT

This section includes a description of the individual SPG Facilities, a summary of available MeHg data for each SPG Facility, and an overview of the proposed MeHg Control Study approach.

2.1 Guidance Document Requirement

Identify the Delta hydrologic subarea that you are addressing, the percent reduction in methylmercury needed for that subarea, and whether the activity that will be addressed is an existing activity, a new project, or both. Briefly state how your management activity may affect methylmercury production and export.

2.2 SPG Facilities

This section provides the following information regarding the SPG Facilities:

- Discharge Locations, Flows and Permit Status
- Discharge Flows and Permit Status
- Current Treatment Levels
- Treatment Level Changes Since 2004-2005
- Planned Treatment Level Changes
- Treatment Level Summary

2.2.1 Discharge Locations, Flows and Permit Status

The SPG Facilities includes 14 of the 20 municipal and industrial dischargers in the Delta and Yolo Bypass with NPDES permits that have been assigned WLAs under the TMDL Program[2] (referred to in the Basin Plan and herein as NPDES Facilities). The SPG Facilities also represent *all* of the municipal wastewater treatment facilities that have been assigned WLAs under the TMDL Program, with the exception of the Deuel Vocational Institute Wastewater Treatment Plant (WWTP). In addition, one or more of the SPG Facilities is located in each of the Delta hydrologic subareas identified under the TMDL Program, with the exception of the Mokelumne/Cosumnes River subarea, where no NPDES Facilities were identified for the TMDL Program. Finally, the SPG Facilities currently includes six (6) existing NPDES Facilities that discharge outside the legal boundary of the Delta and therefore, have not been assigned WLAs under the TMDL Program.[3]

Eight (8) of the SPG Facilities have made process changes since the data that was used to develop the Delta Mercury TMDL was collected (*i.e.*, the 2004 to 2005 timeframe), and two (2) additional facilities are planning changes before the final compliance date for MeHg WLAs in 2030. In total, the facilities that have completed and/or are planning changes represent approximately 74 percent of the total wastewater flow discharged by the SPG Facilities (and 79 percent of wastewater discharged from the SPG Facilities that currently have WLAs). These changes are discussed further in Sections 2.2.3 and 2.2.4 of this Work Plan.

Table 1 provides the names of the agencies (*i.e.*, facility owners), facility names, the surface water discharge receiving waters, the Delta hydrologic subareas where each facility is located (if applicable), the current and permitted effluent flow rates for each facility, the current NPDES permit expiration date for each facility, and a description of the current final effluent monitoring location.

[2] The 20 NPDES Facilities that have been assigned WLAs under the TMDL Program include the Mirant Delta LLC Contra Costa Power Plant, which was assigned a concentration-based allocation, and the Metropolitan Stevedore facility, which has a WLA for MeHg of 0 grams established in its (2012) NPDES permit.

[3] As discussed in the Basin Plan, dischargers in the Central Valley that are not subject to the TMDL Program, but may be subject to future mercury control programs in upstream tributary watersheds, are encouraged to participate in coordinated Control Studies.

Table 1. Discharge Locations and NPDES Permit Details for SPG Facilities

Agency	Facility	Receiving Water	Delta Hydrologic Subarea	Permitted ADWF, MGD	Recent (2009-2012) Annual Average Effluent Flow Rate, MGD	Effluent Monitoring Location: Name	Effluent Monitoring Location: Description	Current Discharge Permit Expiration
Brentwood, City of	Wastewater Treatment Plant (WWTP)	Marsh Creek (trib. to Delta)	Marsh Creek	5.0	3.2	EFF-001	Upstream of cascade aerator, immediately following disinfection and dechlorination.	12/31/2012
Discovery Bay, Town of	WWTP	Old River (trib. to Delta)	Central Delta	2.1	1.4	EFF-001	Immediately following UV disinfection.	11/30/2013
Lodi, City of	White Slough Water Pollution Control Facility (WPCF)	Dredger Cut (trib. to Delta)		8.5	5.7	EFF-001	At filter pump station effluent box, following disinfection.	9/1/2012
Ironhouse Sanitary District	WWTP	San Joaquin River	West Delta	4.3	2.2	EFF-001	Immediately following disinfection.	4/1/2013
Manteca, City of	City of Manteca Wastewater Quality Control Facility (WQCF)	San Joaquin River	San Joaquin River	9.87	5.7	EFF-001	Immediately following UV disinfection.	10/1/2014
Mountain House Community Services District	WWTP	Old River		3.0	0.5	EFF-001[a]	At effluent wet well, immediately following UV disinfection.	1/1/2018
Stockton, City of	Regional Wastewater Control Facility (WWCF)	San Joaquin River		55	26	EFF-001[b]	Immediately following disinfection and dechlorination.	10/1/2013
Tracy, City of	WWTP	Old River (trib. to Delta)		10.8	8.7	EFF-001	At final effluent pump station, immediately following post aeration.	12/1/2017
Rio Vista, City of	Beach Wastewater Treatment Facility (WWTF)	Sacramento River	Sacramento River	0.7	0.5	EFF-001	Immediately following disinfection and dechlorination.	9/30/2013
Rio Vista, City of	Northwest WWTF	Sacramento River		1.0	0.2	EFF-001	Automatic sampler at the end of the UV disinfection channel.	9/30/2013
Sacramento, City of	Combined Wastewater Collection and Treatment System (Combined WWCTS)	Sacramento River		380	46	EFF-002 EFF-003 EFF-006[c]	Immediately following disinfection and dechlorination, upstream of diffuser. At Sump 104, immediately following disinfection and dechlorination. At sample pumps in treatment basins, immediately following disinfection.	1/1/2015
Sacramento Regional County	Sacramento Regional WWTP	Sacramento River		181	145	EFF-001	Immediately downstream of dechlorination structure.	12/1/2015
Davis, City of	WWTP	Willow Slough (trib. to Yolo Bypass)	Yolo Bypass	7.5	5.1	EFF-001 EFF-002[d]	At Discharge Point 001, immediately following disinfection. At Discharge Point 002, downstream of treatment wetland.	10/1/2012
Woodland, City of	WPCF	Tule Canal/Yolo Bypass		10.4	4.9	EFF-001	Immediately following UV disinfection.	2/1/2014
Live Oak, City of	WWTP	Reclamation District 777 Lateral Drain No. 2 (trib. to Sutter Bypass)	Outside the Delta	1.4	0.5	EFF-001[e]	Immediately following UV disinfection.	12/4/2015
Roseville, City of	Dry Creek WWTP	Dry Creek (trib. to Sacramento River)		18	9.0	EFF-001	Immediately following UV disinfection.	6/1/2013
Roseville, City of	Pleasant Grove WWTP	Pleasant Grove Creek (trib. to Sacramento River)		12	6.4	EFF-001	Immediately following UV disinfection.	6/1/2013
UC Davis	Main WWTP	Putah Creek (trib. To Yolo Bypass)		3.6	1.5	EFF-001	At effluent wet well, immediately following UV disinfection.	12/1/2013
Vacaville, City of	Easterly WWTP	Old Alamo Creek (trib to Ulatis Creek/Delta		15	8.2	EFF-001	Immediately following disinfection and dechlorination.	4/1/2013
Yuba City, City of	WWTF	Feather River		10.5	5.5	EFF-001	Immediately following disinfection and dechlorination, prior to valves directing to Discharge Points 001 and 002.	10/1/2012

[a] Discharge permit for Mountain House Community Services District (Order No. R5-2013-0004) also includes an effluent monitoring location "EFF-002", described as "Final treated effluent at the discharge end of the outfall pipeline, approximately 0.9 miles from [the WWTP]." However, EFF-002 is only used for effluent monitoring of temperature. All other parameters, including mercury and methylmercury, are monitored at EFF-001.

[b] Discharge permit for City of Stockton Regional WWCF (Order No. R5-2008-0154) also includes an effluent monitoring location "EFF-002" for monitoring of secondary effluent that is stored in onsite ponds. Mercury and methylmercury is monitored at EFF-001.

[c] Discharge permit for City of Sacramento Combined WWCTS (Order No. R5-2010-0004) also includes effluent monitoring locations EFF-004, EFF-005, and EFF-007 for monitoring untreated effluent. Routine monitoring for methylmercury and mercury (*i.e.* , for every discharge event) is only required at the monitoring locations shown in the table.

[d] Discharge permit for City of Davis WWTP (Order No. R5-2007-0132-02) also includes effluent monitoring location EFF-A ("After disinfection process") for compliance with tertiary treatment requirements (*e.g.* , total suspended solids, settleable solids, turbidity, total coliform organisms), but EFF-001 and EFF-002 are the monitoring and compliance locations for mercury effluent limitations.

[e] Discharge permit for City of Live Oak WWTP (Order No. R5-2011-0034) also includes an effluent monitoring location "EFF-002", used for monitoring of tertiary filtered effluent for pH and turbidity only. All other parameters, including mercury and methylmercury, are monitored at EFF-001.

As indicated in Table 1, many of the SPG Facilities will receive new/modified permits prior to April 2015, which is when the MeHg Control Study is expected to be completed. In addition, some of the planned SPG Facility changes are subject to ongoing planning and/or permit negotiation efforts. Therefore, although not anticipated, it is possible that the outcome of the near-term permitting and planning efforts could result in modifications to the individual SPG Facility information presented in this Work Plan. Such changes, if applicable, will be noted in the MeHg Control Study Reports described later in this Work Plan.

Table 1 also demonstrates that, with the exception of City of Davis' discharge at Eff-002, all of the SPG Facilities are currently required to monitor their final effluent at a location immediately downstream of their final disinfection process. Therefore, effluent data collected under the current SPG Facility permits does not reflect a situation where the effluent is exposed to the atmosphere or other influences (*i.e.*, a long discharge pipeline or an open water conveyance channel) after treatment is complete.

2.2.2 Current Treatment Levels

The SPG Facilities employ a range of possible treatment technologies that are typical to municipal wastewater treatment plants. Details on the treatment technologies installed at each SPG Facility are summarized in Table 2, and flow schematics for each SPG Facility are provided in **Appendix B**.

The SPG also represent a range of "treatment levels" typical for municipal wastewater treatment plants. For purposes of the MeHg Control Study, the "treatment levels" are described based on the treatment processes provided at a given facility and the effluent ammonia as N, nitrate as N, total suspended solids (TSS) and turbidity concentrations that are reliably achieved. Table 3 provides a summary of the facility characteristics associated with the different treatment levels represented by the SPG Facilities. A summary of each SPG Facility's treatment levels (including disinfection method) and average effluent concentrations for parameters of interest is provided in Table 4.

2.2.3 Treatment Level Changes Since 2004-2005

Seven (7) SPG Facilities have implemented significant process changes at their facilities since then that could affect their effluent MeHg concentrations (Table 5). In addition to the facility changes listed in Table 5, the following three (3) facilities have begun surface water discharge operations since 2005: Mountain House Community Services District WWTP[4], City of Rio Vista Northwest WWTF[5], and the Ironhouse Sanitary District WWTP[6].

---

[4] The Mountain House Community Services District WWTP began operation in September 2002 as a land discharge facility. Surface water discharge was initiated in March 2007 following a major facility upgrade.

[5] The Rio Vista Northwest WWTF came online in August 2006 and replaced the City's Trilogy WWTP, which discharged to land during irrigation months and to an unnamed ephemeral stream that is tributary to the Sacramento River the remainder of the year. Upon completion of the Northwest WWTF construction, the City ceased discharging to the golf course irrigation reservoir and to the unnamed tributary to the Sacramento River and initiated year-round discharge directly into the Sacramento River.

[6] The Ironhouse Sanitary District WWTP began operation as a land discharge facility. Surface water discharge was initiated in July 2011 following a major facility upgrade.

Table 2. Existing SPG Facilities Treatment Processes

Schematic Number	Agency	Facility	Changes Since TMDL Hg Data Collected	Primary Settling	Secondary Treatment									Nutrient Removal		Tertiary Treatment			Disinfec - tion		Solids Processing		
					Pond Treatment and/or Storage	MBR	Aeration Basin	Pure Oxygen Aeration	Oxidation Ditches	Biofilters	Sequencing Batch Reactor	Sedimentation	Other Processes	Nitrification	Denitrification	Sand	Cloth	Membrane	Chlorination	UV	Solids Processing Liquid Return	Separate Aerobic Digestion[a]	Anaerobic Digestion
SPG Facilities Within the TMDL Program Area																							
1	Brentwood, City of	WWTP							X			X	Separate denitrification basins, cascade aerator after effluent Hg monitoring.	X	X	X			X		X		
2	Davis, City of	WWTP		X	Pond Based Treatment								Overland Flow	X	X				X				X
3	Discovery Bay, Town of	WWTP			Emergency Storage				X			X		X						X	X	X	
4	Ironhouse Sanitary District	WWTP	Began Surface Water Discharge October 2011		Emergency Storage Return	X							5 mile 24-inch HDPE outfall pipeline.	X	X			X		X	X		
5	Lodi, City of	White Slough WPCF	Yes (See Table 5.)	X			X					X		X	X		X			X	X		X
6	Manteca, City of	WQCF	Yes (See Table 5.)	X	Equalization Storage of Secondary Effluent (used for periods of incoming tides)		X					X		X	X		X			X	X		X
7	Mountain House Community Services District	WWTP	Began Surface Water Discharge March 2007		Emergency Storage						X	X	Sequencing Batch Reactors	X	X		X			X	X	X	
8	Rio Vista, City of	Beach WWTF	Yes (See Table 5.)	X			X					X		X					X		X	X	
9	Rio Vista, City of	Northwest WWTF	Began Surface Water Discharge July 2006		Emergency Storage	X								X	X			X		X			
10	Sacramento, City of	Combined WWCTS		X	Discharge is the Overflow from Reservoir Facilities or Primary Treatment Processes														X				
11	Sacramento Regional County Sanitation District	Sacramento Regional WWTP		X	Equalization Storage During Peak Flows			X				X							X		X		X
12	Stockton, City of	Regional WWCF	Yes (See Table 5.)	X	Treatment Ponds					X		X	Engineered Wetlands	X		X			X		X		X
13	Tracy, City of	WWTP	Yes (See Table 5.)	X	Industrial Influent Storage and Pretreatment		X					X		X	X	X			X		X		X
14	Woodland, City of	WPCF	Yes (See Table 5.)		Equalization Storage During Peak Flows and Emergency Storage				X			X	1.5 Mile effluent pipeline	X			X			X			
SPG Facilities Outside the TMDL Program Area																							
15	Live Oak, City of	WWTP	Yes (See Table 5.)		(Daily) Equalization Storage and Emergency Storage				X			X	Final effluent aeration	X			X			X			
16	Roseville, City of	Dry Creek WWTP		X	Equalization Storage During Peak Flows and Emergency Storage		X					X	Final effluent aeration and pH adjustment	X	X	X				X	X		X
17	Roseville, City of	Pleasant Grove WWTP		X	Emergency Storage				X			X	Reaeration	X	X	X				X			
18	UC Davis	Main WWTP							X			X	Two Types of Filtration in Parallel	X	X	X	X			X	X		
19	Vacaville, City of	Easterly WWTP	Yes (See Table 5.)	X	Equalization Storage During Peak Flows		X					X		X	X[b]				X		X		X
20	Yuba City, City of	WWTF		X				X				X	Final effluent aeration						X		X		X

[a] This column indicates whether solids are aerobically digested separately from the secondary treatment process.
[b] City of Vacaville Easterly Wastewater Treatment Plant recently upgraded to secondary treatment with NDN, as of January 2013.

Table 3. Characteristics of the Treatment Levels Represented by the SPG Facilities

Treatment Level	Symbol Used in this Work Plan	Secondary Treatment Process	Tertiary Filtration Process	Effluent Water Quality			
				Ammonia as N < 2 mg/L	Nitrate as N < 10 mg/L	TSS < 5 mg/L	Turbidity < 2 NTU
Primary Treatment	p	—	—	—	—	—	—
Secondary Treatment	a	✓	—	—	—	—	—
Secondary Treatment with Nitrification	b	✓	—	✓	—	—	—
Secondary Treatment with Nitrification and Denitrification (NDN)	c	✓	—	✓	✓	—	—
Pond Based Secondary Treatment with NDN	g	✓ (a)	—	✓	✓	—	—
Tertiary Treatment	d	✓	✓	—	—	✓	✓
Tertiary Treatment with Nitrification	e	✓	✓	✓	—	✓	✓
Tertiary Treatment with NDN	f	✓	✓	✓	✓	✓	✓

(a) For these facilties, the majority of secondary treatment occurs in a pond facility.

Legend:

✓ Indicates the Feature is Associated with the Treatment Level

— Indicates the Feature is not Associated with the Treatment Level

Table 4. Existing SPG Facilities Treatment Levels and Effluent Water Quality

Agency	Facility	Current Treatment Level[a]	Disinfectant	Average Effluent Concentration (2009-2012)			
				Ammonia, mg/L as N	Nitrate, mg/L as N	TSS, mg/L	BOD, mg/L
SPG Facilities Within the TMDL Program Area							
Brentwood, City of	WWTP	f	Chlorine	< 0.10	7.81	0.64	< 2.0
Davis, City of	WWTP	g	Chlorine	1.74	2.68	14.27	6.57
Discovery Bay, Town of	WWTP	b	UV	0.26	19.03	14.97	< 2.0
Ironhouse Sanitary District	WWTP	f	UV	0.22	7.66	3.82	< 5.0
Lodi, City of	White Slough WPCF	f	UV	0.65	5.13	3.51	2.27
Manteca, City of	WQCF	f	UV	0.51	5.47	0.92	< 2.0
Mountain House Community Services District	Mountain House WWTP	f	UV	0.24	1.18	1.09	2.14
Rio Vista, City of	Beach WWTF	b	Chlorine	0.34	14.19	6.26	6.44
Rio Vista, City of	Northwest WWTF	f	UV	0.33	4.76	2.41	4.49
Sacramento, City of	Combined WWCTS	p	Chlorine	0.52	--	71.96	--
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	a	Chlorine	25.05	< 0.10	6.93	8.56
Stockton, City of	Regional WWCF	e	Chlorine	0.86	18.59	2.55	< 2.0
Tracy, City of	WWTP	f	Chlorine	1.08 [b]	5.85	0.88	2.83
Woodland, City of	WPCF	e	UV	< 0.10	22.18	1.24	< 2.0
SPG Facilities Outside the TMDL Program Area							
Live Oak, City of	WWTP	e[c]	UV	--	--	--	--
Roseville, City of	Dry Creek WWTP	f	UV	< 0.10	9.24	1.55	< 2.0
Roseville, City of	Pleasant Grove WWTP	f	UV	< 0.10	4.55	1.70	< 2.0
UC Davis	Main WWTP	f	UV	0.33	7.93	0.54	2.18
Vacaville, City of	Easterly WWTP	c[d]	Chlorine	< 0.10	21.34	3.51	4.37
Yuba City, City of	WWTF	a	Chlorine	19.12	0.51	10.44	8.71

[a] Facility Treatment-Level Categories:
- p = Primary
- a = Secondary Treatment
- b = Secondary Treatment w/ Nitrification
- c = Secondary Treatment w/ NDN
- e = Tertiary Treatment w/Nitrification
- f = Tertiary Treatement w/ NDN
- g = Pond-Based Secondary w/NDN

[b] Tracy WWTP includes ammonia addition as part of the disinfection process to control trihalomethane formation.

[c] Treatment level for Live Oak WWTP is based on treatment processes at the WWTP and discussions with City staff regarding typical levels for the constituents of concern.

[d] Vacaville Easterly WWTP recently upgraded to secondary treatment with NDN, as of January 2013. Water quality data shown reflects performance prior to the upgrade.

Table 5. SPG Facilities Process Changes Since 2004-2005

Agency	Facility	Description of Changes	Completion Date	Treatment Level: Prior to Changes	Treatment Level: After Changes
Live Oak, City of	WWTP	Replaced pond-based treatment system with a conventional activated sludge process that provides nitrification and denitrification and added tertiary filtration	December 2011	**(g)** Pond-Based Secondary Treatment	**(f)** Tertiary Treatment with NDN
Lodi, City of	White Slough WPCF	Addition of filtration and UV disinfection system	January 2005	**(b)** Secondary Treatment with Nitrification	**(e)** Tertiary Treatment with Nitrification
		Addition of nitrification/ denitrification	March 2009	**(e)** Tertiary Treatment with Nitrification	**(f)** Tertiary Treatment with NDN
Manteca, City of	WQCF	Addition of nitrification/ denitrification	July 2007	**(b)** Secondary Treatment with Nitrification	**(c)** Secondary Treatment with NDN
		Addition of filtration and UV disinfection system	September 2007	**(c)** Secondary Treatment with NDN	**(f)** Tertiary Treatment with NDN
Rio Vista, City of	Beach WWTP	Improved operations to more consistently nitrify	October 2006	**(a)** Secondary Treatment	**(b)** Secondary Treatment with Nitrification
Stockton, City of	Regional WWTP	Nitrification upgrade	January 2007	**(d)** Pond-Based Secondary Treatment and Tertiary Filtration	**(e)** Tertiary Treatment with Nitrification
Tracy, City of	WWTP	Addition of filtration and NDN	August 2007	**(a)** Secondary Treatment	**(f)** Tertiary Treatment with NDN
Woodland, City of	WPCF	Addition of filtration and UV disinfection system	May 2005	**(b)** Secondary Treatment with Nitrification	**(e)** Tertiary Treatment with Nitrification
Vacaville, City of	Easterly WWTP	Modification of Aeration Basins to Provide Denitrification	January 2013	**(b)** Secondary Treatment with Nitrification	**(c)** Secondary Treatment with NDN

2.2.4 Planned Treatment Level Changes

Four (4) SPG Facilities are expected to undergo significant process changes before the final compliance date for MeHg WLAs, which is 2030. The facilities that are anticipated to have process changes are summarized in Table 6, along with a description of the proposed changes, the anticipated completion date, and the resulting change to the treatment level.

Table 6. Anticipated SPG Facilities Process Changes

Agency	Facility	Description of Changes	Scheduled Completion Date[(a)]	Treatment Level	
				Current	After Changes
Davis, City of	WWTP	Replace pond-based treatment system with a conventional activated sludge treatment process that provides nitrification and denitrification and add tertiary filtration	October 2017	**(g)** Pond-Based Secondary Treatment with NDN	**(f)** Tertiary Treatment with NDN
Sacramento Regional County Sanitation District	SRWTP	Replace pure oxygen secondary treatment process with a conventional air-activated sludge reactor that provides nitrification, denitrification, and add tertiary filtration	December 2020	**(a)** Secondary Treatment	**(f)** Tertiary Treatment with NDN[(b)]
Woodland, City of	WPCF	Convert oxidation ditch reactors to plug flow reactors to provide both nitrification and denitrification	December 2015	**(e)** Tertiary Treatment with Nitrification	**(f)** Tertiary Treatment with NDN
Vacaville, City of	Easterly WWTP	Add tertiary filtration	May 2015	**(e)** Secondary Treatment with NDN	**(f)** Tertiary Treatment with NDN

(a) With the exception of the City of Woodland denitrification improvements, the scheduled completion date indicated is based on a regulatory compliance deadline included in the facility's NPDES permit.
(b) The NPDES permit for SRCSD is currently under appeal.

2.2.5 Treatment Level Summary

Table 7 summarizes the current treatment levels for each SPG Facility, the treatment levels provided in 2004-2005, and the treatment levels expected in 2030.

Table 7. SPG Facility Treatment Level Summary

Agency	Facility	Treatment Level[(a)]		
		2004-2005	Current (2013)	Future (2030)
SPG Facilities Within the TMDL Program Area				
Brentwood, City of	WWTP	f	f	f
Davis, City of	WWTP	g	g	f
Discovery Bay, Town of	WWTP	b	b	b
Ironhouse Sanitary District	WWTP	--[(b)]	f	f
Lodi, City of	White Slough WPCF	b	f	f
Manteca, City of	WQCF	b	f	f
Mountain House Community Services District	WWTP	--[(b)]	f	f
Rio Vista, City of	Beach WWTF	a	b	b
Rio Vista, City of	Northwest WWTF	--[(b)]	f	f
Sacramento, City of	Combined WCTS	p	p	p
Sacramento Regional County Sanitation District	SRWTP	a	a	e
Stockton, City of	Regional WWCF	d	e	e
Tracy, City of	Tracy WWTP	a	f	f
Woodland, City of	WPCF	b	e	f
SPG Facilities Outside the TMDL Program Area				
Live Oak, City of	WWTP	g	e	e
Roseville, City of	Dry Creek WWTP	f	f	f
Roseville, City of	Pleasant Grove WWTP	f	f	f
UC Davis	Main WWTP	f	f	f
Vacaville, City of	Easterly WWTP	b	c[(c)]	f
Yuba City, City of	WWTF	a	a	a

(a) Treatment Level Categories:
p = Primary (only)
a = Secondary (no nitrification)
b = Secondary with Nitrification
c = Secondary Treatment w/ Nitrification/Denitrification
d = Tertiary Treatment
e = Tertiary with Nitrification (no Denitrification)
f = Tertiary with Nitrification/Denitrification
g = Pond-Based Secondary with Nitrification/Denitrification
(b) Facility was not discharging to surface water in 2004-2005.
(c) Vacaville Easterly WWTP recently upgraded to secondary treatment with NDN, as of January 2013.

2.3 Effluent MeHg Characterization

A graphical summary of recent effluent MeHg data (*i.e.*, data collected between January 2009 and December 2012) for each SPG Facility is provided in Figure 1. As shown, facilities that provide the same treatment level, as defined in Table 2, appear to perform similar to each other in terms of their MeHg effluent concentrations.

A graphical summary of influent MeHg data (*i.e.*, data collected between January 2009 and December 2012) for each SPG Facility is provided in Figure 2. As indicated there are limited influent MeHg data for the SPG Facilities. Nevertheless, a comparison of the effluent data to the available influent data indicates that variability in influent concentrations may not correlate with measured effluent concentrations when higher levels of treatment are provided.

Finally, **Appendix C** includes time series graphs showing historic MeHg data for the 20 facilities evaluated under this study (grouped by treatment level). Based on a review of these graphs and input provided by each SPG Facility, effluent MeHg concentrations have decreased for a number of facilities since 2004-2005. These reductions are attributable to various causes such as:

- Treatment improvements (see Section 2.2.3);
- Operational/pollution prevention programs (*e.g.*, Sacramento Regional County Sanitation District); and
- Improvements in sampling and analytical methods.

Finally, it should be noted that while a number of the SPG Facilities have collected data between 2005 and 2009, this data is not being considered in this study because 1) there is not a consistent data set for all the facilities for this period and 2) the data may not be representative of current conditions for the following reasons:

- Between 2005 and 2009 a number of the SPG Facilities completed major facility upgrade projects, which could affect effluent MeHg levels.
- Many of the QA/QC procedures described below for the MeHg Control Study sampling program have also generally been followed at the SPG Facilities in collecting data from 2009 and later. Whereas is cannot be verified with certainty that all the SPG Facilities that collected data prior to 2009 were using these best practices.
- The method detection limits and reporting levels (MDLs and RLs) used by the SPG Facilities since 2009 meet the criteria set forth in this Work Plan (*i.e.*, maximum of 0.02 and 0.05 ng/L, respectively).
- The individual SPG Facilities have been using the same laboratories to provide MeHg analyses since 2009, so the level of laboratory quality control is consistent.

Figure 1. SPG Facilities Effluent MeHg Data Summary, 2009-2012

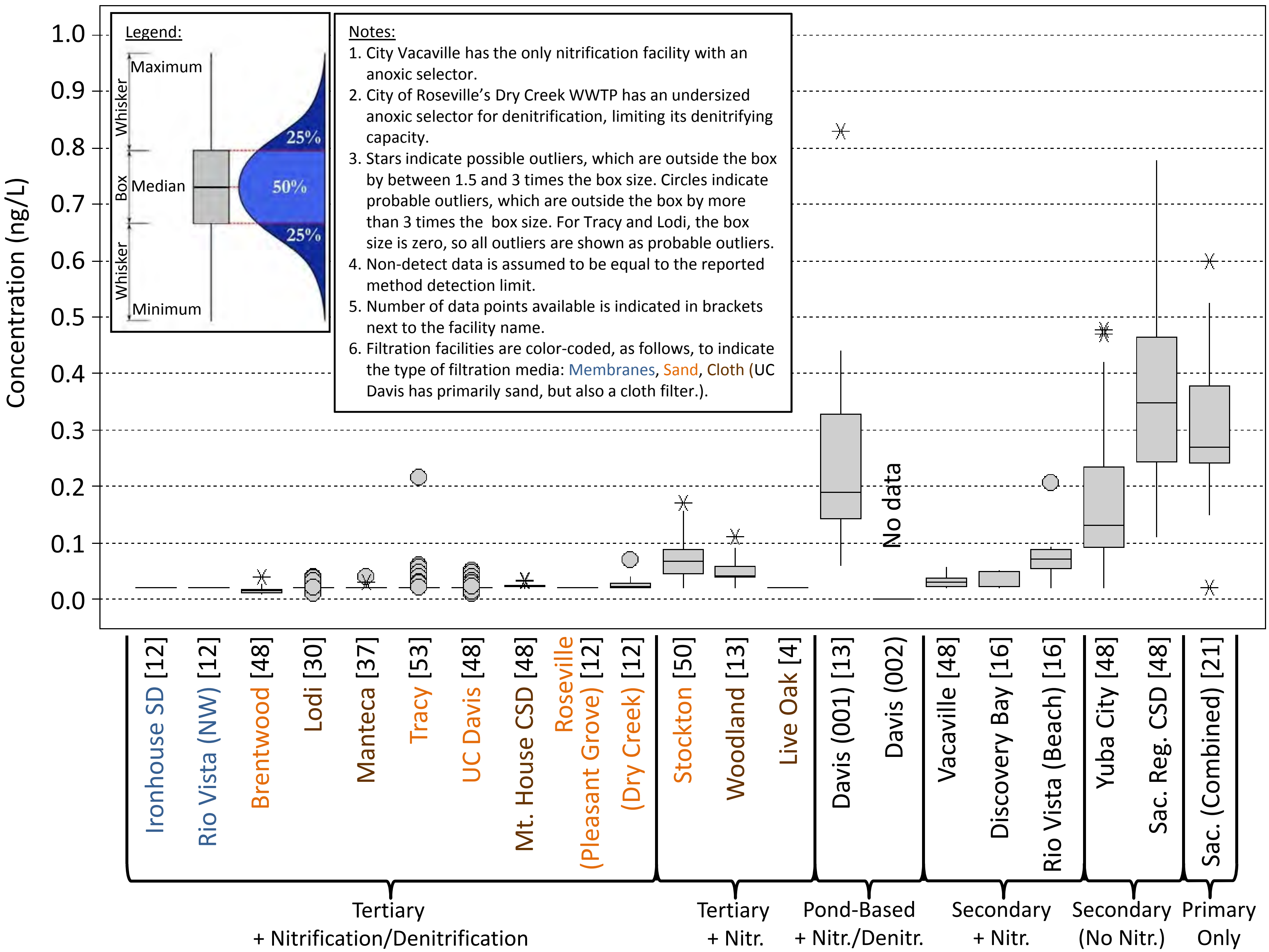
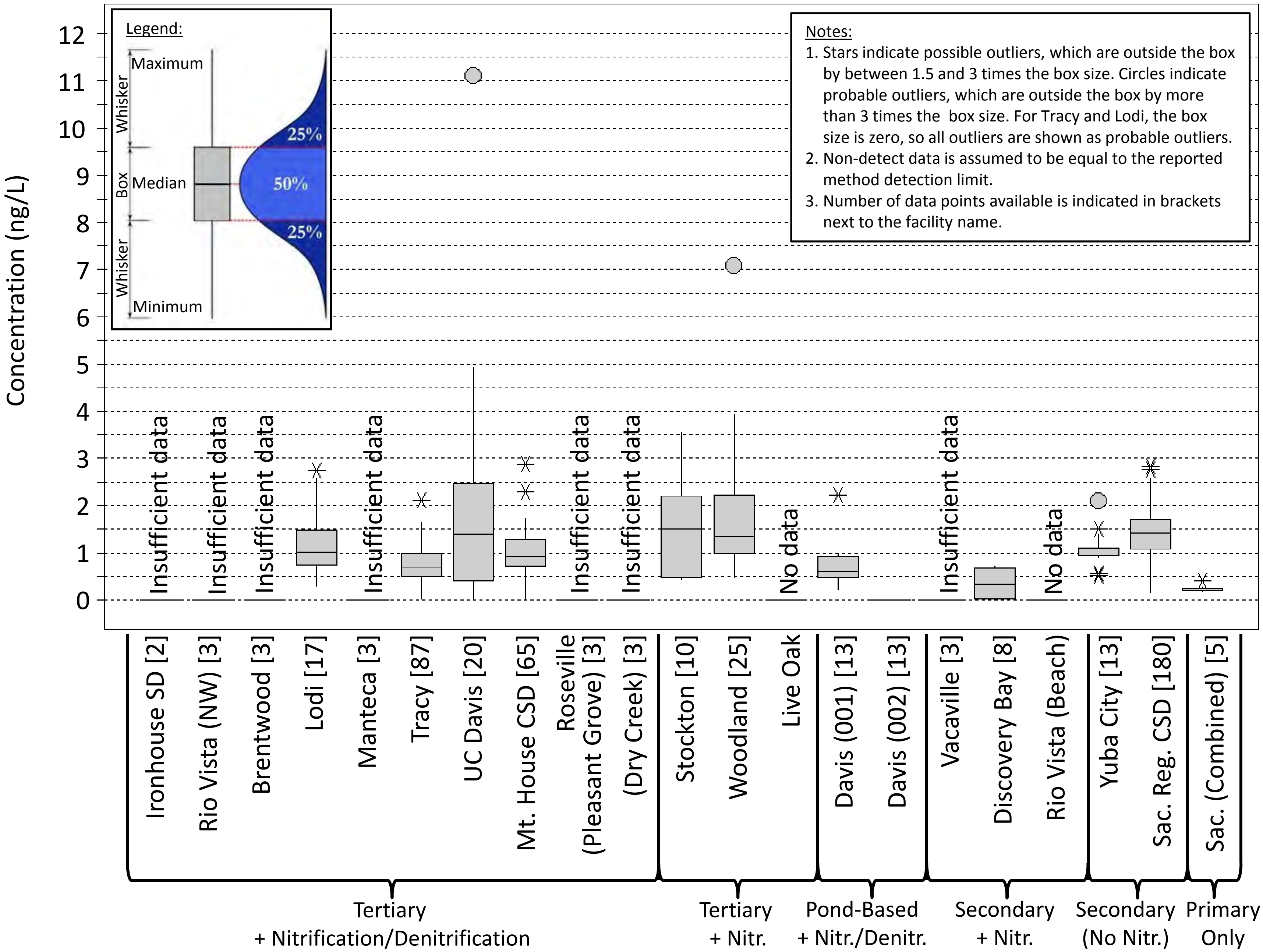


Figure 2. SPG Facilities Influent MeHg Data Summary, 2000-2012



2.4 Control Study Approach

The SPG Facilities being evaluated as a part of this study have made substantial progress toward reducing their MeHg loads discharged to the Delta as compared to the 2004-2005 data presented in the TMDL Staff Report. However, not all of the SPG Facilities have collected enough data to adequately characterize current performance. Moreover, increased influent wastewater flows, increased influent mercury/MeHg loads, future facility changes, and other unforeseen factors could impact effluent mercury and MeHg concentrations/loads. Therefore, the primary purpose of this MeHg Control Study will be to gather the data needed to document whether existing strategies used to control nitrogen and other constituents of concern in the SPG Facilities are effective for ensuring MeHg loads are maintained at or below the WLAs over the long-term.

The SPG Facilities being evaluated under this study are existing facilities. Moreover, with the exception of the four (4) facilities identified in Table 6, the SPG Facilities being evaluated are not expected to be modified in a manner that significantly affects the current treatment performance with respect to MeHg.

Specifically, the focus of this MeHg Control Study will be to evaluate and characterize MeHg effluent concentration by each SPG Facility as compared to the effluent concentrations that were observed in 2004–2005 based on the data presented in TMDL Staff Report.

The MeHg Control Study will also relate the MeHg effluent quality to the particular level of treatment currently provided by each facility. The results will allow a quantification of the MeHg treatment effectiveness of specific treatment levels that can be used to predict effluent MeHg concentrations for the SPG Facilities that are planning treatment improvements prior to the TMDL 2030 compliance date. This analysis, combined with projected flows, will allow for a quantification of effluent loads expected in 2030, by which time the TMDL WLAs must be met.

In addition, the water quality identified for most effective treatment strategies will be extrapolated and applied to all of the listed SPG facilities to provide an estimate of what the resulting overall changes to the MeHg loads to the Delta might be if the treatment technologies shown to be the most effective at removing MeHg were applied uniformly. This information will provide a foundation for potential future evaluations of the costs and benefits of uniform application of a specific treatment technology.

Finally, a comparison of influent to effluent MeHg levels will be developed to characterize the relationship between these levels for the various levels of treatment provided by the SPG Facilities. This information will provide a foundation for potential future evaluations of the costs and benefits of continuing existing, or implementing additional, source control efforts if the treatment technologies shown to be the most effective at removing MeHg are applied.

3.0 OBJECTIVES

This section discusses the overall MeHg Control Study objectives related to the ability of the municipal wastewater treatment NPDES Facilities to meet their WLAs, and presents the specific MeHg Control Study objectives (*i.e.,* the hypotheses that will be tested through the MeHg Control Study).

3.1 Guidance Document Requirements

To the extent possible, provide objectives that are specific, measurable, and relevant to the TMDL, for: 1) the study activity (i.e., experiments, evaluations, and/or modeling) that will be conducted and 2) application of the study results to your ultimate goal of methylmercury control.

a. *Study Objective: What hypotheses do you plan to test with your study? Clearly state your hypotheses in a manner that focuses on the mechanism(s) by which your control measure may contribute to the control objective.*[7]
b. *Control Objective: Describe your total allocation responsibility. Demonstrate how your control measure could be applied, scaled-up or combined with other control measures to achieve the methylmercury allocation*

3.2 Overall Objective

This MeHg Control Study will address measures applicable to controlling MeHg loads discharged from municipal wastewater treatment facilities. All of the municipal wastewater treatment NDPES Facilities identified in the TMDL Program are being evaluated under this study, with the exception of the Deuel Vocational Institute WWTP. Based on the data evaluated and presented in this Work Plan, it is anticipated that the proposed MeHg Control Study will demonstrate that the WLAs assigned to municipal wastewater treatment NPDES Facilities will be achieved through the application of existing and planned control measures.

As indicated by Table 8.5 in the TMDL Staff Report, NPDES Facilities are responsible for approximately 4.2 percent[8] of the total MeHg allocation under the Sacramento – San Joaquin Delta Estuary TMDL Program, including allocations for future growth. (The SPG Facilities make up over 99 percent of the sum of all NPDES Facilities' WLAs.) Given the low percentage of the total TMDL WLA responsibility assigned to NPDES Facilities, it is unlikely that the total MeHg levels in the Delta would be significantly affected by even substantial improvements over the TMDL WLAs assigned to NPDES Facilities.

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[7] *Hypotheses will vary by source type and activity being evaluated. The hypothesis should be able to be statistically tested with data and calculations produced in the study. Although a null hypothesis (e.g., the treatment to be tested will have no effect) is the classic format, it is acceptable to phrase hypotheses in an alternative format (e.g., the treatment to be tested will have a particular effect). Examples: In a floodplain, directing water around areas where sediment mercury concentrations are relatively high will reduce the load of methylmercury discharged, in comparison with no change in water flow pattern. Reducing organic matter on the ground surface before inundation will reduce loads of methylmercury discharged in comparison with not removing organic matter.*

[8] This value does not account for adjustments to the WLAs for the City of Davis WWTP and the Ironhouse Sanitary District WWTP that are shown in Table 8. As indicated in Table 8, these WLAs appear to have been improperly calculated and/or presented in the Basin Plan.

The results of the MeHg Control Study are also not expected to be applicable to other existing MeHg sources identified in the TMDL Program such as agricultural and urban runoff sources. Nevertheless, the findings could be extrapolated to help evaluate the overall contribution from all the municipal wastewater treatment facilities in the Central Valley to the total MeHg loads entering the Delta. The findings could also be used to better define the level of importance that should be placed on municipal wastewater treatment facilities as MeHg TMDL programs are developed for water bodies upstream of the Delta.

3.3 Specific Study Objectives

As described further below, the MeHg SPG has identified three primary study objectives to be evaluated through testing of a null hypothesis. In addition, the MeHg SPG may complete research to evaluate a question of interest.

3.3.1 Null Hypothesis Test Approach

The Study Objectives are expressed as null hypotheses. A null hypothesis typically corresponds to a general or default position and is commonly used in scientific evaluations as the basis for statistical analysis of study results. In the cases presented, the null hypothesis states that a potential treatment or influent condition has no effect. The data collected and/or evaluated under the MeHg Control Study will be used to either reject, or fail to reject, these null hypotheses. For example, if the comparison of two groups (*e.g.*, treatment, no treatment) reveals no statistically significant difference between the two, it means that there is not enough evidence to reject the null hypothesis (in other words, the experiment fails to reject the null hypothesis that the treatment has no effect).

3.3.2 Study Objective 1: Evaluation of Planned Changes

The first study objective is to determine whether treatment improvements made at the SPG Facilities since 2004-2005, along with the changes planned within the next eight years, will result in reductions in MeHg loads such that the TMDL WLAs for the SPG Facilities are met or the required reductions will be exceeded. The specific null hypothesis that will be tested is as follows:

> **Planned Scenario:** In 2030 by which time all TMDL WLAs must be met, there will not be a statistically significant reduction in MeHg loads to the Delta (as compared to the 2004-2005 load estimates presented in the TMDL Staff Report) assuming the SPG Facilities implement the treatment process changes required under the NPDES permits that are effective for each facility at the time the MeHg Control Study data collection efforts are complete.[9]

The null hypothesis will be tested by comparing the annual average loads for each SPG Facility under the planned 2030 conditions to the average loads calculated using the 2004–2005 data set presented in the TMDL Staff Report. For the SPG Facilities that are not planning major process changes by 2030, current effluent MeHg concentrations will be used to calculate annual 2030

[9] As presented in Table 1, many of the SPG Facilities will receive new discharge permits (or potentially modified permits) prior to when the MeHg Control Study is expected to be complete.

loads. For the five (5) SPG Facilities planning major process changes, effluent MeHg concentrations will be estimated based on the concentrations exhibited by other SPG Facilities that already provide the planned level of treatment. Population increases and flow changes will be estimated and included in the calculations.

3.3.3 Study Objective 2: Evaluation of Plausible Future Changes

The second study objective is to determine whether the blanket application of a specific treatment level on all SPG Facilities would result in statistically lower MeHg loads over loads that will be discharged under the planned scenario discussed above. The specific null hypothesis that will be tested is as follows:

> **Plausible Scenarios**: In 2030 by which time all WLAs must be met, there will not be a statistically significant reduction in MeHg loads to the Delta (as compared to the Planned Scenario described above) if all SPG Facilities provide at least the following levels of treatment:
>
> - **Plausible Scenario A:** Conventional nitrification treatment (average effluent ammonia concentrations are less than 2.0 mg/L as N).
> - **Plausible Scenario B:** Conventional nitrification/denitrification treatment (average effluent ammonia concentrations are less than 2.0 mg/L as N and average effluent nitrate concentration are less than 10 mg/L as N).
> - **Plausible Scenario C:** Conventional nitrification/denitrification treatment (average effluent ammonia concentrations are less than 1.5 mg/L as N and average effluent nitrate concentration are less than 10 mg/L as N) and Title 22 filtration (or equivalent).

Each plausible scenario's null hypothesis will be tested by comparing the annual average load values anticipated at the planned condition (discussed under Study Objective 1) to the annual average load values assuming the blanket application of the minimum treatment level. The MeHg loads discharged under the various plausible scenarios will be determined using concentration information derived for each SPG Facility, as follows:

- For the SPG Facilities that are already meeting or exceeding the treatment technology being considered, current effluent MeHg concentrations will be directly applied.
- For the facilities planning major process changes by 2030 to incorporate the treatment technology being considered (or better), the effluent MeHg concentrations will be estimated based on the concentrations exhibited by other facilities that already provide the planned level of treatment.
- For the facilities *not* planning major process changes (or those planning changes that do not meet the water quality expected from the treatment technology being considered), the effluent MeHg concentrations will be estimated based on the concentrations exhibited by facilities that provide the treatment technology being considered under each plausible scenario.

3.3.4 Study Objective 3: Evaluation of Influent Conditions

The third study objective is to determine whether variations in influent MeHg concentrations have a potential to impact the variation in effluent MeHg concentrations if different treatment technologies are applied. The specific null hypothesis that will be tested is as follows:

> **Influent Conditions:** The variance of influent MeHg concentrations is equal to the variance of effluent MeHg concentrations for:
>
> - Secondary facilities,
> - Secondary plus nitrification facilities,
> - Nitrification/Denitrification (NDN)-only facilities, or
> - NDN plus filtration facilities.

The null hypothesis will be tested by comparing the variances observed in the influent and effluent data (*i.e.*, data that has been collected on the same day[10]) for SPG Facilities that provide the treatment level being considered to determine if a statistically a significant difference in variances is demonstrated.

3.3.5 Question of Interest

The MeHg SPG may also compare influent mercury/MeHg concentrations and loads before and after efforts implemented under the required mercury pollutant minimization plans (PMPs).

[10] Note that the influent and effluent samples collected at the Sacramento Regional County Sanitation District Regional WWTP cannot be collected on the same day because the District does not have adequate staff to collect all of the influent and effluent samples required under their NPDES permit in one day.

4.0 MECHANISMS UNDERLYING THE STUDY

This section identifies the SPG Facilities current MeHg concentrations and loads as compared to their WLAs, and describes the underlying information that supports the hypotheses that will be evaluated through the MeHg Control Study.

4.1 Guidance Document Requirements

Provide a conceptual model or set of underlying assumptions to support your hypotheses and explain why or how your proposed control study will achieve the study and control objectives. To the extent that you can, describe factors affecting methylmercury within your source area, including seasonal dynamics. Reference sources include the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) conceptual model and the NPS Workgroup mercury synthesis. Summarize existing aqueous methylmercury concentrations and loads from your source.

4.2 WLAs and Current Effluent Loads

As discussed above, 14 of the SPG Facilities are in subareas identified in the MeHg TMDL section of the Basin Plan and the Regional Board assigned MeHg WLAs to each of these facilities based on estimated loads that were being discharged in 2004-2005. However, six (6) of these facilities have made process changes since 2005, which has resulted in improved effluent water quality. Other efforts, such as pollution prevention and improved sampling and analytical quality control, have also contributed to lower effluent MeHg concentrations in the effluent discharged from the SPG Facilities.

Table 8 provides a characterization of the current loads discharged from each facility as compared to WLAs. This comparison of the WLA to the current loads is presented as follows:

- The average effluent MeHg concentration measured between January 2009 and December 2012 (current) compared to the MeHg concentration used to develop the WLAs[11];
- The current average annual flow *for days in which discharge to surface water occurred* compared to the flow value used to develop the WLAs[12];
- The current average number of discharge days per year compared to the number of discharge days per year used to develop the WLA;
- The current annual MeHg load compared to the WLA[13]; and
- The percentage of the calculated 2005 load that is currently being discharged compared to the percentage of the 2005 load that was allocated for the TMDL Program.

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[11] Note that concentrations presented in Table 8 are not, necessarily, the average effluent concentration observed in 2004-2005, but are instead concentration values derived based on a range of factors that are discussed in detailed in the TMDL documentation.

[12] The flow values presented in Table 8 are generally the actual average flow from 2004-2005, with the exception of the values shown for the Cities of Woodland and Brentwood where the treatment facility capacity was used in the WLA instead of actual flows.

[13] As noted in Table 8, the WLAs provided for the City of Davis WWTP and the Ironhouse Sanitary District WWTP appear to have been improperly calculated and/or presented in the Basin Plan, so revised values have been shown for the current analysis.

Table 8. Comparison of SPG Facility MeHg WLAs to Current Loads

Agency	Facility	Average Effluent MeHg Concentration, ng/l		Average Effluent Flow, mgd		Days of Discharge per Year		Annual MeHg Loading/WLA[a], g/yr		Percent of 2005 Load[b]	
		Current (2009-2012)	Used for WLA	Current (2009-2012)	Used for WLA	Current (2009-2011)	Used for WLA	Current	TMDL MeHg WLA	Current	Used for WLA
SPG Facilities Within the TMDL Program Area											
Brentwood, City of	WWTP	0.008	0.02	3.2	5.0 [c]	365	365	0.04	0.14	29%	100%
Davis, City of	WWTP (Discharge Point 002)	0.265	0.13	5.1	2.4	118	149	0.60	0.43 [d]	30%	21.5%
Discovery Bay, Town of	WWTP	0.028	0.18	1.4	1.5	365	365	0.05	0.37	14%	100%
Ironhouse Sanitary District	WWTP	0.011	0.05	2.2	4.3	245 [e]	365	0.02	0.30 [f]	7%	100%
Lodi, City of	White Slough WPCF	0.014	0.15	5.7	4.6	172	365	0.05	0.94	5%	100%
Manteca, City of	WQCF	0.015	0.06	5.7	4.6	296	365	0.09	0.38	6%	27%
Mountain House Community Services District	WWTP	0.012	0.05	0.5	5.4	365	365	0.01	0.37	3%	100%
Rio Vista, City of	Beach WWTF	0.069	0.089	0.48	0.45	365	365	0.05	0.06	46%	55.51%
Rio Vista, City of	Northwest WWTF	0.011	0.05	0.20	1.00	365	365	0.003	0.07	4%	100%
Sacramento, City of	Combined WWCTS	0.296	0.30	46	1.28	4	365	0.21	0.53	21%	55.51%
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	0.375	0.40	145	162	365	365	75.0	89.0	47%	55.51%
Stockton, City of	Regional WWCF	0.069	0.34	26.2	28.0	352	365	2.40	13.0	7%	36.1%
Tracy, City of	WWTP	0.016	0.06	8.7	9.3	365	365	0.20	0.77	11%	43%
Woodland, City of	WPCF	0.048	0.03	4.9	10.4 [g]	365	365	0.32	0.43	74%	100%
Totals for TMDL Program Dischargers								**79.03** [h]	**106.8**		
SPG Facilities Outside the TMDL Program Area											
Davis, City of	WWTP (Discharge Point 001)	0.265	--	4.1	--	154	--	0.63	--	--	--
Live Oak, City of	WWTP	0.013	--	0.50 [i]	--	365	--	0.01	--	--	--
Roseville, City of	Dry Creek WWTP	0.021	--	9.0	--	365	--	0.26	--	--	--
Roseville, City of	Pleasant Grove WWTP	0.010	--	6.4	--	362	--	0.09	--	--	--
UC Davis	Main WWTP	0.014	--	1.5	--	365	--	0.03	--	--	--
Vacaville, City of	Easterly WWTP	0.030	--	8.2	--	365	--	0.34	--	--	--
Yuba City, City of	WWTF	0.165	--	5.5	--	365	--	1.26	--	--	--

[a] WLAs are calculated in the TMDL as follows: Average Concentration (ng/L) ÷ 1,000,000 (ng/mg) x Average Effluent Flow (mgd) x 8.34 (lb/gallon) x 453.6 (g/lb)

[b] The TMDL identifies WLAs as a percentage of the load discharged in the 2004-2005 timeframe. For many facilities, a load reduction was not required through the TMDL, and the WLA is 100 percent of the 2005 load. However, the TMDL requires some facilities to reduce their 2005 loads by the percentages indicated, and these reductions are accounted for in the numbers used to generate the WLAs shown in this table. Finally, if the "Percent of 2005 Load" used in developing the WLA is greater than the Current "Percent of 2005 Load", the data for that individual facility suggests that the WLA is currently being achieved.

[c] Regional Board staff allowed for a 60% increase in discharge volume for Brentwood because the concentration used to calculate their WLA was less than 0.06 ng/l.

[d] As shown, the TMDL Basin Plan Amendment states that the allocation assigned to the City of Davis Discharge Point 002 is based an annual average discharge flow of 2.4 mgd and a number of discharge days per year of 149. However, the 2.4 mgd flow rate was an average of all the discharge flows over a 365 day period (including zero values for days where discharge did not occur). Applying both the 2.4 mgd flow and an assumed 149 days of discharge significantly underestimates the load that was occurring in the 2004 to 2005 timeframe and the appropriate WLA. It is concluded, therefore, that the 0.17 g/yr value presented in the TMDL summary tables is an error. The 0.43 g/yr WLA presented in this table is based on the 2.4 mgd flow rate and an assumed 365 days of discharge per year.

[e] Ironhouse Sanitary District (ISD) is permitted to discharge to surface water 365 days per year; however, effluent is currently land applied on ISD-owned agricultural lands for a portion of the year. The existing facility has only been in operation since October 2012, so the period of zero surface water discharge has not been clearly established. Nevertheless, it is estimated that discharge to the river will occur approximately 245 days per year.

[f] The TMDL Basin Plan Amendment states that the allocation assigned to the ISD is 0.03 g/yr. However, the TMDL support documentation provides the numbers used to develop the ISD's WLA, and these numbers are reflected in this table. Using the numbers in this table to calculate the WLA indicates that the ISD WLA should be 0.3 g/yr. It is concluded, therefore, that the value presented in the TMDL summary tables is an error.

[g] Regional Board staff allowed for an increase in discharge volume for Woodland up to 10.4 mgd because the concentration used to calculate their WLA was less than 0.06 ng/l.

[h] The Total Current Load is calculated only for the NPDES Dischargers that were assigned WLAs in the TMDL Basin Plan Amendment. Dischargers not assigned WLAs are highlighted in this table.

[i] Daily flow data was not yet available for the current analysis, so flow has been estimated based on a 2/6/13 personal communication with Ron Walker, Chief Plant Operator for the City of Live Oak's Wastewater Treatment Plant.

The WLAs shown in Table 8 were calculated differently for each facility as follows:

- Two (2) facilities had MeHg concentrations below 0.06 ng/L. Thus, they were allowed a modest increase in effluent volume with no required decrease in effluent concentration - resulting in a modest increase in effluent loads over 2004-2005 levels (City of Brentwood WWTP and City of Woodland WPCF).
- Two (2) facilities were not yet online, as the then-current treatment plant was being replaced, but were assigned loads based on the anticipated treatment capacity of the replacement facility and the calibration standard for MeHg analysis available when the TMDL was adopted (0.05 ng/L) (Ironhouse Sanitary District WWTP and Rio Vista Northwest WWTF).
- One (1) facility (Mountain House Community Service District WWTP) was not online when the 2004-2005 data was collected, as the then-existing treatment plant was being replaced; however, data collected between August 2007 and May 2009 from the new plant demonstrated effluent concentrations were at or below the laboratory detection limit of 0.05 ng/l, so the WLA was calculated using a concentration of 0.05 ng/l and the planned ultimate treatment capacity for the facility.
- Two (2) facilities located in the Central Delta were assigned WLAs at their current loads, even though their effluent MeHg concentrations were above 0.06 ng/L, because the Central Delta already meets 0.06 ng/L concentration in its waters. (City of Lodi WPCF and City of Discovery Bay WWTP).
- The remaining seven (7) facilities were assigned WLAs based on load reductions of 21.5 to 55 percent, depending on the subarea where the facility is located. This load reduction was accounted for in the WLA calculations by reducing the effluent concentration by the respective percent reduction or to the goal value of 0.06 ng/L (whichever is greater) and assuming no increase in effluent flow rate.

As indicated in Table 8, the SPG Facilities appear to be making progress toward meeting the WLAs. In fact, all of the facilities have lower MeHg loadings than their respective WLAs. As noted previously, the improved effluent water quality that has occurred since 2005 are attributable to a range of improvements made at the SPG Facilities. As a result of these improvements, the SPG Facilities should be allowed to increase their discharge flow rates without exceeding their respective WLAs.

4.3 Information Supporting the Approach to Hypotheses

The MeHg Control Study Objectives are intended to provide an evaluation of potential relationships between specific municipal wastewater treatment levels and effluent MeHg concentrations. The MeHg Control Study is not intended, however, to provide an evaluation of the specific mechanisms that are causing variation in effluent water quality. Nevertheless, to ensure that the MeHg Control Study is adequately considering the range of potential removal mechanisms, an understanding of how MeHg removal mechanisms may be influenced in a municipal wastewater treatment facility system is necessary.

The concentration of MeHg in any system depends on the relative rates of methylation and demethylation of mercury. Both chemical and physical conditions can affect the methylation and demethylation of mercury in natural environments. These factors include: salinity, pH, dissolved oxygen, oxidation-reduction potential (ORP), organic carbon concentrations, and concentrations of elements that are important to mercury cycling (such as sulfur and iron). Moreover, a number of studies have demonstrated relationships between the methylation of mercury in aquatic environments and sulfate-reducing bacteria and other anaerobes (Alpers *et al*., 2008). Of these factors, dissolved oxygen, ORP, and organic carbon are modified differently for facilities at the different treatment levels evaluated under this MeHg Control Study.

An understanding of how these factors may be affected in a wastewater treatment process is gained by a review of the following available data:

- Recent Effluent Data
- Filtration Plant Inter-Process Monitoring Data
- Sacramento Regional WWTP Pilot Facility MeHg Study Data

4.3.1 Recent Effluent Data

The data provided in Figure 1 suggests that municipal wastewater treatment facilities that provide nitrification have significantly lower concentrations of effluent MeHg than facilities that do not provide nitrification (*i.e.,* primary and secondary facilities). Municipal wastewater treatment facilities that provide nitrification maintain the wastewater under aerobic conditions (where dissolved oxygen levels are typically maintained in the range of 1 to 3 mg/L) for longer periods than treatment plants that do not provide nitrification. This extended aeration period increases the oxidation state of the wastewater, potentially supporting oxidative demethylation processes.

In addition, the nitrification process results in the formation of nitrate (NO_3^-). The sequence of organic matter degradation processes is generally controlled according to the free energy yields of various electron acceptors, where these energy yields decrease progressively in the order O_2 > NO_3 - > Mn^{4+} > Fe^{3+} > SO_4^{2-} > CO_2 (Stumm and Morgan 1996). ORP is a measure of the energy yield state of a given water body. Accordingly, because sulfate (SO_4^{2-}) reduction generally will only proceed in the absence of energetically favorable electron acceptors, the presence of nitrate may inhibit methylation processes that would otherwise occur in a municipal wastewater treatment environment by sulfate-reducing bacteria. Scientific justification for the use of nitrate to control MeHg production has been presented in a number of studies conducted in Onondaga

Lake, where the findings suggest that the presence of nitrate may have abated sulfate reduction and associated MeHg production in the lake sediments (Upstate Freshwater Institute and Syracuse University Center for Environmental Systems Engineering, 2007).

Filtration processes result in greater TSS (and therefore organic carbon) removal than facilities that do not provide filtration. The data provided in Figure 1 suggest that facilities that provide nitrification have similar concentrations of effluent MeHg to facilities that provide nitrification and filtration. However, facilities that provide nitrification, denitrification, and filtration appear to perform better than the facilities that provide nitrification only (with or without filtration). This data therefore suggests that denitrification processes have a greater impact on MeHg reduction than filtration processes.

No specific research has been identified that links demethylation of mercury to denitrification processes. However, such linkages cannot be ruled out. Denitrification also has the potential to produce a better settling secondary sludge, and settling of particles has been identified as a significant MeHg loss mechanism in aquatic system such as the Delta (Foe *et al.*, 2008). Thus, lower effluent MeHg levels in denitrified effluent could potentially be attributed to better settling of sludge in the secondary clarification process. The relationship between secondary sludge settling and MeHg removal may also be demonstrated by data collected at the City of Vacaville WWTP, where an anaerobic selector is used in the secondary process as a means of enhancing the secondary sludge settling properties. As shown in Figure 1, the City of Vacaville WWTP effluent exhibits some of the lowest effluent MeHg levels of all the facilities that provide nitrification only.

4.3.2 Filtration Plant Inter-Process Monitoring Data

Inter-process sampling was completed between October and December 2012 in an effort to better understand what treatment processes are most likely contributing to MeHg removals from the wastewater. Specifically, inter-process monitoring was completed at the following facilities:

- City of Woodland WPCF (a nitrification-only facility)
- City of Roseville Dry Creek WWTP (a nitrification/denitrification plus filtration facility that provides sand media filtration - but where denitrification is not as complete as other denitrifying facilities evaluated under this study)
- City of Manteca WQCF (a nitrification/denitrification plus filtration facility that provides cloth media filtration)
- City of Roseville Pleasant Grove WWTP (a nitrification/denitrification plus filtration facility that provides sand media filtration)
- City of Rio Vista Northwest WWTF (a nitrification/denitrification plus filtration facility that provides membrane media filtration)

With the exception of Rio Vista's Northwest WWTF, inter-process samples were collected of the influent, secondary effluent, filtered effluent, and final effluent. At the Rio Vista Northwest WWTF, there is not a secondary clarification process, so secondary effluent samples could not be collected. The membrane filters are used to separate the liquid wastewater directly from the activated sludge, which combines the secondary clarifier activated sludge separation processes with the filtration process that would occur downstream of secondary clarifiers at the other facilities.

The data from this special monitoring study are presented in Figure 3 (effluent MeHg data), Figure 4 (effluent TSS data), and Figure 5 (effluent nitrate data). As indicated, most facilities exhibited little to no variation in the secondary, filtered and final effluent – thus indicating that the primary removal mechanisms that can be observed given the method detection limits applied occur in the secondary process for these facilities. In addition, the only two facilities where detected concentrations were observed were the two facilities that provide a lower level of denitrification (as indicated in Figure 5).

Sacramento Regional WWTP Pilot Facility MeHg Study

A MeHg Study was also recently completed at a pilot-scale treatment facility constructed at the Sacramento Regional WWTP. The Sacramento Regional County Sanitation District constructed the pilot facility to evaluate the effectiveness of different treatment processes for removing pollutants of concern from the Sacramento Regional WWTP's primary effluent. The pilot-scale facility includes a plug-flow, activated sludge secondary treatment process designed to also provide nitrification and denitrification, a granular media filtration process, and either chlorine disinfection or UV disinfection. (The pilot project also considered effects of ozonation on wastewater quality; however, a sufficient number of ozonated effluent samples were not collected to evaluate this treatment approach.) Mercury and MeHg samples were collected of the influent, the secondary effluent, the filter effluent, and the final (UV-disinfected) effluent.

A summary of the MeHg study data collected from the Sacramento Regional WWTP pilot-scale facility is presented in **Appendix D**, which includes a schematic of the pilot testing sampling locations and a bar chart of the average MeHg concentrations**.** As shown on the bar chart, the pilot-scale facility exhibited performance similar to that observed with the inter-process sampling conducted at the treatment plants discussed above, and the majority of removal occurred in the biological process that provides both nitrification and denitrification. This pilot-scale facility data also supports a conclusion that the MeHg removal processes are effective on a range of potential influent conditions, as the Sacramento Regional WWTP service area includes a range of potential MeHg sources that may not be similar to what occurs in the smaller municipal collection systems being evaluated under this study. Therefore, it is reasonable to assume the performance will be the same at a full-scale Sacramento Regional WWTP that provides nitrification/denitrification treatment as at the smaller facilities that provide the same treatment processes.

Figure 3. CVCWA MeHg Control Study Inter-Process Analysis MeHg Levels (Oct.-Dec. 2012)

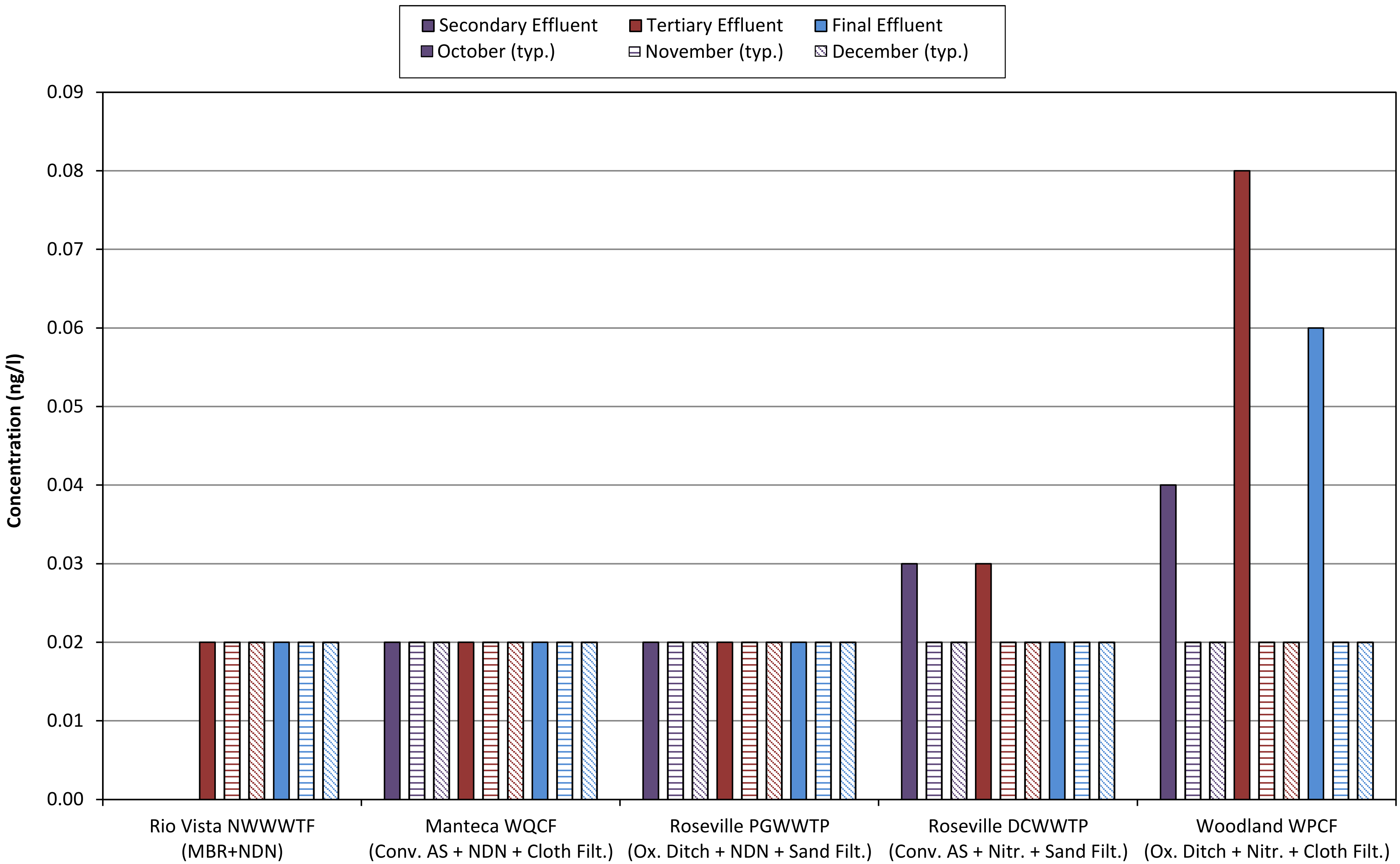


Figure 4. CVCWA MeHg Control Study Inter-Process Analysis
TSS Levels (Oct.-Dec. 2012)

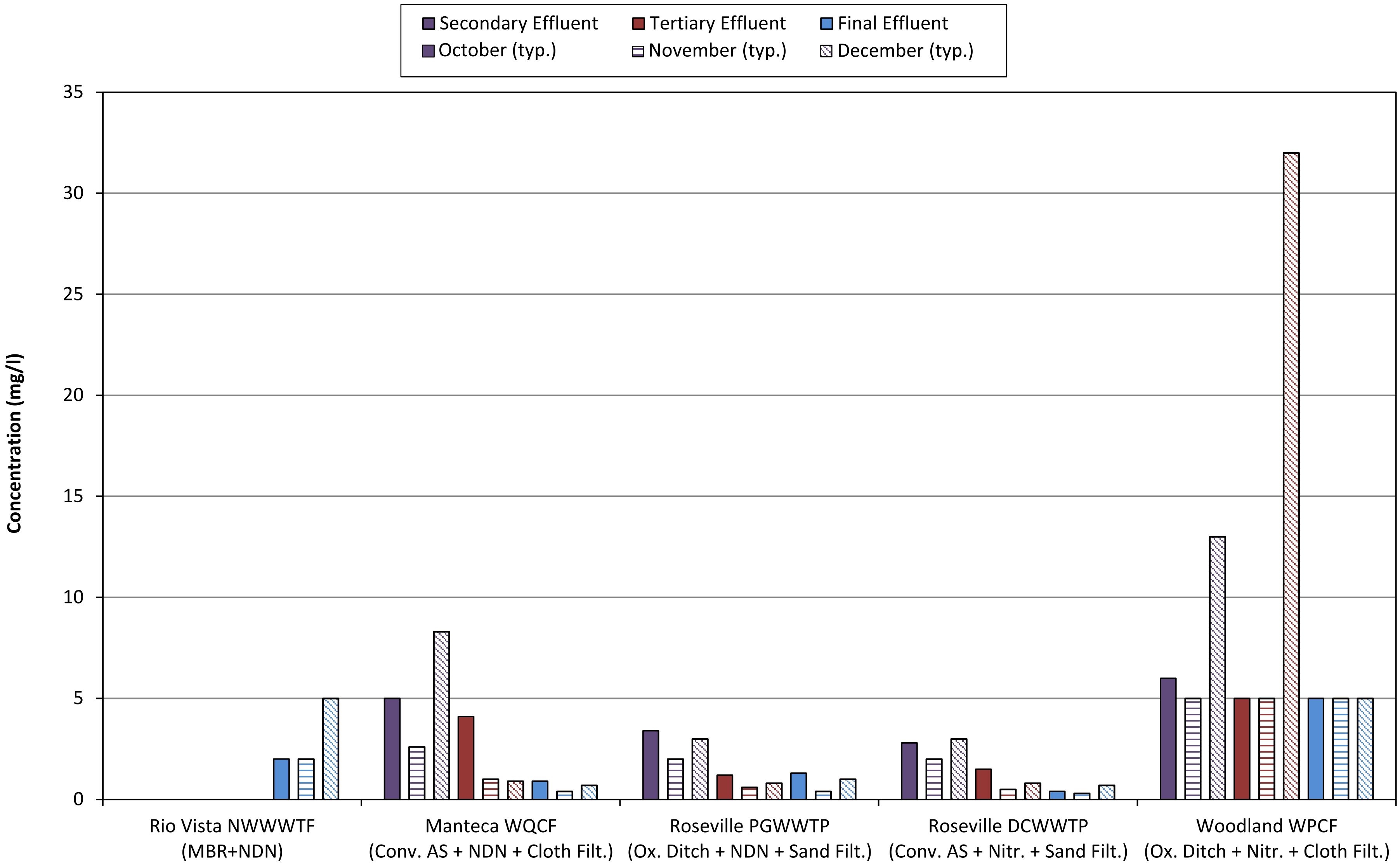
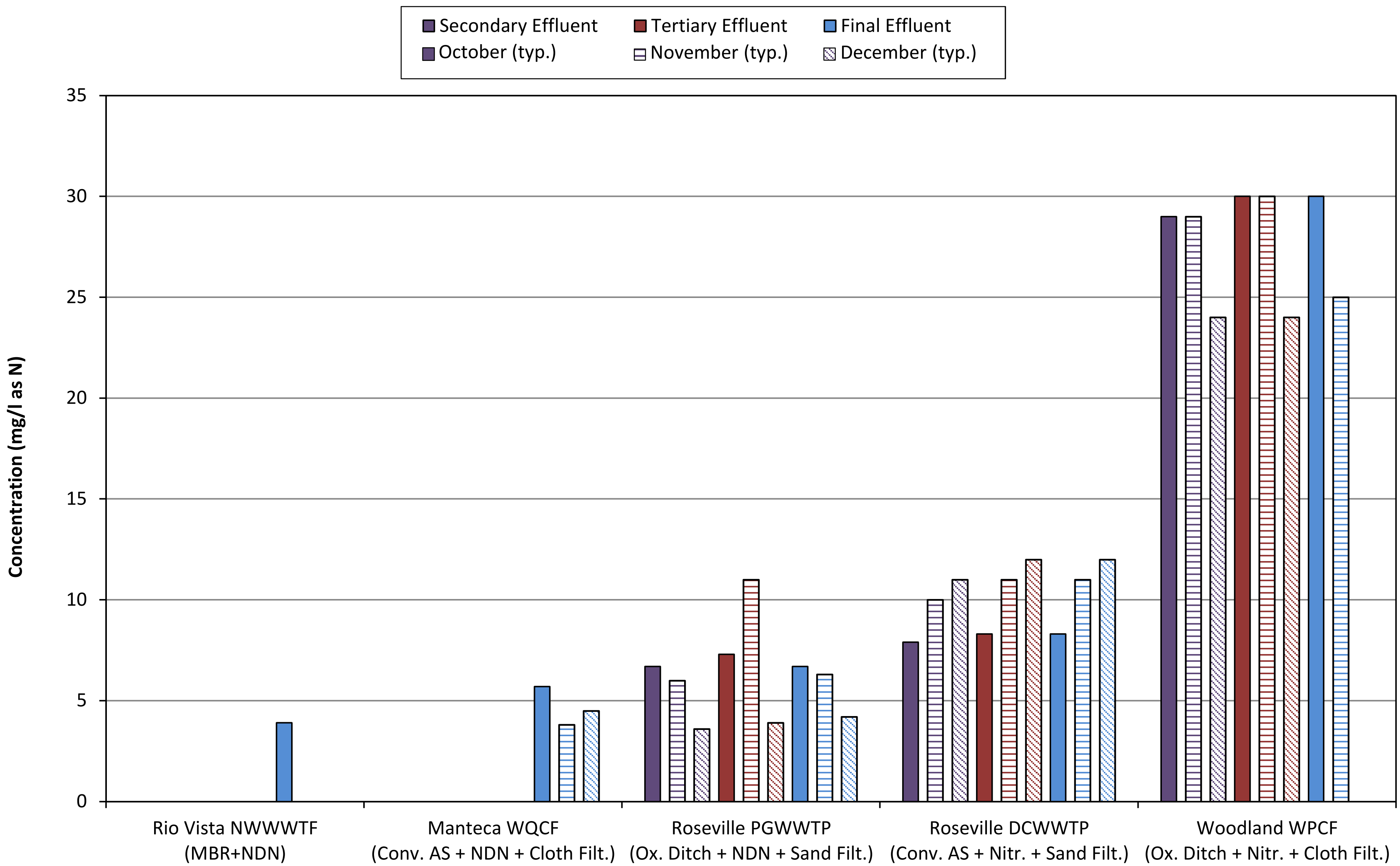


Figure 5. CVCWA MeHg Control Study Inter-Process Analysis
Nitrate Levels (Oct.-Dec. 2012)



4.4 Mechanisms Summary

The available data suggest there are relationships between specific municipal wastewater treatment levels and the ability to reliably lower MeHg concentrations in municipal wastewaters - even when there are varying influent conditions. The data also suggests that nitrification and/or denitrification process may have as much, or potentially more, impact on effluent MeHg water quality as filtration processes. Under the Control Study, data collected from the SPG Facilities will be used to further quantify the relationships between treatment levels and effluent MeHg concentrations.

Given the information available, it would appear that improvements that have recently been completed at municipal treatment facilities in the Central Valley (or will be made over the next ten year period) will result in WLA compliance. The results of the Control Study can be used to evaluate WLA compliance for the individual SPG Facilities. In addition, these results will help identify the level of additional efforts (if any) needed to evaluate the costs and benefits of applying additional control methods at individual NPDES Facilities beyond those that are already planned.

5.0 PROPOSED CONTROL MEASURES

This section describes how the Control Study is designed to evaluate the study objectives discussed in the previous section.

5.1 Guidance Document Requirements

Describe how the study will be designed to test the hypotheses and conceptual models as described in Elements 2 [Section 3.0] *and 3* [Section 4.0] *above. Explain whether the measure is targeted research, a pilot project, or larger in scope. If the project is targeted research, explain why the targeted research cannot be incorporated into a pilot project. If you are proposing a measure that is large in scope, describe the level of risk and how potential negative impacts could be managed or reversed.*

5.2 Data Collection Plan

Data and information from the SPG Facilities will be used as the basis of the evaluations. Specifically, data collected from the existing facilities will be used to:

- Quantify 2004–2005 Effluent Loads (Study Objective 1)
- Quantify Planned/Plausible 2030 MeHg Loads (Study Objectives 1 and 2)
- Evaluate Variances of Influent and Effluent MeHg Levels (Study Objective 3)

5.2.1 Quantify 2004–2005 Loads

Data that is summarized in the TMDL Staff Report will be used to quantify average effluent MeHg concentrations for each SPG Facility in 2004-2005. The average effluent MeHg concentrations presented in the TMDL Staff Report for each SPG Facility are shown in Table 9. The average concentration values shown in Table 9 will be recalculated from the raw data for each facility following the procedures discussed in Section 6.8.1 and **Appendix E** of this Work Plan. This value will be used along with the actual annual average flow and number of discharge days that occurred over the 2004-2005 sampling period to update the 2004-2005 load estimates.

Table 9. Average 2004-2005 Effluent MeHg Concentrations for SPG Facilities[(a)]

Agency	Facility		Sampling Period[(b)]	Average[(c)], ng/L
SPG Facilities Within the TMDL Program Area				
Brentwood, City of	WWTP		8/04-8/05	0.01 [(d)]
Davis, City of	WWTP	(Outfall EFF-001)	8/04-1/05, 7/05	0.55
		(Outfall EFF-002)	2/05-6/05	0.61
Discovery Bay, Town of	WWTP		8/04-7/05	0.19
Ironhouse Sanitary District	WWTP		[(e)]	[(e)]
Lodi, City of	White Slough WPCF		9/04-6/05	0.15
Manteca, City of	WQCF		9/04-7/05	0.22
Mountain House Community Services District	WWTP		[(e)]	[(e)]
Rio Vista, City of	Beach WWTF		8/04-4/05	0.16
	Northwest WWTF		[(e)]	[(e)]
Sacramento, City of	Combined WWCTS		12/04-3/06	0.54
Sacramento Regional County Sanitation District	SRWTP		12/00-6/03	0.72
Stockton, City of	Regional WWCF		8/04-7/05	0.94
Tracy, City of	WWTP		8/04-8/05	0.14
Woodland, City of	WPCF		8/04-7/05	0.03
SPG Facilities Outside the TMDL Program Area				
Live Oak, City of	WWTP		[(b)]	0.59
Roseville, City of	Dry Creek WWTP		[(b)]	0.02
	Pleasant Grove WWTP		[(b)]	0.02
UC Davis	Main WWTP		[(b)]	0.04
Vacaville, City of	Easterly WWTP		[(b)]	0.02
Yuba City, City of	WWTF		[(b)]	0.30

(a) With the exception of the City of Brentwood WWTP, the data provided for the SPG Facilities regulated under the TMDL Program are from Table 6.5 of the TMDL Staff Report and the concentrations represent the value used in the WLA calculations (see Table 8 of this Work Plan). For the SPG Facilities *not* currently regulated under the TMDL Program, the average concentrations shown are taken from Table G.3a of the TMDL Staff Report.
(b) Table G.3a does not indicate the time period for the Live Oak, Roseville, UC Davis, Vacaville, and Yuba City samples.
(c) Calculations assume non-detect (ND) results (less than the Minimum Detection Limit (MDL)) set equal to half of the MDL.
(d) All reported Brentwood data are non-detect with an MDL of 0.02. A value of 0.02 was used by the Regional Board in the WLA calculations (see Table 8).
(e) The following facilities were not in operation during the 2004-2005 monitoring period: Ironhouse Sanitary District WWTP, Mountain House CSD WWTP, and Rio Vista Northwest WWTF.

For facilities that did not discharge effluent in 2004-2005 (*i.e.*, Ironhouse Sanitary District WWTP, Mountain House Community Service District WWTP, and Rio Vista Northwest WWTF), the 2004-2005 average concentrations that will used to test the hypotheses under Study Objective 1 will be based on current effluent water quality data.

5.2.2 Quantify Planned and Plausible 2030 MeHg Loads

As discussed in Section 3.3.2 and Section 3.3.3, evaluation of Study Objectives 1 and 2 will involve comparing MeHg loads that would be discharged from the SPG Facilities under different scenarios. For each evaluation, the average effluent concentrations will be combined with estimated average daily effluent flow rates in 2030, and the anticipated average number of discharge days in 2030 to determine their effluent loads. The procedures that will be used to quantify these values is provided below.

Average 2030 Effluent MeHg Concentrations

Current effluent data will be used to quantify the average effluent concentrations for the SPG Facilities that are not planning process changes before 2030. Sufficient effluent MeHg data are available for most facilities to quantify existing average effluent MeHg concentrations. In addition, additional effluent data will be collected over the course of the study period to ensure that the availability of a robust data set for characterizing the average effluent MeHg concentrations.

Current effluent data will also be used to quantify the average effluent concentrations anticipated under the following treatment levels:

1. Facilities that provide conventional nitrification treatment without filtration,
2. Facilities that provide conventional nitrification and denitrification treatment without filtration, and
3. Facilities that provide conventional nitrification and denitrification treatment with filtration.

Specifically, effluent data collected from all of the facilities that provide a specific treatment level will be combined to represent the average effluent MeHg concentration.

A summary of the number of facilities that provide treatment at a given treatment level is given in Table 10. As indicated, there are ten facilities that provide conventional nitrification, denitrification, and filtration treatment. These facilities represent a range of both secondary biological treatment and tertiary filtration technologies that are common in the wastewater industry (Level 3). Therefore, combining the effluent data from all ten of these facilities should provide an accurate characterization of the range of effluent MeHg water quality from treatment plants that provide conventional nitrification, denitrification, and filtration treatment.

Table 10 also indicates that few SPG Facilities provide conventional nitrification treatment without filtration (Level 1) or conventional nitrification and denitrification treatment without filtration (Level 2). However, samples collected upstream of filtration processes can be used to estimate water quality from a secondary treatment process that provides nitrate and/or ammonia removal. Table 11 provides a summary of the number of facilities per treatment levels that could be represented if all of the SPG Facilities that currently provide filtration collected MeHg samples upstream of the filtration facilities. As indicated, by collecting samples at a location upstream of the filtration process, the total number of facility types represented will be significantly increased.

Table 10. Count of SPG Facilities by Treatment Type

Treatment Category	Total Number	Secondary Treatment Type						Filtration Type		
		MBR	Conv. AS	Pure Ox.	Ox. Ditch	Biofilters	SBR	Sand	Cloth	Membrane
Primary Treatment	1	-	-	-	-	-	-	-	-	-
Secondary Treatment	2	-	-	2	-	-	-	-	-	-
Secondary Treatment w/ Nitrification	3	-	2[(a)]	-	1	-	-	-	-	-
Secondary Treatment w/ NDN	1	-	1[(a)]	-	-	-	-	-	-	-
Pond-Based Secondary Treatment	1	-	-	-	-	-	-	-	-	-
Tertiary Treatment with Nitrification	3	-	-	-	2	1	-	1	2	-
Tertiary Treatment with NDN	10	2	4	-	3	-	1	6[(b)]	3[(b)]	2
Total	**21**	**2**	**7**	**2**	**6**	**1**	**1**	**7**	**5**	**2**

(a) Data from the Vacaville Easterly WWTP collected between January 2009 and December 2012 represents a facility that provides conventional nitrification treatment (without filtration). Data collected from the Vacaville Easterly WWTP after January 2013 represents a treatment facility that provides conventional NDN treatment (without filtration).

(b) UC Davis has three sand filters and one cloth filter at the Main WWTP.

Table 11. Count of SPG Facilities by Treatment Type When Including Secondary Effluent Data Collected from Facilities That Provide Tertiary Filtration

Treatment Category[(a)]	Total Number	Secondary Treatment Type						Filtration Type		
		MBR	Conv. AS	Pure Ox.	Ox. Ditch	Biofilters	SBR	Sand	Cloth	Membrane
Primary Treatment	1	-	-	-	-	-	-	-	-	-
Secondary Treatment	2	-	-	2	-	-	-	-	-	-
Secondary Treatment w/ Nitrification	6	-	2[(a)]	-	3	1	-	-	-	-
Secondary Treatment w/ NDN	9	-[(b)]	5[(a)]	-	3	-	1	-	-	-
Pond-Based Secondary Treatment	1	-	-	-	-	-	-	-	-	-
Tertiary Treatment with Nitrification	3	-	-	-	2	1	-	1	2	-
Tertiary Treatment with NDN	10	2[(b)]	4	-	3	-	1	6[(c)]	3[(c)]	2
Total	**32**	**2**	**11**	**2**	**11**	**2**	**2**	**7**	**5**	**2**

(a) Data from the Vacaville Easterly WWTP collected between January 2009 and December 2012 represents a facility that provides conventional nitrification treatment (without filtration). Data collected from the Vacaville Easterly WWTP after January 2013 represents a treatment facility that provides conventional NDN treatment (without filtration).

(b) Membrane bioreactor (MBR) facilities do not provide a secondary clarification step. Therefore, it is not possible to collect samples from these facilities that would accurately represent secondary wastewater quality.

(c) UC Davis has three sand filters and one cloth filter at the Main WWTP.

2030 Effluent Flows

The 2030 average daily effluent flow rates will be determined for each SPG Facility by applying the predicted growth rate for each facility to the 2014 annual average flow value. The 2014 annual average effluent flow rates will be determined based on the average daily flow rates during periods of surface water discharge over the two-year period from September 2012 to October 2014.

The 2030 average daily flow will be determined using the following equation:

$$Projected\ 2030\ Discharge\ Flow =$$

$$(2014\ Annual\ Average\ Discharge\ Flow) \times (1 + Growth\ Rate)^{2030-2014}$$

The growth rates for each facility will be determined using the following information:

- California Department of Finance (DOF) historic population data for the communities served by the facility (when available) will be used to calculate annual growth rates for each of the 10 year periods between 1971 and 2010. The average of the annual growth rates for each decade will be assumed to be the long-term growth rate.
- For communities where DOF does not provide population data (*i.e.*, smaller communities), the US Census Bureau population data for the period between 1980 and 2010 will be used to predict future long-term growth for these areas. Again, annual growth rates for each ten year period were determined and the long-term growth rate was assumed to be the average of the rates in each decade.
- For facilities serving a number of communities, the US Census Bureau information for a grouping of communities may be provided. In other cases, either the “incorporated” or “unincorporated” county numbers as provided by DOF will be used.
- Finally, where the DOF or US Census Bureau data did not appear to be applicable, data from the communities themselves was identified. Specific data sources included individual NPDES Permits, General Plans, Development Plans, or other readily available documents.

It should be noted that the state established an initiative in 2008, “to achieve a 20 percent reduction in per capita water use statewide by 2020.” Although a significant portion of the water use reductions would likely be associated with landscape irrigation demand, such reductions would result in some decrease in wastewater flow being discharged to POTWs. Nevertheless, it is not proposed at this time that the projected 2030 flows be adjusted to account for future water conservation.

2030 Discharge Days

Daily flow data collected over the three-year period from September 2011 to October 2014 will also be used to define the average number of discharge days anticipated in 2015. As indicated in the "Days of Discharge per Year" column in Table 8, the following SPG Facilities currently do not discharge to surface water year-round:

- City of Lodi WPCF,
- Ironhouse Sanitary District WWTP,
- City of Manteca WQCF,
- Stockton Regional WWCF,
- City of Sacramento Combined WWCTS,
- City of Davis WWTP, and
- City of Roseville Pleasant Grove WWTP.

In the case of Lodi, Ironhouse, Manteca and Roseville, these facilities currently provide recycled water to customers during the summer months and the recycled water demand has the potential to match or exceed the volume of effluent produced. This condition results in periods of zero surface water discharge. For these facilities, it will be assumed that the recycled water demands will increase proportionally to increasing wastewater flows – thus resulting in the same number of discharge days per year in 2030 as occur in the September 2011 and October 2014 period.

In the case of the Stockton Regional WWCF, the treatment process includes a large pond system that provides significant storage capacity. This pond system is used consistently each year to hold wastewater in lieu of surface water discharge (typically during maintenance periods). The City of Stockton has recently completed a comprehensive master plan for the Regional WWTP that identifies continued use of the ponds over the next 20+ year period. Therefore, it is expected that the practice of holding wastewater in lieu of surface water discharge will continue, and the same number of discharge days that occur between September 2011 and October 2014 will be the same in 2030.

In the case of the City of Sacramento Combined WWCTS, this facility is designed to accommodate peak wet weather flows from the combined sewer system that serves the City of Sacramento. The majority of flow is delivered to the Sacramento Regional WWTP. Specifically, flows in excess of 60 mgd are routed to either the Pioneer Reservoir Treatment Plant or to the Combined Wastewater Treatment Plant for treatment and/or storage. Once the storage capacity at these facilities has been reached then treatment of the wastewater flows will begin. Because the number of discharge days and effluent volumes vary based on rainfall, a three-year record of discharge days will not provide an adequate estimate of the typical average number of days of discharge per year. Therefore, for the Sacramento Combined WWCTS, the average discharge volume that is expected to occur in 2030 will be based on the average annual volume discharged between 2001 and 2014. (The average annual discharge volume determined using this method will be increased to the 2030 condition based on growth projections discussed in the "2030 Flows" section above.)

For the City of Davis WWTP, the effluent is discharged year-round. However, the effluent flow is split between two different locations. From approximately April/May through October/November, effluent is directed to outfall EFF-001, which is located upstream of the Yolo Bypass and therefore not regulated under the TMDL Program. During the remainder of the year, the effluent is directed to outfall EFF-002, which is located in the Yolo Bypass (and therefore regulated under the TMDL Program). For purposes of quantifying effluent loads in Table 8, these two discharge locations were considered separately. However, the City is currently evaluating the proposed long-term treatment and disposal approach. It is expected that this planning analysis will demonstrate that either outfall EFF-001 or outfall EFF-002 should be eliminated. Therefore, the loading analysis for the Davis WWTP will be based on an assumed 365 day per year of discharge at one location. However, it is not clear at this time which discharge location will be applicable when considering the 2030 condition.

Finally, it is possible that a reduction in flows (and loads) could result from future water recycling initiatives by the SPG Facilities. However, at this time, no specific plans have been identified. Therefore, unless specific information on recycling efforts by a given SPG Facility is developed during the MeHg Control Study period, future water recycling projects will not be incorporated into the analysis.

5.2.3 Evaluate Variances Influent and Effluent MeHg Levels

Only some of the SPG Facilities have collected concurrent influent and effluent water quality data (*i.e.*, data from samples collected on the same day) in sufficient numbers to confidently evaluate the relationship between the variances of influent and effluent MeHg concentrations. Additional concurrent influent and effluent data, therefore, will be collected over the course of the study period to ensure that there is a robust data set available to evaluate the hypothesis under Study Objective 3.

6.0 MONITORING AND DATA COLLECTION PLAN

Monitoring and data collection encompasses two main tasks: a sampling and analysis plan (SAP) and quality assurance/quality control (QA/QC) procedures. The SAP is described in this section and the QA procedures are described in the following section of this Work Plan, per the Guidance Document. The SAP topics described in this section are as follows:

- Contract Laboratory Involvement
- Data Collection Period
- Sample Locations and Frequency
- Sample Collection Procedures
- Analytical Methods
- Reporting Protocols
- Statistical Methods

6.1 Guidance Document Requirements

Identify parameters and media that will be measured and over what frequency and duration. Describe how these measurements will be used to determine the effectiveness of the control measure(s). Describe the statistical approach you will use to evaluate the results and compare outcomes with the hypotheses. Studies to assess the effects of water management on methylmercury may largely rely on methylmercury data already collected.

6.2 Contract Laboratory Involvement

The MeHg Control Study participants use the services of the following three certified laboratories for low-level mercury and MeHg analyses:

- Basic Laboratory in Redding and Chico, CA (Basic),
- Caltest Analytical Laboratory in Napa, CA (Caltest); and
- Frontier Global Sciences in Bothell, WA (Frontier).

The quality assurance practices employed by these three labs are discussed in Section 7.2.2. If another laboratory is going to be used for this study, a review of the quality assurance practices of the new laboratory will be reviewed to ensure the data provided by that will be of the same quality as what can be provided by the three laboratories listed above.

The SPG Facilities will be responsible for coordinating analyses with their contract laboratories. Additional information regarding the QA/QC procedures used at these laboratories is discussed in Section 7.0.

6.3 Data Collection Period

The sampling period described in this SAP will occur between October 2013 and September 2014. Data collected between October 2009 and September 2013 will also be used to characterize influent and effluent MeHg levels in addition to data collected during the MeHg Control Study monitoring period. Use of these older data is appropriate for the following reasons:

- All of the SPG Facilities have had consistent treatment processes (*i.e.*, no upgrades) since early 2009, with the exception of the City of Vacaville WWTP. To address changes at the City of Vacaville WWTP, only the data collected from this facility since January 2013 will be used to characterize performance anticipated in 2030. (Data collected between October 2009 and December 2012 will also be used to help characterize performance of facilities that provide nitrification only treatment.)
- Many of the QA/QC procedures described below for the MeHg Control Study sampling program have also generally been followed at the SPG Facilities in collecting data from October 2009 and later. Moreover, all SPG Facilities report using low-level metals sampling techniques described in this Work Plan (*i.e.*, clean hands/dirty hands practices) during this period. Finally, a review of 2009 through 2012 data indicates mercury and MeHg results that are relatively consistent (given the

expected variation of municipal wastewater treatment facility effluent data) supporting a conclusion that samples were not likely contaminated in the field.

- The method detection limits and reporting levels (MDLs and RLs) used by the SPG Facilities during this period meet the criteria set forth in this Work Plan (*i.e.*, maximum of 0.02 and 0.05 ng/L, respectively).
- The individual SPG Facilities have been using the same laboratories to provide MeHg analyses since 2009, so the level of laboratory quality control is consistent.

Should a review of the data collected under the MeHg Control Study reveal QA/QC concerns with the older data, it may be determined that *only* the data collected under the MeHg Control Study can provide a reliable estimate of current treatment performance. An analysis of the QA/QC procedures and applicability of older data for describing current facility performance will be further evaluated and discussed in the MeHg Control Study Reports submitted in accordance with this Work Plan.

6.4 Sample Locations and Frequency

During the MeHg Control Study monitoring period, concurrent influent and final effluent mercury and MeHg samples will be collected monthly. In addition, facilities with cloth and/or sand filtration processes will collect monthly secondary effluent samples. All SPG Facilities will complete the sampling, with the following exceptions:

- Ironhouse Sanitary District will collect samples only during months when surface water discharge occurs, in line with their NPDES permit requirements for MeHg monitoring.
- Mountain House Community Services District will collect samples quarterly, in line with their NPDES permit requirements for MeHg monitoring.
- City of Sacramento Combined WWCTS will only collect samples during periods of discharge, in accordance with their NPDES permit requirements for MeHg monitoring.

The first two facilities both have small service areas and minimal mercury loads. In addition, both facilities provide nitrification/denitrification plus filtration treatment and have had demonstrated high effluent water quality with respect to MeHg (final effluent water quality values in the last several years have generally been reported as less than a detection limit of 0.02 ng/L). In addition, as documented previously in this Work Plan, there is already a robust data set available from facilities that provide nitrification/denitrification plus filtration treatment Therefore, a reduced sampling frequency at the Ironhouse Sanitary District and the Mountain House Community Service District facilities should still provide a data set that adequately describes the variability in effluent MeHg concentrations from facilities that provide nitrification/denitrification plus filtration treatment.

With respect to the Sacramento Combined WWCTS, it will only be possible to collect concurrent samples from this facility during the periods when discharges occur.

Daily flow data will also be collected, and ammonia as N, nitrate as N, TSS will be monitored for each SPG Facility at the effluent compliance monitoring location currently specified in the respective NPDES permit. These parameters will also be monitored for secondary effluent concurrently with the mercury and MeHg monitoring schedule.

An overview of the parameters required for MeHg Control Study sampling, including locations and frequencies, are presented in Table 12.

Table 12. Overview of MeHg Control Study Sampling (October 2013-September 2014)

Facilities	Location	Frequency	Parameter of Interest					
			Flow	NH3-N	NO3-N	TSS	Hg	MeHg
All	Influent	Monthly[(a)(b)]					✓	✓
Facilities with Cloth or Sand Filtration	Secondary Effluent	Monthly[(a)(b)]		✓	✓	✓	✓	✓
All	Final Effluent	Monthly[(a)(b)(c)]	✓	✓	✓	✓	✓	✓

(a) Mountain House Community Services District will collect samples quarterly.
(b) Ironhouse Sanitary District will collect effluent samples only during periods of surface water discharge.
(c) Samples for non-mercury parameters may be taken more or less frequently in accordance with the permit requirements for each SPG Facility.

6.5 Sample Collection Procedures

This section presents an overview of the sample collection procedures that will be followed during the October 2013 through September 2014 data collection period. These procedures have been and/or will be generally followed by the SPG Facilities for all data collected between October 2009 and September 2013.

6.5.1 Sample Types

Grab and composite samples will be collected at each SPG Facility in accordance with the NPDES permitting requirements for the facility. Where sampling requirements are not specified in current NPDES permits, grab samples will be collected. Mercury and MeHg sampling types being used currently at each of the SPG Facilities are presented in Table 13. As shown, grab samples are collected by most of the SPG Facilities, in accordance with their NPDES permits. (Note that sampling procedures listed in Table 13 may be modified in accordance with the renewed NPDES permits for the individual SPG Facilities.)

Table 13. Mercury and MeHg Sampling Types Currently Used at SPG Facilities

Agency	Facility	Sample Type	
		Composite	Grab
Facilities Within the TMDL Program Area			
Brentwood, City of	WWTP		✓
Davis, City of	WWTP		✓
Discovery Bay, Town of	Discovery Bay WWTP		✓
Ironhouse Sanitary District	WWTP		✓
Lodi, City of	White Slough WPCF		✓
Manteca, City of	WQCF		✓
Mountain House Community Services District	Mountain House WWTP		✓
Rio Vista, City of	Beach WWTF		✓
Rio Vista, City of	Northwest WWTF		✓
Sacramento, City of	Combined WWCTS		✓
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	✓	
Stockton, City of	Regional WWCF		✓
Tracy, City of	Tracy WWTP		✓
Woodland, City of	WPCF		✓
SPG Facilities Outside the TMDL Program Area			
Live Oak, City of	WWTP	✓	
Roseville, City of	Dry Creek WWTP		✓
Roseville, City of	Pleasant Grove WWTP		✓
UC Davis	Main WWTP		✓
Vacaville, City of	Easterly WWTP		✓
Yuba City, City of	WWTF	✓	

Composite samples are not specified for all SPG Facilities for the following reasons:

- MeHg sampling, particularly for the relatively low levels of MeHg expected, requires strict control to avoid contamination (EPA Method 1669 is specifically a grab sample method), and composite sampling for mercury has not been shown to be free of contamination at levels that could compromise reliable measurements (USEPA, 2001).
- Since most of the SPG Facilities are not currently collecting composite mercury and MeHg samples, staffs are not comprehensively trained on the stricter composite sampling requirements for low-level metals.

- Although most SPG Facilities have sample compositing equipment, the equipment is used for daily monitoring of conventional parameters such as BOD and TSS. Therefore, facilities do not have equipment available for dedicated mercury/MeHg sampling.
- Changes in MeHg concentration could occur in composite sampling containers. (Preservation is not always a viable option, as sampling equipment is used to collect samples for multiple parameters.)

Composite sampling has not been shown to provide more accurate or less variable results for mercury and MeHg than grab sampling (Monson, 2007). Moreover, a review of the recent effluent data (Figure 1) indicates a significant number of non-detect effluent MeHg results for the treatment types of interest and limited variation. Therefore, effluent MeHg results are not expected to vary significantly within the limits of detection.

To ensure that grab samples provide a range of conditions expected, the SPG Facilities will use the following sampling procedures[14]:

- Samples will be collected during normal, working days. In addition, SPG Facilities will collect one monthly sample within each hour of a typical workday for the given facility, up to an eight (8) hour window. The remaining four (4) samples will be collected once per hour during the four-hour window of expected peak load for the respective facility[15].
- At least one sample will be collected for each day of the five-day work week.

Each SPG Facility collecting grab samples will be responsible for ensuring that this procedure is followed. The data evaluation, described later in this Work Plan, will document conformity with this procedure.

6.5.2 Sampling Equipment Preparation

The analytical laboratory will provide the sample bottles, including those containing sample preservative, where applicable. Facility staff performing the sampling will need to label the bottles appropriately. Each sample bottle label will include the following information:

- Location, type, and name/number of collected sample (*e.g.*, EFF-001 Grab)
- Container pretreatment or preservatives (including cooling and added preservatives)
- Analyses to be performed on sample
- Date and time of collected sample
- Initials of persons collecting the sample

[14] Some of the SPG Facilities specifically require samples be collected during the peak flow and load period of the day. These facilities will, therefore, collect samples in accordance with their permit requirements.
[15] SPG Facilities that provide equalization will attenuate the peaks loads. For these facilities grab samples will simply be spaced throughout the typical work day.

The date and time when the sample is collected, as well as the initials of the sampler, will be written on the sample container when the sample is collected. The other information may be written on the container in advance of sample collection.

Sampling equipment will also be clean and free from contaminants, including reusable equipment, if any. (Specific equipment preparation procedures that will be followed are discussed in Section 7.2.1.) The only other equipment preparation anticipated in addition to routine sampling procedures is having refrigeration facilities and/or ice chests stocked with ice for samples requiring cooling as a preservative (*e.g.*, nitrate).

6.5.3 Sampling Protocols

Table 14 provides the sampling protocols, including sample containers, volume, preservatives, and holding times.

Table 14. Water Quality Sampling Handling Procedures

Parameter	Container	Sample Volume	Preservation	Maximum Holding Time
Ammonia as N	500 mL plastic or glass	150 mL	H_2SO_4 to pH<2 and Cool to 4°C, Dark	28 days
Mercury[a]	1 liter glass, double-bagged	1 liter (no headspace)	HCl	48 hours (unpreserved) 90 days (preserved)
Methylmercury[a]				
Nitrate as N	500 mL plastic or glass	150 mL	H_2SO_4 to pH<2 and Cool to 4°C, Dark	28 days
Total Suspended Solids	500 mL plastic or glass	200 mL	Cool to 4°C, Dark	7 days

(a) Mercury and methylmercury samples can be collected together. The volume indicated allows for adequate volume for matrix spike/matrix spike duplicate analysis.

SPG Facility staff will make note of any deviations from the protocols given in Table 14 (the data reporting templates discussed below include a “Notes” column where such notes can be recorded). Specific sampling procedures for both grab and composite samples are discussed further in Section 7.2.1.

Proper safety procedures will need to be followed by the field and laboratory staff collecting and analyzing samples. The sampling and analytical parameters of interest for the MeHg Control Study are similar in nature to the current NPDES permit requirements for the facilities, and the onsite laboratory staff should have safety plans and procedures already in place to provide adequate protection. The laboratory will be responsible for maintaining a safe work environment and a current awareness of Occupational Safety and Health Administration (OSHA) regulations regarding the safe handling of chemicals known or suspected to be present in the collected samples.

6.6 Analytical Methods

Onsite readings will be conducted at each of the SPG Facilities for influent flow via continuous flow meters. Water quality samples will be analyzed using the analytical test methods and Method Detection Limits (MDLs) and Reporting Limits (RLs) listed in Table 15.

Table 15. Water Quality Sampling Analytical Requirements

Parameter	Units	Analytical Test Method	Maximum MDL	Maximum RL
Flow	MGD	Continuous Flow Meter	Not applicable	
Ammonia as N	mg/L	Standard Method 4500-NH_3 Nitrogen (Ammonia)	0.2	0.5
Mercury	ng/L	EPA Method 1631 (Revision E)	0.2	0.5
Methylmercury	ng/L	EPA Method 1630	0.02	0.05
Nitrate as N	mg/L	Standard Method 4500-NO_3 Nitrogen (Nitrate) EPA Method 300.0	0.01	0.1
Total Suspended Solids	mg/L	Standard Method 2540 D: TSS	2	6

6.7 Reporting Protocols

For purposes of this study, data will be reported as follows:

- With each sample result, both the applicable RL and the MDL will be reported.
- Sample results greater than or equal to the RL will be reported as measured by the laboratory (*i.e.*, the measured chemical concentration in the sample).
- Sample results less than the RL, but greater than or equal to the laboratory's MDL, will be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported.
- For the purposes of data collection, the laboratory will write the estimated chemical concentration next to DNQ. The words "Estimated Concentration" may also be indicated.
- Sample results less than the laboratory's MDL will be reported as "Not Detected," or ND.

6.8 Statistical Methods

This section describes the statistical approach that will be used to complete the following tasks:

- Quantifying Average Effluent Concentrations
- Comparing Effluent Load Conditions
- Evaluating Influent and Effluent Data Variances

6.8.1 Quantifying Average Effluent Concentrations

Testing the MeHg Control Study Objective hypotheses will involve calculating average effluent concentrations for each individual SPG Facility and for all SPG Facilities that represent a treatment level of interest. These values will be calculated as follows:

- If all of the values are reported (whether a quantified or estimated concentration) the averages will be directly calculated from the data.
- When there are at least 5 detected values, but non-detect values make up some portion of the data set (up to 90 percent), a log-normal probability distribution of detected and non-detected data will used to calculate average values using the "Robust Method" (Helsel and Cohn, 1988). **Appendix E** includes further details regarding the use of "Robust Method" to apply non-detect data in developing probability plots.
- When there are less than 5 reported detected or estimated values, or when the non-detect data are greater than 90 percent of the total data set, a meaningful statistical analysis of the data cannot be performed. Under this case, the average concentration will be directly calculated assuming all non-detect values are equal to half the detection limit.

An example of the log-normal probability plots that will be developed from data sets with non-detect values is shown in Figure 6. (The example shown represents a combined data set from multiple SPG Facilities providing the same treatment level.) As indicated, non-detect data are not plotted directly on a given lognormal probability plot. However, these data points are used to define the plotting position for the detected data points. The average (mean) of the lognormal data set will be calculated from the probability plot based on the following formula:

$$Average\ Concentration = e^{(C+S^2/2)}$$

where

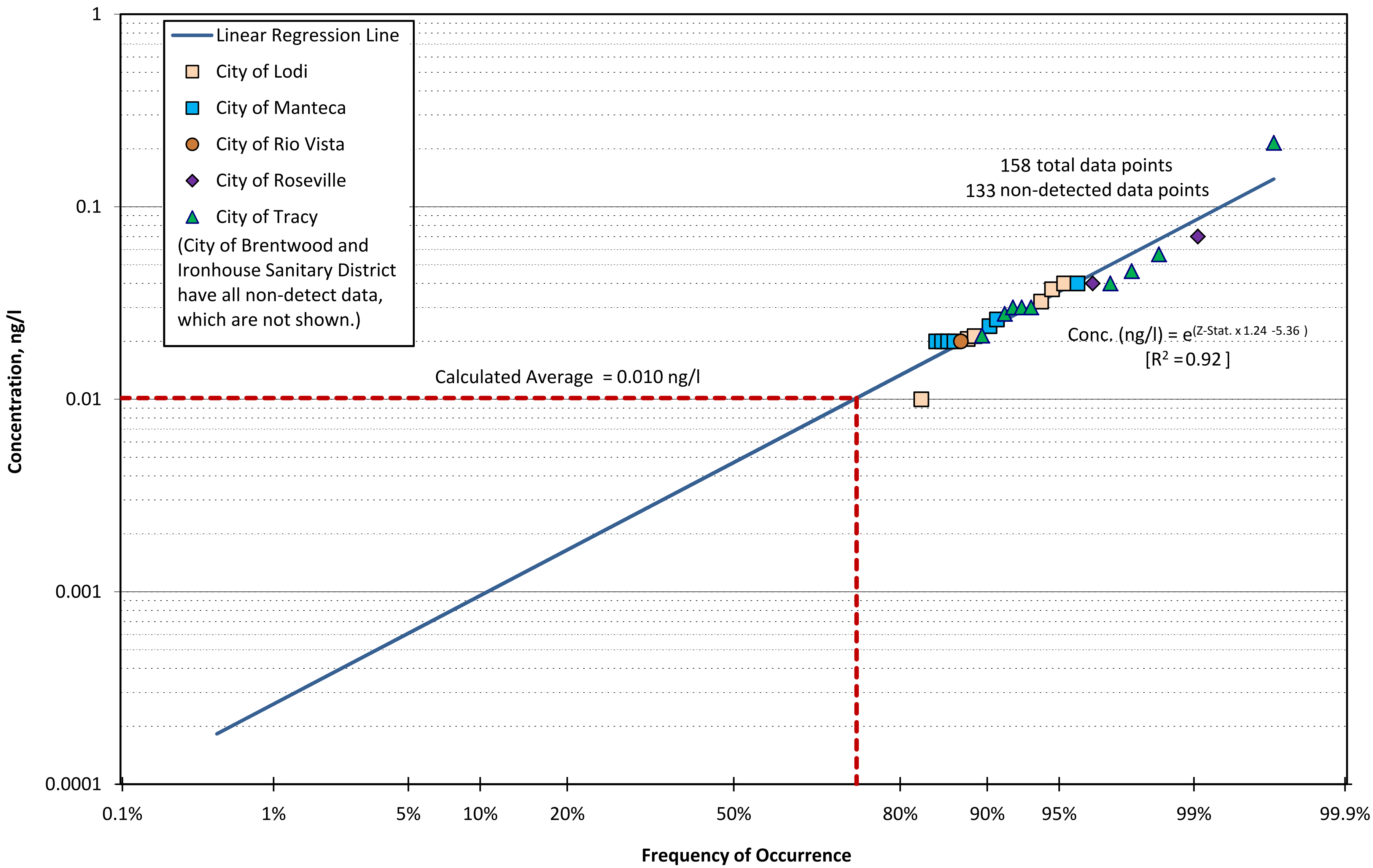
C = "intercept" of the log-normal distribution line, and

S = slope of the log-normal distribution line.

6.8.2 Comparing Effluent Load Conditions

Evaluating Study Objectives 1 and 2 requires a comparison of two annual average load data sets calculated from paired effluent water quality data (concentration data from the same facilities, but collected at different time periods or under different conditions). As is common for environmental data, the effluent water quality data are not expected to be normally distributed (Metcalf and Eddy, Inc., 2003). Whereas the paired t-test could be used for comparing normally distributed data, the (Wilcoxon) signed-rank test is a similar statistical test for use with non-parametric data (*i.e.*, data with an unknown distribution). The signed-rank test will therefore be used to test the Study Objective hypotheses described in this Work Plan.

Figure 6. Sample Probability Plot for Facilities with Filtration and Nitrification/Denitrification Effluent MeHg Data, Jan. 2009-Apr. 2012



The signed-rank test can be performed with standard statistical software (*e.g.,* Statistix Analytical Software) with two sets of data that have been paired. Running the signed rank test produces a one-tailed p-value. A p-value of less than 0.05 (95 percent confidence) will be used to determine whether two data sets are significantly different from each other. If a statistically significant difference is found, then the results will be considered sufficient to reject the null hypothesis. Alternatively, if a statistically significant difference is not found, then the results will fail to reject the null hypothesis.

6.8.3 Evaluating Influent and Effluent Data Variances

Evaluation of Study Objective 3 will require testing whether the variance of influent MeHg concentrations is significantly different from the variance of effluent MeHg concentrations at a given treatment level. In statistical terms, this testing will involve evaluating whether there is an equality of variance for the influent and effluent MeHg data. Influent and effluent MeHg data will be evaluated using the following steps for facilities representing each of the four treatment levels of interest (see Section 3.3.4):

1. October 2009 to September 2014 influent and effluent MeHg data from facilities with the same treatment level will be combined into one data set. Non-detect data will be set equal to half the reported MDL for purposes of this analysis.
2. Statistical software will be used to perform a Brown-Forsythe test, which is a non-parametric test (*i.e.*, normally distributed data is not necessary) for evaluating the equality of variances, with variances calculated based on medians[16]. As part of the Brown-Forsythe test, a one-way analysis of variance test is conducted with the full data set to calculate an F-statistic.
3. If the calculated F-statistic is greater than the critical F-value for a 0.05 significance level (95 percent confidence), the variance will be considered unequal, and the MeHg Control Study data will reject the null hypothesis.
4. If the results do not indicate a statistically significant difference (F-statistic less than critical F-value), there is insufficient evidence of a significant difference between the variances, and the MeHg Control Study data will fail to reject the null hypothesis.

[16] The similar Levene's test is more commonly used to test equality of variance but includes a calculation of variance based on averages; since the data sets may include significant amount of non-detect data, a test based on medians is more appropriate.

7.0 QUALITY ASSURANCE PROCEDURES

This section describes the specific Quality Assurance (QA) and Quality Control (QC) procedures that will be applied during the October 2013 to September 2014 sampling period.

7.1 Guidance Document Requirements

The Control Study Workplan must contain or summarize and reference quality assurance procedures that cover all aspects of sample collection, handling, and analyses for all parameters that will be measured. Quality assurance plans that may be referenced include:

a. *Monitoring and Reporting Plans (MRP) that have been approved for Irrigated Agriculture Coalitions and NPDES permittees.*
b. *SWAMP Quality Assurance Program Plan*
c. *CALFED Mercury Quality Assurance Project Plan*

Note that the SWAMP QAPP describes appropriate sample containers, preservation, and analytical methods for many parameters, including mercury and methylmercury. It does not cover sample collection methods. Appendix A of the SWAMP QAPP describes acceptable frequency and types of quality control tests. If an entity is following an MRP or quality assurance plan that does not address a measurement that will be taken during the study, then quality assurance procedures must be described in the Control Study Workplan.

Aqueous samples for mercury and methylmercury should be collected using clean hands/dirty hands techniques (US EPA Method 1669). Water samples that will be used for direct comparisons with the methylmercury allocations should be analyzed as unfiltered. For methylmercury, aqueous samples should be analyzed using USEPA method 1630 with a method detection limit of 0.02 ng/L or less. For total recoverable mercury, aqueous samples should be analyzed with a method detection limit of 0.2 ng/l or less. The preferred method for total mercury is USEPA Method 1631 Revision E.7

Entities developing Study Workplans are encouraged to contact Central Valley Water Board staff or the SWAMP QA Help Desk with any data collection or analysis questions.

7.2 QA Protocols

Quality assurance (QA) entails the policies, procedures, and actions established to provide and maintain a degree of confidence in data integrity and accuracy. Additional QA protocols described in this section include the following:

- Clean Sampling Practices
- Multiple, Accredited Laboratories
- Chain of Custody (COC) forms
- Data Reporting Template

7.2.1 Clean Sampling Practices

In accordance with the individual NPDES Permits for the SPG Facilities, all MeHg samples are being collected in general accordance with the procedures detailed in *EPA Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA, 1996). In addition, although Method 1669 was not written to apply to composite sampling, compositing equipment and sample containers can be prepared following Method 1669. Additional guidance regarding appropriate wastewater treatment plant sampling practices, including specific guidelines for using automatic wastewater sampling equipment, is provided in Section 9, and Appendix B and C of *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (USEPA, 2001).

7.2.2 Multiple, Accredited Laboratories

As discussed previously, the various SPG Facilities have contracted with three different laboratories for mercury and MeHg testing: Basic, Caltest, and Frontier. The use of three separate laboratories is a significant QA tool, allowing for a check on the quality of data reported by different laboratories. (Note that the lack of anomalous data observed in recent, historical mercury and MeHg data for the SPG Facilities, which is from these three laboratories, indicates the high quality of results from all three laboratories (See data presented in **Appendix C**).

In addition to using multiple laboratories, all three laboratories have current, available certifications for mercury and MeHg, and, as part of these certifications, are subject to regular outside auditing of the certified procedures. The relevant certifications are specifically as follows:

- All of the laboratories are certified from the California Environmental Laboratory Accreditation Program (ELAP) Branch for mercury testing by EPA Method 1631E.
  - Basic has the statewide ELAP accreditation
  - Caltest and Frontier have the more stringent accreditation under the National Environmental Laboratory Accreditation Program (NELAP).
- Basic has received accreditation (through April 2013) from the State of Washington Department of Ecology under their ELAP for MeHg by EPA Method 1630.
- Frontier has NELAP certification under the State of Louisiana's ELAP for MeHg by EPA Method 1630.

Basic and Caltest have also participated in a large-scale, inter-laboratory comparison study for MeHg (Brooks Rand Labs, 2012). Surface water samples from three different sites in northwestern Washington State were split and sent to participating laboratories for mercury and/or MeHg analyses. Each laboratory's results are given a score based on how well the results conform to a grand average of results from all participating laboratories. The numerical scores include 3 for "satisfactory" results, 4 for "good" results, and 5 for "very good" results. Basic's MeHg results for the three different sites were given the top score of "5", and Caltest's MeHg results were given the next highest score of "4".

7.2.3 COC Forms

Chain-of-Custody (COC) procedures and documentation demonstrate sample control by tracing possession and handling of a sample from the time of collection through analysis. Use of COC forms is thus a tool to assure that sample integrity has not been compromised. In addition, COC forms can be used to verify details of requested analyses and provided samples. COC forms will be reviewed, as needed, for such verification. To facilitate the QA/QC process, copies of completed COC forms will be provided by the analytical laboratory as part of the analytical report.

7.3 Quality Control

Quality control (QC) involves samples and procedures that are additional to those required for analytical data and intended to verify performance characteristics of a sampled system (*i.e.*, QC verifies whether monitoring data collected sufficiently represents the condition of the sampled waters when the sample was collected.). The most common types of QC samples are blanks and duplicates (both field and laboratory varieties), and spikes used in the laboratory. The QC sample types and frequencies for the Control Sampling period (October 2013-September 2014) are detailed in Table 16. These QC protocols for the MeHg Control Study have been developed based on the current practice for the SPG Facilities, as well as information available from the three contract laboratories.

Table 16. Sampling Requirements for MeHg Monitoring Quality Control

QC Sample Type	Frequency of Collection/Analysis	Measurement Quality Objective
Agency-Prepared Samples (Per Facility)		
Field Duplicate	1 per analytical method per 12-month period (~5 percent of total annual sample count)	Relative Percent Difference (RPD) < 25 percent (n/a if native concentration of either sample < RL)
Field Blank	2 per analytical method per 12-month period	< Reporting Limit (RL) for target analyte
Laboratory-Prepared Samples[(a)]		
Method Blank	1 per 20 samples or per analytical batch (whichever is more frequent)	< RL for target analyte
Laboratory Control (Blank)		< RL for target analyte
Matrix Spike		80-120 percent recovery
Matrix Spike Duplicate		80-120 percent recovery RPD < 25 percent

(a) The contract laboratory will prepare these samples. The frequencies indicated are standard for the contract laboratories. Sample volumes in Table 14 have been set at levels sufficient for laboratory QC samples (including MS/MSD samples).

As indicated in Table 16, each SPG Facility will collect field duplicates and field blank samples during the sampling period. Field duplicates are defined as two samples collected by the same team, at the same place, and at the same time. It is used to estimate sampling and laboratory analysis precision. Field blanks are defined as an aliquot of contaminant-free reagent water that is provided by the laboratory, taken to the field, and treated as a sample in all respects, including the following treatments:

- Transferred into a laboratory-provided sample bottle at or near the most exposed sampling location using the same sampling devices as used for field samples. The goal is to expose the blank sample to all of the sampling site conditions.
- Stored and shipped to the laboratory using the same methods as other samples.

Both field duplicates and field blanks will be provided to the laboratory with a unique label for identification by the agency staff, but that does not indicate to the laboratory staff that it is a QC sample.

Table 17 includes the specific schedule that the SPG Facilities will follow for collecting field QC samples, which include both field duplicates and blanks. As provided in Table 17, field blanks and duplicates will be collected at different intervals for each SPG Facility to ensure that QC samples are being directed to a range of laboratories during each month when samples are collected.

A thorough review of the reported QC data results will identify potential errors and outliers, as well as verification that QC procedures were followed and that QC results indicate high quality data. Any results that are suspected of being inaccurate, as determined from QC results not meeting the measurement quality objectives in Table 16, will be removed from the data set prior to further evaluation. Anomalous data remaining after the QC review will be listed per agency and discussed with the agency staff to determine if other factors may account for the suspect results. These or other results determined to be errors or otherwise unrepresentative of the conditions of interest in the MeHg Control Study will also be removed from the data set prior to further evaluation. A list of anomalous data and reasons for removal will be provided in the MeHg Control Study reports.

Table 17. Field Duplicate and Field Blank Sample Collection Schedule for Each SPG Facility

Agency	Facility	Typical Contract Laboratory for Mercury/MeHg Analysis	Year and Month[a]											
			2013			2014								
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Manteca, City of	WQCF	Basic	✓				D				✓			
Woodland, City of	WPCF	Basic			✓				D				✓	
Davis, City of	WWTP	Caltest	✓					✓			D			
Ironhouse Sanitary District	WWTP	Caltest	✓					✓				D		
Live Oak, City of	WWTP	Caltest		✓					✓				D	
Lodi, City of	White Slough WPCF	Caltest		✓					✓					D
Rio Vista, City of	Beach WWTF	Caltest			✓			D		✓				
Rio Vista, City of	Northwest WWTF	Caltest			✓			D		✓				
Roseville, City of	Dry Creek WWTP	Caltest				✓			D		✓			
Roseville, City of	Pleasant Grove WWTP	Caltest				✓			D		✓			
Sacramento, City of[b]	Combined WWCTS	Caltest												
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	Caltest	D				✓					✓		
Stockton, City of	Regional WWCF	Caltest		D			✓					✓		
Tracy, City of	WWTP	Caltest						✓		D			✓	
UC Davis	Main WWTP	Caltest			D			✓					✓	
Vacaville, City of	Easterly WWTP	Caltest				D			✓					✓
Yuba City, City of	WWTF	Caltest					D		✓					✓
Brentwood, City of	WWTP	Frontier	✓			D			✓					
Discovery Bay, Town of	WWTP	Frontier			✓			D			✓			
Mountain House Community Services District	WWTP	Frontier					✓			D			✓	

(a) Agencies scheduled in a given month for collecting a field duplicate are indicated by a "D". Agencies scheduled in a given month for collecting a field blank are indicated by a "✓". For facilities not collecting primary samples in month scheduled for duplicate/blank collection (i.e., those without year-round surface water discharge), duplicate/blank samples should be collected in the next month in which surface water discharge occurs.

(b) Sampling from the City of Sacramento Combined WWCTS will only occur during periods of discharge. Therefore, a field duplicates and field blanks collection schedule cannot be provided.

8.0 PROJECT EVALUATION AND DATA SHARING PLAN

This section provides an overview of how the results of the efforts described in this Work Plan will be used to develop the Final Study Report and how information developed through the MeHg Control Study will be made available for public consideration.

8.1 Guidance Document Requirements

Describe the information that will be gathered and how it will be used to evaluate the effectiveness of the management practices or actions. Consider that Final Study Reports will be expected to address:

- a. *effectiveness of the control method at reducing methylmercury in discharge;*
- b. *estimates of cost if this control method were implemented;*
- c. *potential, redirected environmental impacts of the control method; and*
- d. *overall feasibility of implementing the control methods.*

The evaluation of a control method's effectiveness should include a general description of the hydrologic and climactic conditions under which the study was conducted and a description of additional information that would be needed, if any, to adapt the method to likely changes in conditions.

So that data can be easily shared, all entities collecting data are encouraged to compile data in a consistent format and place it in a centralized location. Staff will work with entities to develop a process for reporting and sharing data within the California Data Exchange Network (CEDEN) or other repository.

8.2 Evaluation Plan

The efforts outlined in this Work Plan will be presented in the MeHg Control Study Progress Report, which is due October 2015. The Progress Report will specifically include an evaluation of the effectiveness of various treatment-related control methods for reducing MeHg loads from municipal wastewater treatment facilities.

In addition, the results of the MeHg Control Study will be used to inform the process of determining what (if any) additional control methods can and/or should be applied at individual NPDES Facilities. Therefore, the MeHg Control Study Progress Report will also identify a proposed approach to this process. However, the MeHg Control Study Progress Report will not provide an evaluation of: 1) the implications associated with universally applying a specific control method and/or 2) the overall effectiveness of a control method to cause any real decrease in the MeHg levels in the Delta.

Following TAC review of the Progress Report, the recommended final analyses will be developed and the combined with the Progress Report to complete the Final Project Report. The expected schedule for completing the MeHg Control Study is summarized in Table 18.

Table 18. MeHg Control Study Schedule

Task	Estimated Completion
Submit Control Study Work Plan to Regional Board	April 19, 2013
Regional Board and TAC Work Plan Review	July 2013
Finalize Work Plan (If Necessary)	September 2013
Initiate Work Plan Sampling Period	October 2013
Complete Control Study Sampling	September 2014
Analyze Control Study Sampling Data	February 2015
Submit Control Study Progress Report	October 20, 2015
Regional Board and TAC Progress Report Review	January 2016
Submit Control Study Final Report to Regional Board	October 2018

8.3 Data Sharing Plan

Reporting templates for mercury/MeHg and conventional data have been developed for the MeHg Control Study to facilitate efficient reporting and data management of the MeHg Control Study data. Different templates are provided for mercury/MeHg data and conventional data. For the mercury/MeHg data, these templates are set up in a database format and currently include columns for: agency, facility name, sample site, sample date, sample time, sample type (composite or grab), parameter (mercury or MeHg), result, qualifiers, MDL, RL, analytical method, and laboratory. In addition, a notes column is provided for each sample.

Effluent MeHg data collected under the Control Study and required by NPDES permits will also be uploaded by the individual SPG Facility to the California Integrated Water Quality System (CIWQS) database in accordance with the database template that has been developed by the State and/or Regional Water Board for that website and facility.

Finally, it is expected that the finding from the MeHg Control Study will be publicized through journal articles and industry conference presentations.

9.0 REFERENCES

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MeHg CONTROL STUDY WORK PLAN
APPENDIX A

Regional Board and TAC Comments on the
Control Study Concept Proposal

METHYLMERCURY TMDL FOR THE DELTA

Central Valley Clean Water Association Methylmercury Special Project
Methylmercury Central Study Concept Proposal

Central Valley Clean Water Association Methylmercury Special Project
Methylmercury Central Study Concept Proposal

OVERVIEW

- This submission describes a MeHg control study proposed by the Central Valley Clean Water Association representing 14 wastewater treatment plants (WWTPs) discharging to the Delta and four additional plants whose discharges fall outside the Delta and are not covered by the methylmercury (MeHg) TMDL . Each individual plant discharging to the Delta has received a MeHg wasteload allocation (WLA); these are presented in Appendix B of the proposal. All of the regulated plants are currently achieving their TMDL MeHg allocation.
- The results of previous studies suggest that non-mercury constituents discharged by WWTPs will not have an appreciable effect on the overall MeHg production or export in the Delta.
- The overall study approach is to characterize MeHg removals across all the WWTPs, and relate the MeHg removal effectiveness to the particular level of treatment provided by each plant. The results will allow a ranking of specific treatment processes and strategies with regard to their effectiveness in removing MeHg. Extrapolating the results of the most effective treatment strategies to all plants (i.e., what if all the plants were upgraded to the most effective processes?) allows for an estimate of what the overall WWTP MeHg discharge to the Delta might look like if the current best available technology was applied across the board.

PROBLEM STATEMENT

- The Problem Statement should include a reference to, and explanation of, the data in Appendix B describing the current MeHg discharge loads and the % reductions required to meet the wasteload allocations (if necessary). Include also a statement summarizing the current situation with regard to WLA compliance.
- This section should describe specific management activities, control technologies, and reduction strategies that will be tested. Explain the overall approach the study will take to determine the effectiveness of the proposed MeHg control technologies.
- See also the additional comments appended at the end of this document.

OBJECTIVES

- In the Study Objectives section, include explicit statements of the objectives related to each hypothesis. So, for instance, for Hypothesis 1, provide Study Objective 1 which describes what you will study to test this hypothesis. A possible statement of Study Objective 1 might be: "Plant effluent methylmercury concentrations will be measured at each plant and loadings to the Delta will be calculated." Do this for all the hypotheses you have listed.
- Provide an explicit statement of your Control Objective: Describe your total allocation responsibility. Describe how your control measure could be applied, scaled-up or combined with other control measures to achieve the methylmercury allocation.

MECHANISMS UNDERLYING THE STUDY

- The hypotheses in the Objectives section should follow directly from your conceptual understanding of the MeHg removal mechanisms in the various wastewater treatment processes. Present your conceptual models here, describing the specific mechanistic understanding behind each individual hypothesis. Include citations to literature or previous results that support your understanding.

PROPOSE CONTROL MEASURES

- Describe the test strategy/protocol for testing each hypothesis. Describe how each of the "planned" and "plausible scenarios" will be tested. Describe in detail how the process and effluent conditions identified in Hypothesis 2 will be applied to all the facilities in the study to test hypotheses 2a, 2b, and 2c.

MONITORING AND COLLECTION PLAN

- Describe in detail the complete test procedure to be undertaken for each plant and treatment process tested. Indicate what will be measured, where, and how, and on what schedule. 24-hr composite sampling is recommended. Provide complete quality control and assurance information. This information might best be presented in a table or tables.

- Describe how the data obtained will be used to test the hypotheses and characterize MeHg reductions. Include an outline of the statistical approach.

APPPENDICES

- Include here a description of each WWTP's permit situation and any known/anticipated process changes expected during the test period (before 2015). Describe how these process changes will affect the test procedure.

- Provide complete plant process schematics for all treatment plants; include a paragraph describing the process and summarize relevant overall plant data.

Additional Comments

- Authors may need more direction than already given in slide 2 for Problem Statement in order to get it right. I suggest as a template: "14 NPDES facilities belonging to the CVCWA SPG are in subareas identified in the methylmercury TMDL program. One is in Marsh Creek, 2 in the Central Delta, etc. (Appendix A). The MeHg loads from each of these facilities were estimated from 2005 data on concentrations and outflows. Five of these facilities had MeHg concentrations below the target of 0.06 ng/L, and so were not assigned a load reduction target. Also, the 2 plants located in the Central Delta were not assigned a load reduction target, even through their effluent concentrations were above 0.06 ng/L, because the Central Delta already meets the target MeHg concentration in its waters. The remaining 7 facilities were assigned load reduction targets of 21.5 to 55% (RELATIVE TO 2005), depending on the subarea where the facility is located."

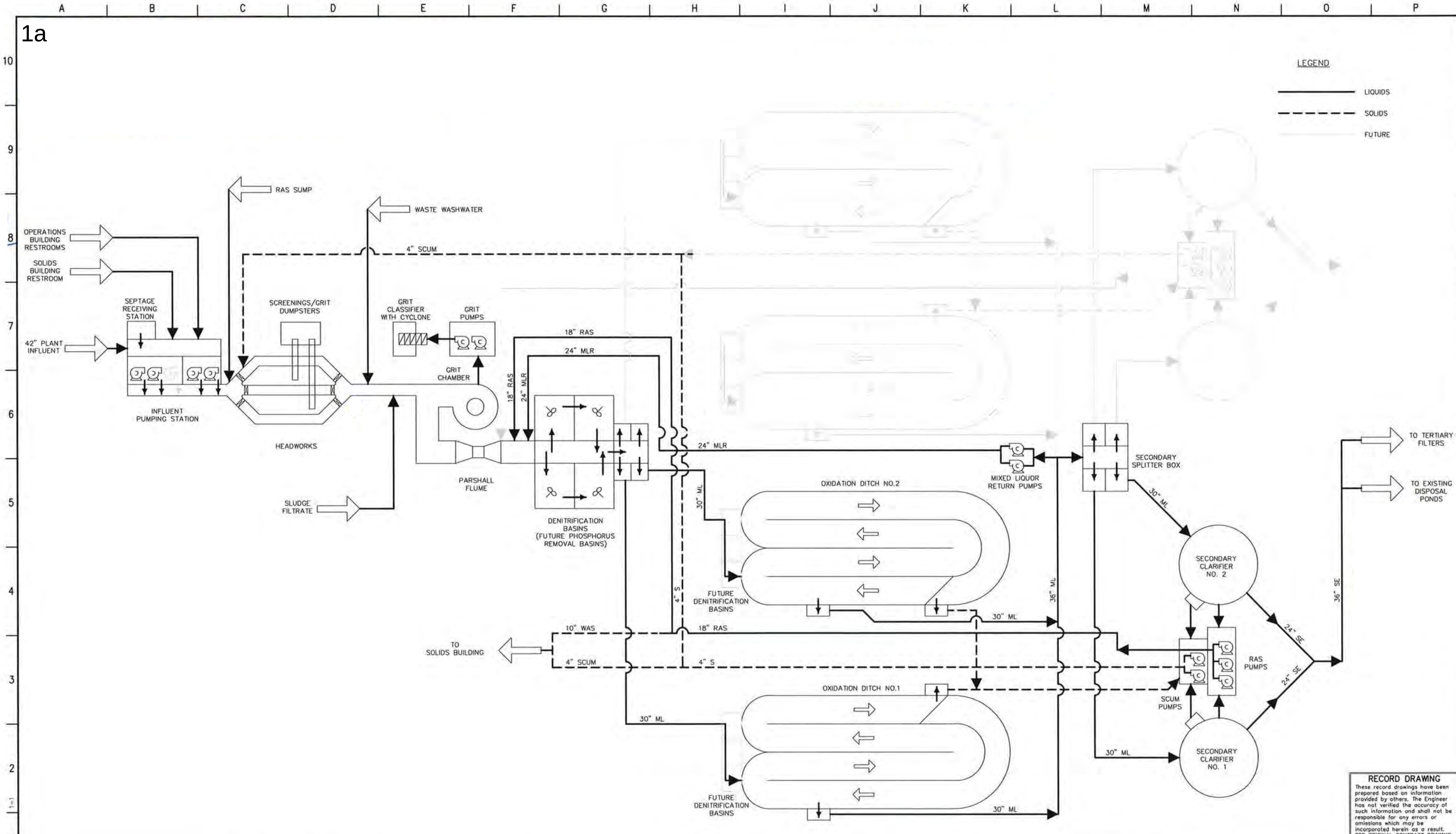
- The next paragraph should go over whether these reduction targets have already been met or not (NOTE; WHEN I LOOK AT APPENDIX B TABLE 2 IT LOOKS LIKE ALL THE PLANTS ARE CURRENTLY AT OR BELOW THEIR TMDL REQUIREMENTS.—COMPARE COLUMNS HEADED CURRENT AND TMDL MEHG WLA UNDER ANNUAL MEHG LOADING/WLA G/YR. THE LAST TWO COLUMNS OF THIS ARE CONFUSING AND OBSCURE THIS. If my impression is wrong then this table needs much better explanation.)

- The third paragraph should explain that while current annual loads are good, there could be changes in the future and this study will look at data from existing plants and determine 1) the best control methods in terms of producing low MeHg loads and 2) how much influent conditions have on treatment effectiveness. It appears that no new control methods are being suggested for testing. Needs to be made clear whether any specific plants will be having new methods installed that are not already there,. If so, there would be an opportunity for a before and after study.

MeHg CONTROL STUDY WORK PLAN
APPENDIX B

Treatment Technologies and Process Schematics for NPDES Facilities in the CVCWA Methylmercury SPG

1a



RECORD DRAWING
These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. SEE ORIGINAL CONTRACT DRAWING FOR SEAL AND SIGNATURES.

5702-G08 GT 7/7/2000 1=1

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APPROVED: ____ GSDA	DATE: 4/14/2000
APPROVED: ____ CITY OF BRENTWOOD	DATE: 4/14/2000

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JOB NO 5702.90
DRAWN CT
DESIGNED JMS
CHECKED WLF
CHECKED

G.S. DODSON & ASSOCIATES
CONSULTING ENGINEERS

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.
		RECORD DRAWING		7/05	

CITY OF BRENTWOOD

WASTEWATER TREATMENT PLANT EXPANSION PROJECT

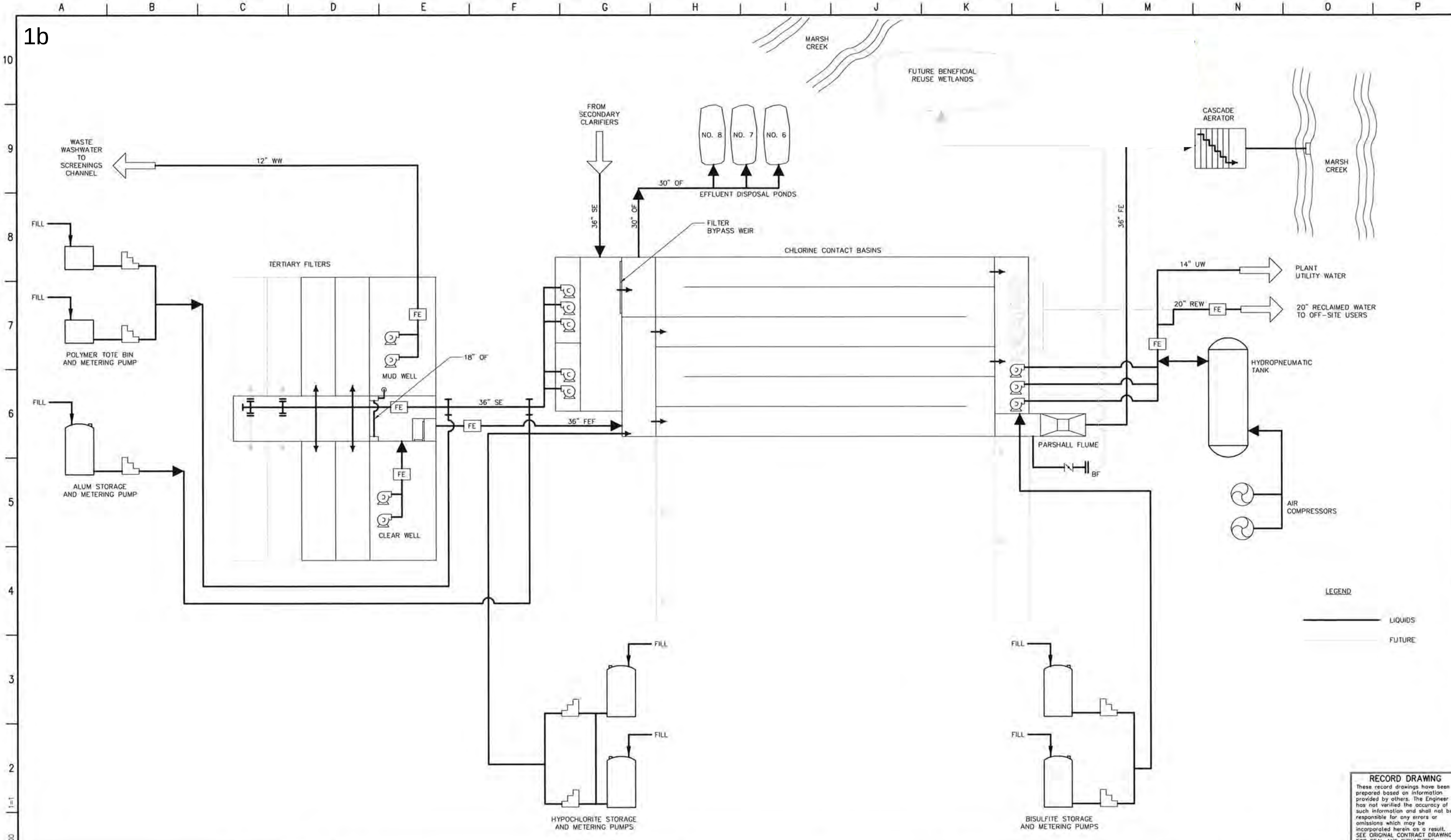
GENERAL
LIQUID TREATMENT
FLOW SCHEMATIC 1 OF 2

NO SCALE

DRAWING NUMBER G-8

SHEET NUMBER 9 of 434

1b



RECORD DRAWING
These record drawings have been prepared based on information provided by others. The Engineer has not verified the accuracy of such information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. SEE ORIGINAL CONTRACT DRAWING FOR SEAL AND SIGNATURES.

SUBMITTED: PROJECT MANAGER	DATE: 4/14/2000
APPROVED: GSDA	DATE: 4/14/2000
APPROVED: CITY OF BRENTWOOD	DATE: 4/14/2000

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)

JOB NO	5702.90
DRAWN	CT
DESIGNED	JMS
CHECKED	WLF
CHECKED	

G.S. DODSON & ASSOCIATES
CONSULTING ENGINEERS

REVISIONS

ZONE	REV	DESCRIPTION	BY	DATE	APP
		RECORD DRAWING		7/05	

CITY OF BRENTWOOD

WASTEWATER TREATMENT PLANT EXPANSION PROJECT

GENERAL
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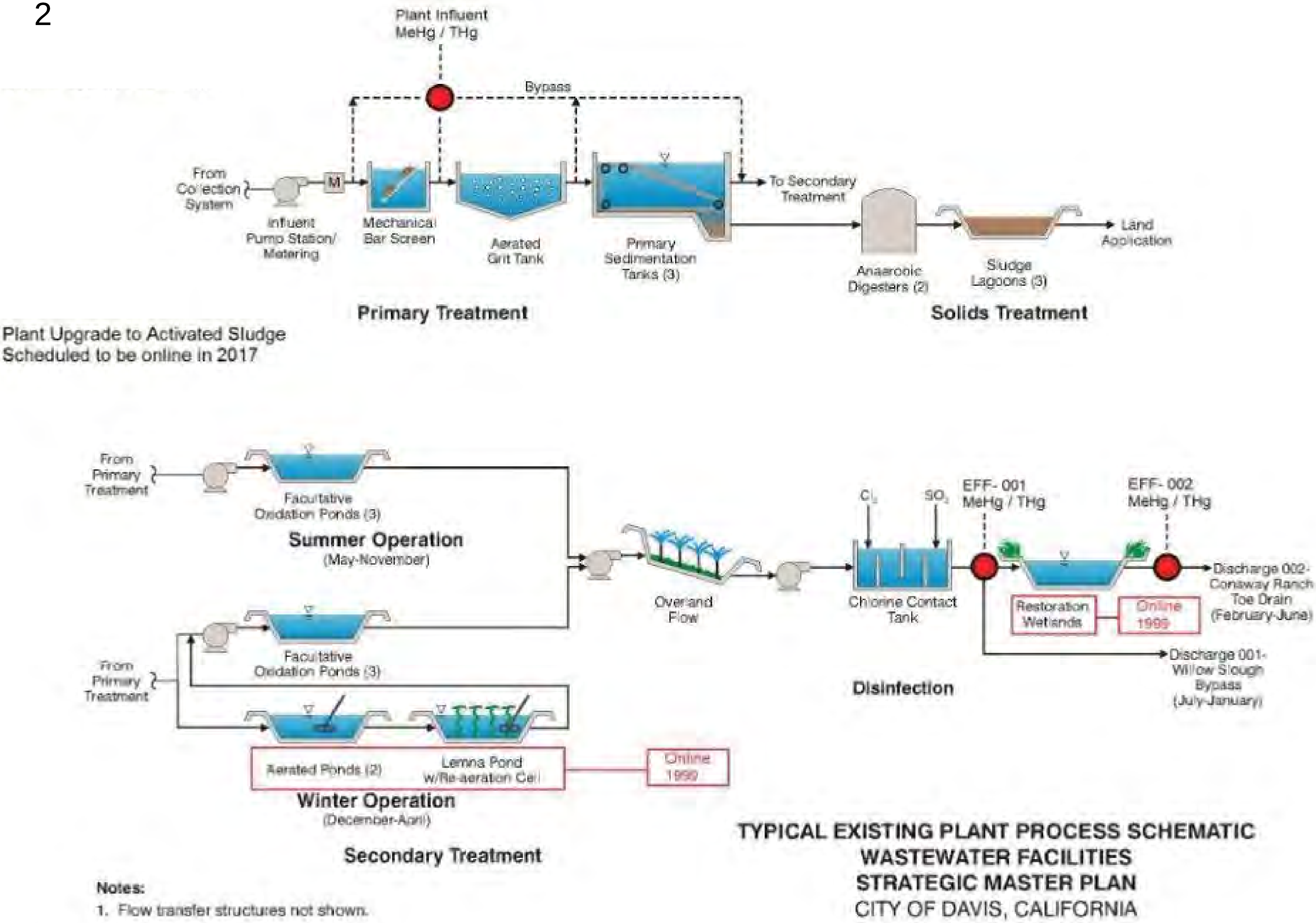
SHEET NUMBER 10 of 434

5702-G09 GT 7/7/2000 1=1

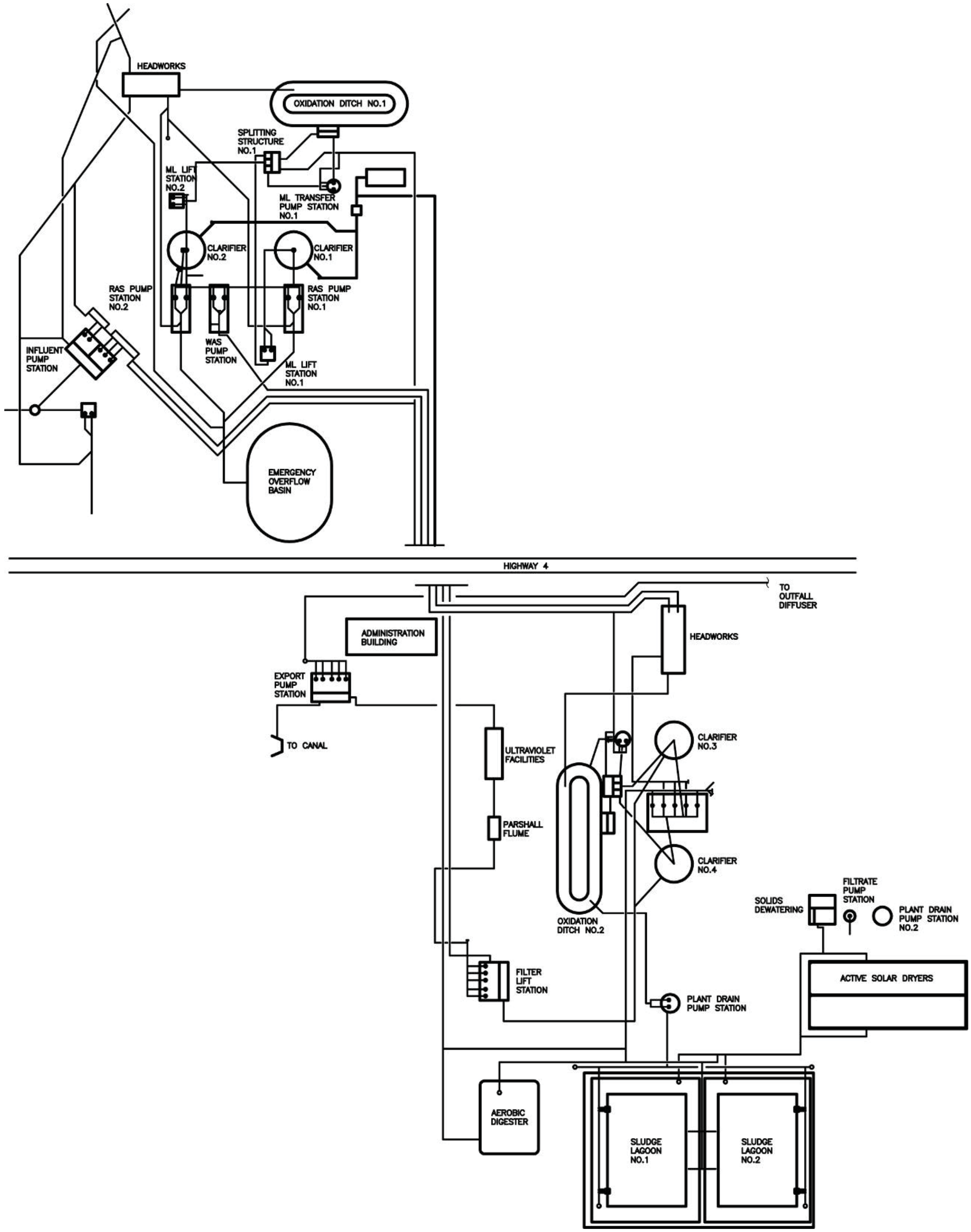


TYPICAL EXISTING PLANT PROCESS SCHEMATIC
WASTEWATER FACILITIES
STRATEGIC MASTER PLAN
CITY OF DAVIS, CALIFORNIA

dav805118-7011.cdr

3

ATTACHMENT C – FLOW SCHEMATIC



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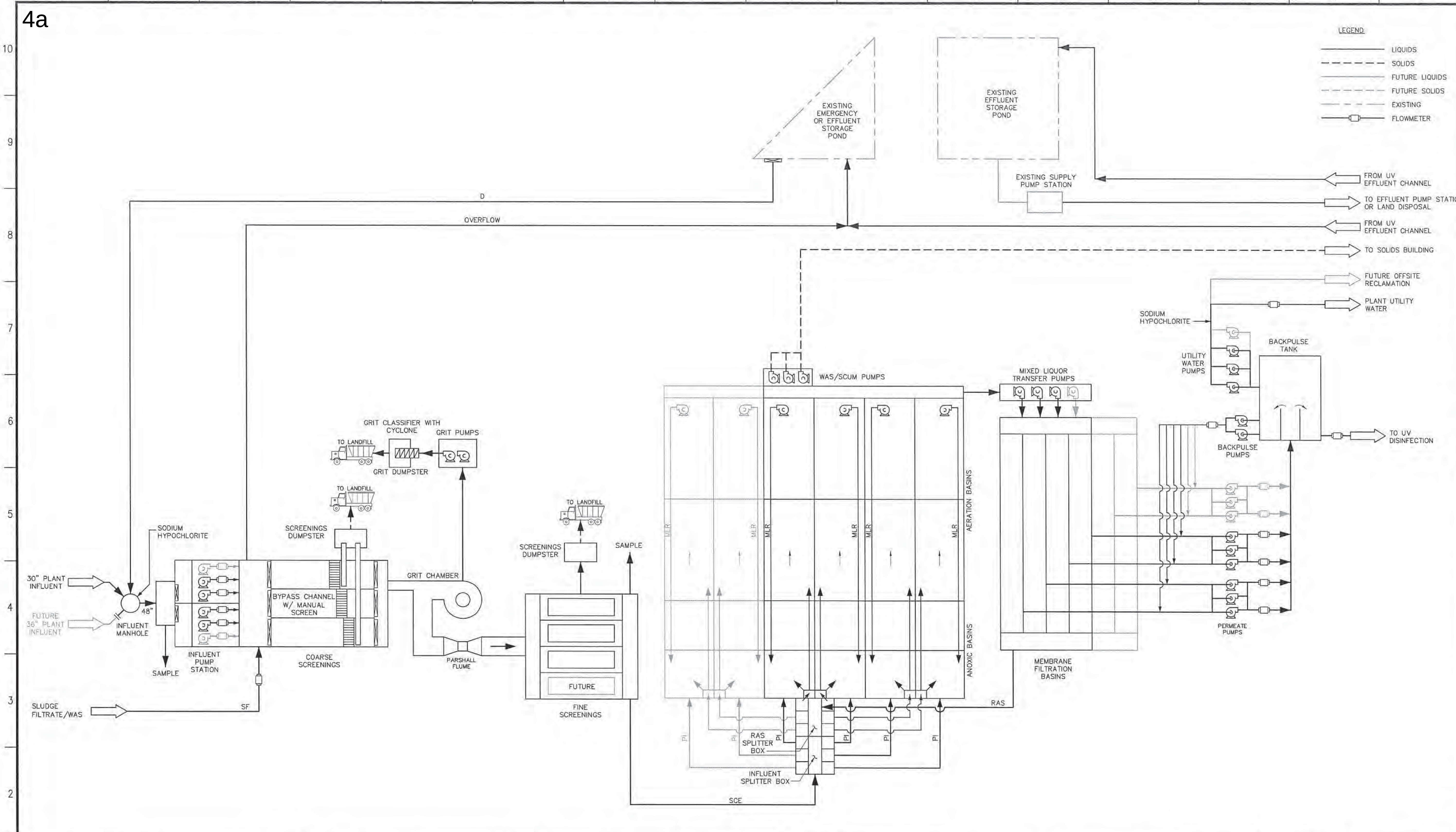

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)	
DRAWN	J. MAY
DESIGNED	J. SKREL
CHECKED	L. FISHER

APPROVED: IRONHOUSE SANITARY DISTRICT DATE: JANUARY 2009

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP.
		CONFORMED DRAWINGS		4/09	

IRONHOUSE SANITARY DISTRICT

WASTEWATER TREATMENT PLANT EXPANSION PROJECT

GENERAL
LIQUID TREATMENT
FLOW SCHEMATIC 1 OF 2

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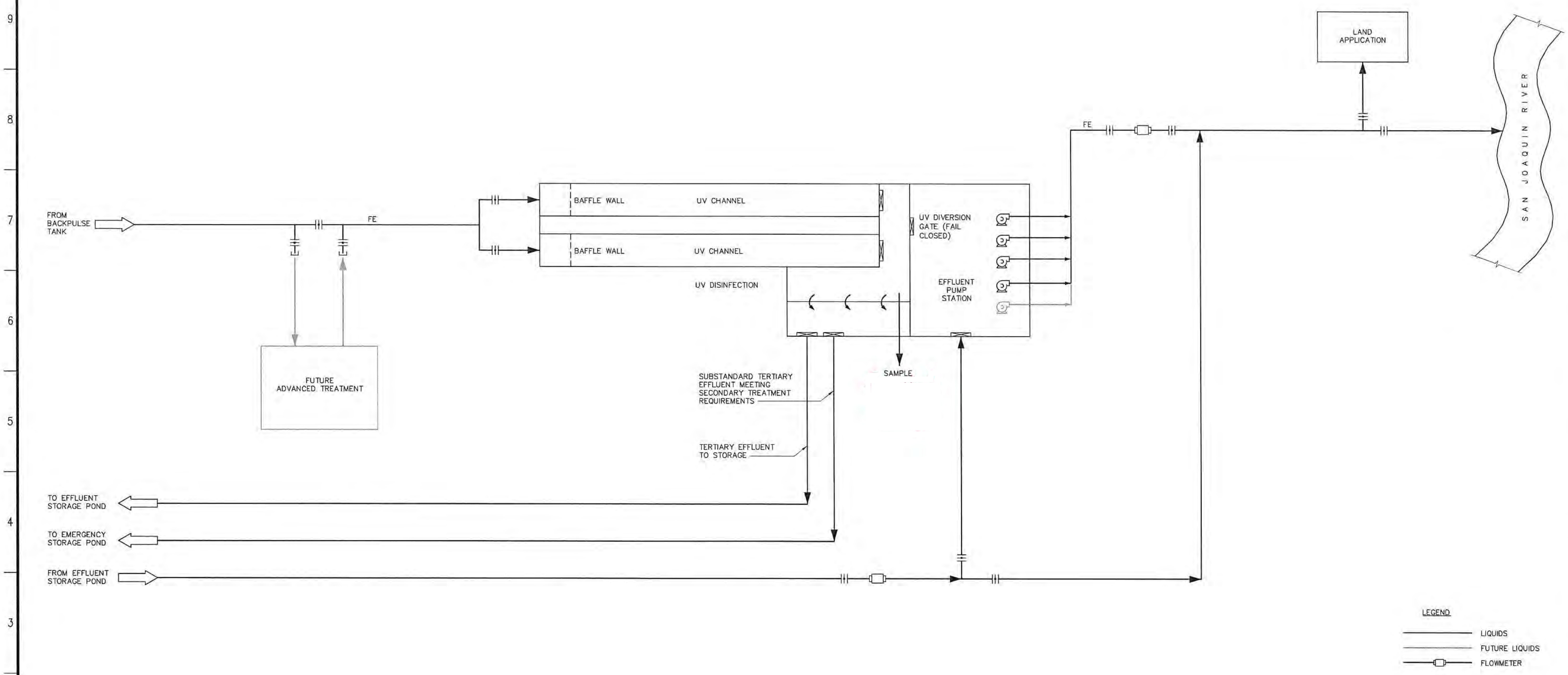
4b



APPROVED: IRONHOUSE SANITARY DISTRICT DATE: JANUARY 2009

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DRAWN J. MAY
DESIGNED J. SKREL
CHECKED L. FISHER

REGISTERED PROFESSIONAL ENGINEER JENNIFER MARY SKREL No. C 043548 Exp. 6-30-10 CIVIL STATE OF CALIFORNIA

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.
		CONFORMED DRAWINGS		4/09	

IRONHOUSE SANITARY DISTRICT

WASTEWATER TREATMENT PLANT EXPANSION PROJECT

GENERAL
LIQUID TREATMENT
FLOW SCHEMATIC 2 OF 2

SCALE AS NOTED

DRAWING NUMBER G-9

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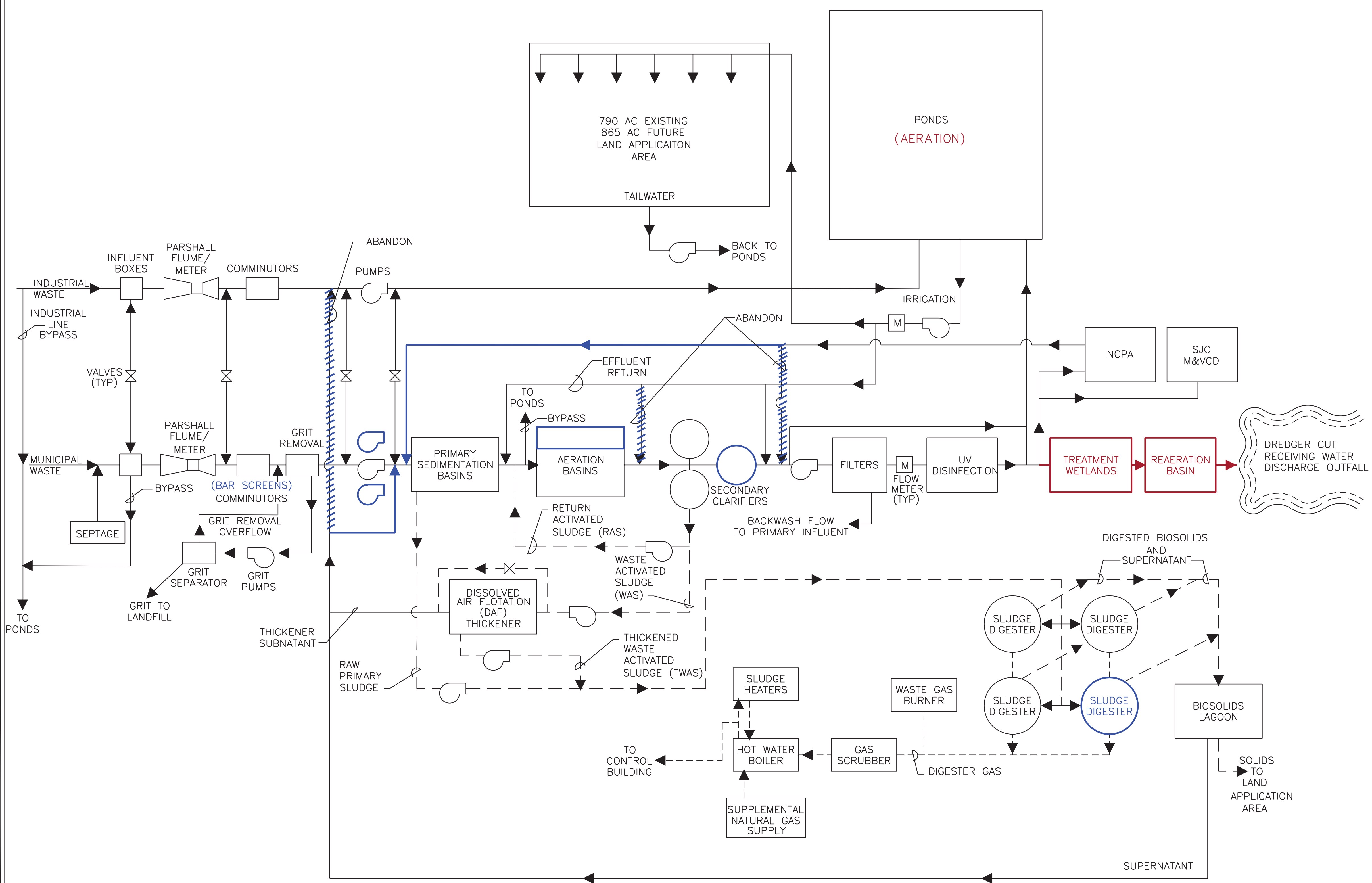
5

Figure 2-2
City of Lodi
White Slough WPCF
<u>Groundwater Investigation</u>
WPCF PROCESS FLOW DIAGRAM



LEGEND

EXISTING

IMPROVEMENTS PROJECT 2007

POTENTIAL FUTURE IMPROVEMENT PROJECT

NOTES

1. SOLID LINE INDICATES LIQUID FLOW.
2. DASHED LINE INDICATES SOLIDS FLOW.
3. SMALL DASHED LINE INDICATES GAS FLOW.

WEST YOST ASSOCIATES
Consulting Engineers

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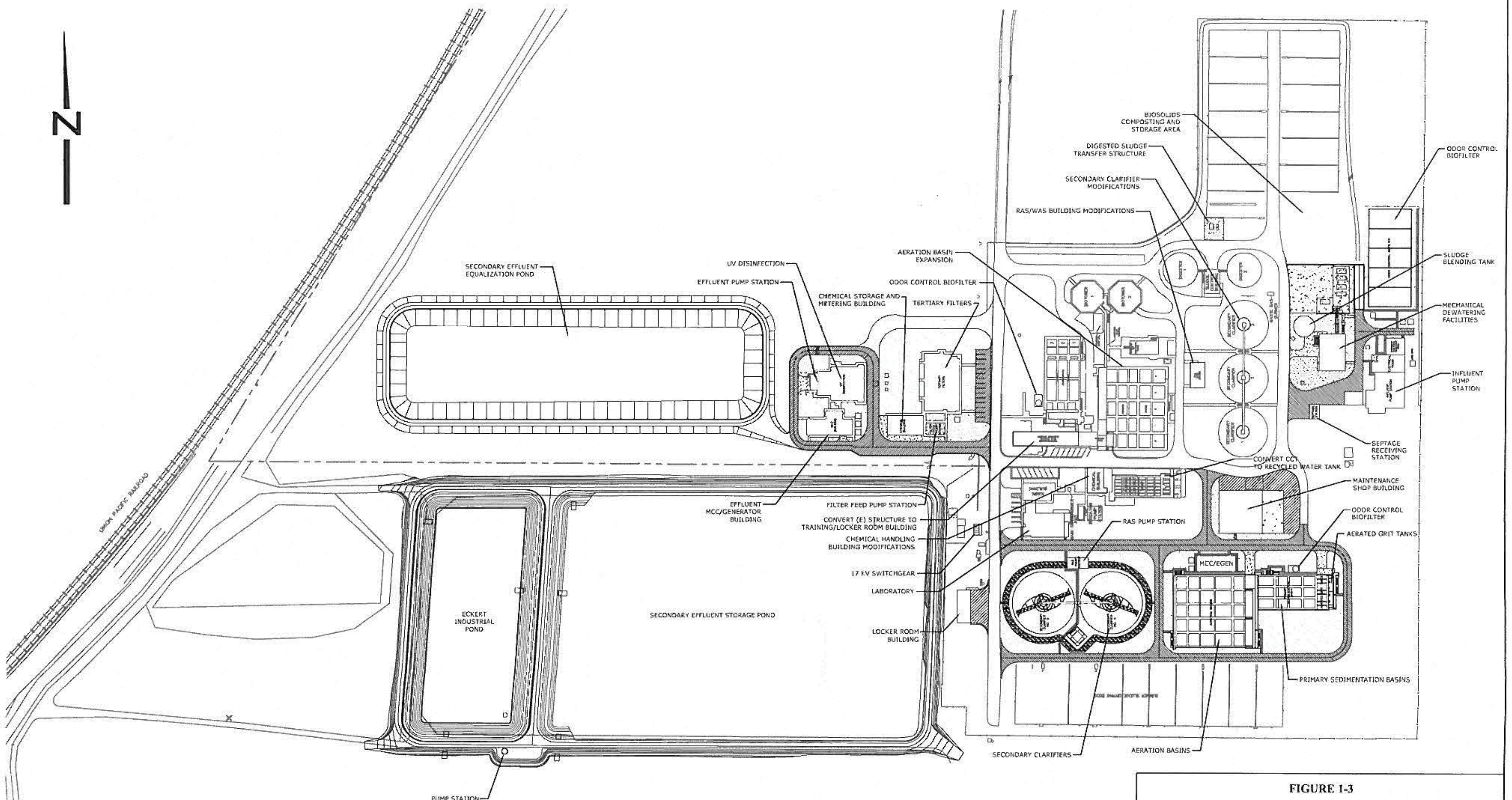


FIGURE 1-3

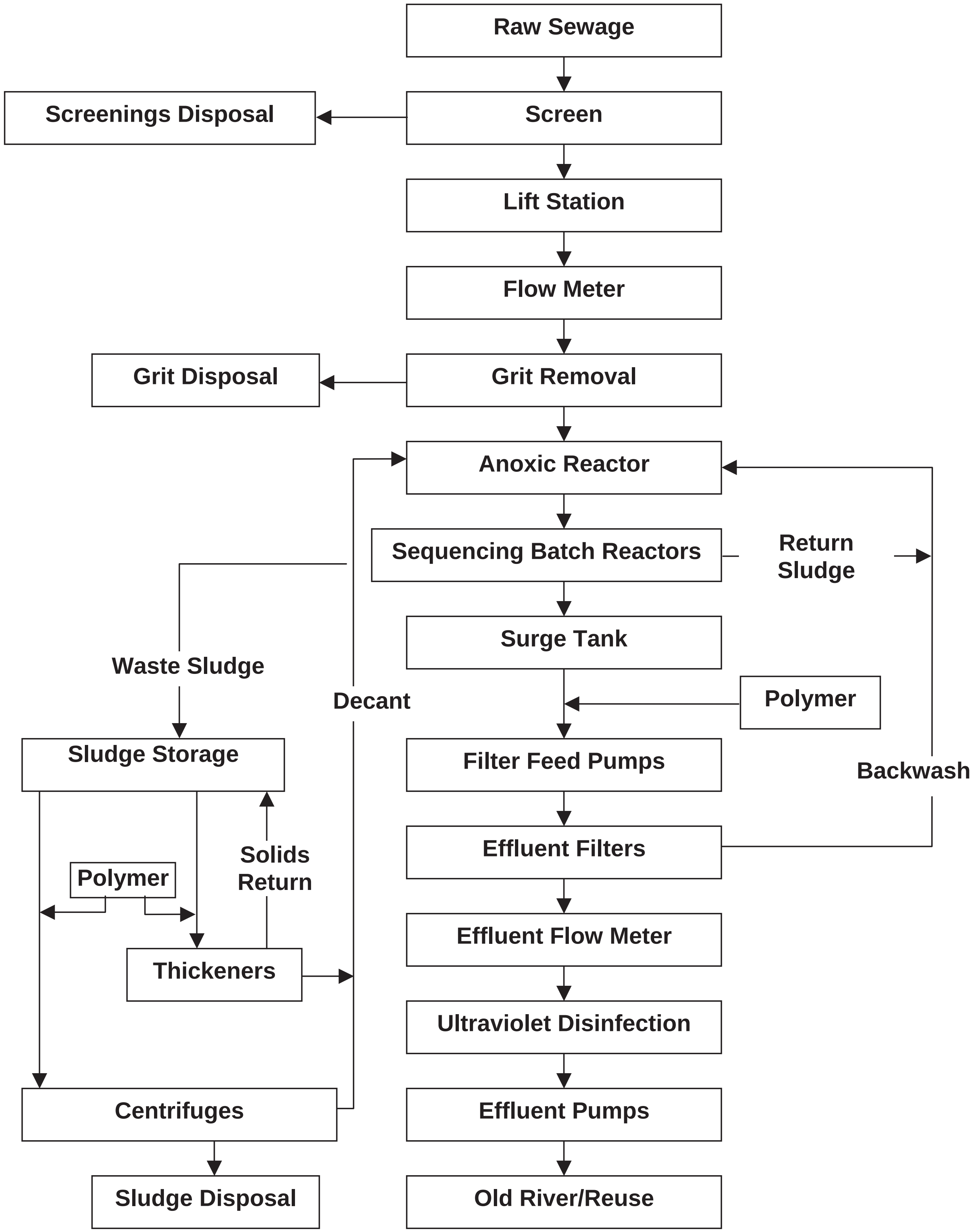
MANTECA WASTEWATER QUALITY CONTROL FACILITY
PHASE IV EXPANSION PROJECT
BASIS OF DESIGN REPORT

SITE PLAN PRIOR TO PHASE IV EXPANSION PROJECT

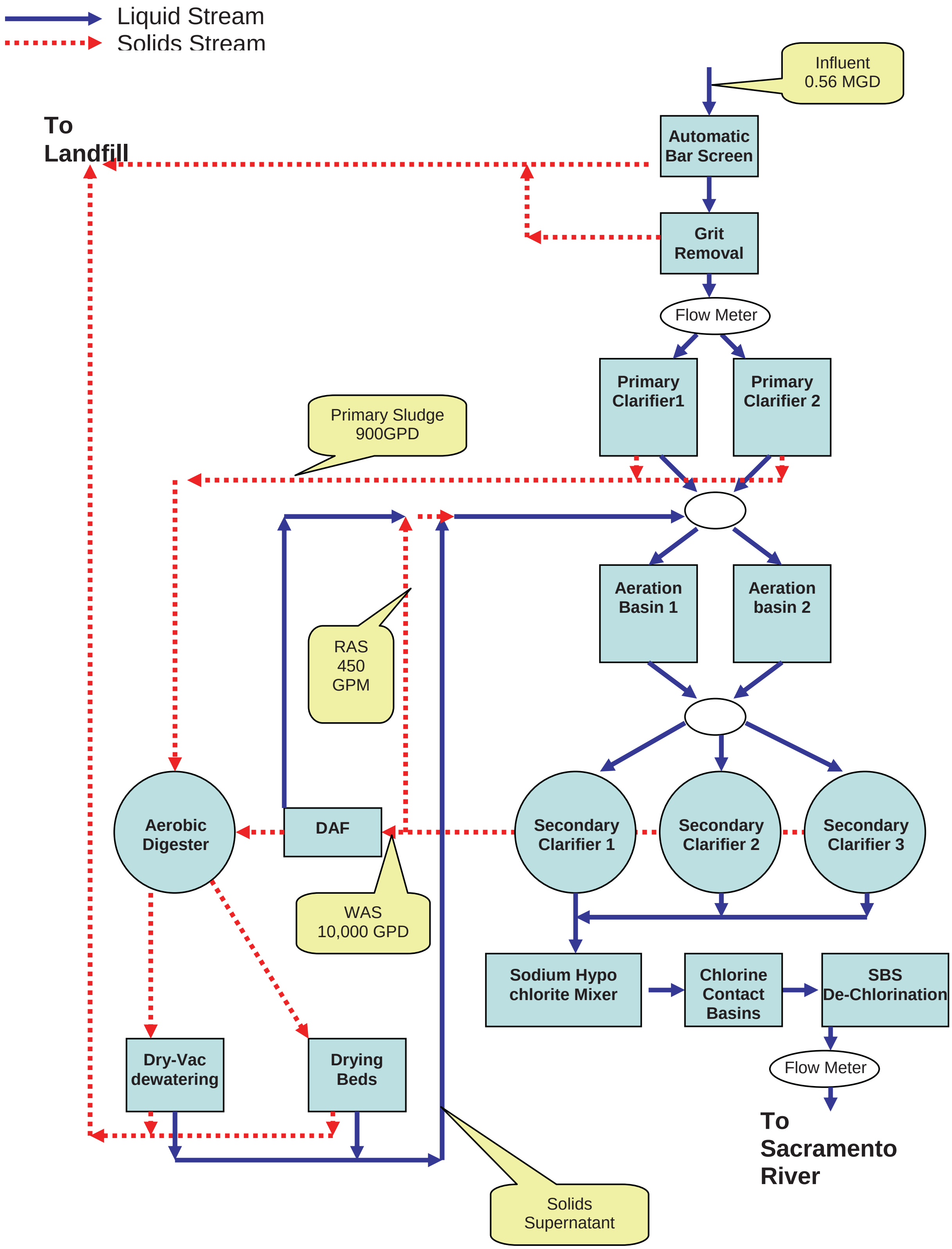
NOLTE

BEYOND ENGINEERING

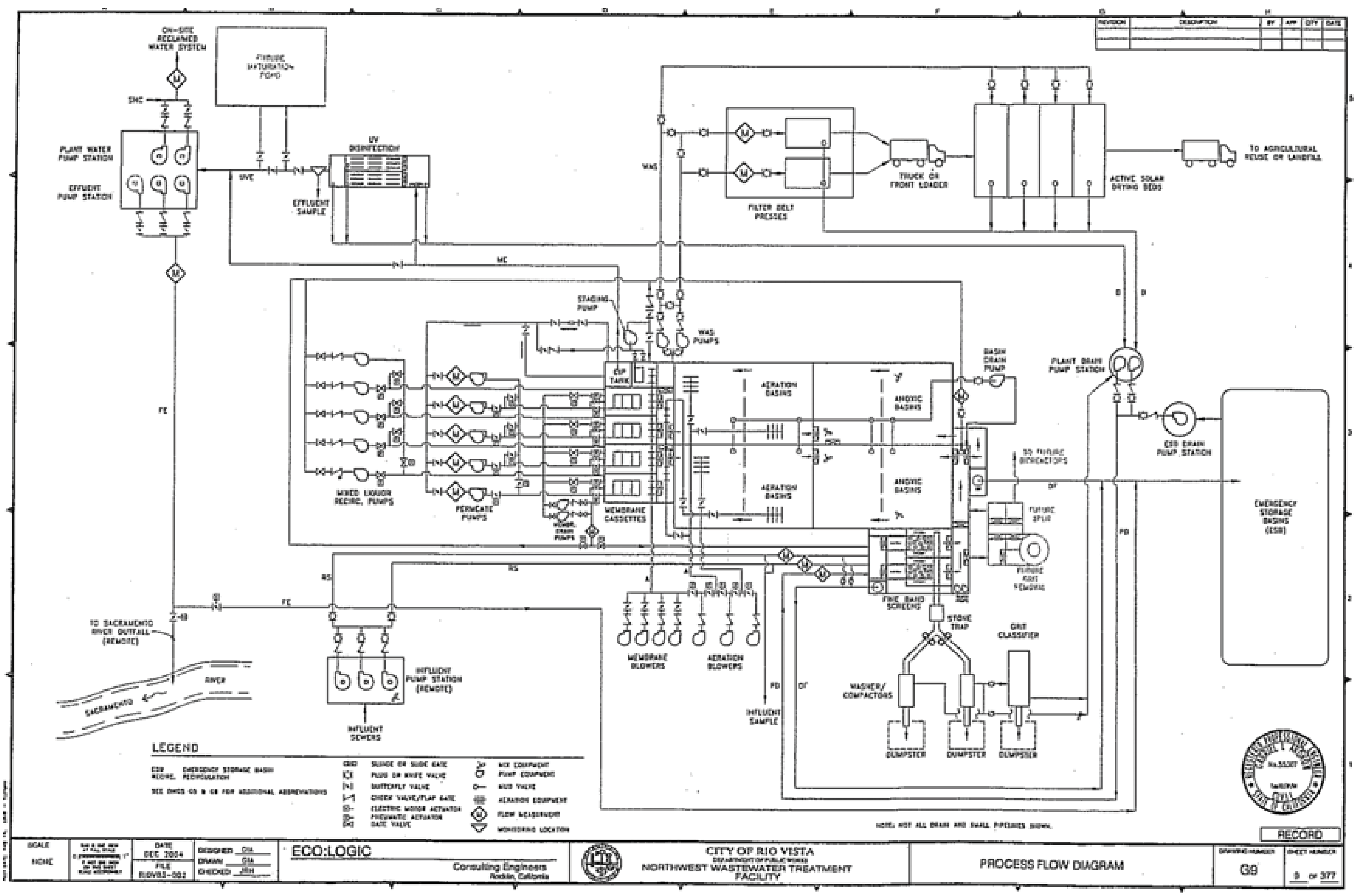
Mountain House Community Services District - Wastewater Treatment Facility - Flow Schematic



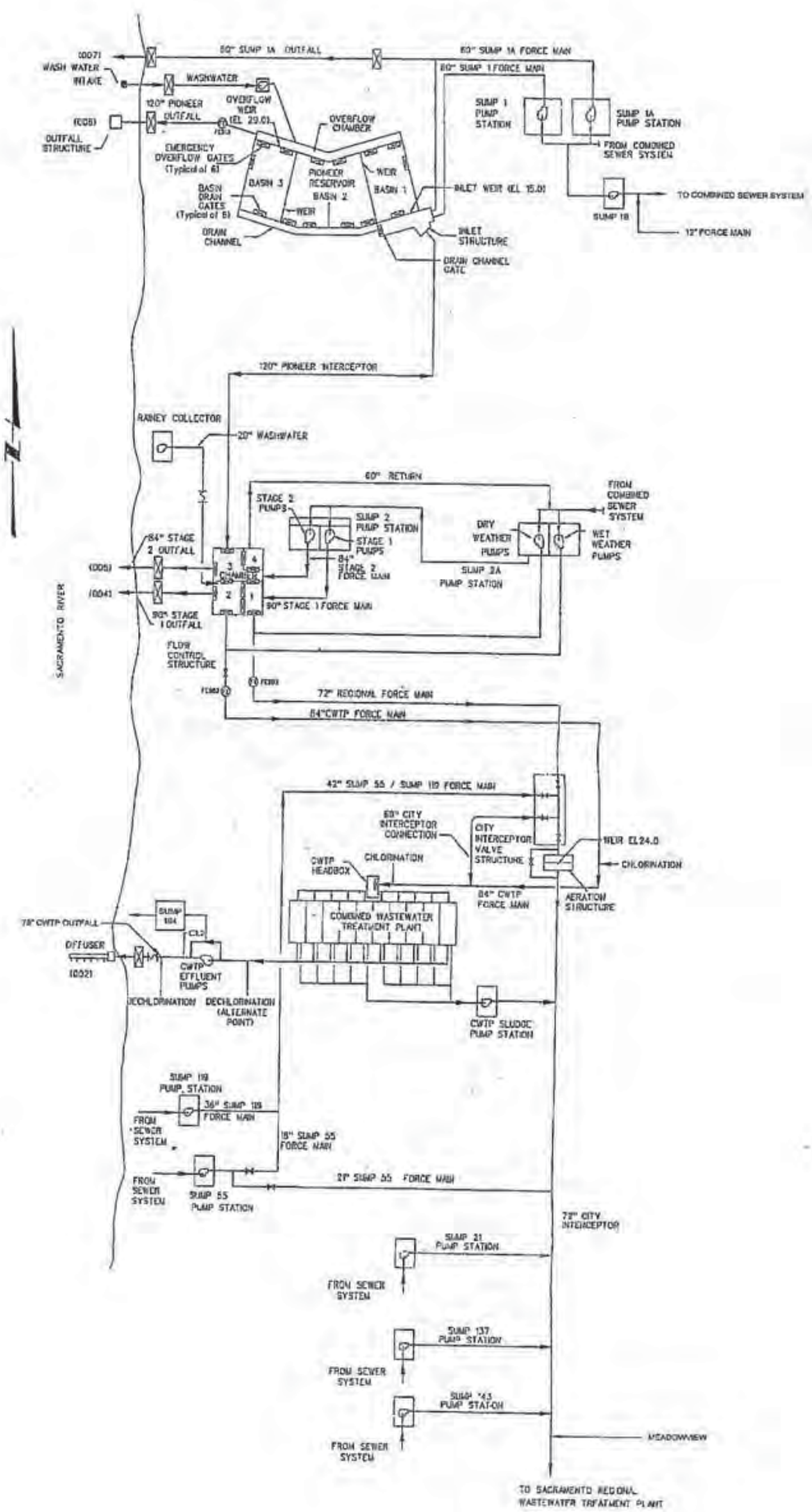
City of Rio Vista - Beach Wastewater Treatment Facility - Flow Schematic



City of Rio Vista - Northwest Wastewater Treatment Facility - Flow Schematic



City of Sacramento - Combined Wastewater Collection and Treatment System - Flow Schematic



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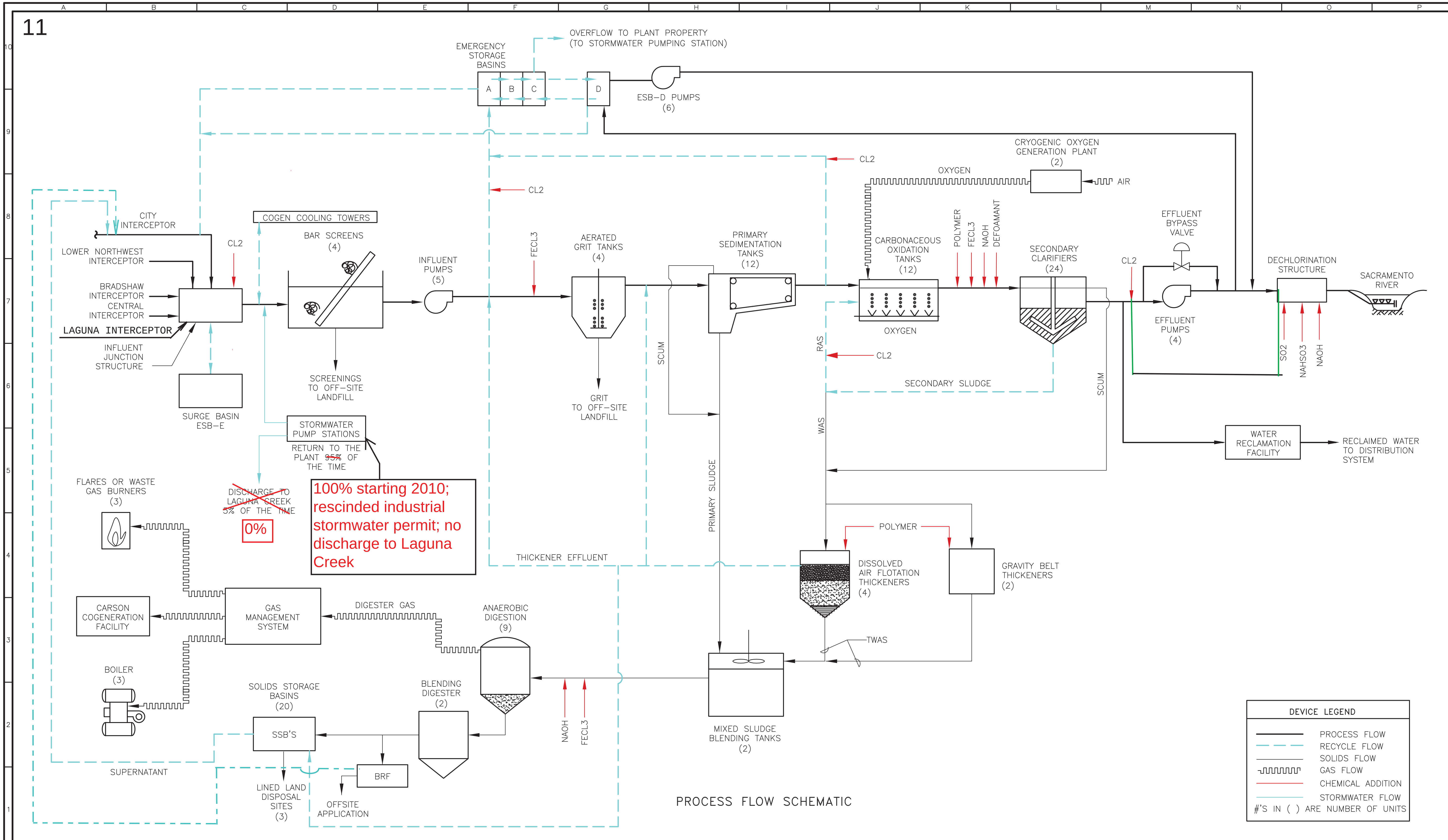

SRCSD
Sacramento Regional County Sanitation District

MASTER SET

THIS DOCUMENT CONTAINS THE MOST CURRENT, BEST AVAILABLE INFORMATION. UPDATE THIS DOCUMENT WHEN CHANGES OCCUR.

REVISIONS

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VAR	2	PER DCN-5097	MD	11/08	JMB						
VAR	3	PER DCN-5875	HR	8/10	GO						

SCALE
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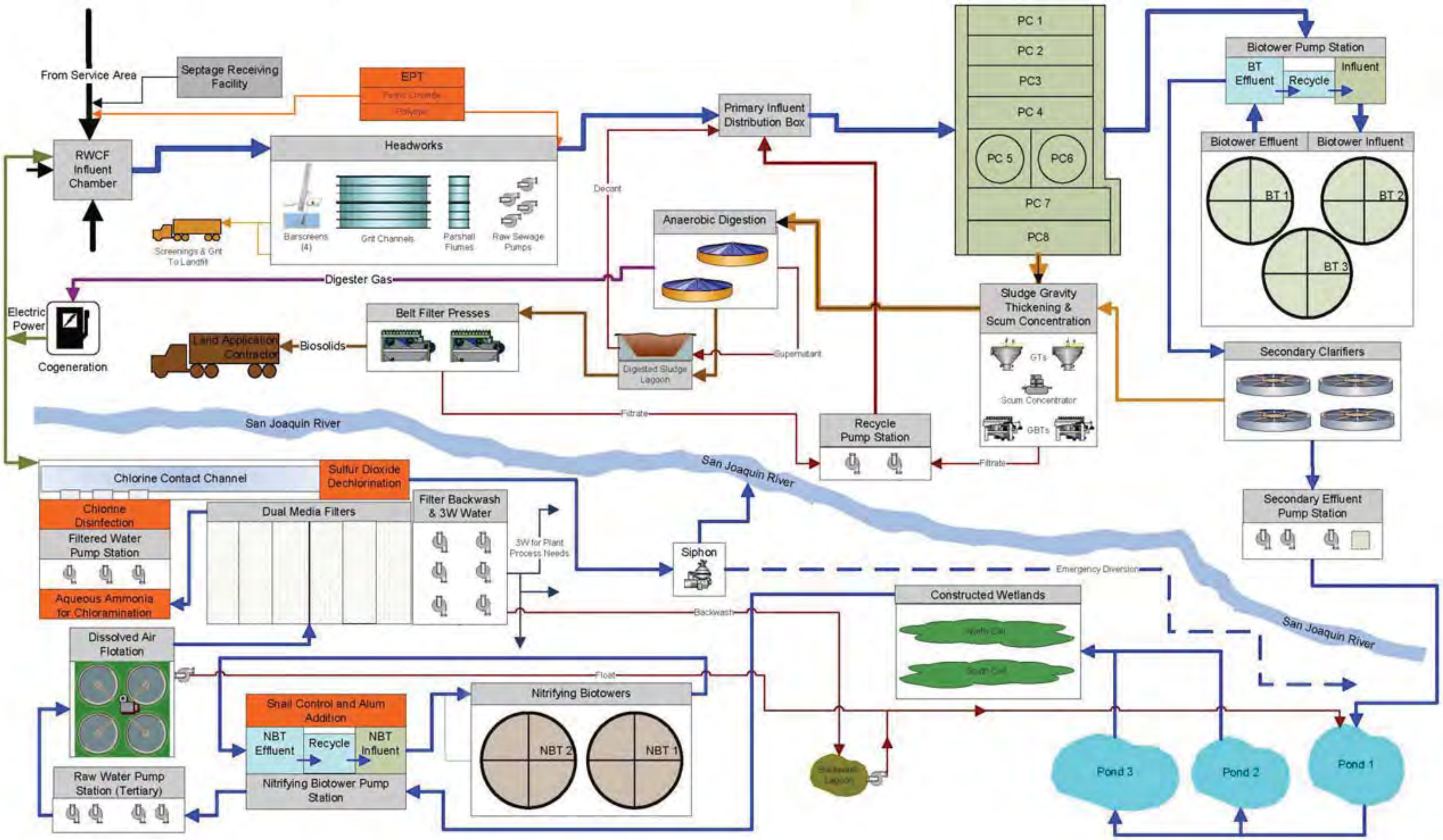
LINE IS 2 INCHES AT FULL SIZE (IF NOT 2"-SCALE ACCORDINGLY)
DRAWN SRWTP
DATE

PROCESS AND PIPING SCHEMATIC

PROCESS FLOW SCHEMATIC WITH RECYCLE FLOWS

FILE NUMBER 10003358
DRAWING NUMBER P1FLOW
SHEET NUMBER 1 OF 1

City of Stockton Regional Wastewater Control Facility - Flow Schematic



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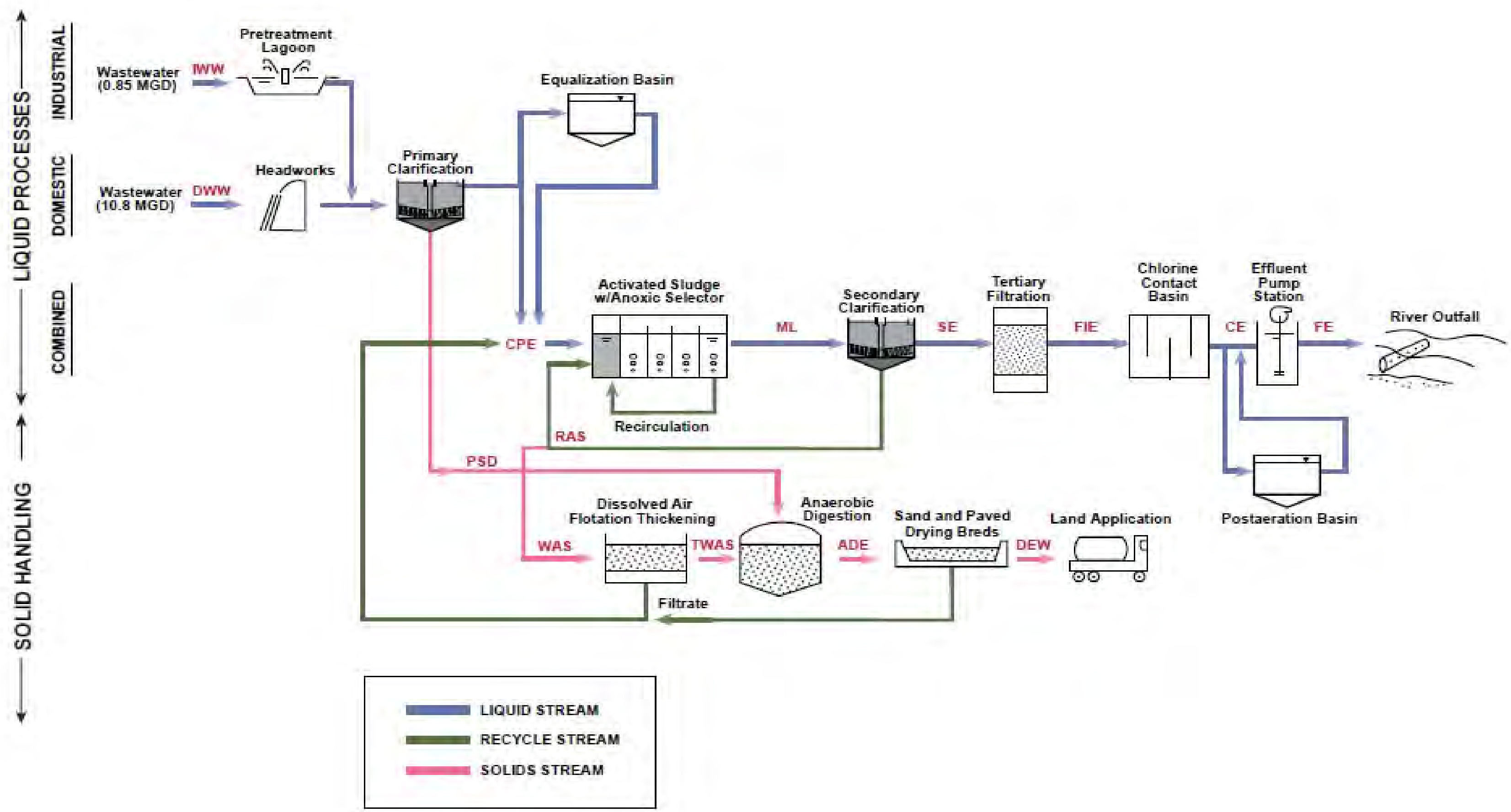
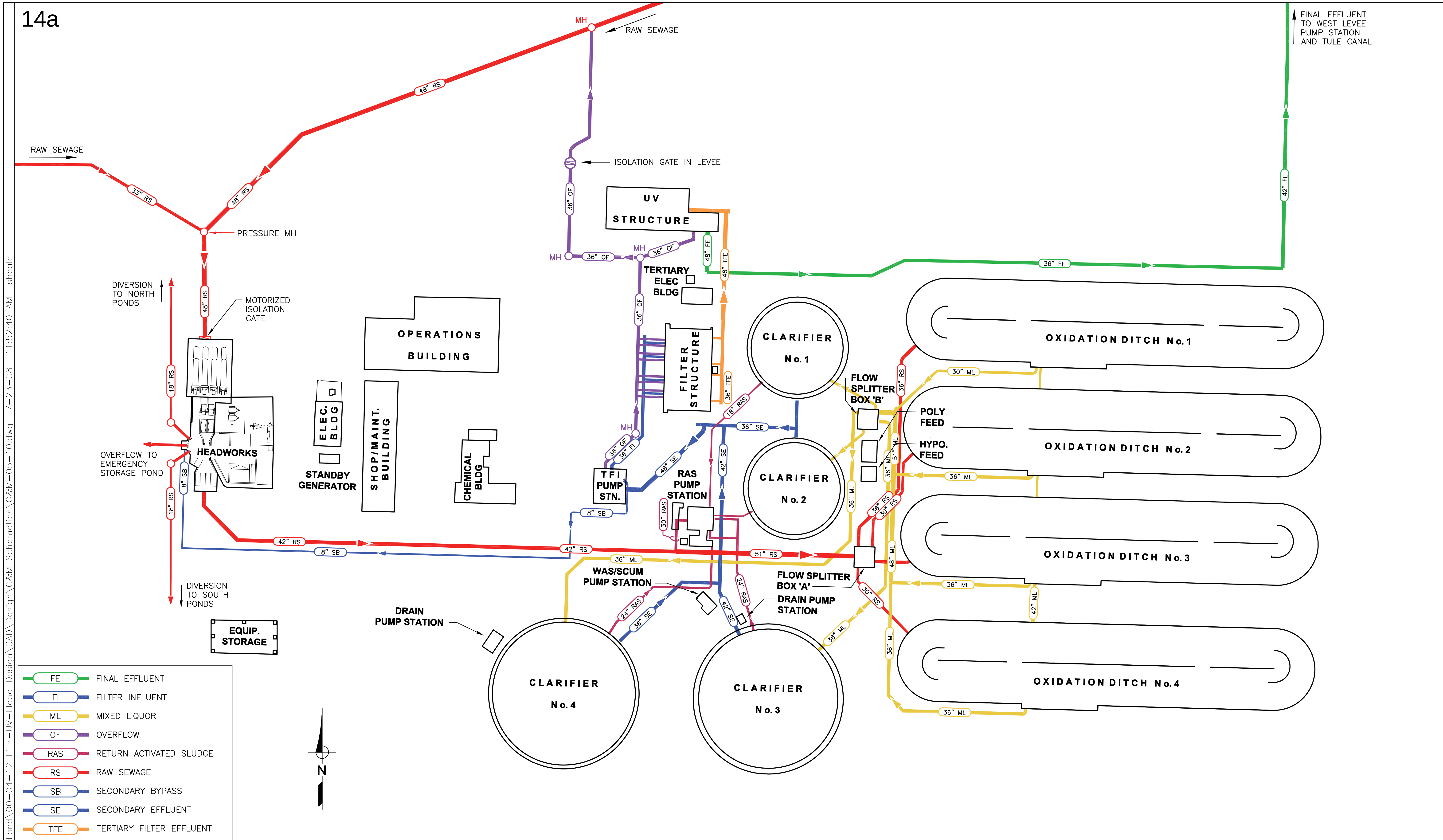
ATTACHMENT C – FLOW SCHEMATICS

MAIN WASTEWATER TREATMENT FACILITY





WEST YOST ASSOCIATES
Consulting Engineers

In Association With

Dan Cortinovis Consulting Engineer

City of Woodland

City of Woodland Wastewater Treatment Plant
Operations & Mantenance Manual
LIQUID PROCESS PIPING

Schematic
5
Revised
Plotted 07/08

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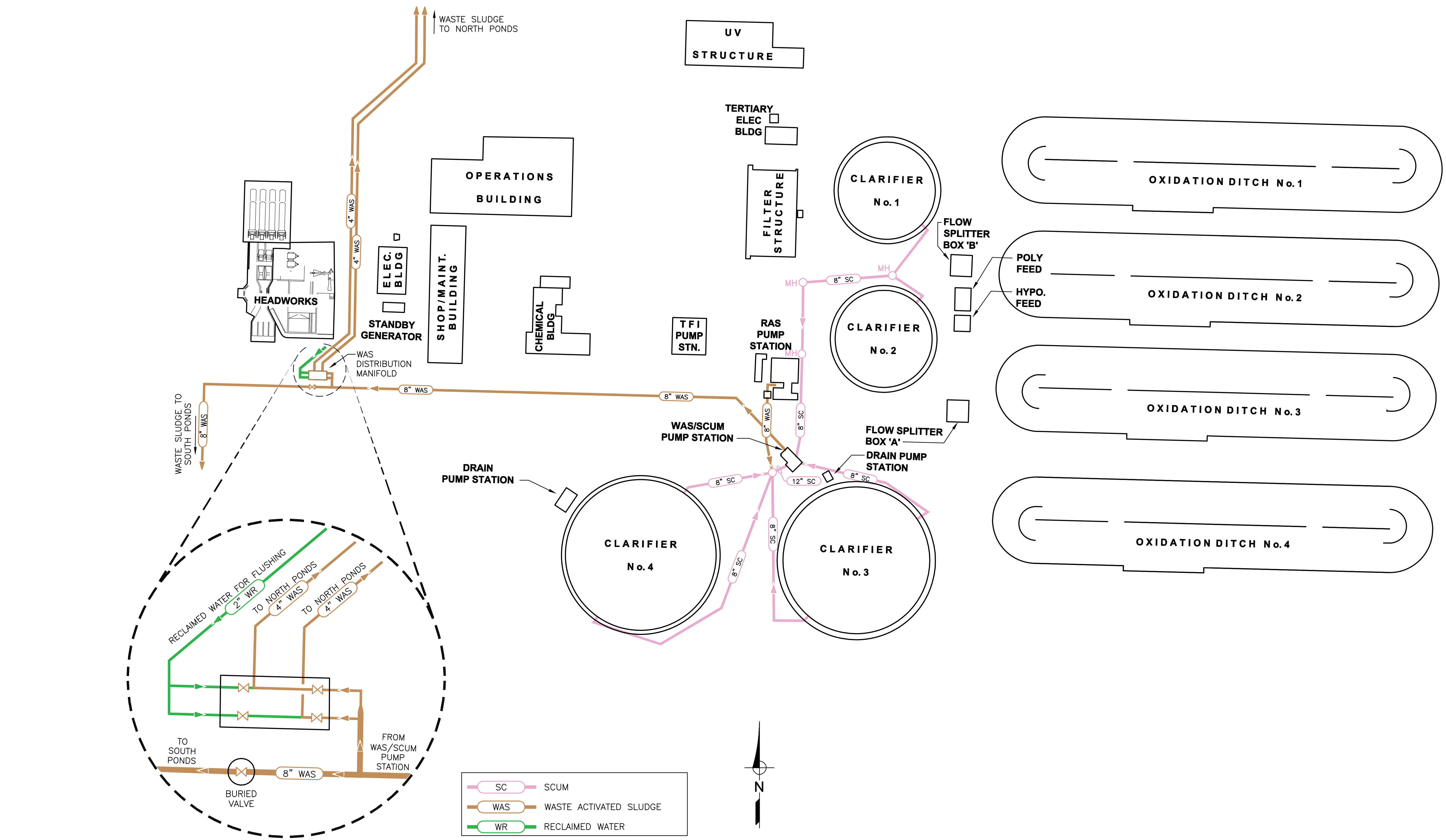
14b



WEST YOST ASSOCIATES
Consulting Engineers

In Association With

Dan Cortinovis Consulting Engineer

City of Woodland

City of Woodland Wastewater Treatment Plant
Operations & Mantenance Manual
WASTE SLUDGE PIPING

Schematic
6
Revised
Plotted 07/08

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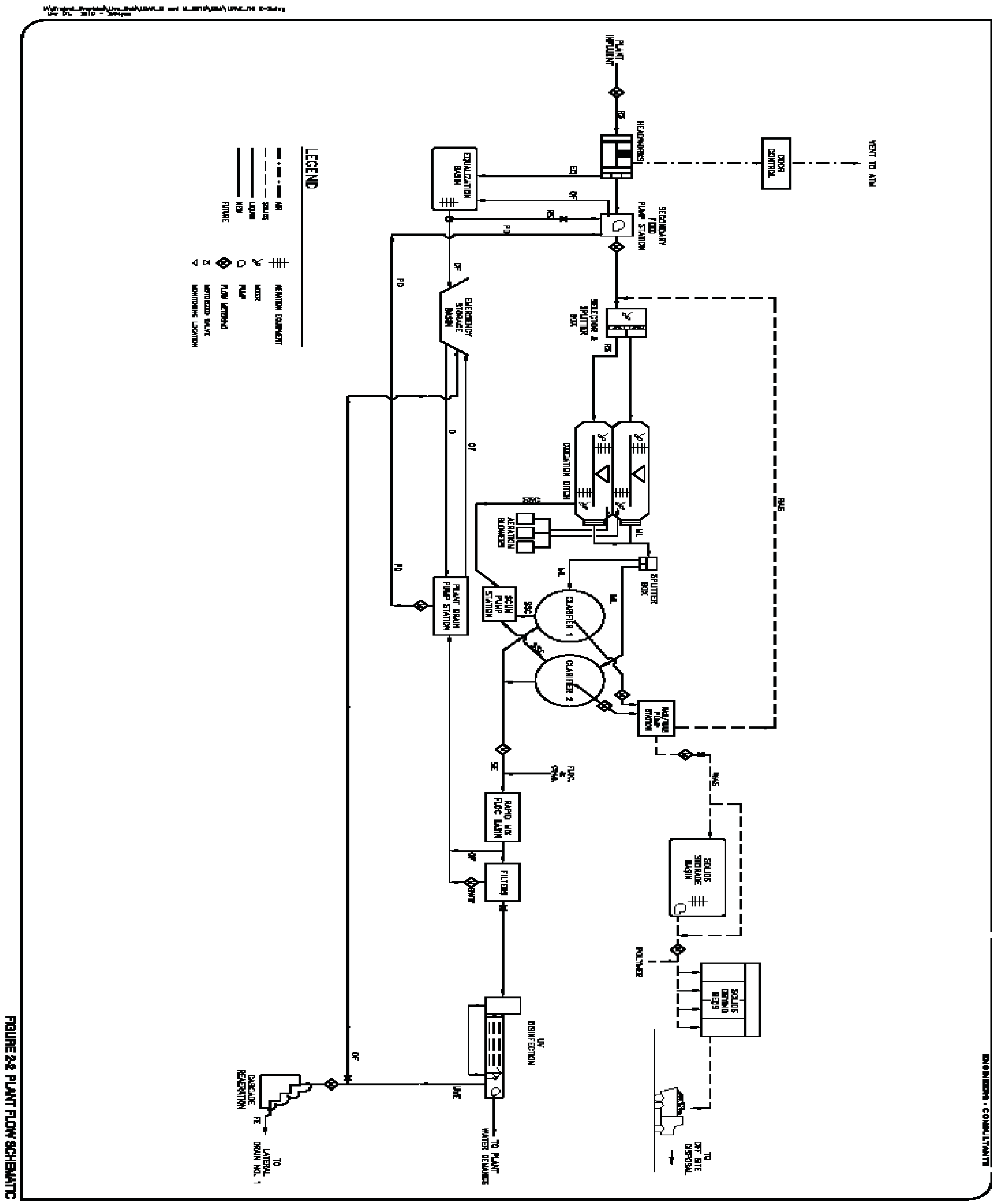
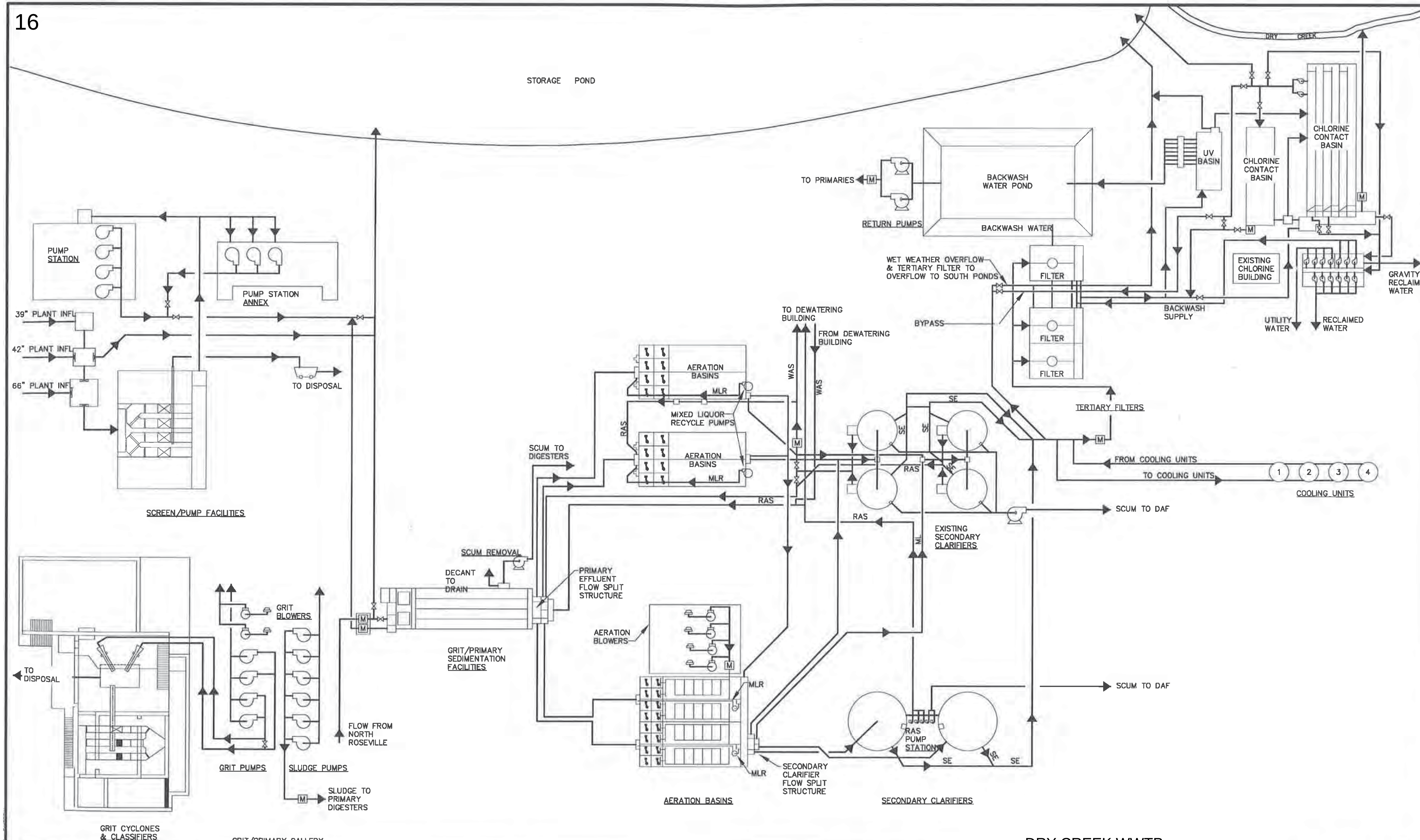
15

ATTACHMENT C – FLOW SCHEMATIC (NEW PLANT UNDER CONSTRUCTION)





DRY CREEK WWTP

REV	DATE	BY	DESCRIPTION

RECORD DRAWING
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THIS DRAWING WAS PREPARED ONLY FOR THE PROJECT AND SITE SPECIFICALLY IDENTIFIED HEREON AND IS NOT TO BE USED ELSEWHERE
Date NOVEMBER 2009
By KATHLEEN J. MARKS

DESIGNED
DRAWN
CHECKED
DATE JUNE, 2006

DISCIPLINE ENGINEER 5/23/06

PROJECT ENGINEER: ** ORIGINAL STAMPED BY KATHLEEN J. MARKS ** 5/23/06

PARTNER: ** ORIGINAL STAMPED BY ROBERT A. GILLETTE ** 5/23/06

carollo engineers

CITY OF ROSEVILLE INCORPORATED APRIL 10, 1909

CITY OF ROSEVILLE – SCHEDULE A
CHLORINE CONVERSION TO UV DISINFECTION PROJECT
LIQUID TREATMENT FLOW SCHEMATIC

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 6538B.11
DRAWING NO. G–06
SHEET NO. 7 OF 234

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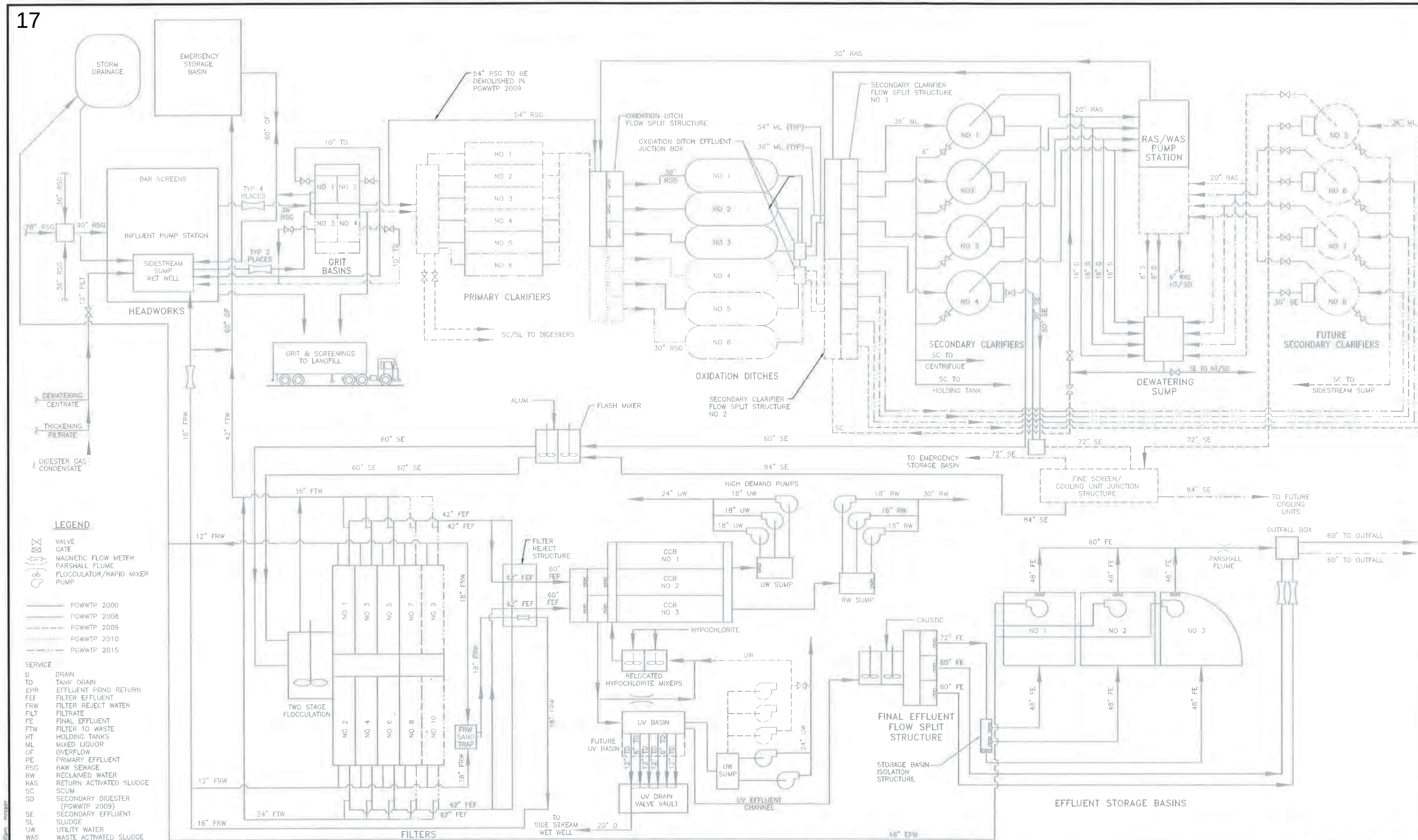

REV	DATE	BY	DESCRIPTION

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THIS DRAWING WAS PREPARED ONLY FOR THE PROJECT AND SITE SPECIFICALLY IDENTIFIED HEREON AND IS NOT TO BE USED ELSEWHERE
Date JUNE 2010
By KATHLEEN J. MARKS

DESIGNED TCJ
DRAWN THO
CHECKED KJM
DATE AUGUST 2011

DISCIPLINE ENGINEER: ORIGINAL STAMPED BY RYAN A. HOOK 03/31/2008 PE C68462

PROJECT ENGINEER: ORIGINAL STAMPED BY KATHLEEN J. MARKS 03/31/2008 PE C42651

PARTNER: ORIGINAL STAMPED BY JAMEL DEMIR 03/31/2008 PE C30355

carollo

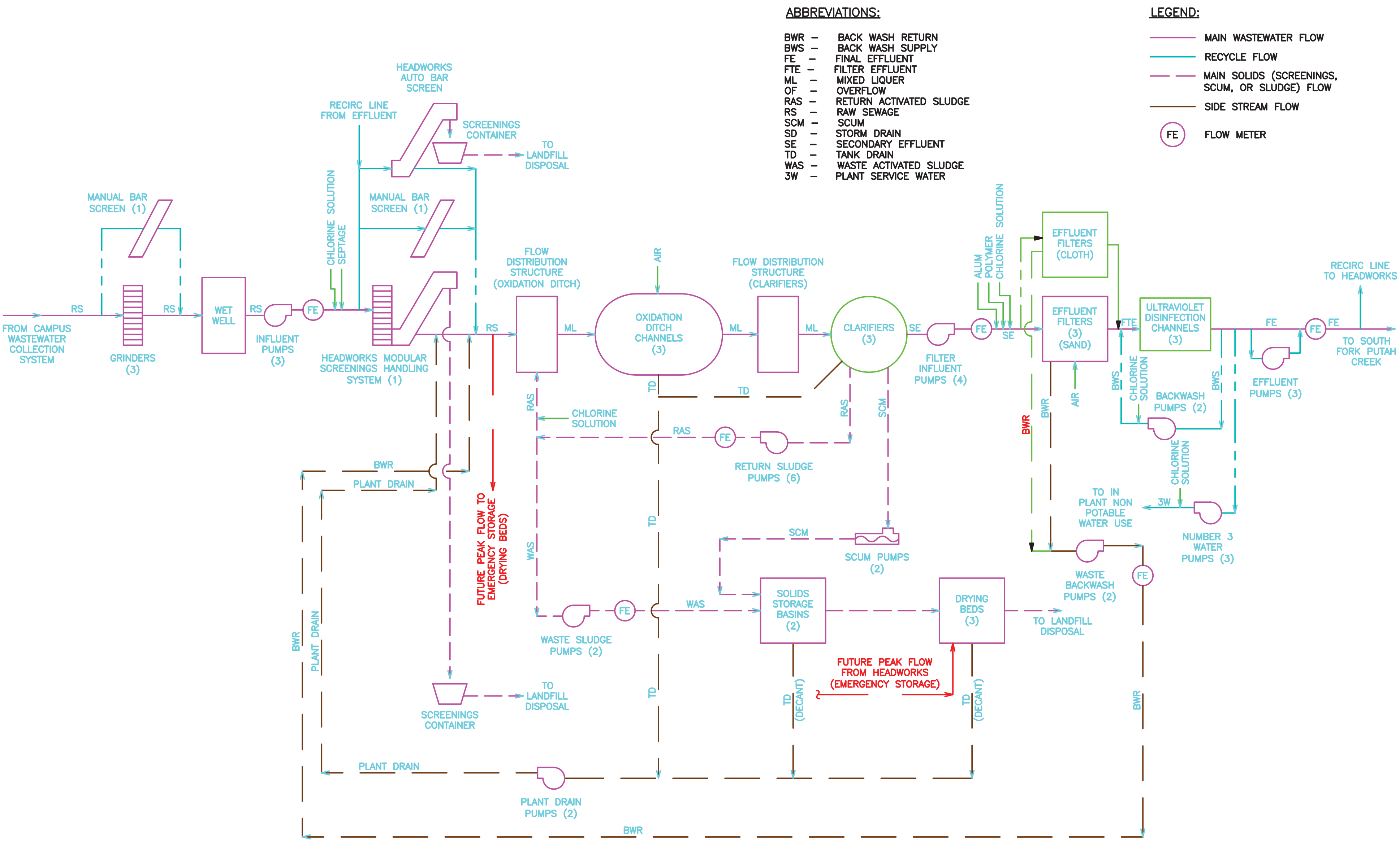
CITY OF ROSEVILLE CALIFORNIA

CITY OF ROSEVILLE
PLEASANT GROVE WWTP
GENERAL
LIQUID STREAM FLOW SCHEMATIC

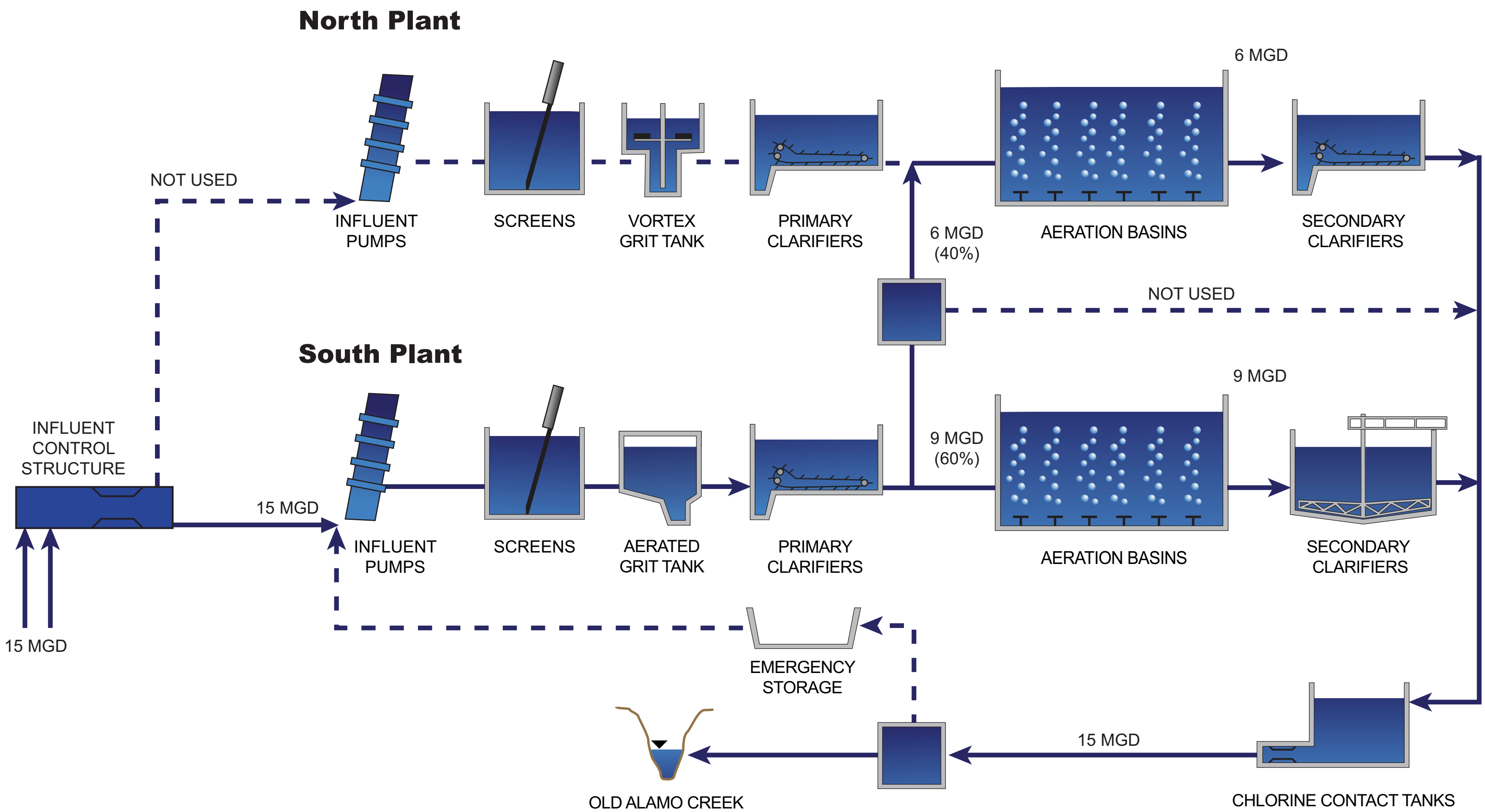
VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 — 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

JOB NO. 7451B10
DRAWING NO. 00-G-006
SHEET NO.
OF XXX

FILENAME: Last Saved By: SMF_DENL 7-07-11 01:24pm



UC Davis Wastewater Treatment Plant Schematic



NOTES:
1. ALL FLOWS ARE DESIGN INFLUENT ADWF VALUES

LEGEND

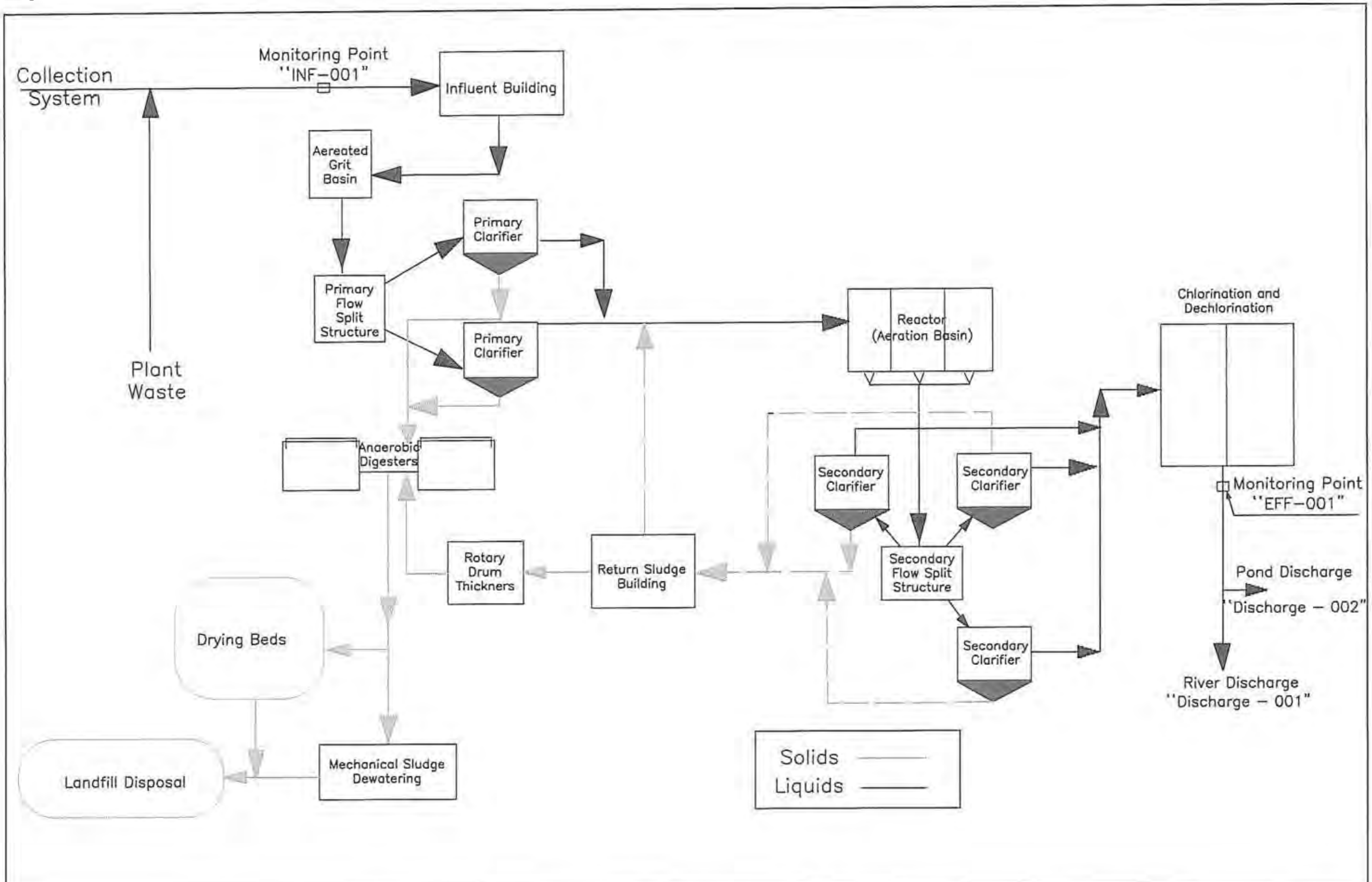
Normal Flow Path

Optional Flow Path

Figure 1-1

EXISTING WWTP SCHEMATIC
NORMAL FLOW ROUTING
City of Vacaville

WEST YOST ASSOCIATES



UPDATED: 02-03-12

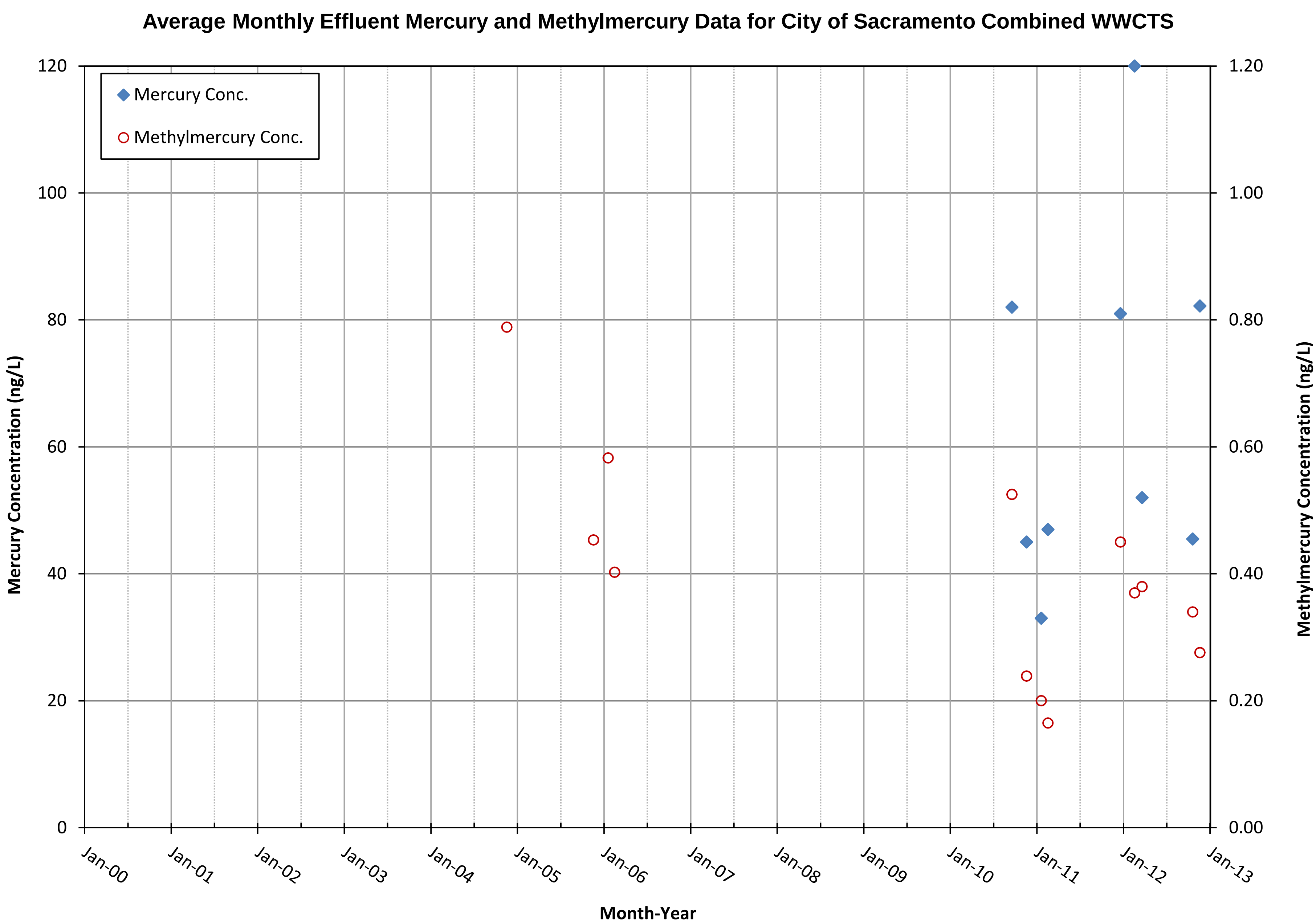
CITY OF YUBA CITY
PLANT FLOW DIAGRAM
WASTEWATER TREATMENT FACILITY

MeHg CONTROL STUDY WORK PLAN
APPENDIX C

Discharger-Specific Mercury and Methylmercury Data

PRIMARY TREATMENT FACILITY

Sacramento Combined WWCTS

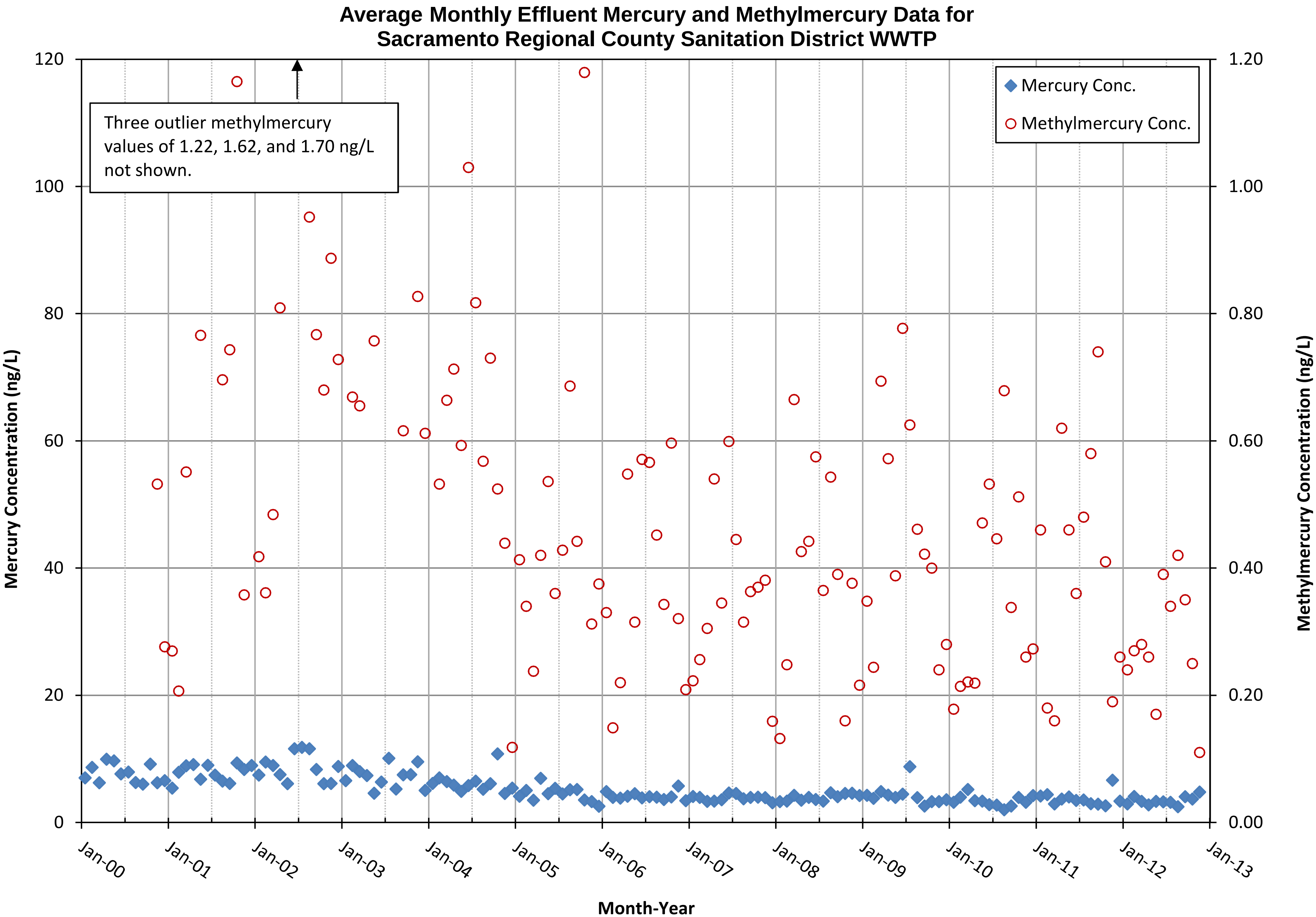


WEST YOST ASSOCIATES
w\c\203\06-12-04\e\di\Summary-SCSS.xlsx
Last Revised: 02-11-13

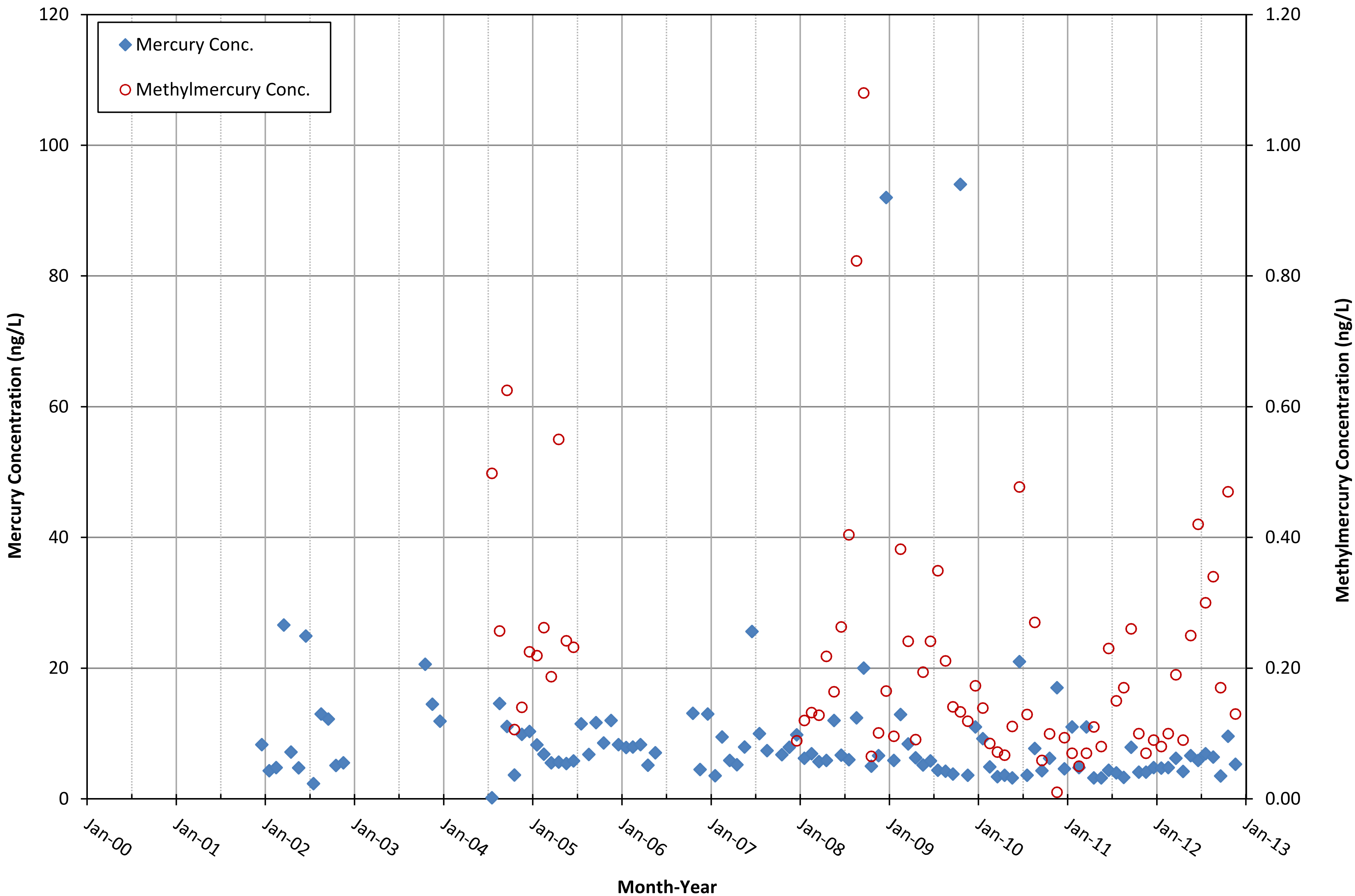
Central Valley Clean Water Association
Methylmercury Control Study Work Plan

SECONDARY TREATMENT FACILITIES

Sacramento Regional County Sanitation District WWTP
Yuba City WWTF

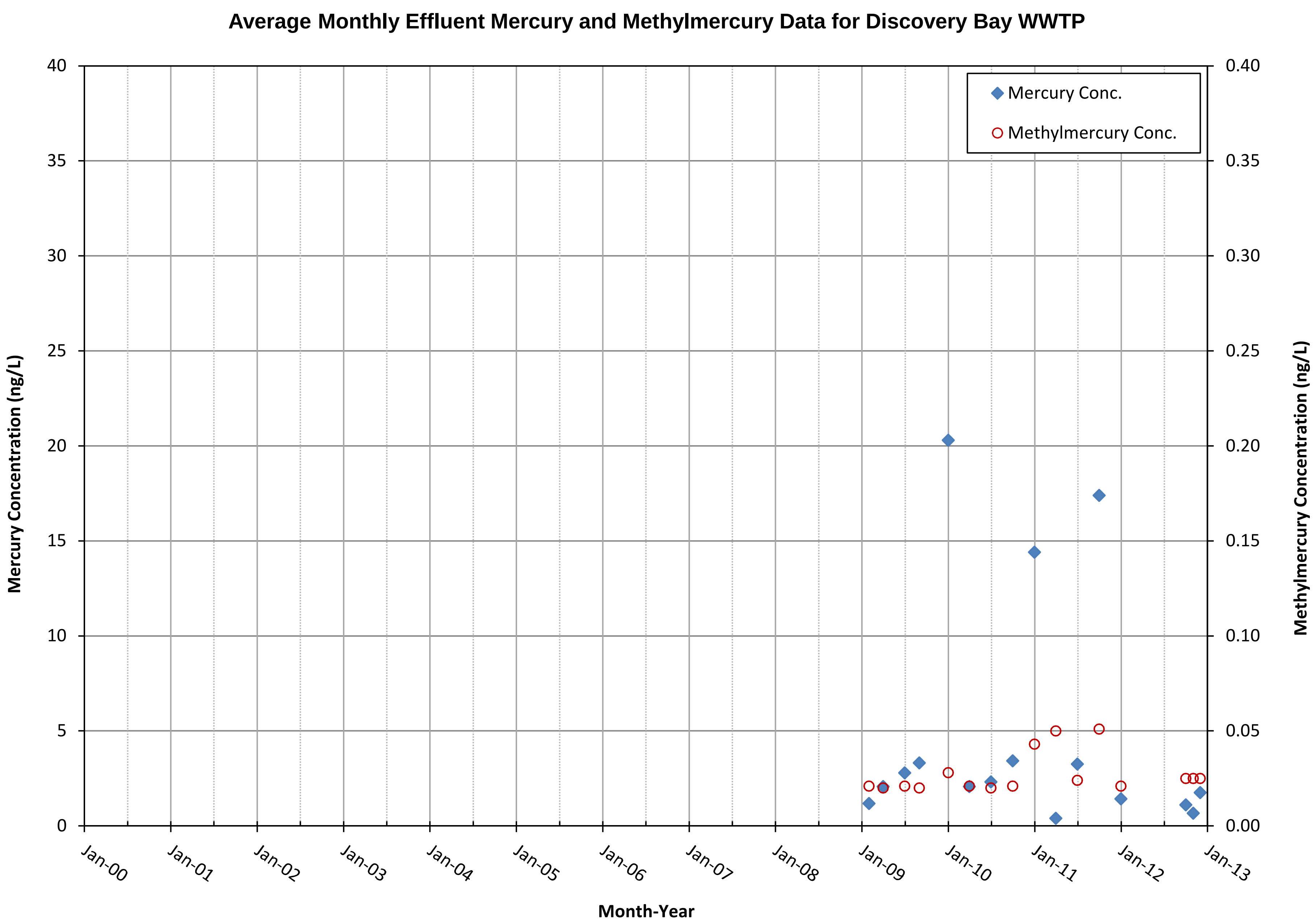

Average Monthly Effluent Mercury and Methylmercury Data for
Sacramento Regional County Sanitation District WWTP
Three outlier methylmercury values of 1.22, 1.62, and 1.70 ng/L not shown.
Mercury Conc.
Methylmercury Conc.
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
20
40
60
80
100
120
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

Average Monthly Effluent Mercury and Methylmercury Data for Yuba City WWTF



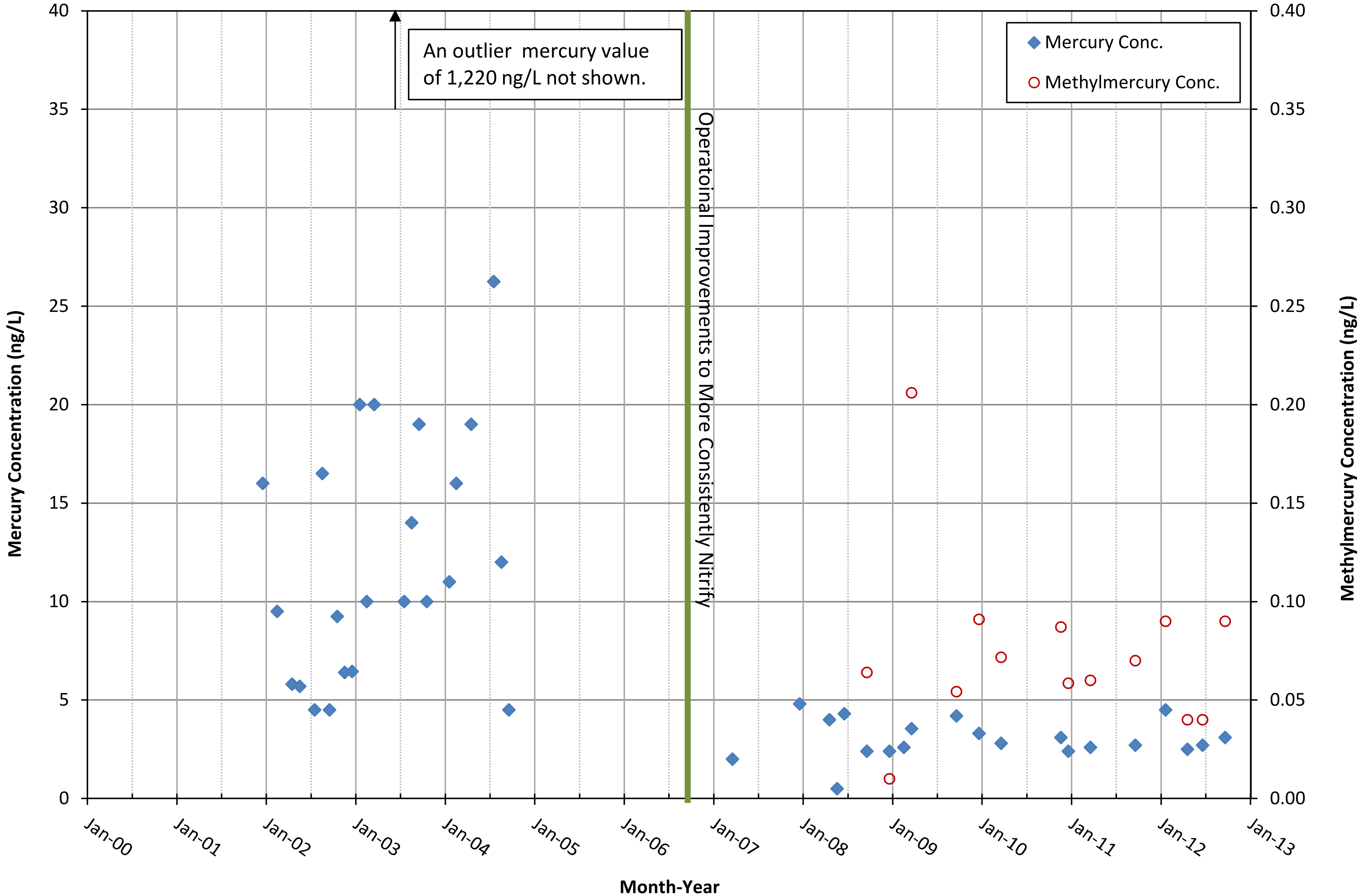
SECONDARY TREATMENT FACILITIES WITH NITRIFICATION

Discovery Bay WWTP
Rio Vista Beach WWTF
Vacaville Easterly WWTP

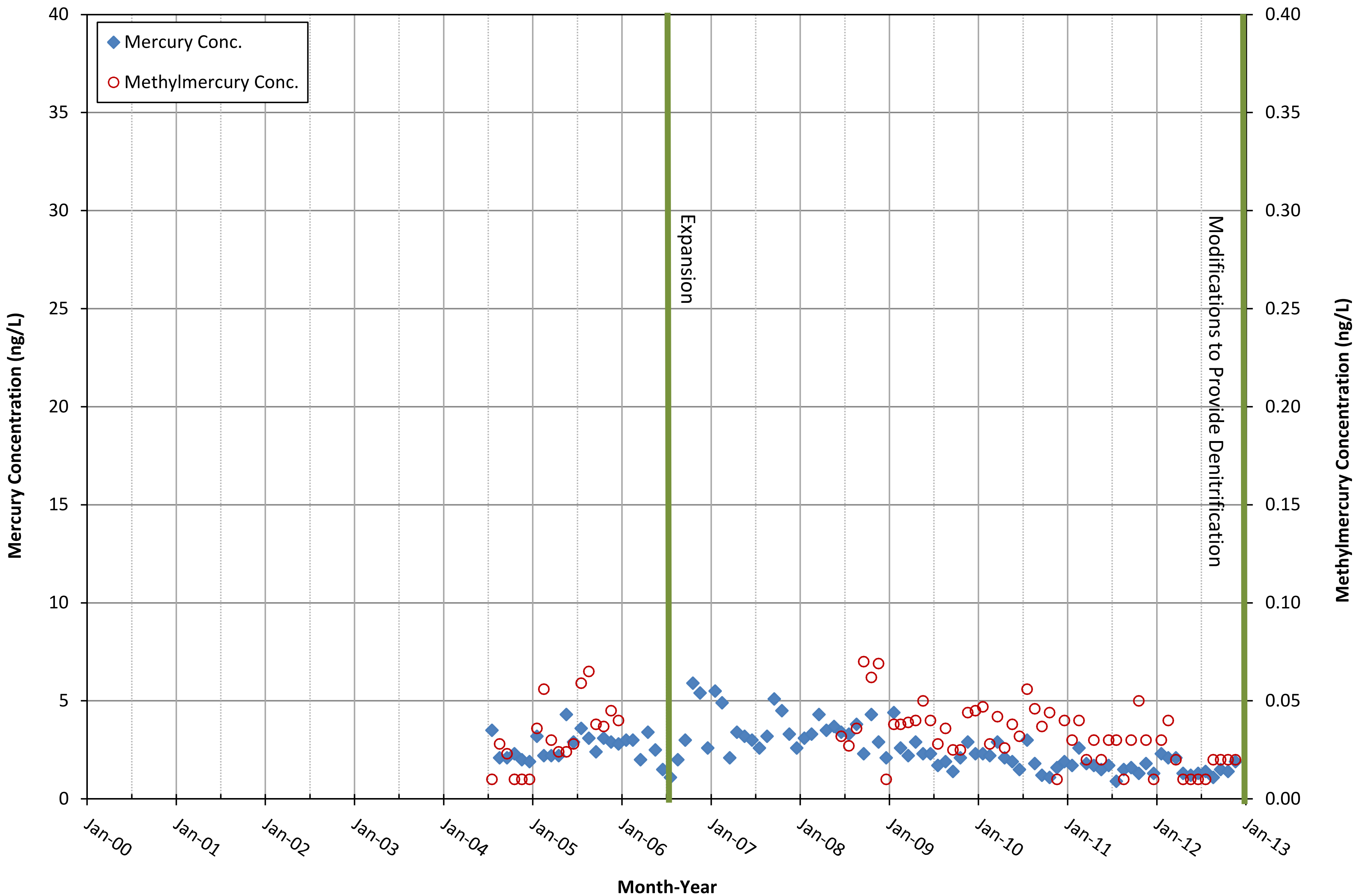


Average Monthly Effluent Mercury and Methylmercury Data for Discovery Bay WWTP
Mercury Conc.
Methylmercury Conc.
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
5
10
15
20
25
30
35
40
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

Average Monthly Effluent Mercury and Methylmercury Data for City of Rio Vista Beach WWTF



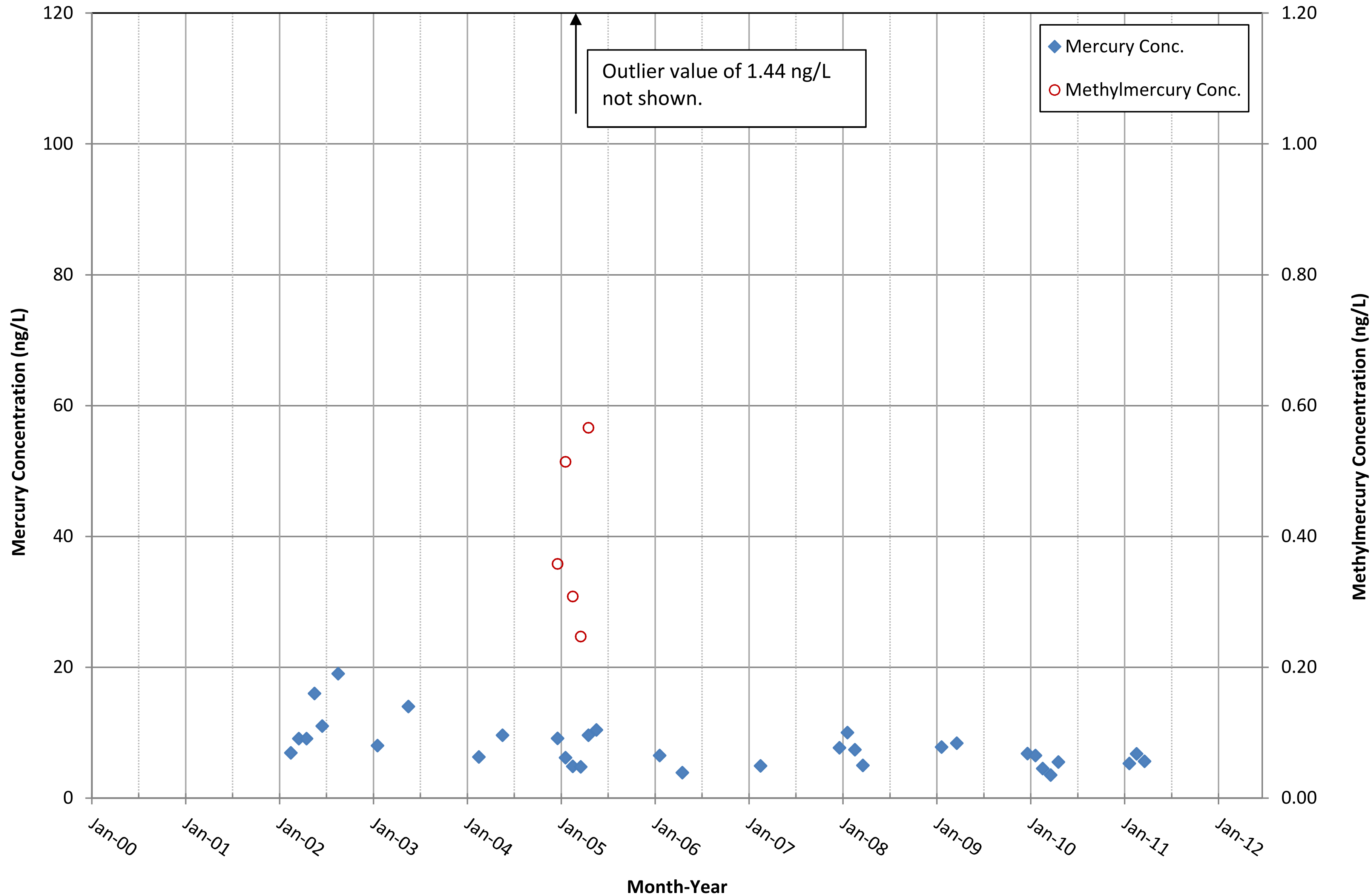
Average Monthly Effluent Mercury and Methylmercury Data for City of Vacaville Easterly WWTP



POND-BASED FACILITY WITH NITRIFICATION

Davis WWTP 002

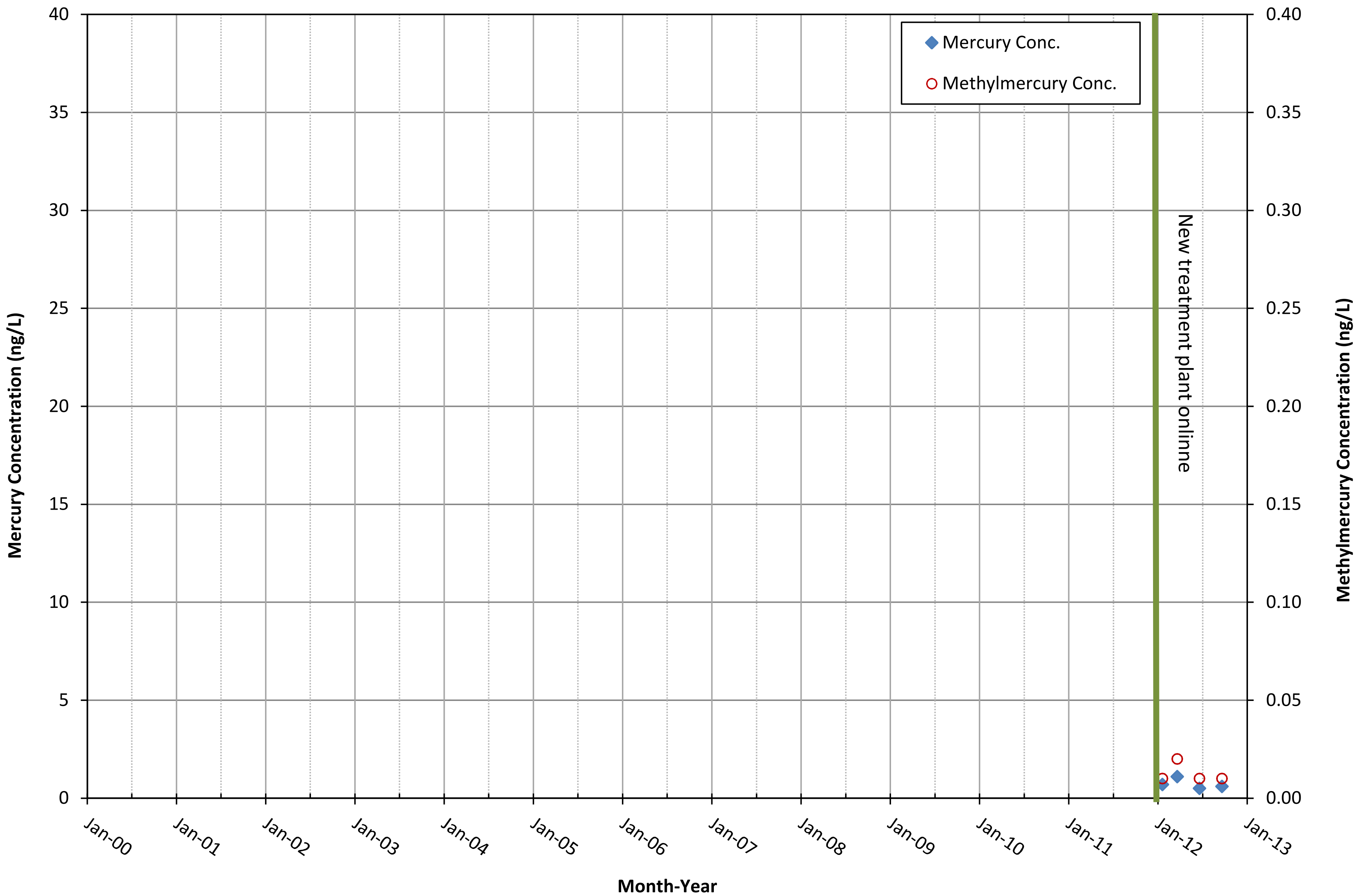
Average Monthly Effluent Mercury and Methylmercury Data for City of Davis WWTP (Discharge Location 002)

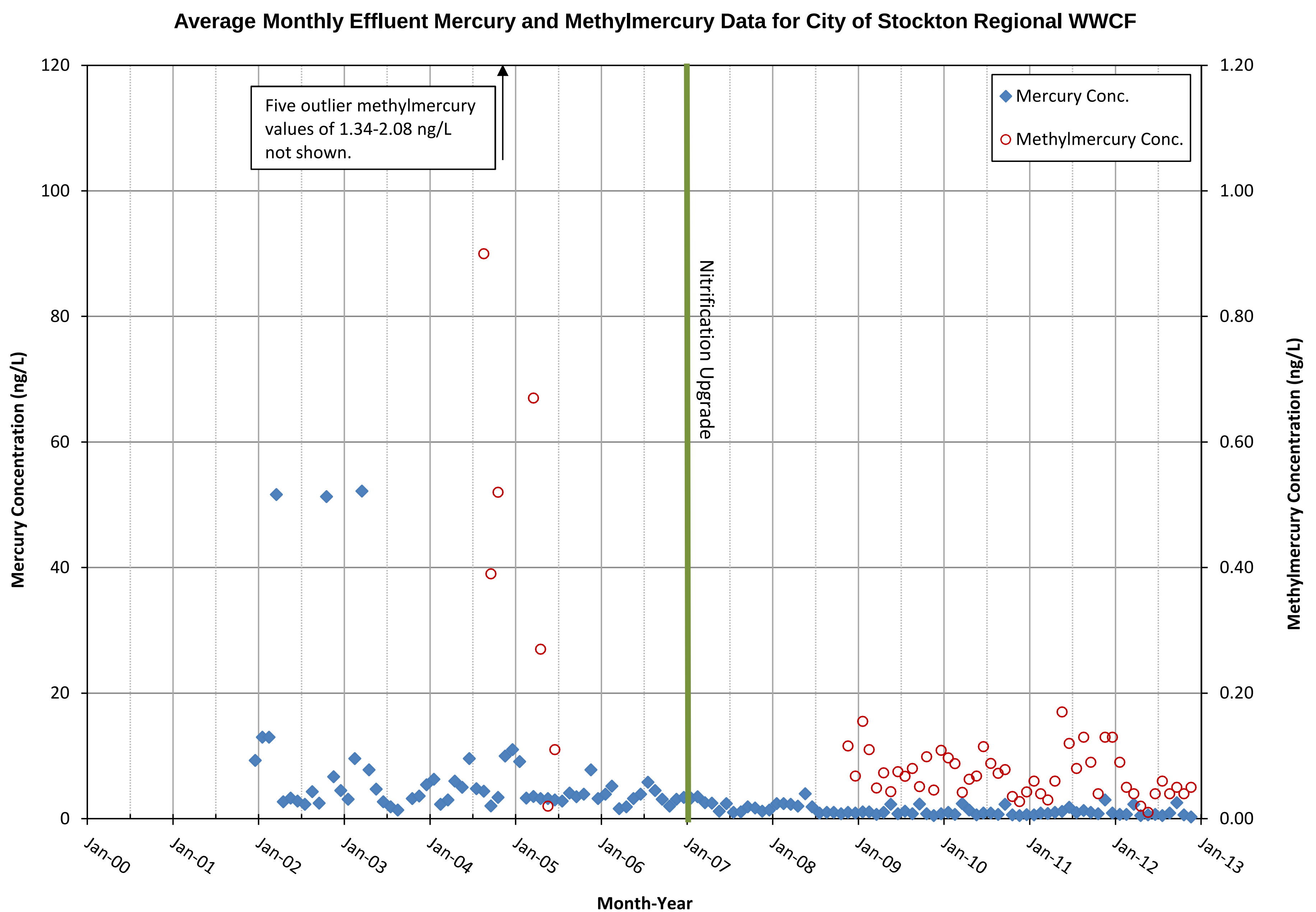


TERTIARY TREATMENT FACILITIES WITH NITRIFICATION

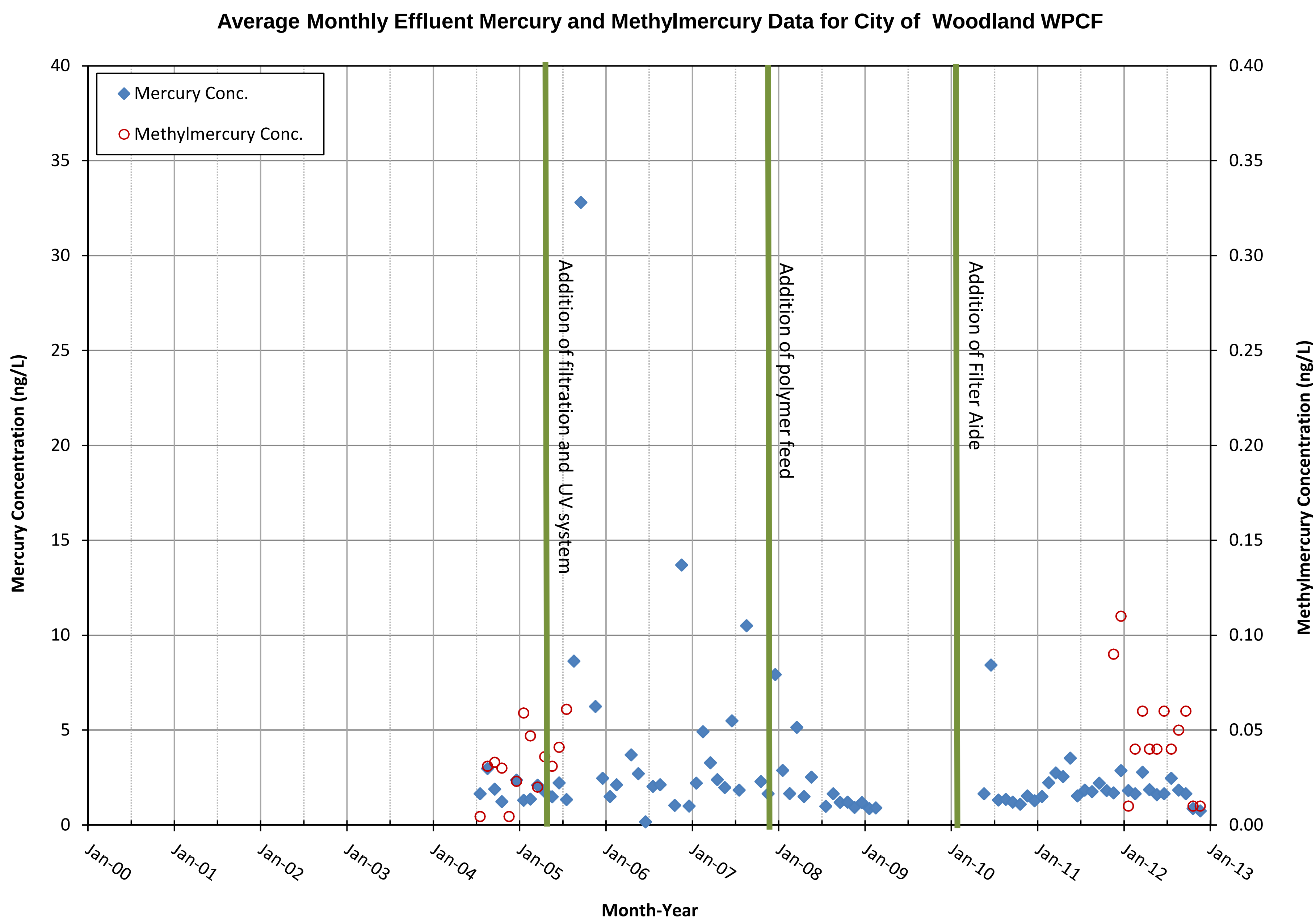
Live Oak WWTP
Stockton Regional WWCF
Woodland WPCF

Average Monthly Effluent Mercury and Methylmercury Data for City of Live Oak WWTP





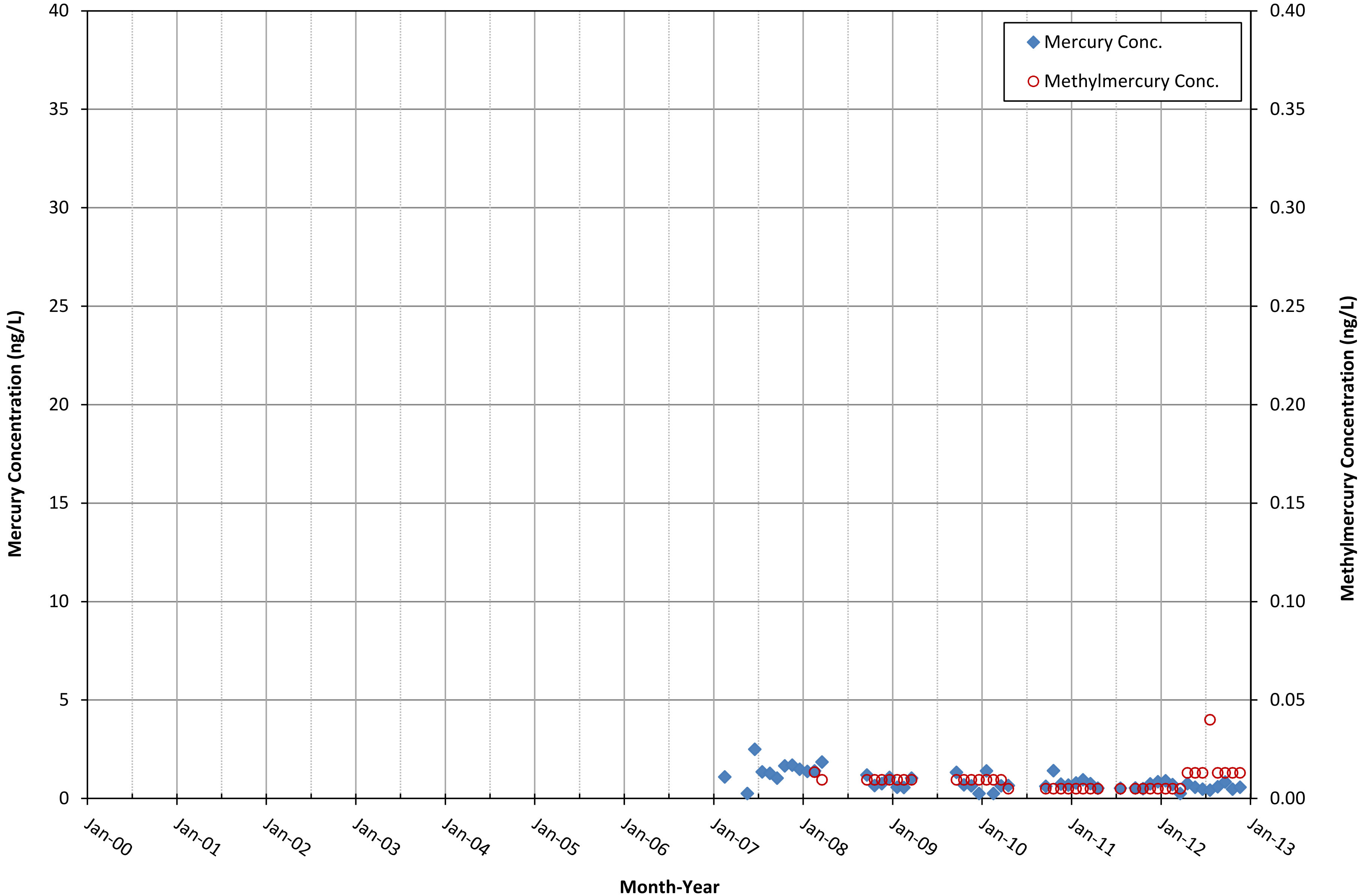
Average Monthly Effluent Mercury and Methylmercury Data for City of Stockton Regional WWCF
Five outlier methylmercury values of 1.34-2.08 ng/L not shown.
Mercury Conc.
Methylmercury Conc.
Nitrification Upgrade
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
20
40
60
80
100
120
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

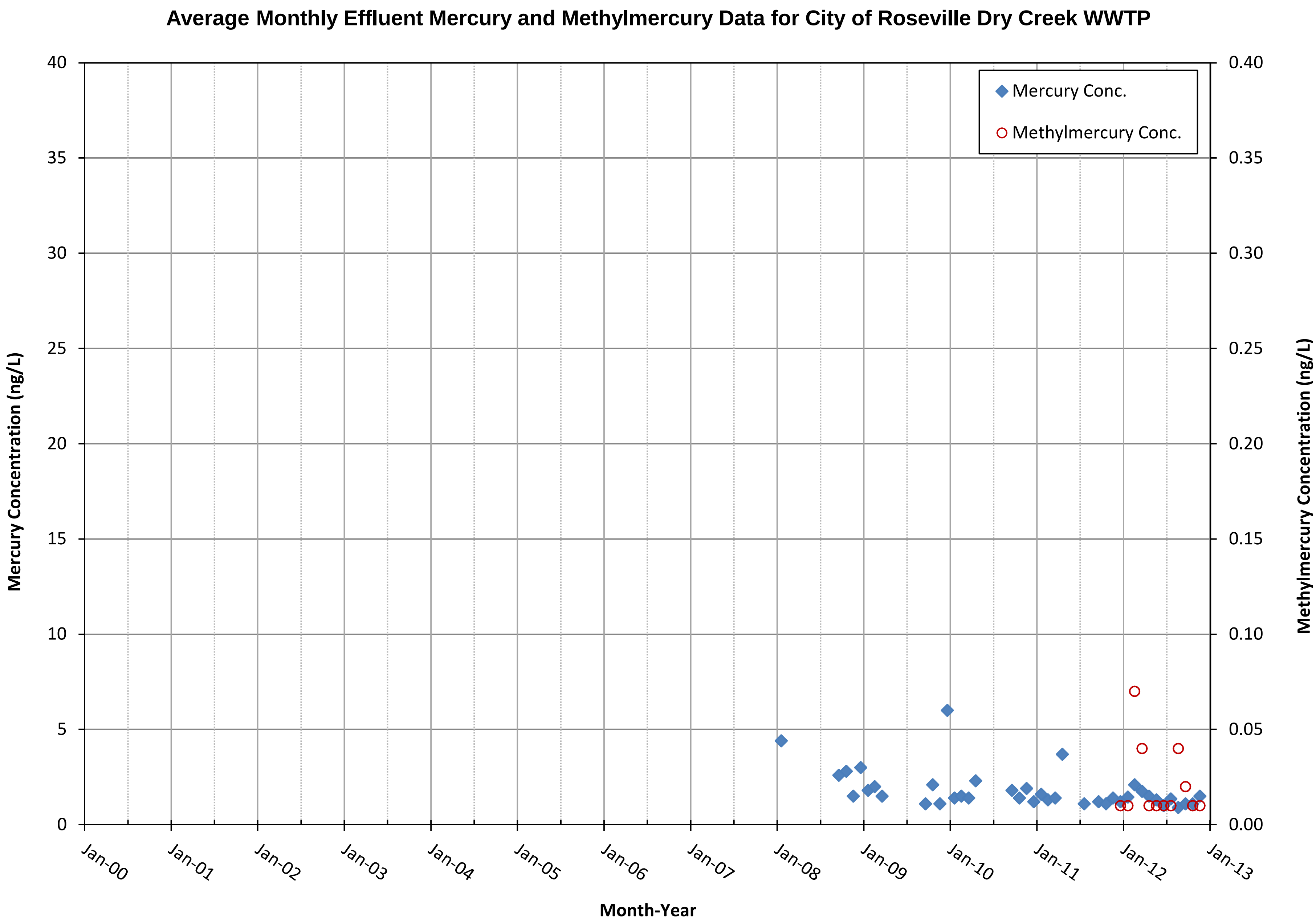

Average Monthly Effluent Mercury and Methylmercury Data for City of Woodland WPCF
Mercury Conc.
Methylmercury Conc.
Addition of filtration and UV system
Addition of polymer feed
Addition of Filter Aide
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
5
10
15
20
25
30
35
40
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

TERTIARY TREATMENT FACILITIES WITH NDN

Brentwood WWTP
Roseville Dry Creek WWTP
Roseville Pleasant Grove WWTP
Lodi WPCF
Manteca WQCF
Tracy WWTP
Ironhouse Sanitary District WWTP
Mountain House Community Services District WWTP
Rio Vista Northwest WWTF
UC Davis Main WWTP

Average Monthly Effluent Mercury and Methylmercury Data for City of Brentwood WWTP

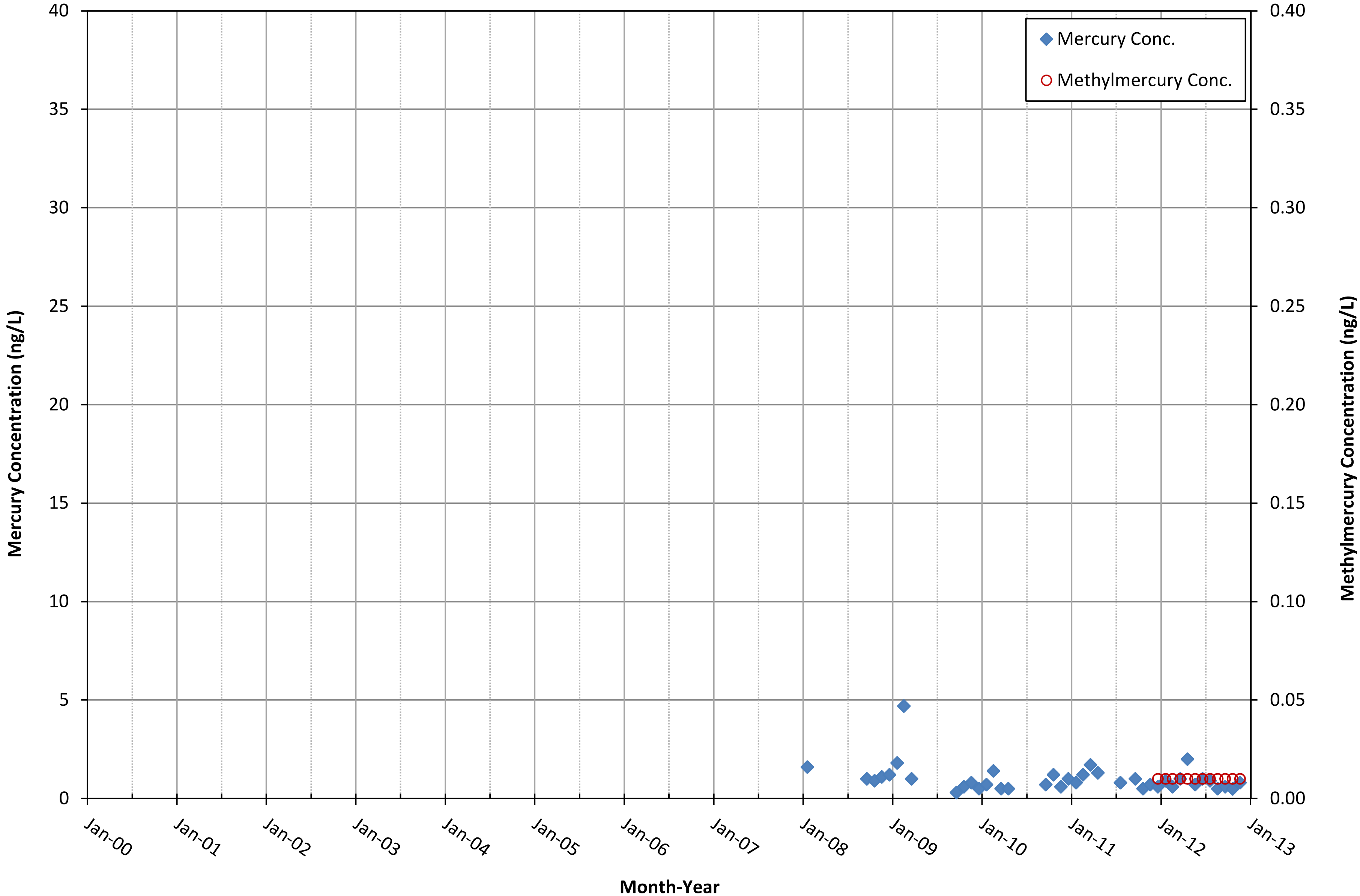


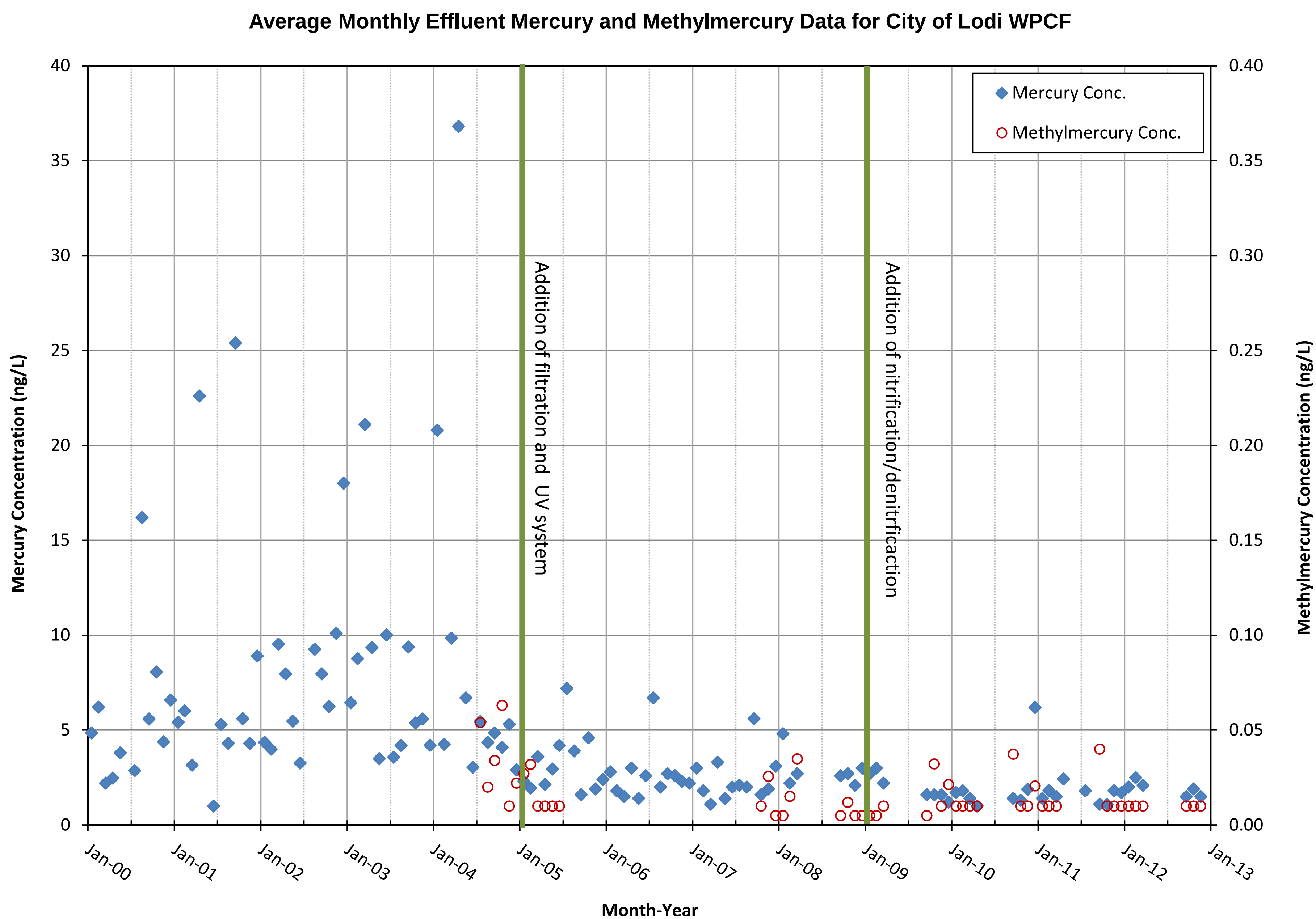


WEST YOST ASSOCIATES
w\c\203\06-12-04\e\di\Summary-RosevilleDC.xlsx
Last Revised: 02-11-13

Central Valley Clean Water Association
Methylmercury Control Study Work Plan

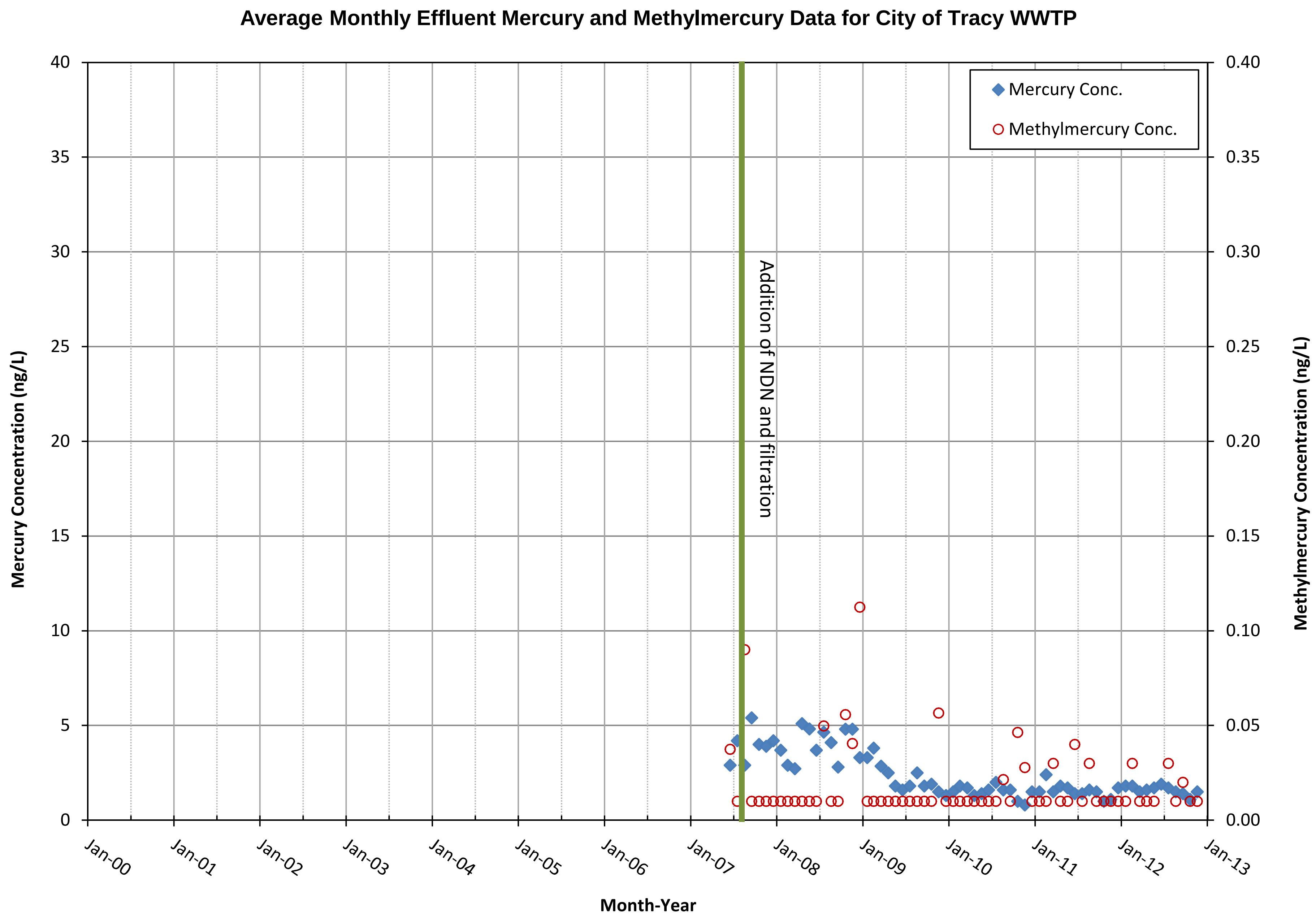
Average Monthly Effluent Mercury and Methylmercury Data for City of Roseville Pleasant Grove WWTP

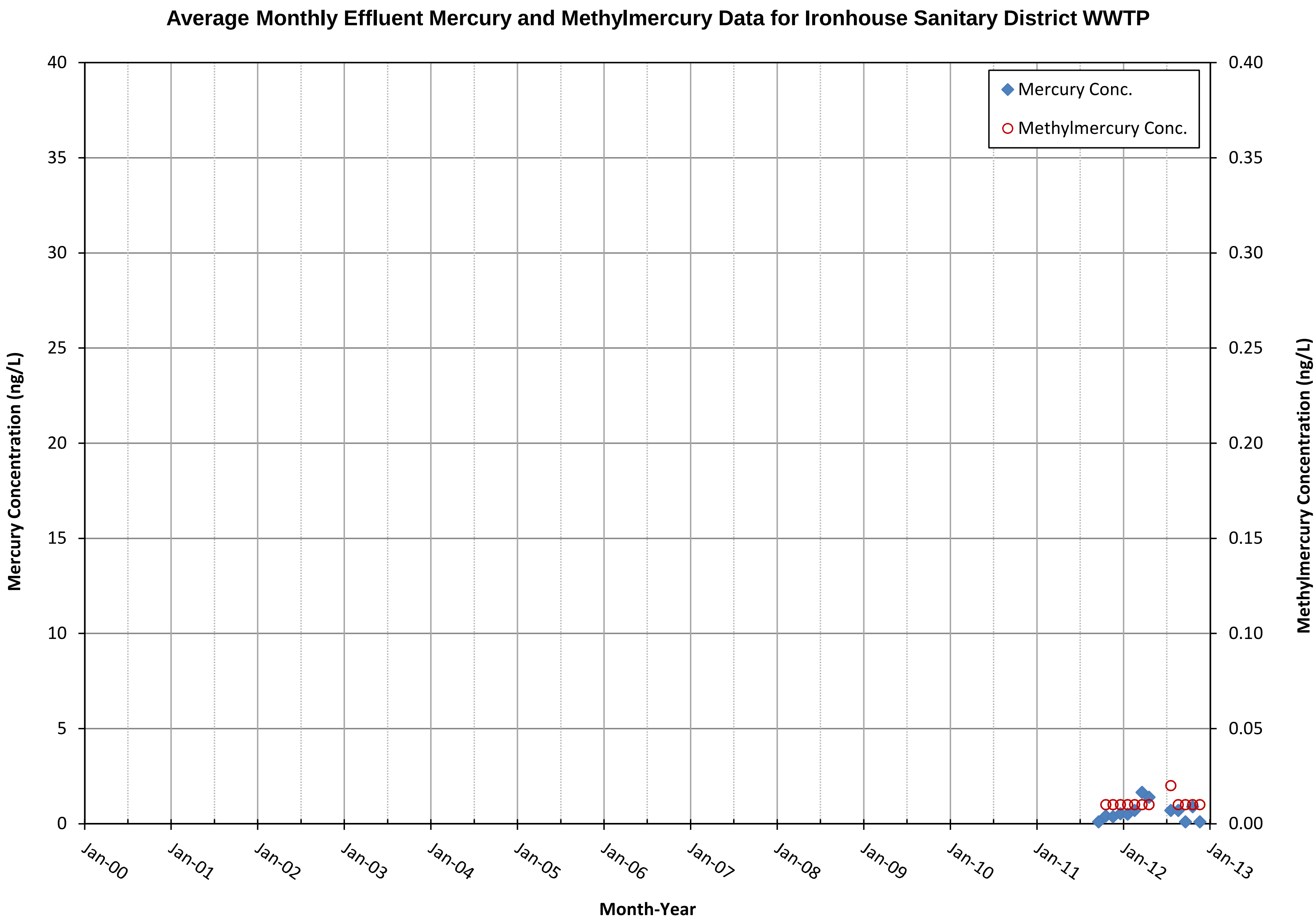




Average Monthly Effluent Mercury and Methylmercury Data for City of Lodi WPCF
Mercury Conc.
Methylmercury Conc.
Addition of filtration and UV system
Addition of nitrification/denitrficaction
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
5
10
15
20
25
30
35
40
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

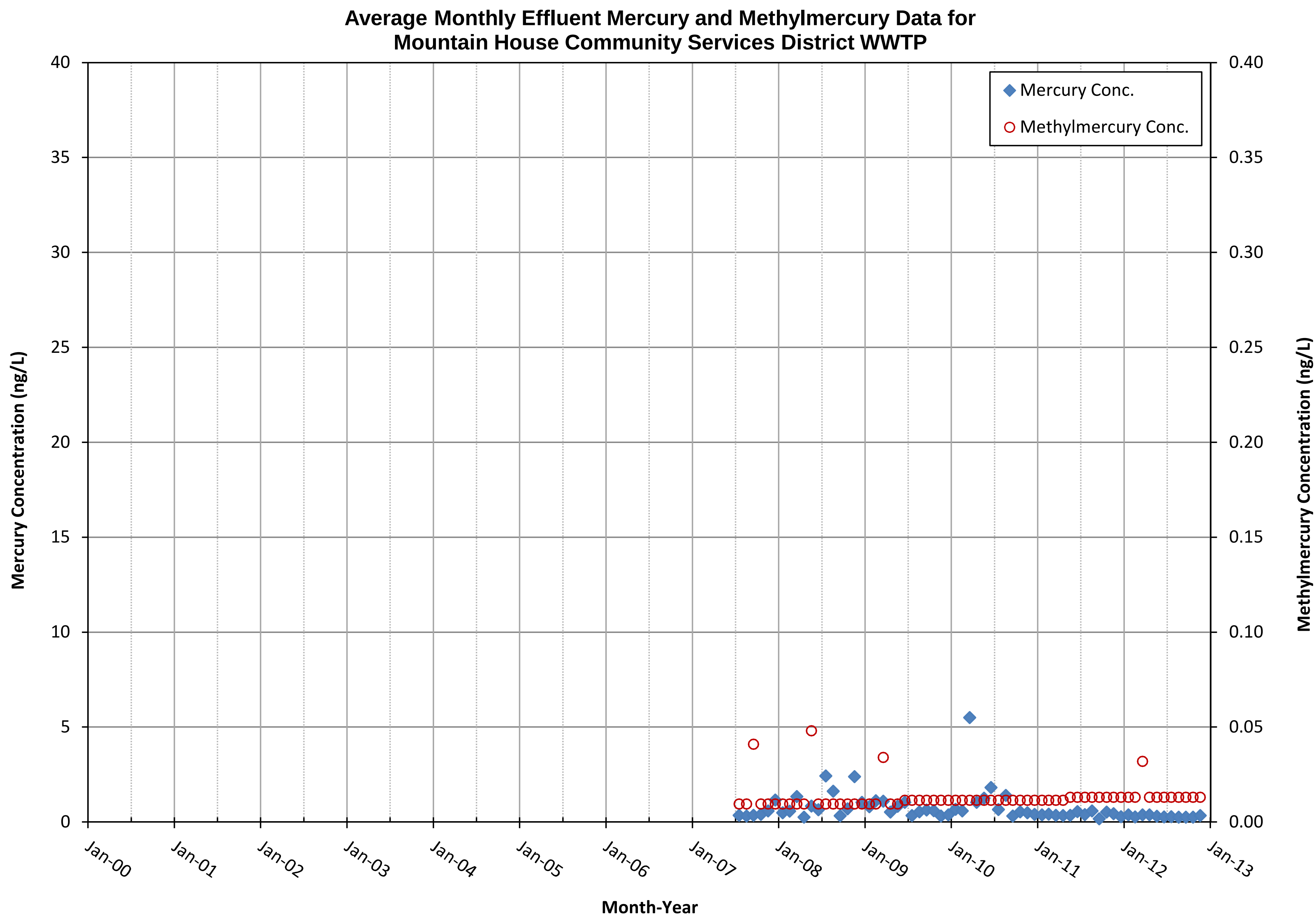
WEST YOST ASSOCIATES
w\c\203\06-12-04\e\di\Summary-Manteca.xlsx
Last Revised: 02-11-13


Average Monthly Effluent Mercury and Methylmercury Data for City of Tracy WWTP
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
Mercury Conc.
Methylmercury Conc.
Addition of NDN and filtration
0
5
10
15
20
25
30
35
40
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

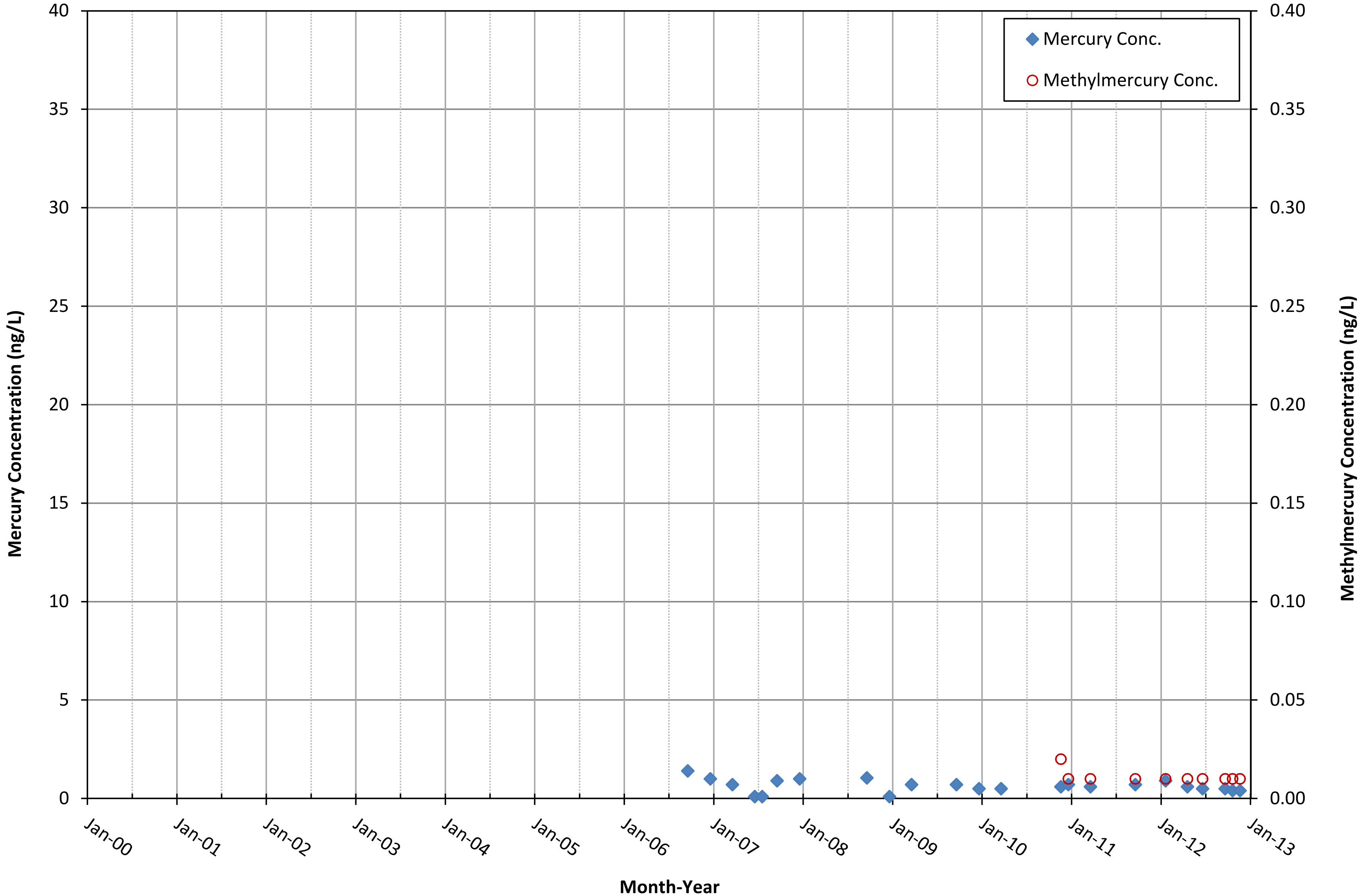


WEST YOST ASSOCIATES
w\c\203\06-12-04\e\di\Summary-ISD.xlsx
Last Revised: 02-11-13

Central Valley Clean Water Association
Methylmercury Control Study Work Plan

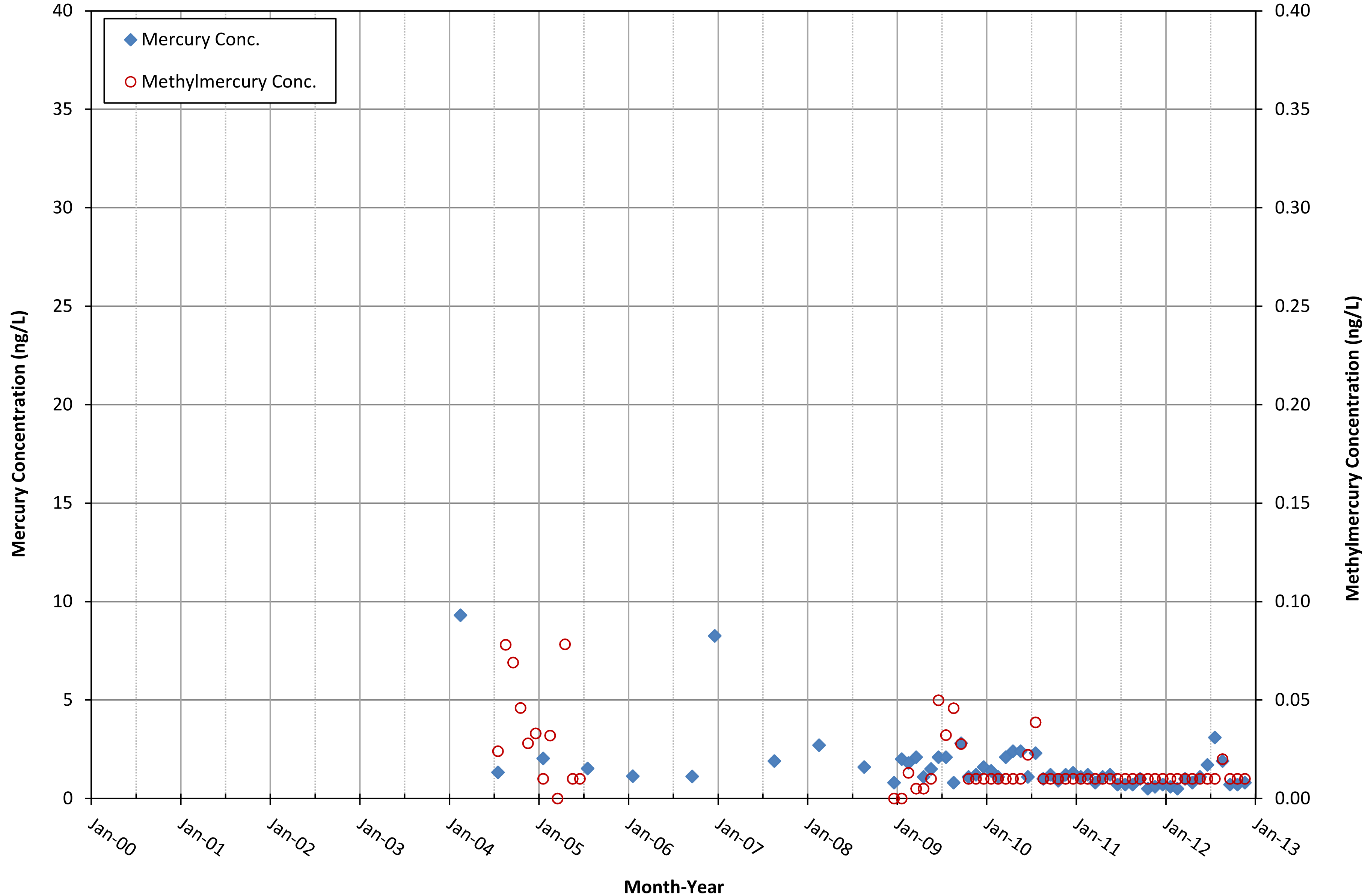

Average Monthly Effluent Mercury and Methylmercury Data for
Mountain House Community Services District WWTP
Mercury Conc.
Methylmercury Conc.
Mercury Concentration (ng/L)
Methylmercury Concentration (ng/L)
Month-Year
0
5
10
15
20
25
30
35
40
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13

Average Monthly Effluent Mercury and Methylmercury Data for City of Rio Vista Northwest WWTF



WEST YOST ASSOCIATES
w\c\203\06-12-04\e\di\Summary-RioVistaNW.xlsx
Last Revised: 02-11-13

Average Monthly Effluent Mercury and Methylmercury Data for UC Davis Main WWTP



MeHg CONTROL STUDY WORK PLAN
APPENDIX D

Sacramento Regional WWTP Pilot Facility MeHg Testing Data

Figure D-1.

SRCSD ATTP

MERCURY & METHYLMERCURY CONTROL STUDY

Sampling Locations

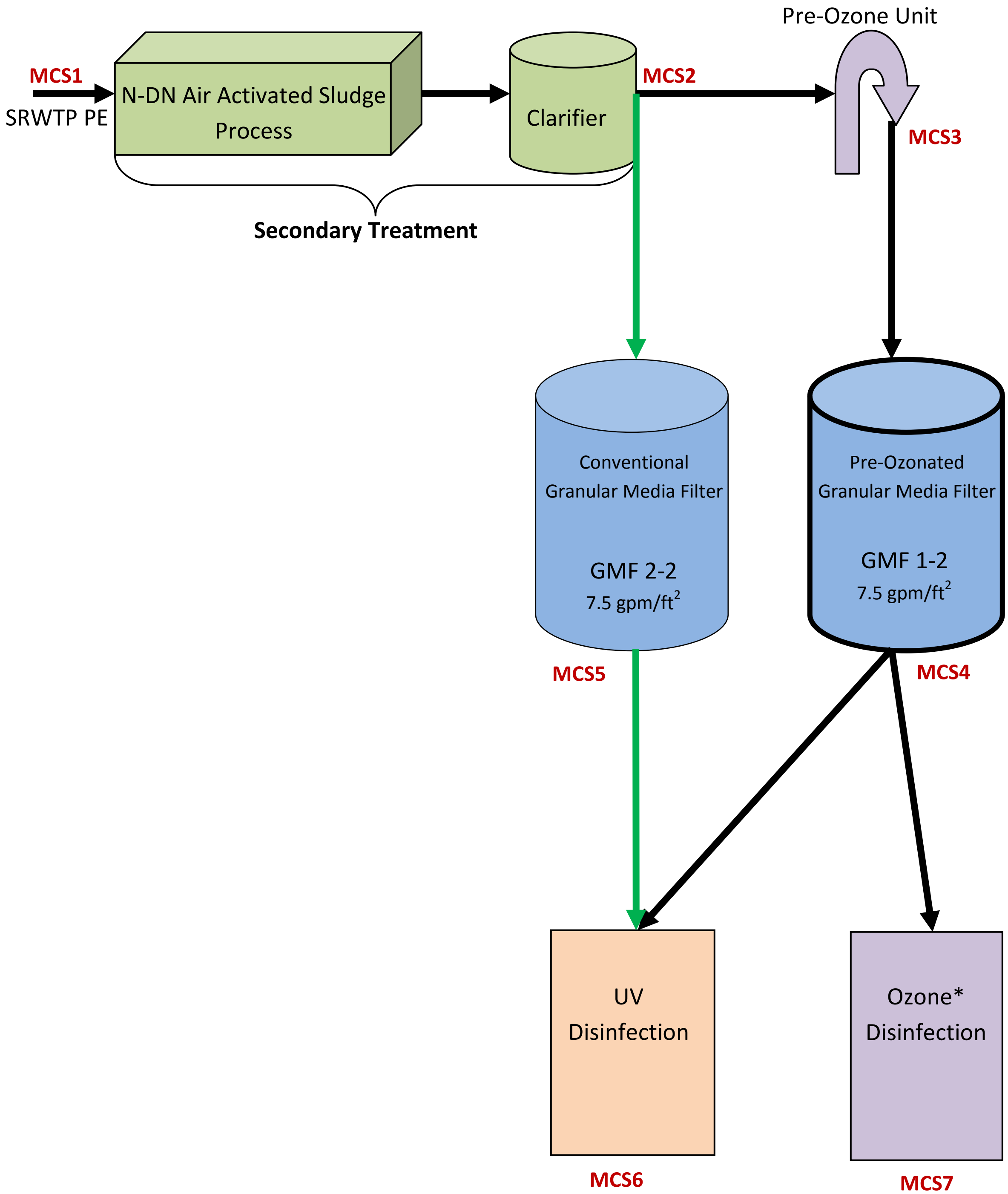
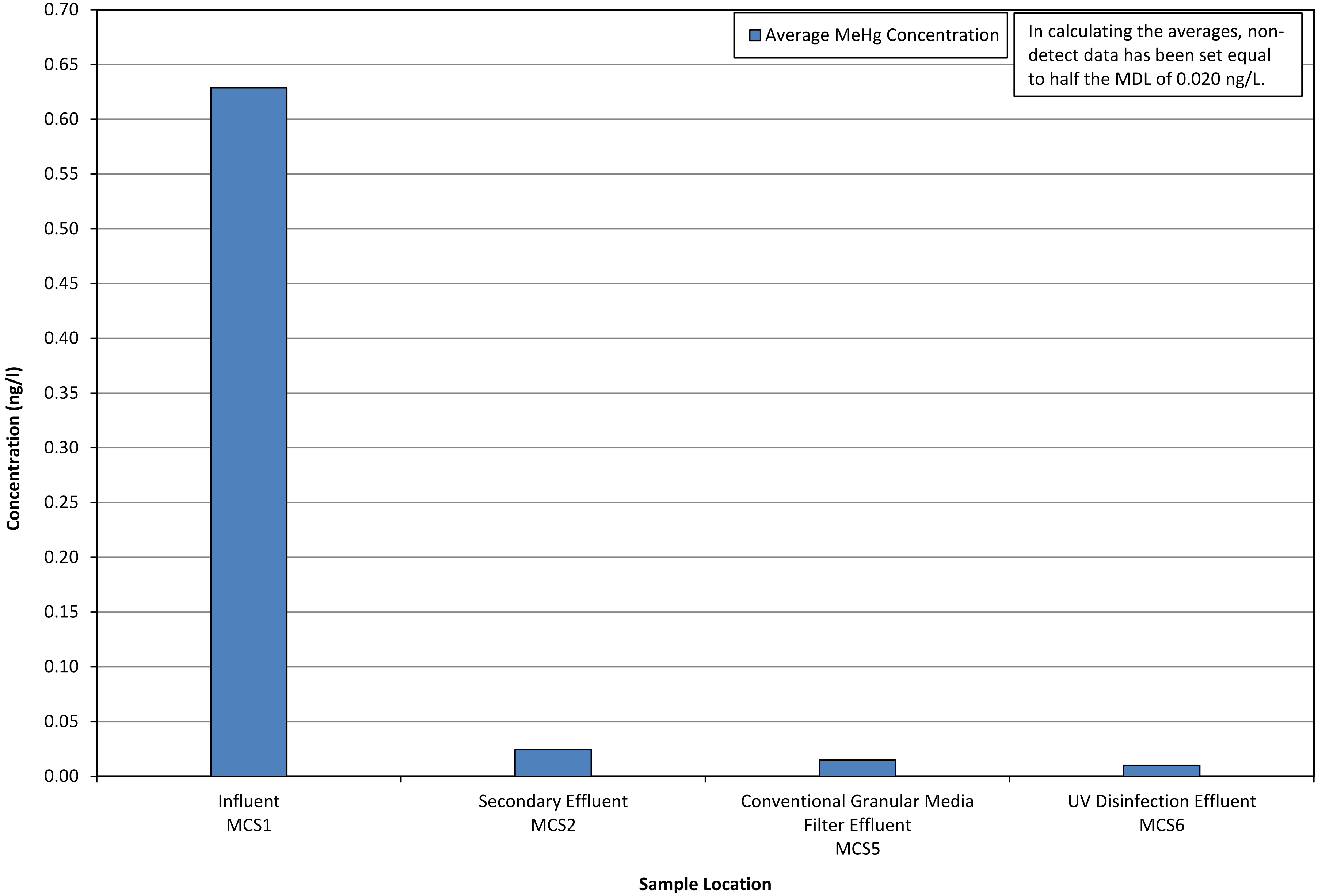


Figure D-2. Sacramento Regional WWTP Pilot Facility Average MeHg (Jul.-Dec. 2012)



MeHg CONTROL STUDY WORK PLAN
APPENDIX E

Statistical Methods for Development of Probability Plots using Effluent Data with Non-Detect Values

APPENDIX E
STATISTICAL METHODS FOR DEVELOPMENT OF PROBABILITY PLOTS USING EFFLUENT DATA WITH NON-DETECT VALUES

The statistical methods utilized in developing the probability plots make use of the "Robust Method" for dealing with data sets that may include non-detect values [Helsel and Cohn, 1988]. Key issues to consider when using such methods include:

- Identification of data sets with sufficient detected data
- Assigning plotting positions for data sets with a single non-detect threshold
- Assigning plotting positions for data sets with multiple non-detect thresholds
- Developing log-normal probability plots

Identification of Data Sets with Sufficient Detected Data

The first step in the process of developing the probability plots is to determine whether a given data set has a sufficient number of detected data to perform a meaningful statistical analysis. Therefore, guidelines for determining what constitutes a sufficient amount of detected values are needed. Based on recommendations of Helsel and Cohn, the following guidelines will be followed for the development of the probability plots for the Control Study:

1. A minimum of 5 detected or estimated data values is needed.
2. If there are less than 20 detected values, a minimum of 10% of the data set should be detected data values.
3. Both of the above guidelines are subject to the caveat that the detected values in the data set need to be non-repeated values. Two or more repeated values should be regarded as one unique value in applying the above guidelines.

An example should suffice to explain the latter guideline. Consider the following hypothetical data set (in units of µg/L):

<2, <2, <2, <2, <0.2, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2

This data set consists of only two distinct detected values (1 µg/L and 2 µg/L), thus creating a two-level stair-step appearance to the data distribution, which, by definition, cannot be accurately represented by a lognormal distribution. It can therefore be concluded that the data set in question contains an insufficient number of detected data to produce a meaningful probability plot.

Establishing Plotting Positions for Data Sets with a Single Non-Detect Threshold

Data with a single non-detect will be sorted in ascending order, and plotting positions (*i.e.*, probabilities) will be assigned to each data point, following the Hazen method (Helsel and Cohn, 1988) as follows:

$$P_i = (i - 0.5) / n$$

Under this approach, the non-detect data are used to establish the plotting position of the detected values, but do not appear directly in the probability plot.

Consider the following hypothetical data set (in units of µg/L) of ten sorted data values:

$$<1, <1, <1, <1, 1, 2, 4, 7, 12, 20$$

Using the Hazen Method, the assigned plotting positions are, respectively, as follows:

$$0.05, 0.15, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, 0.95.$$

Establishing Plotting Positions for Data Sets with Multiple Non-Detect Thresholds

The data analysis becomes considerably more complex where multiple data thresholds exist within a given data set; however, Helsel and Cohn provide a method for analyzing such data sets. As with the methodology described above for data sets with a single non-detect threshold, when the data are plotted using the method outlined below, the non-detect values influence the plotting positions of the detected values; however, those non-detect values do not explicitly appear on the probability plot. Consider the following hypothetical data set (in units of µg/L) of 18 sorted data values:

$$<1, <1, <1, <1, <1, <1, 3, 7, 9, <10, <10, <10, 13, 15, 20, 27, 33, 50$$

For this hypothetical data set with *m* thresholds (where m=2 in the above example data set), threshold j=1 is 1 µg/L and threshold j=2 is 10 µg/L. The probability (P_j) associated with the last data point in the j^{th} threshold is calculated as follows:

$$P_j = (1 - A_j / (A_j + B_j)) P_{j+1}$$

where:

P_{j+1} = The probability associated with the $j+1^{st}$ threshold. By convention, P_{m+1} is equal to 1.

A_j = The number of detected values at or above the j^{th} threshold and below the $j+1^{st}$ threshold. Therefore, in example above, $A_1 = 3$, and $A_2 = 6$.

B_j = The total number of detected and non-detect values below the j^{th} threshold. Therefore, in example above, $B_1 = 6$, and $B_2 =12$.

Therefore, in example above, $P_3 = 1$ and P_2 and P_1 are calculated as follows:

$$P_2 = (1 - 6/(6+12)) * 1 = 0.667$$

and

$$P_1 = (1 - 3/(3+6)) * 0.667 = 0.444$$

The Hazen plotting position (D) for the i^{th} <u>detected</u> data value between the j^{th} and $j+1^{st}$ thresholds is:

$$D_{i,j} = P_j + (P_{j+1} - P_j)\,(i - 0.5)/A_j$$

In the example above, the first (i=1) detected value above the j=1 threshold is 3 µg/L, and the plotting position ($D_{1,1}$) is calculated as follows:

$$D_{1,1} = 0.444 + (0.667 - 0.444)\,(1 - 0.5) / 3 = 0.481$$

Similarly, the first detected value above the j=2 threshold is 13 µg/L, and the plotting position ($D_{1,2}$) is calculated as follows:

$$D_{1,2} = 0.67 + (1.0 - 0.67)\,(1 - 0.5) / 6 = 0.694$$

The Hazen plotting position (N) for the i^{th} <u>non-detect</u> data value among C_j non-detect values between the j^{th} and $j\text{–}1^{st}$ thresholds (where the $j\text{–}1^{st}$ threshold is 0 for j=1) is:

$$N_{i,j} = P_j\,(i - 0.5) / C_j$$

Therefore, for the first (i=1) non-detect value for threshold j=1 in the above data set, the plotting position ($N_{1,1}$) is calculated as follows:

$$N_{1,1} = 0.444\,(1 - 0.5) / 6 = 0.038$$

Similarly, for the first non-detect value for threshold j=2 in the above data set, the plotting position ($N_{1,2}$) is as follows:

$$N_{1,2} = 0.667\,(1 - 0.5) / 3 = 0.111$$

From the standpoint of probability plots, the plotting positions of the detected data {3, 7, 9, 12, 15, 20, 27, 33, 50} in the above data set are of primary interest since the non-detect values cannot be plotted. The calculated plotting positions for the detected data values are, respectively, as follows:

0.481, 0.556, 0.630, 0.694, 0.750, 0.806, 0.861, 0.917, 0.972.

<u>Developing Log-Normal Probability Plots</u>

Data will be plotted according to the plotting position on log-log chart with an exponential trendline fit to the data, based on "slope" (S) and "intercept" (C) as follows:

$$Conc. = e^{(Z\text{-}Stat*S+C)}$$

(Note, the "Z-Stat" in the trendline equation is not shown directly on the probability plot but is used in the development of the plot in the underlying data spreadsheet. For instance, a Z-Stat of "1" is equivalent to a 50 percent probability.)

When the results are plotted, the non-detect values are excluded because there is no fixed value to plot. Thus, the non-detect values influence the probability plot, but they do not explicitly appear on the probability plot.

WEST YOST
ASSOCIATES

MeHg CONTROL STUDY PROGRESS REPORT
APPENDIX B

Discharger Specific Tables

Table B-1. SPG Facility Average MeHg Concentrations

Treatment Type	Agency	Facility	2004-2005 Final Effluent (TMDL Staff Report)		2004-2005 Final Effluent (Sep 2004-Sep 2005)		Current Influent (Oct 2009-Sep 2014)		Current Secondary Effluent (Oct 2012-Sep 2014)		Current Final Effluent (Oct 2009-Sep 2014)	
			Average,[a] ng/L	Sampling Date Range	Average,[a] ng/L	Percent ND	Average,[a] ng/L	Percent ND	Average,[a] ng/L	Percent ND	Average,[a] ng/L	Percent ND
Tertiary plus NDN	Brentwood, City of	WWTP	0.01	8/04-8/05	*0.01*	100%	0.70	0%	*0.01*	100%	*0.01*	98%
	Ironhouse Sanitary District	WWTP	(b)	(b)	(b)	(b)	0.57	0%	(c)	(c)	*0.01*	96%
	Lodi, City of	White Slough WPCF	0.15	9/04-6/05	0.02	45%	0.53	0%	*0.01*	100%	0.01	84%
	Manteca, City of	WQCF	0.22	9/04-7/05	0.22	0%	0.86	0%	*0.01*	80%	0.01	81%
	Mountain House Community Services District	Mountain House WWTP	(b)	(b)	(b)	(b)	0.91	0%	*0.01*	100%	*0.01*	96%
	Rio Vista, City of	Northwest WWTF	(b)	(b)	(b)	(b)	0.72	4%	(c)	(c)	0.02	82%
	Roseville, City of	Pleasant Grove WWTP	(d)	(d)	(d)	(d)	0.48	0%	*0.01*	96%	*0.01*	91%
	Roseville, City of	Dry Creek WWTP	(d)	(d)	(d)	(d)	0.46	0%	0.02	48%	0.02	70%
	Tracy, City of	WWTP	0.14	8/04-8/05	0.16	8%	0.52	0%	0.03	40%	0.02	73%
	UC Davis	WWTP	(d)	(d)	(d)	(d)	0.95	0%	0.03	33%	0.01	82%
Tertiary plus N	Live Oak, City of	WWTP	(d)	(d)	(d)	(d)	1.9	0%	0.08	0%	0.02	58%
	Stockton, City of	Regional WWCF	0.94	8/04-7/05	0.90	0%	0.51	0%	0.11	0%	0.07	8%
	Woodland, City of	WPCF	0.03	8/04-7/05	0.04	8%	1.2	0%	0.04	20%	0.03	26%
Pond Based	Davis, City of	WWTP (001)	(d)	(d)	(d)	(d)	0.60	0%	(c)	(c)	0.26	0%
	Davis, City of	WWTP (002)	0.61	2/05-6/05	0.57	0%	0.60	0%	(c)	(c)	0.37	0%
Secondary plus NDN	Vacaville, City of (After Dec 2012)	Easterly WWTP	(d)	(d)	(d)	(d)	0.51	0%	(c)	(c)	0.02	33%
Secondary plus N	Discovery Bay, Town of	WWTP	0.19	8/04-7/05	0.40	55%	0.75	0%	(c)	(c)	0.03	69%
	Rio Vista, City of	Beach WWTF	0.16	8/04-4/05	(e)	(e)	1.5	0%	(c)	(c)	0.08	0%
	Vacaville, City of (Before Jan 2013)	Easterly WWTP	(d)	(d)	(d)	(d)	0.65	0%	(c)	(c)	0.03	18%
Secondary	Sacramento Regional County Sanitation District	Sacramento Regional WWTP	0.72	12/00-6/03	0.43	0%	0.80	0%	(c)	(c)	0.35	0%
	Yuba City, City of	WWTF	(d)	(d)	(d)	(d)	0.91	0%	(c)	(c)	0.18	2%
Primary Only	Sacramento, City of	Combined WWCTS	0.54	12/04-3/06	0.79	0%	0.22	0%	(c)	(c)	0.32	0%

[a] Values in red were calculated using a log-normal distribution and italicized values were directly calculated assuming all Non Detect (ND) values are equal to half the MDL. Individual SPG Facility log plots are provided in **Appendix D.**
[b] This facility was not in operation during the 2004-2005 period.
[c] No secondary effluent collected.
[d] Outside MeHg TMDL Project Area.
[e] Data unavailable.

Table B-2. SPG Facility Average Surface Water Discharge Flow Rates

Agency	Facility	Flows, mgd[a]	
		TMDL Staff Report Data Collection Period (Oct 2004-Sep 2005[b,c])	Current (Sep 2012-Oct 2014)[d]
SPG Facilities Within the MeHg TMDL Project Area			
Brentwood, City of	WWTP	2.6	3.2
Davis, City of	WWTP (002)	6.0	4.1
Discovery Bay, Town of	WWTP	1.5	1.3
Ironhouse Sanitary District	WWTP	[e]	2.4
Lodi, City of	White Slough WPCF	6.1	4.0
Manteca, City of	WQCF	5.5	5.2
Mountain House Community Services District	WWTP	[e]	0.7
Rio Vista, City of	Beach WWTF	[f]	0.39
Rio Vista, City of	Northwest WWTF	[g]	0.2
Sacramento, City of [b]	Combined WWCTS	18	33
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	152	118
Stockton, City of	Regional WWCF	29	24
Tracy, City of	WWTP	9.3	9.1
Woodland, City of	WPCF	6.1	3.5
SPG Facilities Outside of the MeHg TMDL Project Area			
Davis, City of	WWTP (001)	-	3.1
Live Oak, City of	WWTP	-	0.7
Roseville, City of	Dry Creek WWTP	-	7.5
Roseville, City of	Pleasant Grove WWTP	-	5.8
UC Davis	WWTP	-	1.5
Vacaville, City of	Easterly WWTP	-	7.3
Yuba City, City of	WWTF	-	5.4

[a] For SPG Facilities that discharge intermittently, the average flow is calculated using only the days where effluent flow data were reported.
[b] Flows for City of Brentwood and City of Tracy were calculated from August 2004 through August 2005.
[c] Monthly flow data was used to calculate 2004-2005 Town of Discovery Bay flow rates.
[d] City of Sacramento discharge flows occur an average of 4 days per year.
[e] This facility was not in operation during the 2004-2005 period.
[f] Data unavailable.

Table B-3. Estimated SPG Facility Service Area Annual Growth Rates Through 2030

Agency	Facility	Growth Rate	Basis of Estimated Growth Rate
SPG Facilities Within the MeHg TMDL Project Area			
Brentwood, City of	WWTP	1.5%	Per email correspondence with Casey Wichert 2/5/15
Davis, City of	WWTP (002)	-	No discharge expected for this location after 2017
Discovery Bay, Town of	WWTP	0.2%	DOF 1991 - 2010
Ironhouse Sanitary District	WWTP	1.4%	Per email correspondence with Jenny Skrel 2/3/15
Lodi, City of	White Slough WPCF	0.8%	DOF 1991 - 2010
Manteca, City of	WQCF	2.3%	DOF 1991 - 2010
Mountain House Community Services District	WWTP	5.1%	City projects an increase in population from 6,000 (2010) to 44,000 (2050, assumed)
Rio Vista, City of	Beach WWTF	1.1%	0.5 x DOF 1991-2010 estimate due to disproportionate flow between the two Rio Vista Facilities. The resulting value was halved due to decreased growth expectations per email correspondence with David Melilli 2/4/15
Rio Vista, City of	Northwest WWTF	3.2%	1.5 x DOF 1991-2010 estimate due to disproportionate flow between the two Rio Vista Facilities. The resulting value was halved due to decreased growth expectations per email correspondence with David Melilli 2/4/15
Sacramento, City of	Combined WWCTS	0%	Per correspondence with Kyle Ericson and Hope Taylor 5/7/15 and 6/17/2015
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	1.5%	Estimate from Echo Water Flow and Loads per email correspondence from Nanette Bailey 6/23/2015
Stockton, City of	Regional WWCF	1.3%	DOF 1991 - 2010
Tracy, City of	WWTP	2.4%	Per email correspondence with Erich Delmas 2/4/15
Woodland, City of	WPCF	1.4%	DOF 1991 - 2010
SPG Facilities Outside of the MeHg TMDL Project Area			
Davis, City of	WWTP (001)	0.8%	City projects increase to 5.35 mgd by 2030. Davis Basis of Design for their current Secondary and Tertiary Improvements Project
Live Oak, City of	WWTP	2.9%	DOF 1991 - 2010
Roseville, City of	Dry Creek WWTP	1.8%	Per email correspondence with Kim Spear 2/5/15
Roseville, City of	Pleasant Grove WWTP	2.5%	Per email correspondence with Kim Spear 2/5/15
UC Davis	WWTP	1.8%	Projected increase in population from 45,000 (Current Permit) to 51,700 (Long Range Plan, 2016)
Vacaville, City of	Easterly WWTP	1.5%	Per email correspondence with Tony Pirondini 2/3/15 and 6/16/2015
Yuba City, City of	WWTF	2.5%	Per email correspondence with Mandeep Chohan 2/4/15

Table B-4. Design Capacity and Predicted 2030 SPG Facility Surface Water Discharge Flow Rates, mgd

Agency	Facility	Design Capacity Flow	Predicted 2030 Flow			
			0% Reduction	2% Reduction	5% Reduction[a]	10% Reduction
SPG Facilities Within the MeHg TMDL Project Area						
Brentwood, City of	WWTP	5.0	4.0	3.9	3.8	3.6
Davis, City of	WWTP (002)	7.5	[b]	[b]	[b]	[b]
Discovery Bay, Town of	WWTP	2.1	1.3	1.3	1.3	1.2
Ironhouse Sanitary District	WWTP	4.3	3.0	2.9	2.8	2.7
Lodi, City of	White Slough WPCF	8.5	4.5	4.4	4.3	4.1
Manteca, City of	WQCF	9.9	7.5	7.4	7.1	6.8
Mountain House Community Services District	Mountain House WWTP	3.0	1.5	1.4	1.4	1.3
Rio Vista, City of	Beach WWTF	0.65	0.46	0.45	0.44	0.42
Rio Vista, City of	Northwest WWTF	1.0	0.33	0.32	0.31	0.29
Sacramento, City of [c]	Combined WWCTS	33	33	33	33	33
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	181	149	146	142	134
Stockton, City of	Regional WWCF	55	29	28	28	26
Tracy, City of	WWTP	11	13	13	13	12
Woodland, City of	WPCF	10	4.4	4.3	4.2	4.0
SPG Facilities Outside of the MeHg TMDL Project Area						
Davis, City of [d]	WWTP (001)	7.5	5.3	5.2	5.1	4.8
Live Oak, City of	WWTP	1.4	1.2	1.1	1.1	1.0
Roseville, City of	Dry Creek WWTP	18	10	9.8	9.5	9.0
Roseville, City of	Pleasant Grove WWTP	12	8.7	8.5	8.2	7.8
UC Davis	WWTP	3.6	2.0	2.0	1.9	1.8
Vacaville, City of	Easterly WWTP	15	9.3	9.1	8.8	8.4
Yuba City, City of	WWTF	11	8.0	7.8	7.6	7.2

[a] Flows shown in blue highlighted columns were used for the Control Study evaluation.

[b] No discharge expected at this location after 2017.

[c] City of Sacramento discharge flows occur an average of 4 days per year. Current flow rate is used for permitted flows in lieu of the maximum allowable discharge reported in the permit because a future flow rate increase is not anticipated. Similarly, Current flow rate is used for all Predicted 2030 flow conditions because conservation is not expected to impact future flow rate.

[d] Davis 001 flows are based on historic influent data.

Table B-5. SPG Facility Annual Total Flows at Various Discharge Conditions

Agency	Facility	Total Annual Flows, million gallons			
		2004-2005	Current	2030	Design Capacity
SPG Facilities Within the MeHg TMDL Project Area					
Brentwood, City of	WWTP	930	1,200	1,400	1,800
Davis, City of	WWTP (002)	890	110	(a)	(a)
Discovery Bay, Town of	WWTP	560	470	470	770
Ironhouse Sanitary District	WWTP	(b)	390	460	710
Lodi, City of	White Slough WPCF	1,600	840	910	1,800
Manteca, City of	WQCF	1,700	1,700	2,300	3,200
Mountain House Community Services District	WWTP	(b)	240	510	1,100
Rio Vista, City of	Beach WWTF	(c)	140	160	240
Rio Vista, City of	Northwest WWTF	(b)	73	110	370
Sacramento, City of (d)	Combined WWCTS	37	140	140	140
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	56,000	43,000	52,000	66,000
Stockton, City of	Regional WWCF	10,000	8,400	10,000	20,000
Tracy, City of	WWTP	3,400	3,300	4,700	3,900
Woodland, City of	WPCF	2,200	1,300	1,500	3,800
SPG Facilities Outside of the MeHg TMDL Project Area					
Davis, City of	WWTP (001)	-	900	1,860	2,740
Live Oak, City of	WWTP	-	270	400	510
Roseville, City of	Dry Creek WWTP	-	2,800	3,500	6,600
Roseville, City of	Pleasant Grove WWTP	-	2,100	3,000	4,400
UC Davis	WWTP	-	560	690	1,310
Vacaville, City of	Easterly WWTP	-	2,700	3,200	5,500
Yuba City, City of	WWTF	-	2,000	2,800	3,800

(a) No discharge expected at this location after 2017.

(b) This facility was not in operation during the 2004-2005 period.

(c) Data unavailable.

(d) Current flow rate is used for permitted flows in lieu of the maximum allowable discharge reported in the permit for Sacramento City because a future flow rate increase is not anticipated.

Table B-6. Comparison of 2004-2005 TMDL Staff Report MeHg WLA's and Calculated MeHg WLA's for SPG Facilities Within the MeHg TMDL Project Area

Agency	Facility	MeHg Load, gram/year	
		TMDL Staff Report WLA [a]	Calculated TMDL WLA [b]
Brentwood, City of	WWTP	0.14	0.14 [c]
Davis, City of	WWTP (002)	0.17	0.43 [d]
Discovery Bay, Town of	WWTP	0.37	0.37
Ironhouse Sanitary District	WWTP	0.030	0.30 [e]
Lodi, City of	White Slough WPCF	0.94	0.94
Manteca, City of	WQCF	0.38	0.38
Mountain House Community Services District	WWTP	0.37	0.37
Rio Vista, City of	Beach WWTF	0.056	0.058
Rio Vista, City of	Northwest WWTF	0.069	0.069 [f]
Sacramento, City of	Combined WWCTS	0.53	0.53
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	89	89
Stockton, City of	Regional WWCF	13	13
Tracy, City of	WWTP	0.77	0.77
Woodland, City of	WPCF	0.43	0.43 [g]
Unassigned NPDES Facility Allocations		11.31	11.31
Total Allocated WLAs for SPG Facilities		**106.3**	**106.8**
Total Potential WLAs for SPG Facilities		**117.6**	**118.1**

[a] TMDL Staff Report WLA Load cells that are highlighted in blue differ from calculated WLA loads

[b] WLAs are calculated here and in the TMDL Staff Report as follows: Average Concentration (ng/L) ÷ 1,000,000 (ng/mg) x Average Effluent Flow (mgd) x 8.34 (lb/gallon) x 453.6 (g/lb), rounded to two significant figures.

[c] Includes an allowed 60% increase in discharge volume.

[d] The TMDL Basin Plan Amendment states that the allocation assigned to the City of Davis Discharge Point 002 is based an annual average discharge flow of 2.4 mgd and a number of discharge days per year of 149. However, in review of the City's data, the 2.4 mgd flow rate was an average of all the discharge flows over a 365 day period (including zero values for days where discharge did not occur). Therefore, applying both the 2.4 mgd flow and an assumed 149 days of discharge significantly underestimates the load that was occurring in the 2004 to 2005 timeframe and the appropriate WLA. It is concluded, therefore, that the 0.17 g/yr value presented in the TMDL summary tables is an error. The 0.43 g/yr WLA presented in this table is based on the 2.4 mgd flow rate and an assumed 365 days of discharge per year.

[e] Ironhouse Sanitary District (ISD) is permitted to discharge to surface water 365 days per year; however, effluent is currently land applied on ISD-owned agricultural lands for a portion of the year. The existing facility has only been in operation since October 2012, so the period of zero surface water discharge has not been clearly established. Nevertheless, it is estimated that discharge to the river will occur approximately 245 days per year. The TMDL Basin Plan Amendment states that the allocation assigned to the ISD is 0.03 g/yr. However, the TMDL support documentation provides the numbers used to develop the ISD's WLA. Using these numbers to calculate the WLA indicates that the ISD WLA should be 0.3 g/yr. It is concluded, therefore, that the value presented in the TMDL summary tables is an error.

[f] Includes an allowed 60% increase in discharge volume because the concentration used to calculate the WLA is less than 0.06 ng/l..

[g] Includes an allowance to increase the discharge volume up to 10.4 mgd because the concentration used to calculate the WLA is less than 0.06 ng/l.

Table B-7. Comparison of 2004-2005 and Current MeHg Loads for SPG Facilities Within the MeHg TMDL Project Area

Agency	Facility	MeHg Load, gram/year				
		2004-2005 TMDL Staff Report	2004-2005 Using TMDL Concentration[a]	2004-2005 Using SPG Concentration[a]	Calculated TMDL MeHg WLA	Current
Brentwood, City of	WWTP	0.09	0.04	0.04	0.14	0.04
Davis, City of	WWTP (002)	0.78	2.0	1.90	0.43	0.16
Discovery Bay, Town of	WWTP	0.37	0.40	0.85	0.37	0.06
Ironhouse Sanitary District	WWTP	0.03	[b]	[b]	0.30	0.02
Lodi, City of	White Slough WPCF	0.93	0.90	0.14	0.94	0.04
Manteca, City of	WQCF	1.4	1.4	1.4	0.38	0.09
Mountain House Community Services District	WWTP	0.03	[b]	[b]	0.37	0.01
Rio Vista, City of	Beach WWTF	0.10	0.04	0.04	0.06	0.04
Rio Vista, City of	Northwest WWTF	0.069	[b]	[b]	0.069	0.004
Sacramento, City of	Combined WWCTS	0.95	0.07	0.11	0.53	0.17
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	161	151	90	89	57
Stockton, City of	Regional WWCF	36	36	34	13	2.2
Tracy, City of	WWTP	1.8	1.8	2.0	0.77	0.21
Woodland, City of	WPCF	0.25	0.25	0.30	0.43	0.16
Totals for TMDL Program Dischargers		**204**	**194**	**131**	**107**	**60.1**

[a] Current loads are used for City of Rio Vista Beach 2004-2005 load calculations because 2004-2005 data was not provided for this facility.
[b] This facility was not in operation during the 2004-2005 period.

Table B-8. Comparison of Current and Planned Discharge Period Loads

Agency	Facility	Calculated TMDL MeHg WLA	MeHg Load, gram/year Current	MeHg Load, gram/year 2030 Planned	MeHg Load, gram/year Design Capacity
SPG Facilities Within the MeHg TMDL Project Area					
Brentwood, City of	WWTP	0.14	0.04	0.05	0.06
Davis, City of	WWTP (002)	0.43	0.16	(a)	(a)
Discovery Bay, Town of	WWTP	0.37	0.06	0.06	0.10
Ironhouse Sanitary District	WWTP	0.30	0.02	0.02	0.03
Lodi, City of	White Slough WPCF	0.94	0.04	0.04	0.08
Manteca, City of	WQCF	0.38	0.09	0.12	0.17
Mountain House Community Services District	WWTP	0.37	0.01	0.03	0.06
Rio Vista, City of	Beach WWTF	0.058	0.041	0.046	0.068
Rio Vista, City of	Northwest WWTF	0.069	0.004	0.007	0.021
Sacramento, City of[b]	Combined WWCTS	0.53	0.17	0.17	0.17
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	89	57	2.3	3.0
Stockton, City of	Regional WWCF	13	2.2	0.45	0.88
Tracy, City of	WWTP	0.77	0.21	0.30	0.25
Woodland, City of	WPCF	0.43	0.16	0.069	0.17
Totals for TMDL Program Dischargers		**107**	**60**	**3.7**	**5.0**
SPG Facilities Outside of the MeHg TMDL Project Area					
Davis, City of	WWTP (001)	-	0.89	0.08	0.12
Live Oak, City of	WWTP	-	0.02	0.04	0.05
Roseville, City of	Dry Creek WWTP	-	0.17	0.21	0.40
Roseville, City of	Pleasant Grove WWTP	-	0.09	0.13	0.19
UC Davis	WWTP	-	0.03	0.03	0.06
Vacaville, City of	Easterly WWTP	-	0.21	0.14	0.24
Yuba City, City of	WWTF	-	1.3	1.9	2.6
Totals for Non-TMDL Program Dischargers		-	**2.7**	**2.5**	**3.6**
Totals for all SPG Dischargers		-	**63**	**6.2**	**8.6**

(a) No discharge expected at this location after 2017.

(b) Current flow rate is used for permitted flows in lieu of the maximum allowable discharge reported in the permit for Sacramento City because a future flow rate increase is not anticipated.

Table B-9. Comparison of 2030 Planned and 2030 Plausible Loads					
		MeHg Load, gram/year			
Agency	Facility	2030 Planned	2030 Plausible A: Min. Secondary plus N	2030 Plausible B: Min. Secondary plus NDN	2030 Plausible C: Min. Tertiary plus NDN
SPG Facilities Within the MeHg TMDL Project Area					
Brentwood, City of	WWTP	0.05	0.05	0.05	0.05
Davis, City of	WWTP (002)	(a)	(a)	(a)	(a)
Discovery Bay, Town of	WWTP	0.06	0.06	0.03	0.02
Ironhouse Sanitary District	WWTP	0.02	0.02	0.02	0.02
Lodi, City of	White Slough WPCF	0.04	0.04	0.04	0.04
Manteca, City of	WQCF	0.12	0.12	0.12	0.12
Mountain House Community Services District	WWTP	0.03	0.03	0.03	0.03
Rio Vista, City of	Beach WWTF	0.046	0.046	0.010	0.007
Rio Vista, City of	Northwest WWTF	0.007	0.007	0.007	0.007
Sacramento, City of	Combined WWCTS	0.17	0.03	0.009	0.006
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	2.3	2.3	2.3	2.3
Stockton, City of	Regional WWCF	0.45	0.45	0.45	0.45
Tracy, City of	WWTP	0.30	0.30	0.30	0.30
Woodland, City of	WPCF	0.07	0.07	0.07	0.07
Totals for TMDL Program Dischargers		**3.7**	**3.5**	**3.4**	**3.4**
SPG Facilities Outside of the MeHg TMDL Project Area					
Davis, City of	WWTP (001)	0.08	0.08	0.08	0.08
Live Oak, City of	WWTP	0.04	0.04	0.02	0.02
Roseville, City of	Dry Creek WWTP	0.21	0.21	0.21	0.21
Roseville, City of	Pleasant Grove WWTP	0.13	0.13	0.13	0.13
UC Davis	WWTP	0.03	0.03	0.03	0.03
Vacaville, City of	Easterly WWTP	0.14	0.14	0.14	0.14
Yuba City, City of	WWTF	1.9	0.51	0.18	0.12
Totals for Non-TMDL Program Dischargers		**2.5**	**1.2**	**0.8**	**0.7**
Totals for all SPG Dischargers		**6.2**	**4.7**	**4.2**	**4.2**

[a] No discharge expected at this location after 2017.

MeHg CONTROL STUDY PROGRESS REPORT
APPENDIX C

Quality Assurance and Control Protocols and Results

APPENDIX C
Quality Assurance and Control Protocols and Results

As discussed in the Progress Report, the Methylmercury Special Project Group (MeHg SPG) developed the *CVCWA MeHg Control Study Work Plan* (West Yost Associates, et al. 2013), Quality Assurance (QA) and Quality Control (QC) procedures were applied by each of the wastewater treatment facilities in the Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (SPG Facilities) during the Control Study monitoring period (October 2013 through September 2014). A discussion of these QA/QC practices and the resulting QA/QC data is provided below.

Quality Assurance

Quality assurance (QA) entails the policies, procedures, and actions established to provide and maintain a degree of confidence in data integrity and accuracy. In addition to the QA protocols developed in the Guidance Document, protocols regarding the following topics were addressed in the Work Plan:

- Clean Sampling Practices
- Multiple, Accredited Laboratories
- Chain of Custody (COC) forms
- Data Reporting Templates

The three accredited laboratories that the SPG Facilities contracted for Hg and MeHg testing during this time were: Basic, Caltest, and Frontier.

Quality Control

Quality control (QC) involves samples and procedures that are additional to those required for analytical data and intended to verify performance characteristics of a sampled system. Sampling in addition to that required for control study analytical data was collected to verify performance characteristics of the sampled system as part of the QC process.

Each SPG Facility was specified to collect both field duplicates and field blank samples during the sampling period. Field duplicates are defined as two samples performed by the same team, at the same place, and at the same time. It is used to estimate sampling and laboratory analysis precision. Field blanks are defined as an aliquot of contaminant-free reagent water that is provided by the laboratory, taken to the field, and treated as a sample in all respects, including the following treatments:

- Transferred into a laboratory-provided sample bottle at or near the most exposed sampling location using the same sampling devices as used for field samples. The goal is to expose the blank sample to all of the sampling site conditions.
- Stored and shipped to the laboratory using the same methods as other samples.

Both field duplicates and field blanks were provided to the laboratories with a unique label for identification by the agency staff, but that did not indicate to the laboratory's staff that it was a QC sample.

The QC sample types and frequencies identified in the Work Plan for the Control Sampling period are detailed on Table C-1. These QC protocols for the MeHg Control Study were developed based on current practice for the SPG Facilities at the time, as well as information available from the three contract laboratories.

Table C-1. Sampling Requirements for MeHg Monitoring Quality Control

QC Sample Type	Frequency of Collection/Analysis	Measurement Quality Objective
Agency-Prepared Samples (Per Facility)		
Field Duplicate	1 per analytical method per 12-month period (~5 percent of total annual sample count)	Relative Percent Difference (RPD) < 25 percent (n/a if native concentration of either sample < RL)
Field Blank	2 per analytical method per 12-month period	< Reporting Limit (RL) for target analyte
Laboratory-Prepared Samples[(a)]		
Method Blank	1 per 20 samples or per analytical batch (whichever is more frequent)	< RL for target analyte
Laboratory Control (Blank)		< RL for target analyte
Matrix Spike		80-120 percent recovery
Matrix Spike Duplicate		80-120 percent recovery RPD < 25 percent

(a) The contract laboratory prepared these samples. The frequencies indicated are standard for the contract laboratories.

It should be noted that an RPD threshold of less than 35 percent was used in lieu of the 25 percent threshold identified in Table C-1 and in the Control Study Work Plan, which states that potential error would be identified when the relative percent difference between two samples exceeds twenty-five percent. This change was implemented to be in accordance with RPD values provided on the individual laboratory reports. A schedule of when duplicates and blanks were collected by each Facility throughout the Control Study monitoring period is provided on Table C-2. The table also indicates if these sampling schedules adhered to the protocols described above. As shown on Table C-2, the desired number of duplicates was collected by all Facilities, with the exception of Ironhouse Sanitary District and the City of Live Oak Facilities. Likewise, the appropriate number of blanks were collected by all Facilities, with the exception of the City of Sacramento Facility.

Similarly, the total number of duplicates and blanks tested at each of the three laboratories is tabulated on Table C-3, along with an indicator for whether the number of samples tested met QC expectations. As shown on Table C-3, the number of blanks collected at each laboratory met QC expectations. The number of duplicates collected met QC expectations for Basic and Frontier Laboratories, but was one sample short of meeting QC expectations for the Caltest laboratory. Caltest handled the majority of samples and collected 93 percent of the desired duplicate samples.

The results of duplicate and field blank testing are shown for each SPG Facility on Table C-4 and C-5 respectively. Table C-4 includes a potential error indicator when the relative percent difference between the two samples exceeded the thirty-five percent threshold. Potential error indicators were not included when a duplicate pair included one J-Flag and one Non-Detect value. This change was made since the actual concentration of Non-Detect samples is not known and J-flagged values are only estimates.

Table C-5 includes a potential error indicator when the field blank sample was qualified as J-Flag or Detect. A J-Flag indicates that the sample result was less than the reporting limit but greater than or equal to the laboratory's MDL. In these cases the corresponding result that is provided is an estimated concentration.

Table C-2. Field Duplicate and Field Blank Sample Collections for Each SPG Facility

Agency	Facility	Year and Month[(a)]												Appropriate Number of Blanks [(b)]	Appropriate Number of Duplicates [(c)]
		2013			2014										
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
Basic															
Manteca, City of	WQCF	✓				D				✓				✓	✓
Woodland, City of	WPCF			✓				D				✓		✓	✓
Frontier															
Brentwood, City of	WWTP	✓	✓	✓	✓	D, ✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discovery Bay, Town of	WWTP						D	✓		✓				✓	✓
Mountain House	WWTP								D, ✓			✓		✓	✓
Caltest															
Davis, City of	WWTP	✓					✓			D				✓	✓
Ironhouse Sanitary District	WWTP	✓					✓							✓	
Live Oak, City of	WWTP							✓		✓	✓	✓		✓	
Lodi, City of	White Slough WPCF												D		✓
Rio Vista, City of	Northwest WWTF							D, ✓	✓					✓	✓
	Beach WWTF							D, ✓	✓					✓	✓
Roseville, City of	Dry Creek WWTP	✓	✓	✓	✓			D		✓				✓	✓
	Pleasant Grove WWTP	✓	✓	✓	✓			D		✓				✓	✓
Sacramento Regional County Sanitation District	Sac Regional WWTP		D	D		✓					✓			✓	✓
Sacramento, City of [(d)]	Combined WWCTS					D									✓
Stockton, City of [(e)]	Regional WWCF	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	D, ✓	✓	✓
Tracy, City of	WWTP						✓		D			✓		✓	✓
UC Davis	Main WWTP			D			✓					✓		✓	✓
Vacaville, City of	Easterly WWTP				✓	✓	D, ✓	✓		✓			✓	✓	✓
Yuba City, City of	WWTF					D		✓					✓	✓	✓

(a) Agencies collecting a field duplicate in a given month are indicated by a "D". Agencies collecting a field blank in a given month are indicated by a "✓".

(b) 1 per analytical method per 12-month period (~5 percent of total annual sample count).

(c) 2 per analytical method per 12-month period.

(d) Sampling from the City of Sacramento Combined WWCTS only occurred during periods of discharge. Discharge during the control study period only occurred during February 2014.

(e) Red duplicate collections indicate that duplicates were not collected at all sample locations, as indicated in Control Study Work Plan. These samples were not counted towards the total for the contract laboratory.

Table C-3. Field Duplicate and Field Blank Sample Collections for Each SPG Facility								
	Field Blanks			Duplicates				
	Number of Samples		Percent Collected versus Wanted	Number of Samples		Percent Collected versus Wanted	Met QC Expectations	
Laboratory	Wanted	Collected		Wanted	Collected			Notes
Basic	4	4	100%	2	2	100%	✓	Agencies followed Schedule outlined in Control Study Workplan.
Frontier	6	16	267%	3	3	100%	✓	Schedule not followed, but QC samples still spaced appropriately.
Caltest	26	48	185%	15	14	93%		Duplicates from at least one facility per month not collected as scheduled.

Table C-4. Quality Control - Methylmercury Duplicates

Agency	Facility	Sample Date		Duplicate Result, ng/L[a,b]		Original Result, ng/L[a,b]	Relative Percent Difference	Potential Error
Influent								
Brentwood, City of	WWTP	02/18/14		0.33		0.37	11%	
Davis, City of	WWTP	06/10/14		0.57		0.72	23%	
Discovery Bay, Town of	WWTP	03/26/14		0.826		0.714	15%	
Lodi, City of	White Slough	09/09/14		0.46		0.4	14%	
Manteca, City of	WQCF	02/04/14		0.528		0.538	2%	
Mountain House	WWTP	05/05/14	<	0.05		0.86	188%	x[e]
Rio Vista, City of	Northwest WWTF	04/02/14		0.81		0.99	20%	
Rio Vista, City of	Beach WWTF	04/02/14		1.5		1.5	0%	
Roseville, City of	Pleasant Grove	04/10/14		0.39		0.49	23%	
Roseville, City of	Dry Creek WWTP	04/10/14		0.39		0.38	3%	
Roseville, City of	Dry Creek WWTP	04/10/14		0.5		0.38	27%	
Sacramento Regional	Sacramento	11/05/13		0.59		0.82	33%	
Sacramento Regional	Sacramento	12/10/13		0.89		0.73	20%	
Sacramento, City of	EFF-006	02/08/14		0.35		0.21	50%	x[c]
Sacramento, City of	EFF-002	02/09/14		0.16		0.07	78%	x[c]
Stockton, City of	Regional WWCF	11/06/13		0.56		0.56	0%	
Tracy, City of	WWTP	05/27/14		0.63		0.62	2%	
UC Davis	WWTP	12/16/13		0.82		0.88	7%	
Vacaville, City of	Easterly WWTP	03/05/14		0.56		0.52	7%	
Woodland, City of	WPCF	04/07/14		1.47		1.16	24%	
Yuba City, City of	WWTF	02/05/14		0.74		0.51	37%	x[d]
Primary Effluent								
Sacramento, City of	EFF-006	2/8/2014		0.26		0.38	38%	x[d]
Sacramento, City of	EFF-002	2/9/2014		0.3		0.28	7%	
Secondary Effluent								
Brentwood, City of	WWTP	02/18/14	<	0.02	<	0.02	0%	
Brentwood, City of	WWTP	02/18/14	<	0.02	<	0.02	0%	
City of Woodland	WPCF	04/07/14	J	0.037	J	0.038	3%	
Davis, City of	WWTP	06/10/14		0.32		0.33	3%	
Discovery Bay, Town of	WWTP	03/26/14	<	0.026		0.072	94%	x[f]
Lodi, City of	White Slough	09/10/14	<	0.02	<	0.02	0%	
Lodi, City of	White Slough WPCF	09/10/14	<	0.02	J	0.02	0%	
Manteca, City of	WQCF	02/04/14	<	0.02	<	0.02	0%	
Manteca, City of	WQCF	02/04/14	<	0.02	<	0.02	0%	
Mountain House Community Services	WWTP	05/05/14		0.059	<	0.05	17%	
Mountain House Community Services	WWTP	05/05/14	<	0.05	<	0.05	0%	
Rio Vista, City of	Beach WWTF	04/02/14		0.13		0.15	14%	
Rio Vista, City of	Northwest WWTF	04/02/14	<	0.02	<	0.02	0%	
Roseville, City of	Pleasant Grove	04/10/14	<	0.02	<	0.02	0%	
Roseville, City of	Pleasant Grove	04/10/14	<	0.02	<	0.02	0%	
Roseville, City of	Dry Creek WWTP	04/10/14	<	0.02	<	0.02	0%	
Roseville, City of	Dry Creek WWTP	04/10/14	<	0.02	<	0.02	0%	
Roseville, City of	Pleasant Grove WWTP	04/10/14	<	0.02	<	0.02	0%	
Roseville, City of	Dry Creek WWTP	04/10/14	<	0.02	J	0.02	0%	
Sacramento Regional	Sacramento	11/05/13		0.43		0.39	10%	
Sacramento Regional	Sacramento	12/10/13		0.21		0.16	27%	
Stockton, City of	Regional WWCF	11/06/13		0.06	J	0.03	67%	
Stockton, City of	Regional WWCF	10/09/13	J	0.02	<	0.02	0%	
Stockton, City of	Regional WWCF	11/06/13	J	0.03	<	0.02	40%	
Stockton, City of	Regional WWCF	12/11/13	J	0.03	J	0.03	0%	
Stockton, City of	Regional WWCF	01/15/14		0.09		0.08	12%	
Stockton, City of	Regional WWCF	02/12/14		0.2		0.19	5%	
Stockton, City of	Regional WWCF	03/12/14	J	0.048	J	0.04	18%	
Stockton, City of	Regional WWCF	04/09/14	J	0.04	<	0.02	67%	
Stockton, City of	Regional WWCF	05/15/14	J	0.048		0.06	22%	
Stockton, City of	Regional WWCF	06/13/14		0.06		0.07	15%	
Stockton, City of	Regional WWCF	07/08/14		0.09		0.08	12%	
Stockton, City of	Regional WWCF	08/19/14		0.11		0.09	20%	
Stockton, City of	Regional WWCF	09/09/14	J	0.03	J	0.03	0%	
Tertiary Effluent								
Tracy, City of	WWTP	05/27/14	J	0.02	J	0.03	40%	
Tracy, City of	WWTP	05/27/14	<	0.02	J	0.02	0%	
UC Davis	WWTP	12/16/13	<	0.02	J	0.03	40%	
UC Davis	WWTP	12/16/13	<	0.02	<	0.02	0%	

Table C-4. Quality Control - Methylmercury Duplicates

Agency	Facility	Sample Date	Duplicate Result, ng/L[(a,b)]		Original Result, ng/L[(a,b)]		Relative Percent Difference	Potential Error
Vacaville, City of	Easterly WWTP	03/05/14	<	0.02	J	0.03	40%	
Woodland, City of	WPCF	04/07/14	<	0.02	J	0.029	37%	
Yuba City, City of	WWTF	02/05/14		0.1		0.1	0%	

(a) The Reporting Limit (RL) is 0.05 ng/L. All laboratories used an MDL of 0.02 ng/L, except the laboratory used by Mountain House Community Services District and the City of Discovery Bay which used an MDL of 0.026 ng/L.

(b) J indicates the sample result was less than the RL, but greater than or equal to the laboratory's MDL. The result provided is an estimated concentration.

(c) The City of Sacramento influent only occurs during peak wet-weather flow events. The observed variability could be associated with unusual influent characteristics of this flow. Data was not excluded from the analysis.

(d) Both reported values fall within the range of the remaining data set. Both values were included in the analysis.

(d) All other collected influent data for this facility is reported above the detection limit and the observed detected value falls within the expected range.

(e) Lab reports indicated that matrix duplicate/triplicate and spike recovery were outside of acceptance limits. Potential laboratory error with all samples in batch. Nevertheless, reported value does fall within the range of the remaining data set. Therefore, data was not excluded from the analysis.

Table C-5. Quality Control - Methylmercury Blanks

Agency	Facility	Sample Date	Result, ng/L[(a,b)]		Potential Error
Influent					
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	11/13/13	<	0.02	
Brentwood, City of	WWTP	12/11/13	<	0.02	
Brentwood, City of	WWTP	01/13/14	<	0.02	
Brentwood, City of	WWTP	02/18/14	<	0.02	
Brentwood, City of	WWTP	03/17/14	<	0.02	
Brentwood, City of	WWTP	04/14/14	<	0.02	
Brentwood, City of	WWTP	05/05/14	<	0.02	
Brentwood, City of	WWTP	06/23/14	<	0.02	
Brentwood, City of	WWTP	07/15/14	<	0.02	
Brentwood, City of	WWTP	08/12/14	<	0.02	
Brentwood, City of	WWTP	09/11/14	<	0.02	
Discovery Bay, Town of	WWTP	04/15/14	<	0.026	
Discovery Bay, Town of	WWTP	06/25/14		0.079	x [(c)]
Ironhouse Sanitary District	WWTP	03/10/14	<	0.02	
Manteca, City of	WQCF	10/08/13	<	0.02	
Manteca, City of	WQCF	06/12/14	<	0.02	
Rio Vista, City of	Northwest WWTF	04/02/14	<	0.02	
Rio Vista, City of	Beach WWTF	04/02/14	<	0.02	
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	02/04/14	<	0.02	
Stockton, City of	Regional WWCF	10/09/13	<	0.02	
Stockton, City of	Regional WWCF	02/12/14	<	0.02	
Stockton, City of	Regional WWCF	07/08/14	<	0.02	
Tracy, City of	WWTP	03/27/14	<	0.02	
Tracy, City of	WWTP	08/21/14	<	0.02	
Woodland, City of	WPCF	08/21/14	<	0.02	
Primary Effluent					
no field blank samples provided					
Secondary Effluent					
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	11/13/13	<	0.02	
Brentwood, City of	WWTP	12/11/13	<	0.02	
Brentwood, City of	WWTP	01/13/14	<	0.02	
Brentwood, City of	WWTP	02/18/14	<	0.02	
Brentwood, City of	WWTP	03/17/14	<	0.02	
Brentwood, City of	WWTP	04/14/14	<	0.02	
Brentwood, City of	WWTP	05/05/14	<	0.02	
Brentwood, City of	WWTP	06/23/14	<	0.02	
Brentwood, City of	WWTP	07/15/14	<	0.02	
Brentwood, City of	WWTP	08/12/14	<	0.02	
Brentwood, City of	WWTP	09/11/14	<	0.02	
Davis, City of	WWTP	10/11/13	<	0.02	
Davis, City of	WWTP	03/03/14	<	0.02	
Manteca, City of	WQCF	06/12/14	<	0.02	
Manteca, City of	WQCF	10/08/13	<	0.02	
Rio Vista, City of	Beach WWTF	04/02/14	<	0.02	
Rio Vista, City of	Beach WWTF	05/07/14	<	0.02	
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	02/04/14	<	0.02	
Sacramento Regional County Sanitation District	Sacramento Regional WWTP	07/08/14	<	0.02	
Stockton, City of	Regional WWCF	02/12/14	<	0.02	
Stockton, City of	Regional WWCF	07/08/14	<	0.02	
UC Davis	WWTP	03/19/14	<	0.02	
UC Davis	WWTP	08/12/14	<	0.02	
Woodland, City of	WPCF	08/21/14	<	0.02	
Yuba City, City of	WWTF	04/09/14	<	0.02	
Yuba City, City of	WWTF	09/05/14	<	0.02	
Tertiary Effluent					
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	10/24/13	<	0.02	
Brentwood, City of	WWTP	11/13/13	<	0.02	
Brentwood, City of	WWTP	12/11/13	<	0.02	
Brentwood, City of	WWTP	01/13/14	<	0.02	
Brentwood, City of	WWTP	02/18/14	<	0.02	
Brentwood, City of	WWTP	03/17/14	<	0.02	
Brentwood, City of	WWTP	04/14/14	<	0.02	
Brentwood, City of	WWTP	05/05/14	<	0.02	
Brentwood, City of	WWTP	06/23/14	<	0.02	
Brentwood, City of	WWTP	07/15/14	<	0.02	
Brentwood, City of	WWTP	08/12/14	<	0.02	
Brentwood, City of	WWTP	09/11/14	<	0.02	
Ironhouse Sanitary District	WWTP	03/10/14	<	0.02	
Live Oak, City of	WWTP	8/13/2014	J	0.03	x
Manteca, City of	WQCF	10/08/13	<	0.02	
Manteca, City of	WQCF	06/12/14	<	0.02	
Rio Vista, City of	Northwest WWTF	04/02/14	<	0.02	
Rio Vista, City of	Northwest WWTF	05/07/14	<	0.02	
Roseville, City of	Dry Creek WWTP	10/09/13	<	0.02	
Roseville, City of	Dry Creek WWTP	11/13/13	<	0.02	

Table C-5. Quality Control - Methylmercury Blanks

Agency	Facility	Sample Date	Result, ng/L[(a,b)]		Potential Error
Roseville, City of	Dry Creek WWTP	12/11/13	<	0.02	
Roseville, City of	Dry Creek WWTP	10/09/13	<	0.02	
Roseville, City of	Dry Creek WWTP	11/13/13	<	0.02	
Roseville, City of	Dry Creek WWTP	12/11/13	<	0.02	
Stockton, City of	Regional WWCF	10/09/13	<	0.02	
Stockton, City of	Regional WWCF	11/06/13	<	0.02	
Stockton, City of	Regional WWCF	12/11/13	<	0.02	
Stockton, City of	Regional WWCF	01/15/14	<	0.02	
Stockton, City of	Regional WWCF	02/12/14	<	0.02	
Stockton, City of	Regional WWCF	03/12/14	<	0.02	
Stockton, City of	Regional WWCF	04/09/14	<	0.02	
Stockton, City of	Regional WWCF	05/15/14	<	0.02	
Stockton, City of	Regional WWCF	06/13/14	<	0.02	
Stockton, City of	Regional WWCF	07/08/14	<	0.02	
Stockton, City of	Regional WWCF	08/19/14	<	0.02	
Stockton, City of	Regional WWCF	09/09/14	<	0.02	
Woodland, City of	WPCF	08/21/14		0.051	x
Unknown					
Ironhouse Sanitary District	WWTP	10/24/2013	<	0.02	
Live Oak, City of	WWTP	4/9/2014	<	0.02	
Live Oak, City of	WWTP	6/18/2014	<	0.02	
Live Oak, City of	WWTP	7/9/2014	<	0.02	
Live Oak, City of	WWTP	8/13/2014		0.06	x
Vacaville, City of	Easterly WWTP	1/6/2014	<	0.02	
Vacaville, City of	Easterly WWTP	2/3/2014	<	0.02	
Vacaville, City of	Easterly WWTP	3/5/2014	<	0.02	
Vacaville, City of	Easterly WWTP	4/3/2014	<	0.02	
Vacaville, City of	Easterly WWTP	4/3/2014	<	0.02	
Vacaville, City of	Easterly WWTP	6/3/2014	<	0.02	
Vacaville, City of	Easterly WWTP	6/3/2014	J	0.02	x
Vacaville, City of	Easterly WWTP	9/9/2014	<	0.02	
Woodland, City of	WPCF	12/5/2013	<	0.02	

[(a)] The Reporting Limit (RL) is 0.05 ng/L. All laboratories used an MDL of 0.02 ng/L, except the laboratory used by Mountain House Community Services District and the Town of Discovery Bay which used an MDL of 0.026 ng/L.

[(b)] J indicates the sample result was less than the RL, but greater than or equal to the laboratory's MDL. The result provided is an estimated concentration.

[(c)] Lab reports indicated that matrix duplicate/triplicate and spike recovery were outside of acceptance limits. Potential laboratory error with all samples in batch.

MeHg CONTROL STUDY PROGRESS REPORT
APPENDIX D

Influent and Effluent Data Collection Variability

APPENDIX D
Influent and Effluent Data Collection Variability

As discussed in the MeHg Control Study Work Plan (West Yost Associates, et al. 2013), influent and effluent grab samples were to be collected for each of the wastewater treatment facilities in the Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (SPG Facilities) throughout the day and work week to ensure the data sets for each facility provides an adequate representation of the variability. The SPG Facilities were specifically requested to use the following sampling procedures[1]:

- Samples will be collected during normal, working days. In addition, SPG Facilities will collect one monthly sample within each hour of a typical workday for the given facility, up to an eight (8) hour window. The remaining four (4) samples will be collected once per hour during the four-hour window of expected peak load for the respective facility.[2]
- At least one sample will be collected for each day of the five-day work week.

Figures C1 through C19 show plots for each Facility[3] with the hours and days of the week that SPG Facility influent samples were collected, in addition to the peak flow periods indicated as red lines. As shown on these figures, while most of the SPG Facilities followed the prescribed sampling protocols, several SPG Facilities did not.

EVALUATION OF PEAK CONDITIONS

Due to concerns regarding the need to capture the variability of influent and effluent data, and in particular the peak influent and/or effluent concentration conditions, a statistical test was completed to evaluate the differences in concentrations throughout the diurnal cycle using all of the available influent data. Specifically, a Wilcoxon Rank Sum Test was performed to test (at a ninety-five percent confidence level) the null hypothesis that there is no difference in concentrations between samples collected at different times of day versus samples collected during the peak discharge period as follows:

- Data collected during peak (38 observations) were compared to data from all off-peak samples (169 observations)
- Data collected during peak (38 observations) were compared to data collected 0 to 2 hours before peak (58 observations)
- Data collected during peak (38 observations) were compared to data collected 1 to 3 hours before peak (44 observations)
- Data collected during peak (38 observations) were compared to data collected 2 to 4 hours before peak (31 observations)

[1] Some of the SPG Facilities specifically require samples be collected during the peak flow and load period of the day. These facilities will, therefore, collect samples in accordance with their permit requirements.

[2] SPG Facilities that provide equalization will attenuate the peaks loads. For these facilities grab samples will simply be spaced throughout the typical work day.

[3] Note that only one influent plot is provided to represent the City of Davis 001 and 002 discharge locations.

- Data collected during peak (38 observations) were compared to data collected 0 to 2 hours after peak (45 observations)
- Data collected during peak (38 observations) were compared to data collected 1to 3 hours after peak (39 observations)
- Data collected during peak (38 observations) were compared to data 2 to 4 hours after peak (20 observations)

The following facilities were not included in this analysis for the following reasons:

- Sacramento Regional County Sanitation District collects composite samples in accordance with their permit requirements.
- The City of Tracy did not provide information regarding when their peak flows occur.
- City of Sacramento does not discharge regularly, and does not experience a diurnal peak due to the nature of this facility.
- Mountain House Community Service District peaks are attenuated by an influent pump station.
- The City of Yuba City collects both composite and grab samples. However, neither samples were used in this analysis.

Wilcoxon Rank Sum testing demonstrated that the null hypothesis was not rejected (i.e., data collected during the peak period is not statistically different from data collected during other periods in the diurnal cycle) for all of the sampling periods except the 1 to 3 and the 2 to 4 hour windows before the peak. For both of these periods, the samples collected during the peak are higher.

CONCLUSIONS AND NEXT STEPS

From the analysis described above, it was concluded that dischargers who only collected samples in the time before their peak may have missed the peak methylmercury load into and out of their facilities because concentrations are lowest during the lowest flow and load periods that occur just before the peak. Due to this conclusion, the sampling periods for each SPG Facility were analyzed to determine if testing for any Facility was limited to this pre-peak flow period.

Facilities that were identified as only collecting samples in the time before their peak include:

- City of Live Oak (Shown in Figure C5)
- City of Lodi (Shown in Figure C6)
- Roseville Dry Creek and Pleasant Grove Facilities (Shown in Figures C11 and C12 respectively)

This timing impact for the Roseville plants was determined to be potentially significant. As a result it was requested that additional data be collected from Roseville plants moving forward. Specifically, it was requested that an additional four samples be collected, two during the peak (reportedly from 11 am to 1 pm for both plants) and two during the two hour period after the peak (1 to 3pm).

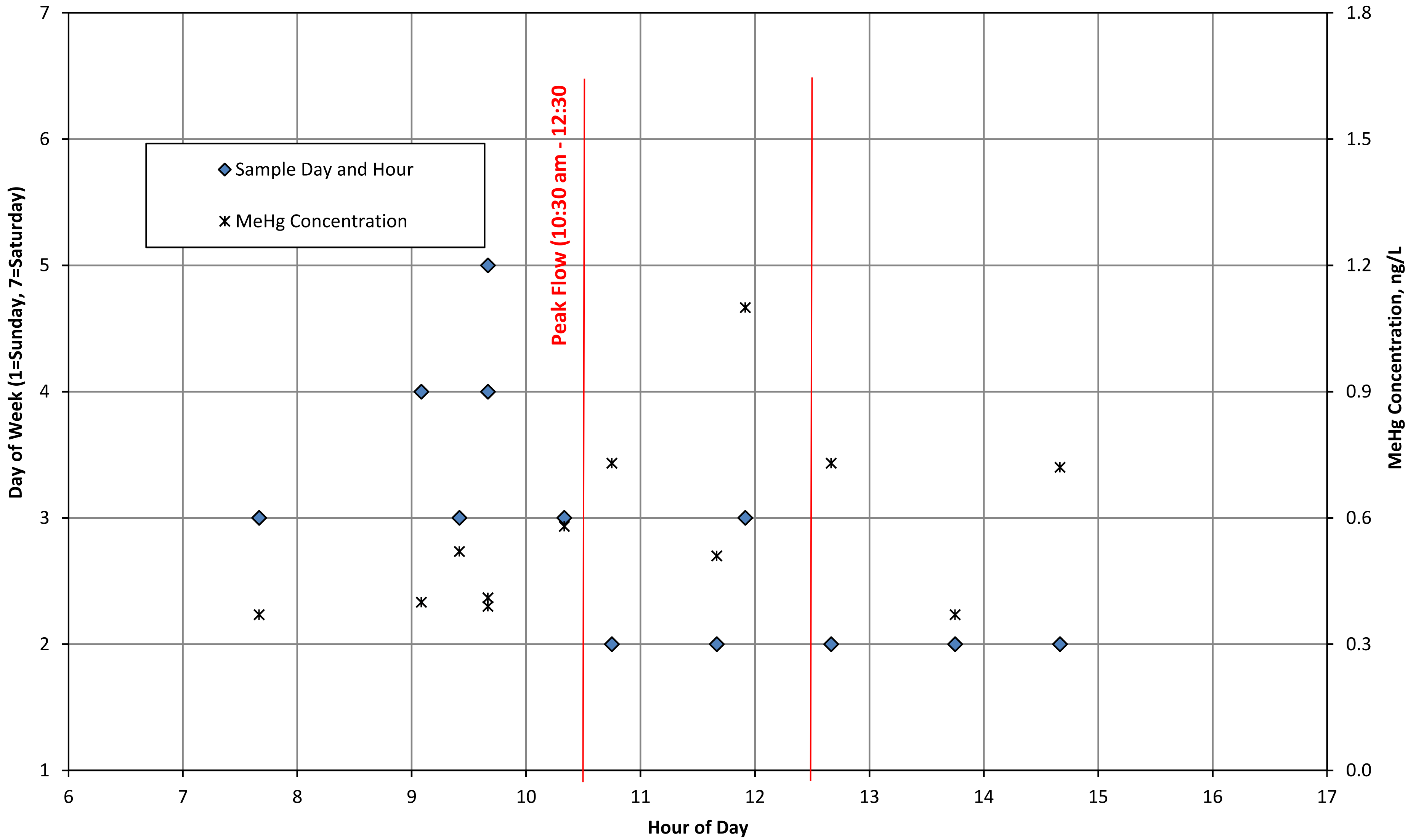


Figure D-1

City of Brentwood Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

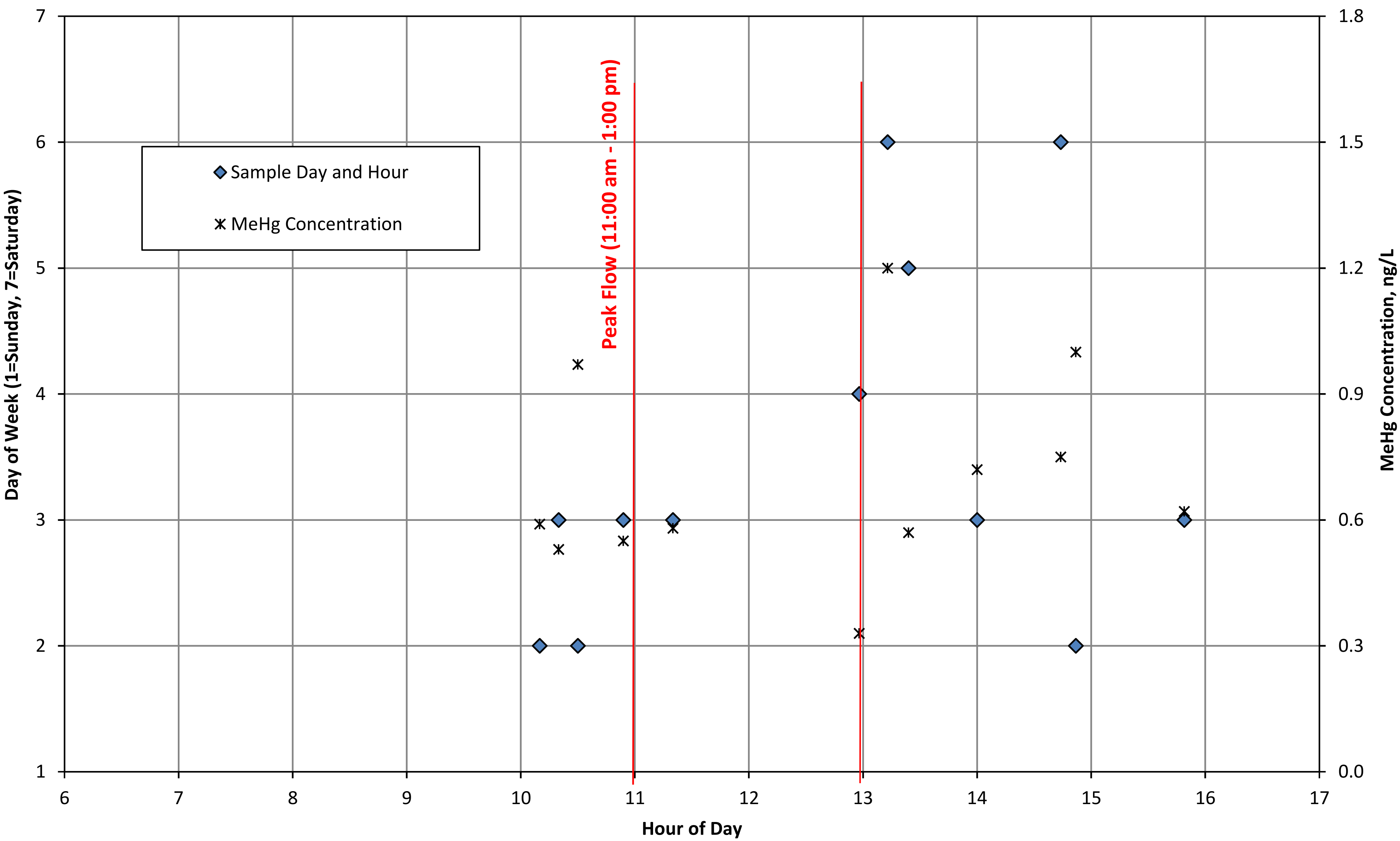


Figure D-2

City of Davis Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

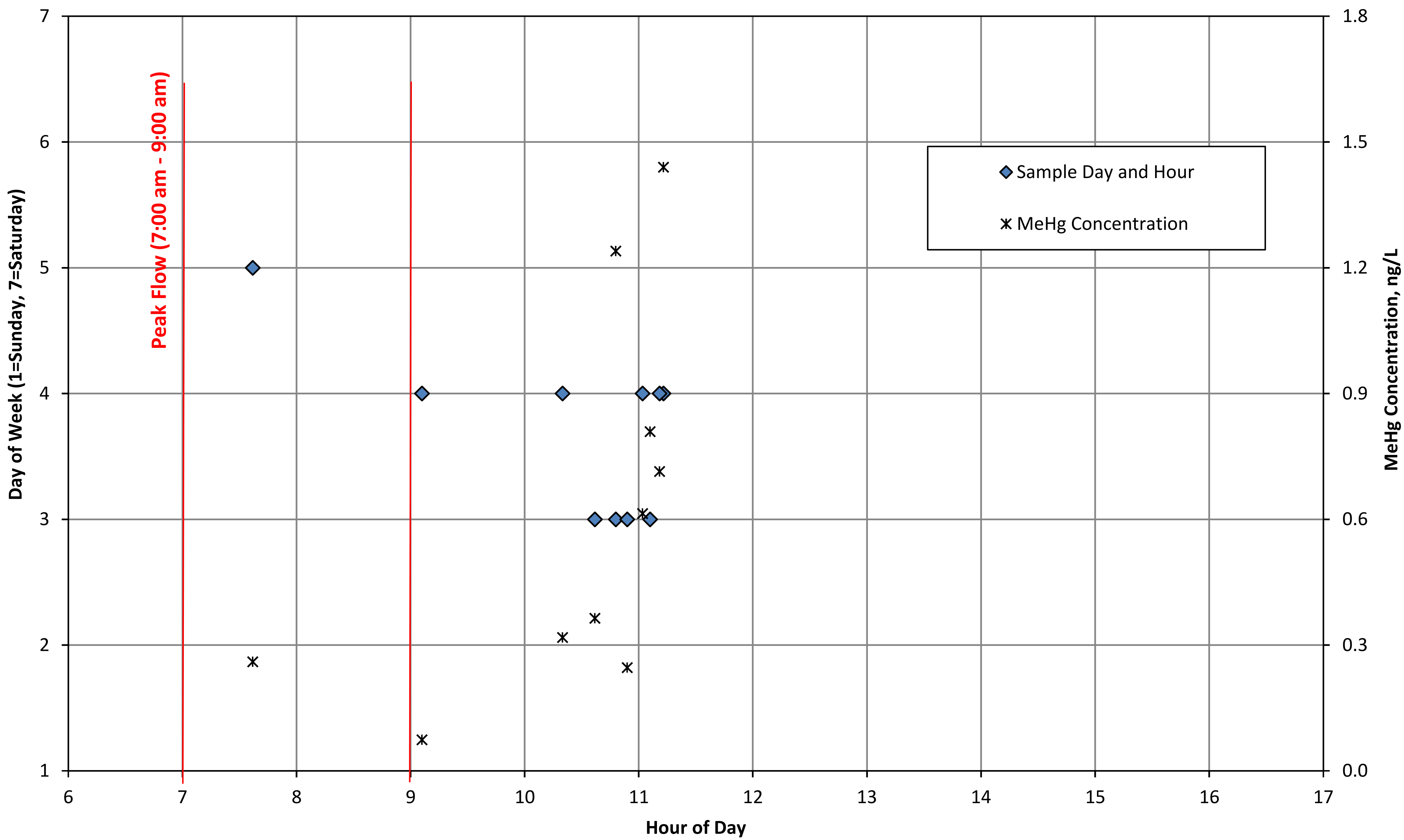


Figure D-3

Town of Discovery Bay Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

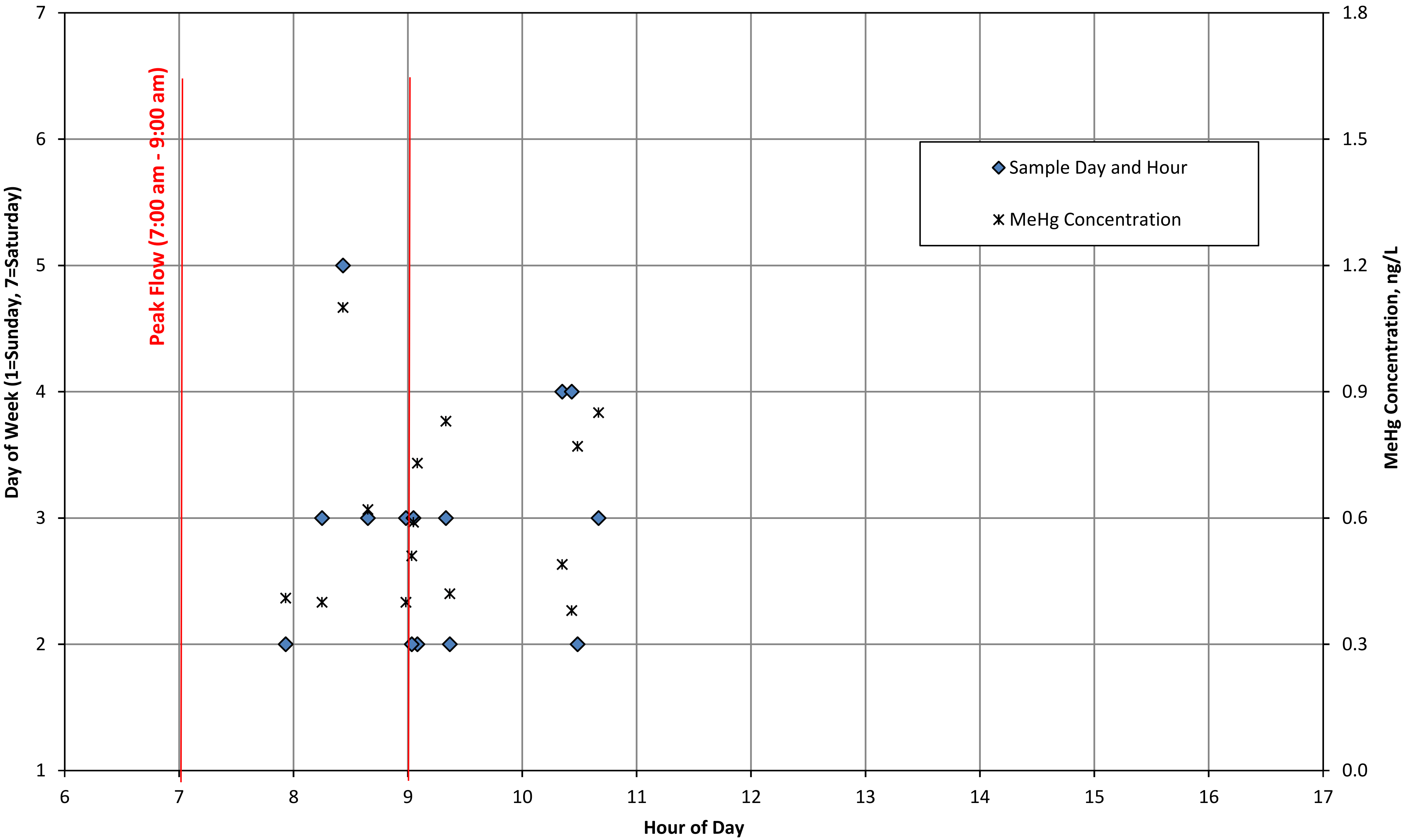


Figure D-4

Ironhouse Sanitary District Influent Methylmercury Samples Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

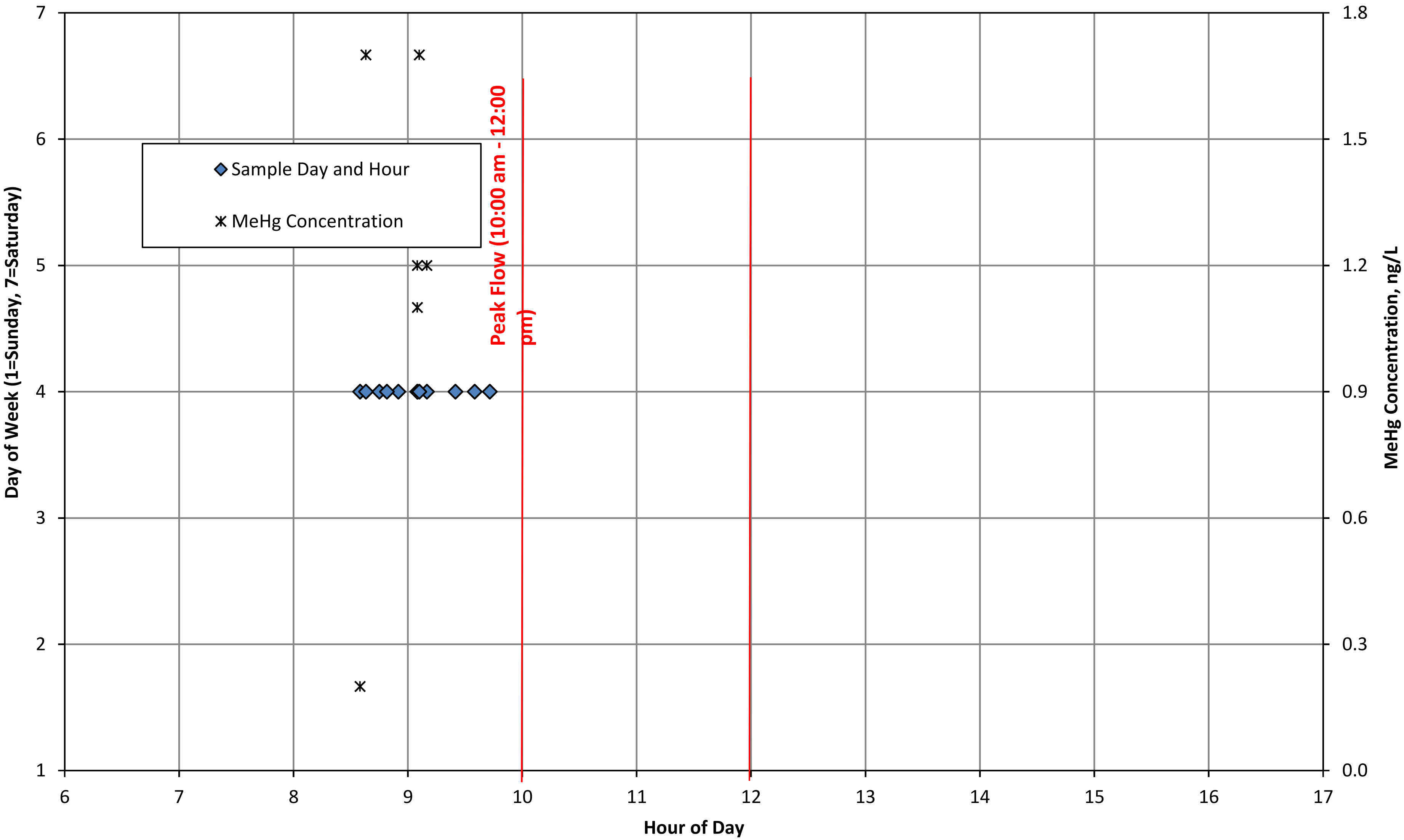


Figure D-5

City of Live Oak Influent Methylmercury Samples Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

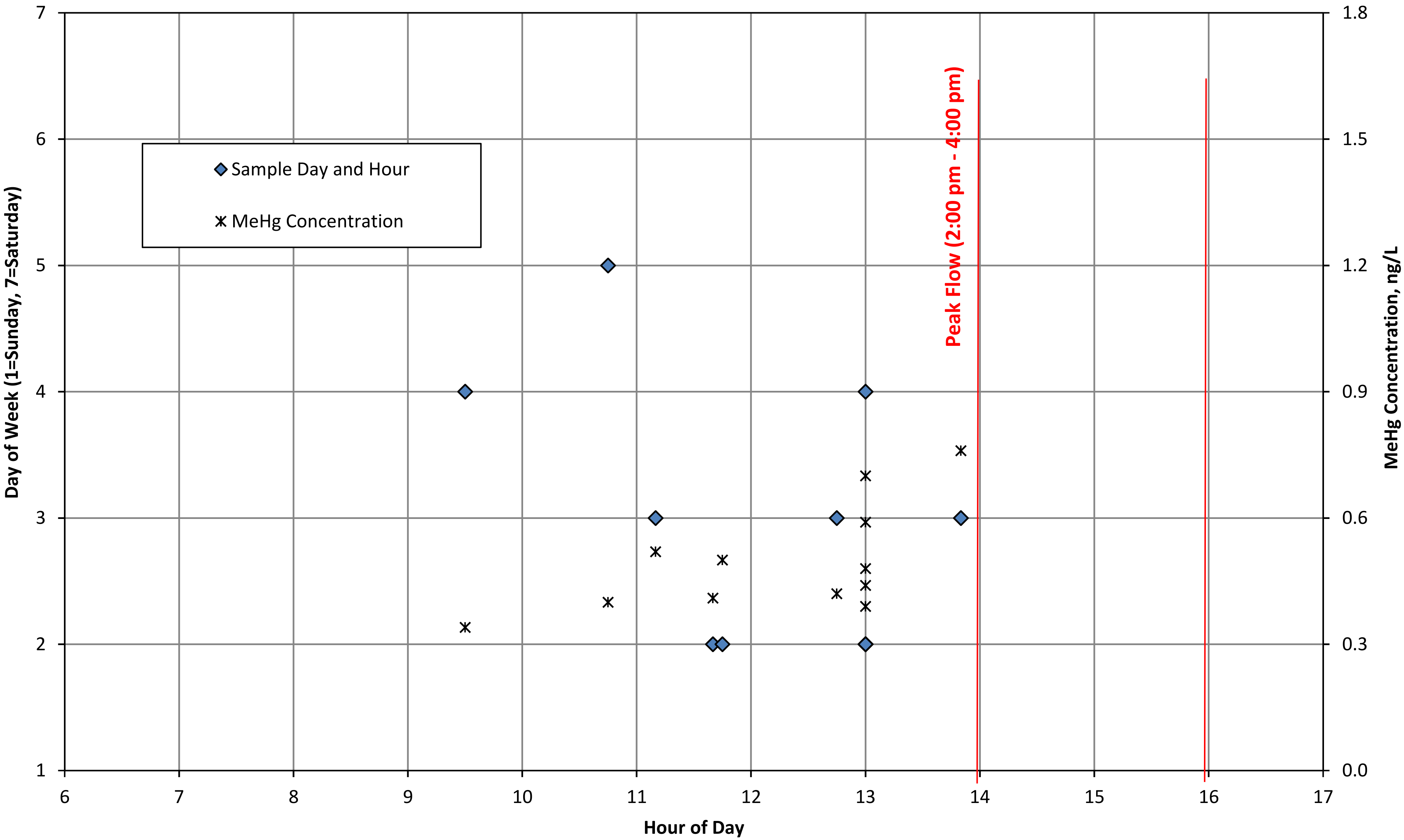


Figure D-6

City of Lodi Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

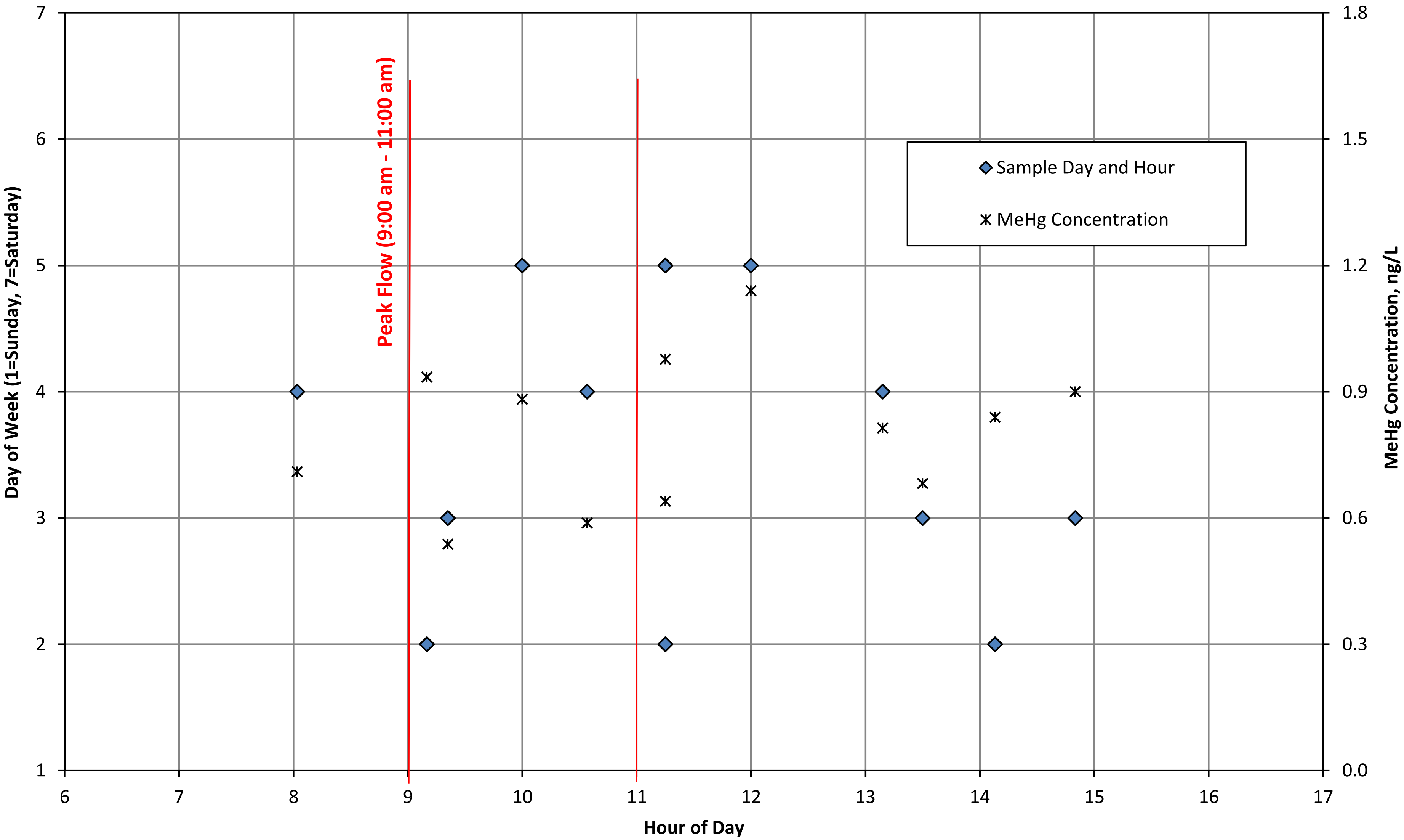


Figure D-7

City of Manteca Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

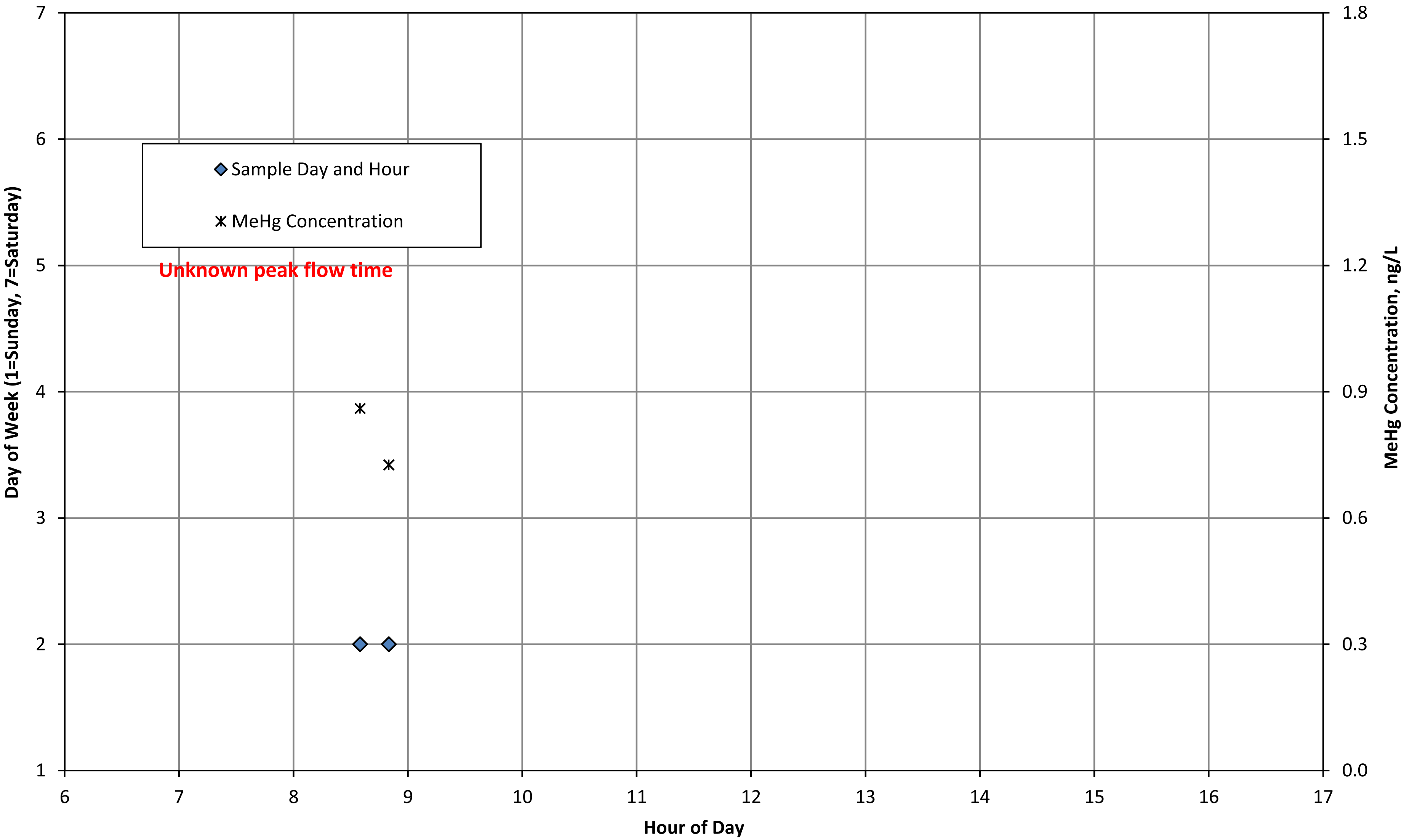


Figure D-8

Mountain House CSD Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

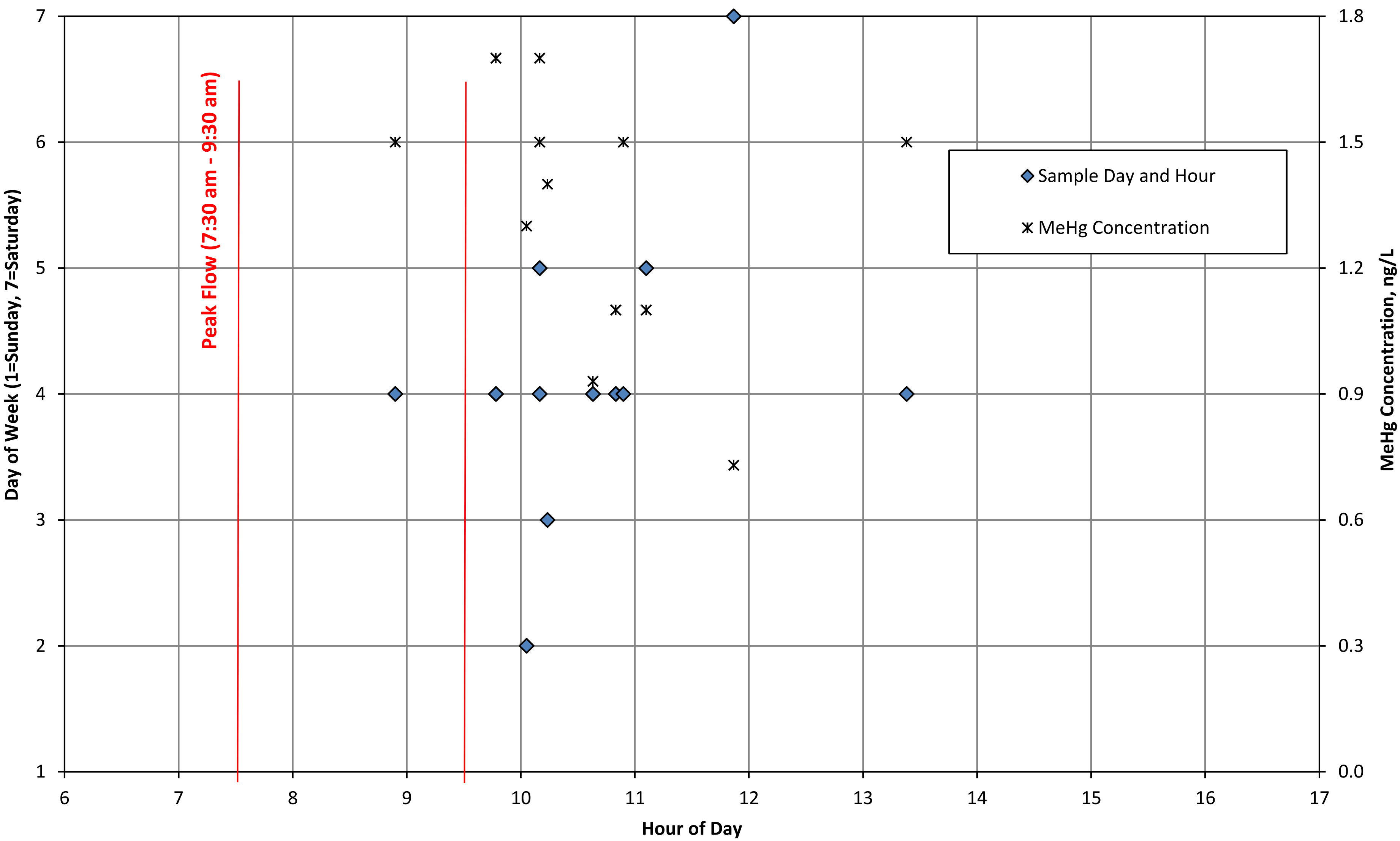


Figure D-9

City of Rio Vista Beach Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

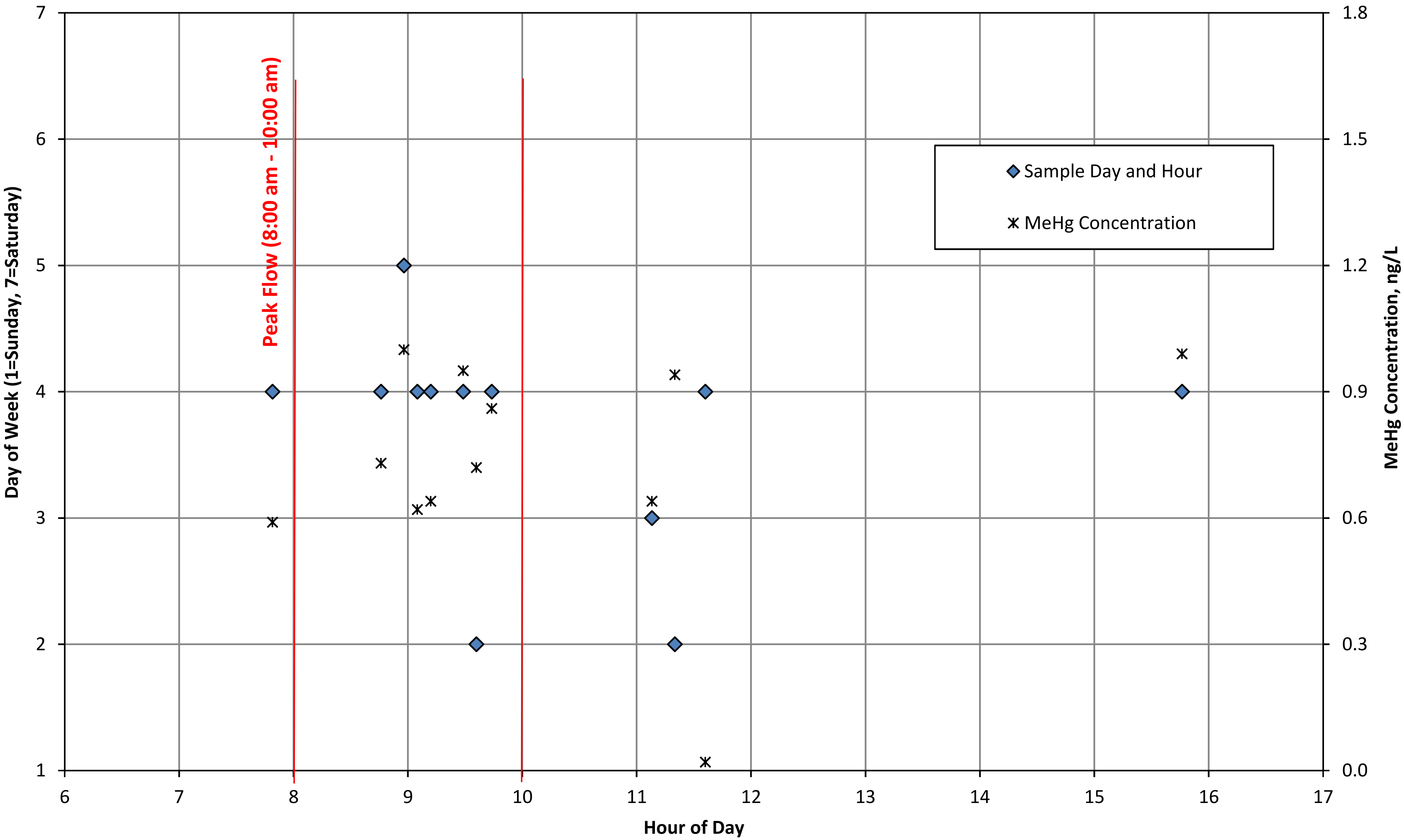


Figure D-10

City of Rio Vista Northwest Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

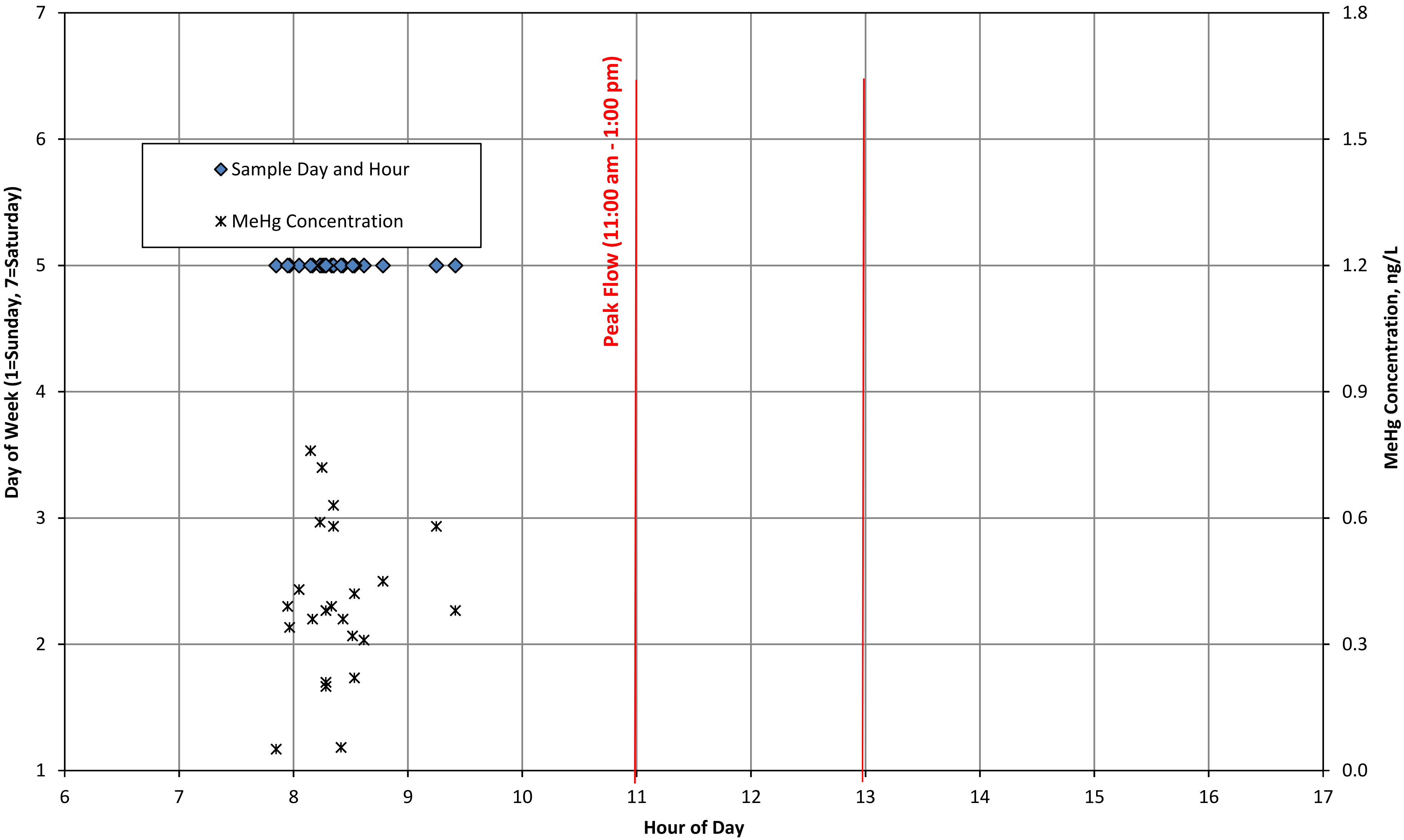


Figure D-11

City of Roseville Dry Creek Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

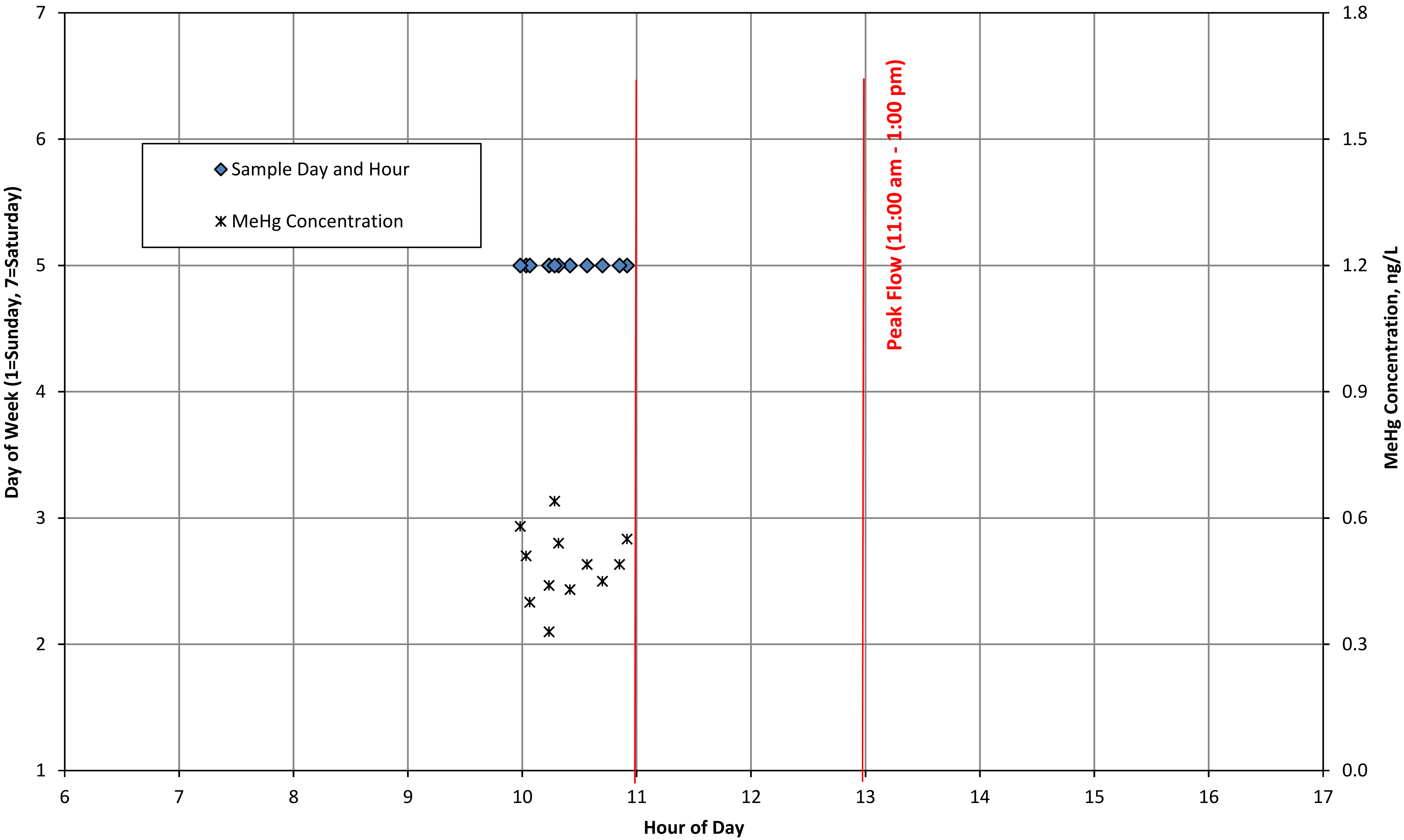


Figure D-12

City of Roseville Pleasant Grove Influent Methylmercury Samples Hours and Days of the Week

CVCWA MeHg Special Project Group

MeHg Control Study Progress Report

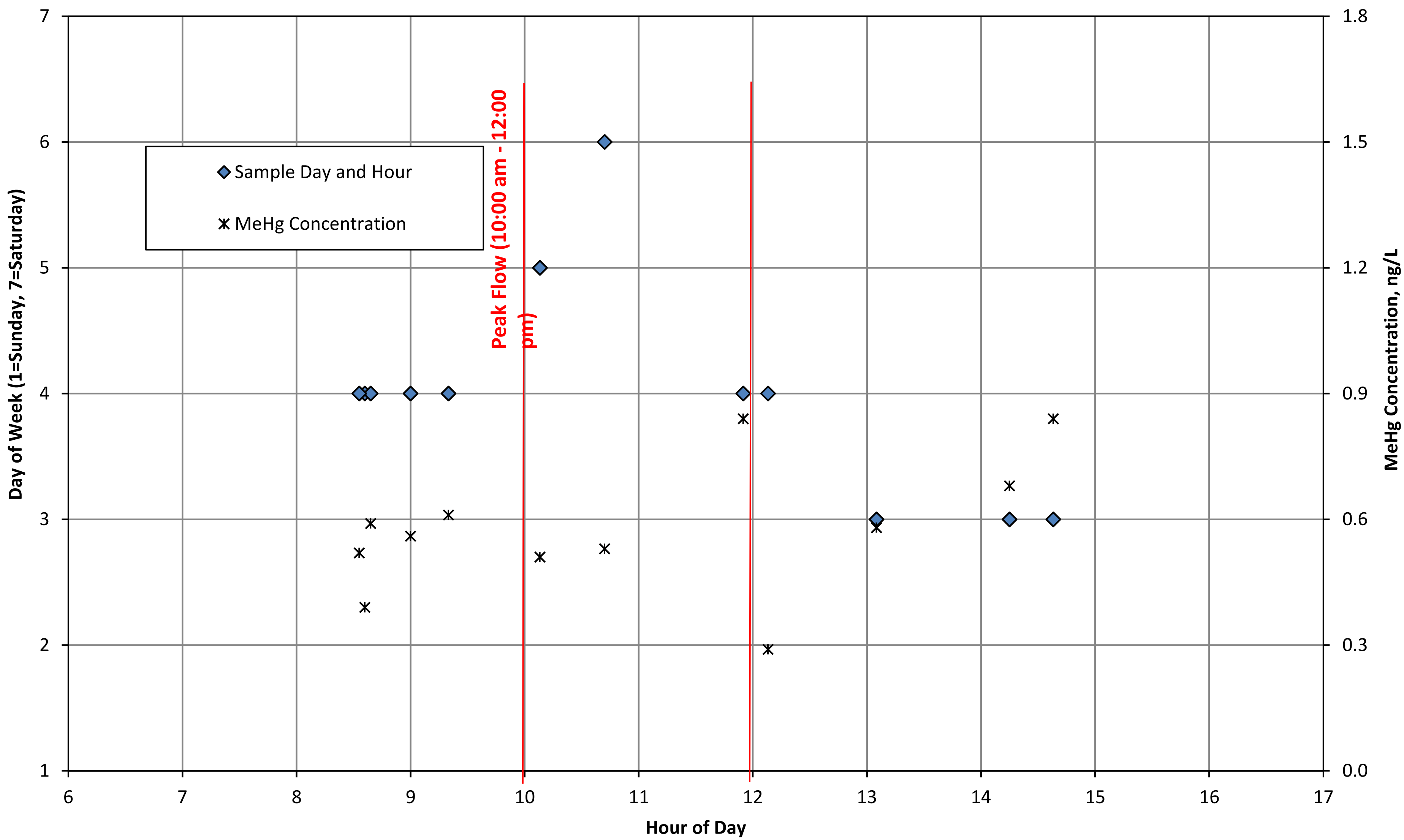


Figure D-13

City of Stockton Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

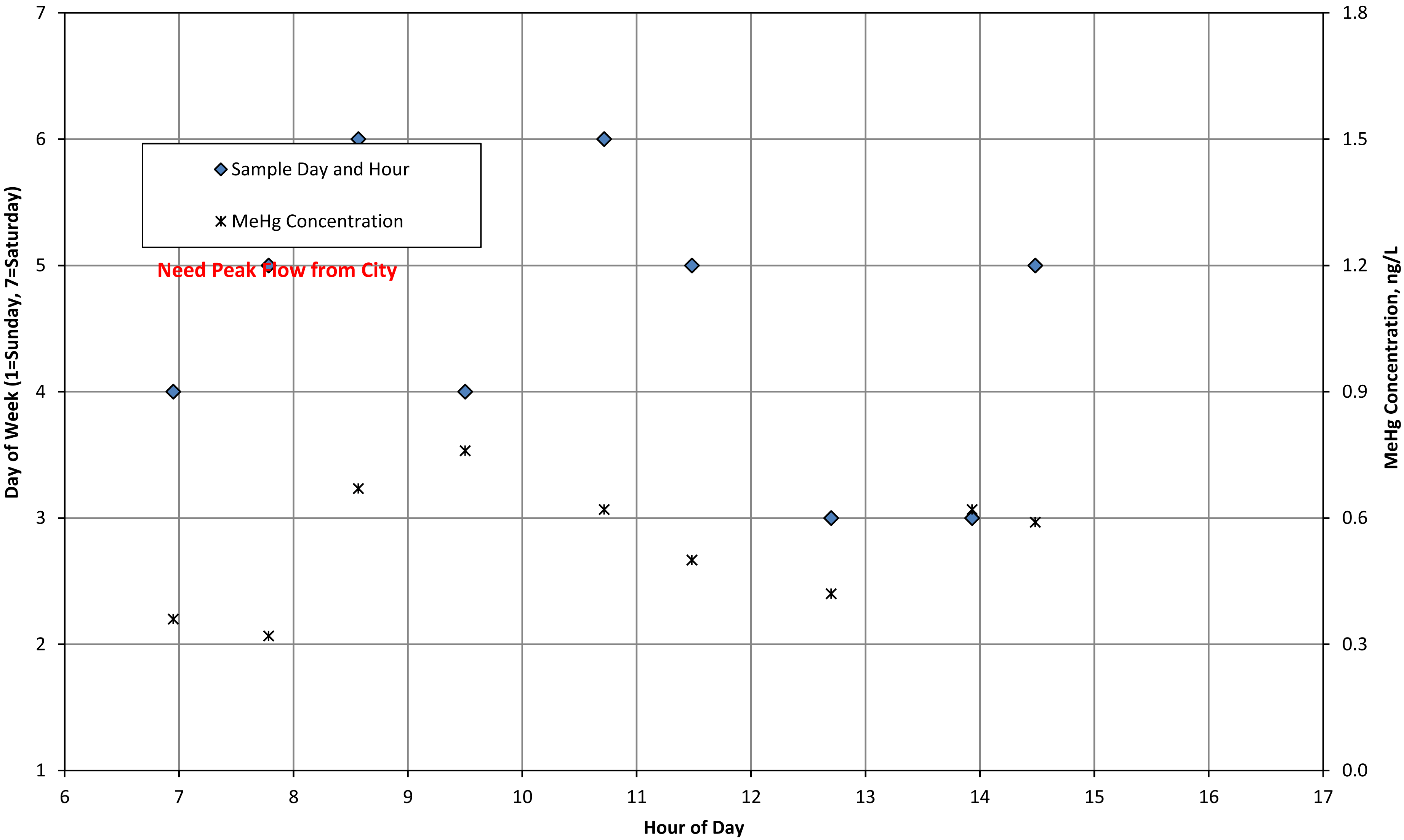


Figure D-14

City of Tracy Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

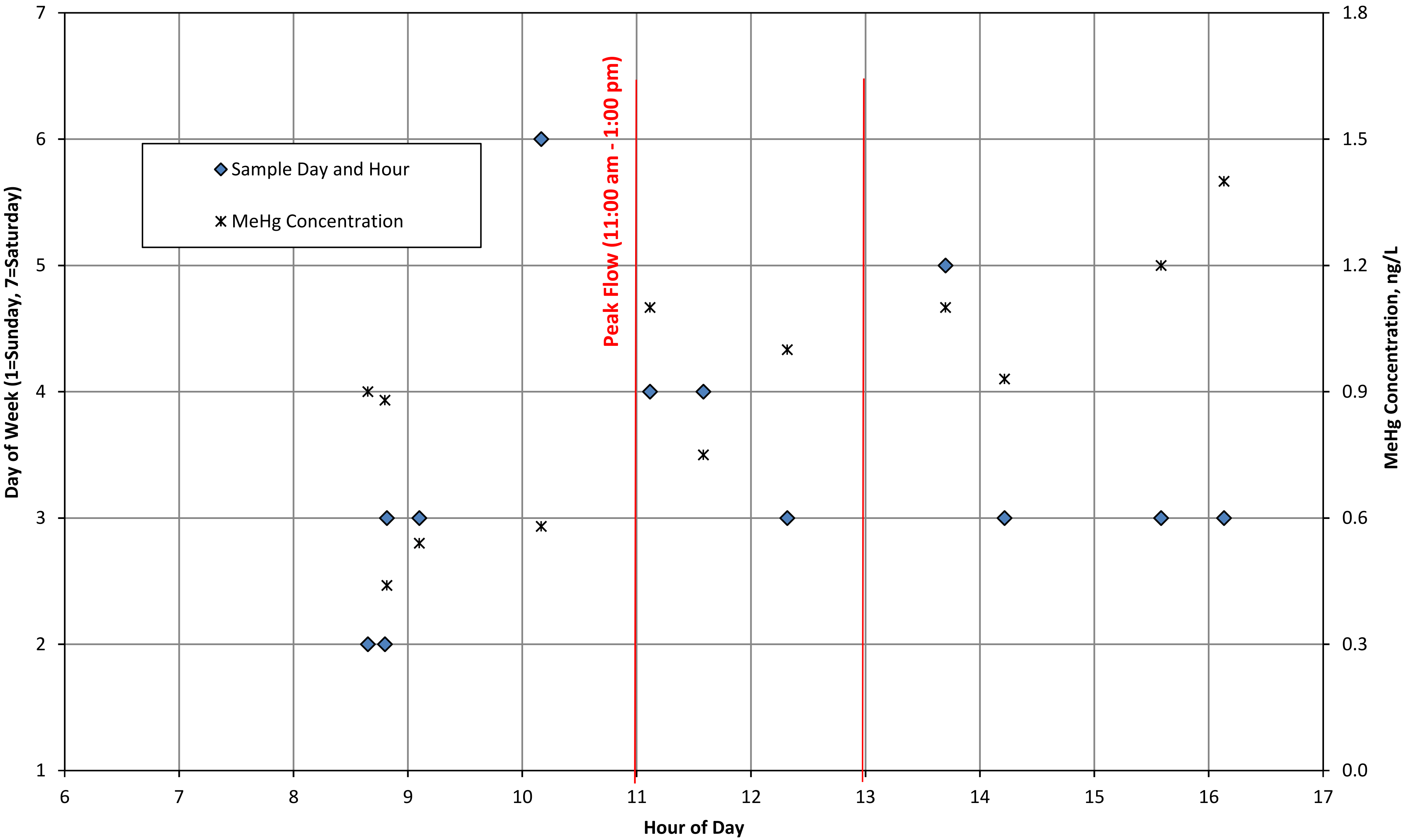


Figure D-15

UC Davis Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

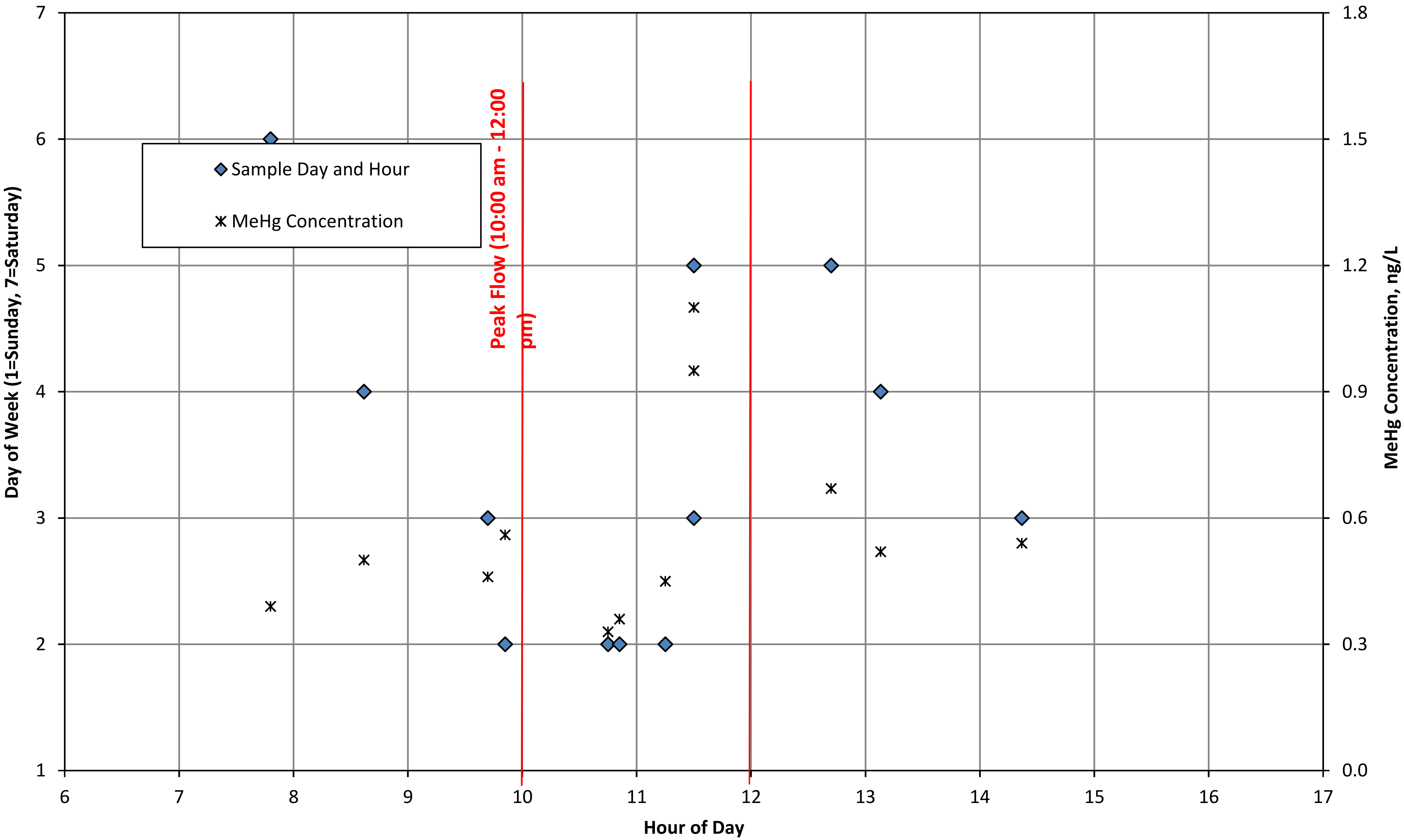


Figure D-16

City of Vacaville Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

Last Revised: 09-24-15, w\c\203\06-12-04\e\DischargerInfo\masterdatabaseCVCWAMeHg-Influent-071615 PR

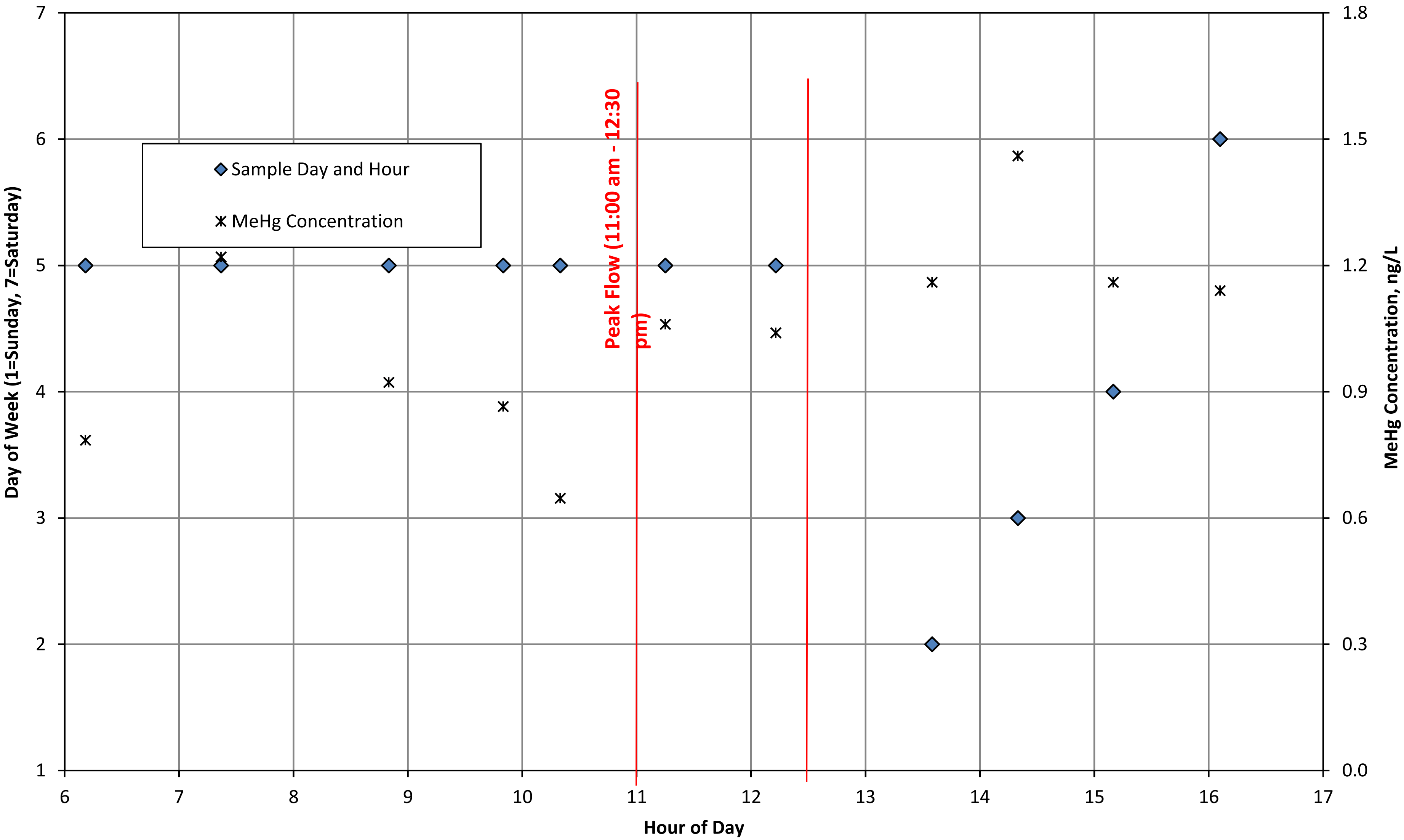


Figure D-17

City of Woodland Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

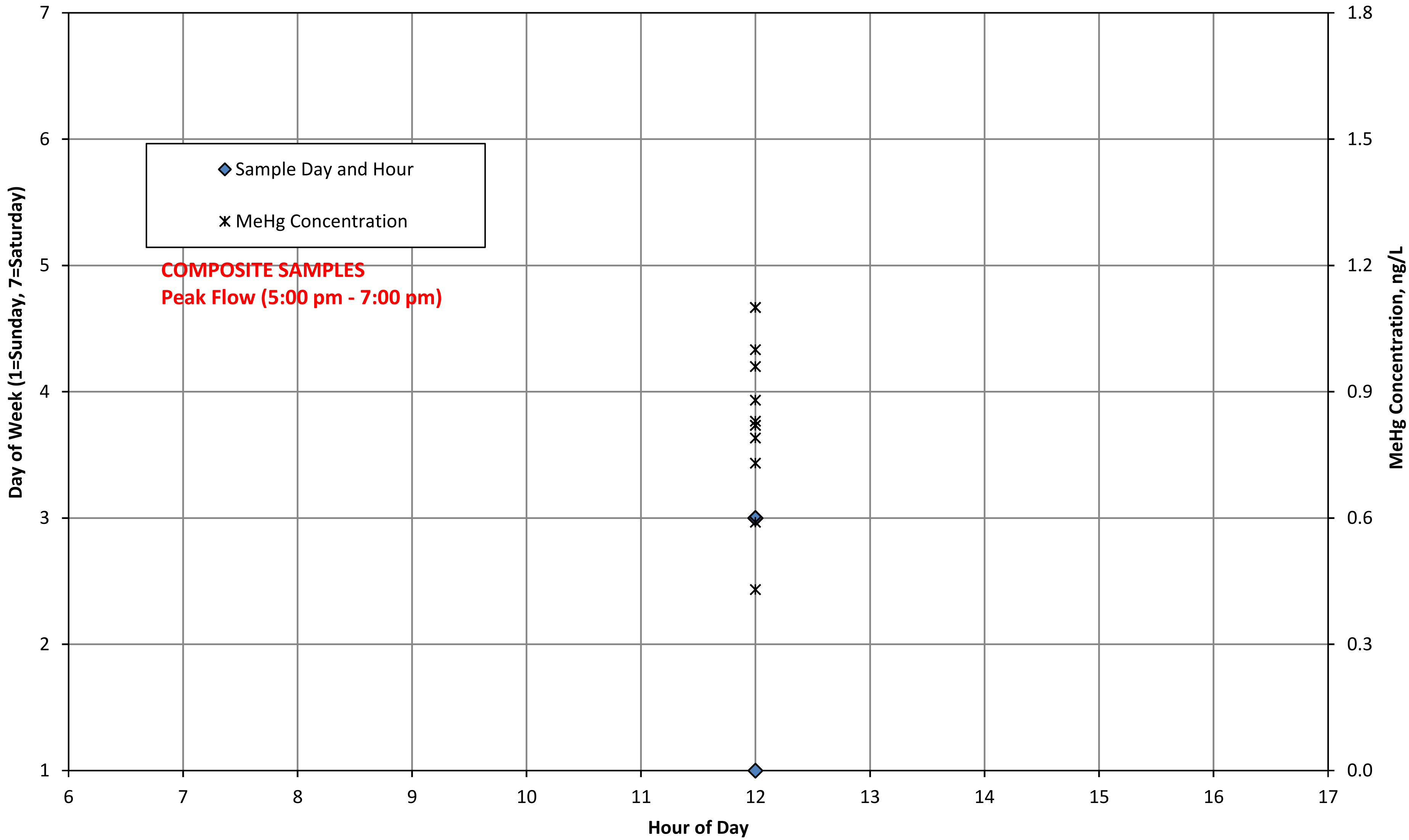


Figure D-18

Sacramento Regional County Sanitation District
Influent Methylmercury Samples
Hours and Days of the Week

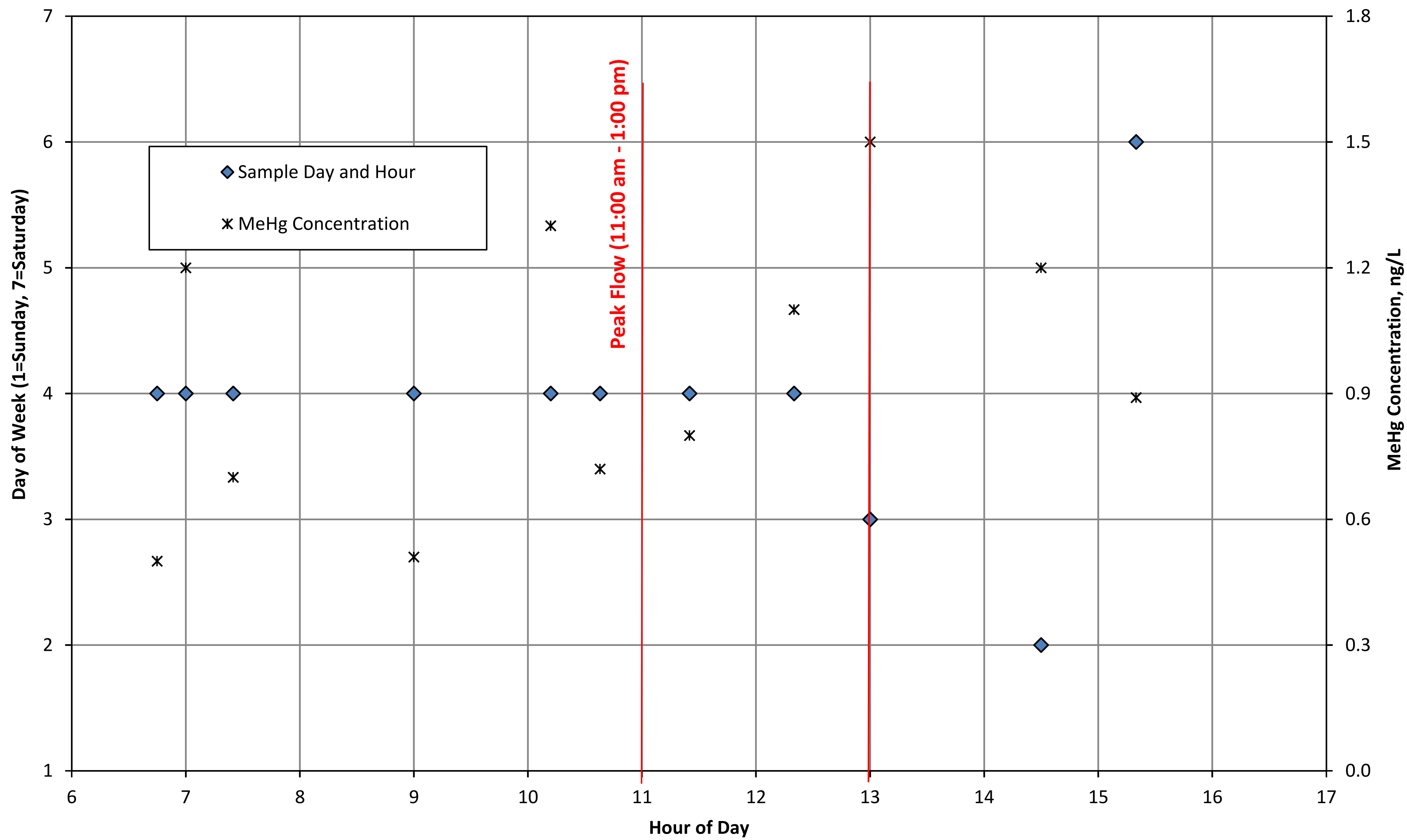


Figure D-19

City of Yuba City Influent Methylmercury Samples
Hours and Days of the Week

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

MeHg CONTROL STUDY PROGRESS REPORT
APPENDIX E

Methylmercury Control Study Mercury Data Technical Memorandum

WEST YOST ASSOCIATES Consulting Engineers

LARRY WALKER ASSOCIATES Science. Policy. Solutions.

MCCORD ENVIRONMENTAL

REGISTERED PROFESSIONAL ENGINEER KATHRYN ELIZABETH GIES No. 65022 Exp. 06-30-2017 CIVIL STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

DATE: October 16, 2015 Project No.: 203-06-12-04

TO: Central Valley Clean Water Association
Methylmercury Special Project Group

FROM: Kathryn E. Gies, P.E., West Yost Associates, R.C.E. #65022
Karen Ashby, Larry Walker Associates
Tom Grovhoug, Larry Walker Associates
Stephen McCord, McCord Environmental

REVIEWED BY: Jeffrey D. Pelz, West Yost Associates, P.E., R.C.E. #46088

SUBJECT: Mercury Data Summary

The purpose of this Mercury Data Summary Technical Memorandum (Hg Summary TM) is to present the total mercury (Hg) data collected to date for the Methylmercury Control Study (MeHg Control Study) being completed by Central Valley Clean Water Association (CVCWA) Methylmercury Special Project Group (MeHg SPG). The MeHg Control Study was developed in accordance with the Sacramento-San Joaquin River Delta Estuary Methylmercury Control Program Phase I Implementation requirements, hereinafter referred to as the Delta MeHg Control Program. The topics addressed in this Hg Summary TM are as follows:

- Available Data
- Individual Facility Average Concentrations
- Graphical Summary by Treatment Level
- Effluent Data Variability by Treatment Level
- Graphical Comparison of Influent versus Effluent Data by Treatment Level
- Graphical Comparison of Hg versus MgHg Data by Treatment Level

Additional evaluation of this Hg data may be presented in the in the MeHg Control Study Final Report that is due October 20, 2018.

Available Data

The Hg data presented herein was compiled/collected for each of the MeHg SPG wastewater treatment facilities (SPG Facility) in accordance with the procedures provided in the *CVCWA MeHg Control Study Work Plan* (Larry Walker Associates et al. 2013), hereinafter referred to as the Control Study Work Plan. Specifically, the following Hg data have been collected and/or compiled:

- Available influent and final effluent data collected between October 2009 and September 2013 was compiled for all of the SPG Facilities.
- Paired (collected on the same day) influent and final effluent data was collected between October 2013 and September 2014 at all of the SPG Facilities and complied.
- Secondary effluent data was also collected between October 2013 and September 2014 at the SPG Facilities that employ either cloth disk or granular media filters and compiled.
- Available effluent data collected between October 2004 and September 2005 was compiled for the SPG Facilities that are subject to the Delta MeHg Control Program. The Regional Water Board relied on data collected during this period when developing the Delta MeHg Control Program. Differences between data collected during the 2004-2005 period and the more recent data is relevant to the MeHg Control Study.

Individual Facility Average Concentrations

Average influent, secondary effluent, and final effluent concentrations for both the current period (defined as any available data collected between October 2009 and September 2014) and the 2004-2005 period were calculated for each applicable SPG Facility and are shown in **Table 1**. These average concentrations were calculated using the following procedures:

- If all values were detected (whether a quantified or estimated concentration) the averages were directly calculated from the data.
- When there were at least 5 detected values, but non-detect values made up some portion of the data set (up to 90 percent), a log-normal probability distribution of detected and non-detected data was used to calculate estimated averages using the "Robust Method" (Helsel and Cohn, 1988). This method is described in detail in the Control Study Work Plan.
- When there were less than 5 reported detected or estimated values, or when the non-detect data are greater than 90 percent of the total data set, a meaningful statistical analysis of the data using the "Robust Method" cannot be performed. Under this case, the average concentration was directly calculated assuming all non-detect values are equal to half the MDL.

Table 1. SPG Facility Average Hg Concentrations

Treatment Type	Agency	Facility	2004-2005 Final Effluent (Sep 2004-Sep 2005) Average,[a] ng/L	2004-2005 Final Effluent Percent ND	Current Influent (Oct 2009-Sep 2014) Average,[a] ng/L	Current Influent Percent ND	Current Secondary Effluent (Oct 2012-Sep 2014) Average,[a] ng/L	Current Secondary Effluent Percent ND	Current Final Effluent (Oct 2009-Sep 2014) Average,[a] ng/L	Current Final Effluent Percent ND
Tertiary plus NDN	Brentwood, City of	WWTP	(b)	(b)	73	0%	0.8	21%	0.6	5%
	Ironhouse Sanitary District	WWTP	(c)	(c)	100	0%	(d)	(d)	0.5	33%
	Lodi, City of	White Slough WPCF	3.7	0%	160	0%	1.5	0%	1.6	0%
	Manteca, City of	WQCF	11	8%	140	0%	1.6	0%	1.3	0%
	Mountain House Community Services District	Mountain House WWTP	(c)	(c)	43	0%	2.1	0%	0.6	10%
	Rio Vista, City of	Northwest WWTF	(c)	(c)	39	0%	(d)	(d)	0.7	0%
	Roseville, City of	Pleasant Grove WWTP	(e)	(e)	140	2%	1.5	0%	0.8	0%
	Roseville, City of	Dry Creek WWTP	(e)	(e)	140	13%	2.9	0%	1.6	0%
	Tracy, City of	WWTP	11	0%	110	0%	5.0	0%	1.6	0%
	UC Davis	Main WWTP	(e)	(e)	190	0%	2.2	0%	1.1	0%
Tertiary plus N	Live Oak, City of	WWTP	(e)	(e)	120	0%	5.0	0%	0.8	0%
	Stockton, City of	Regional WWCF	4.4	13%	200	0%	1.4	0%	1.0	0%
	Woodland, City of	WPCF	6.0	0%	130	0%	3.8	0%	2.3	0%
Pond Based	Davis, City of	WWTP (001)	(e)	(e)	120	0%	(d)	(d)	9.3	1%
	Davis, City of	WWTP (002)	7.8	0%	120	0%	(d)	(d)	5.7	0%
Secondary plus NDN	Vacaville, City of (After Dec 2012)	Easterly WWTP	(e)	(e)	70	0%	(d)	(d)	1.6	0%
Secondary plus N	Discovery Bay, Town of	WWTP	(b)	(b)	70	0%	(d)	(d)	2.8	0%
	Rio Vista, City of	Beach WWTF	(b)	(b)	98	0%	(d)	(d)	3.6	0%
	Vacaville, City of (Before Jan 2013)	Easterly WWTP	(e)	(e)	160	0%	(d)	(d)	1.8	0%
Secondary	Sacramento Regional County Sanitation District	Sacramento Regional WWTP	5.4	0%	130	3%	(d)	(d)	3.4	0%
	Yuba City, City of	WWTF	(e)	(e)	320	0%	(d)	(d)	7.9	0%
Primary Only[f]	Sacramento, City of	Combined WWCTS	(b)	(b)	68	0%	(d)	(d)	64	0%

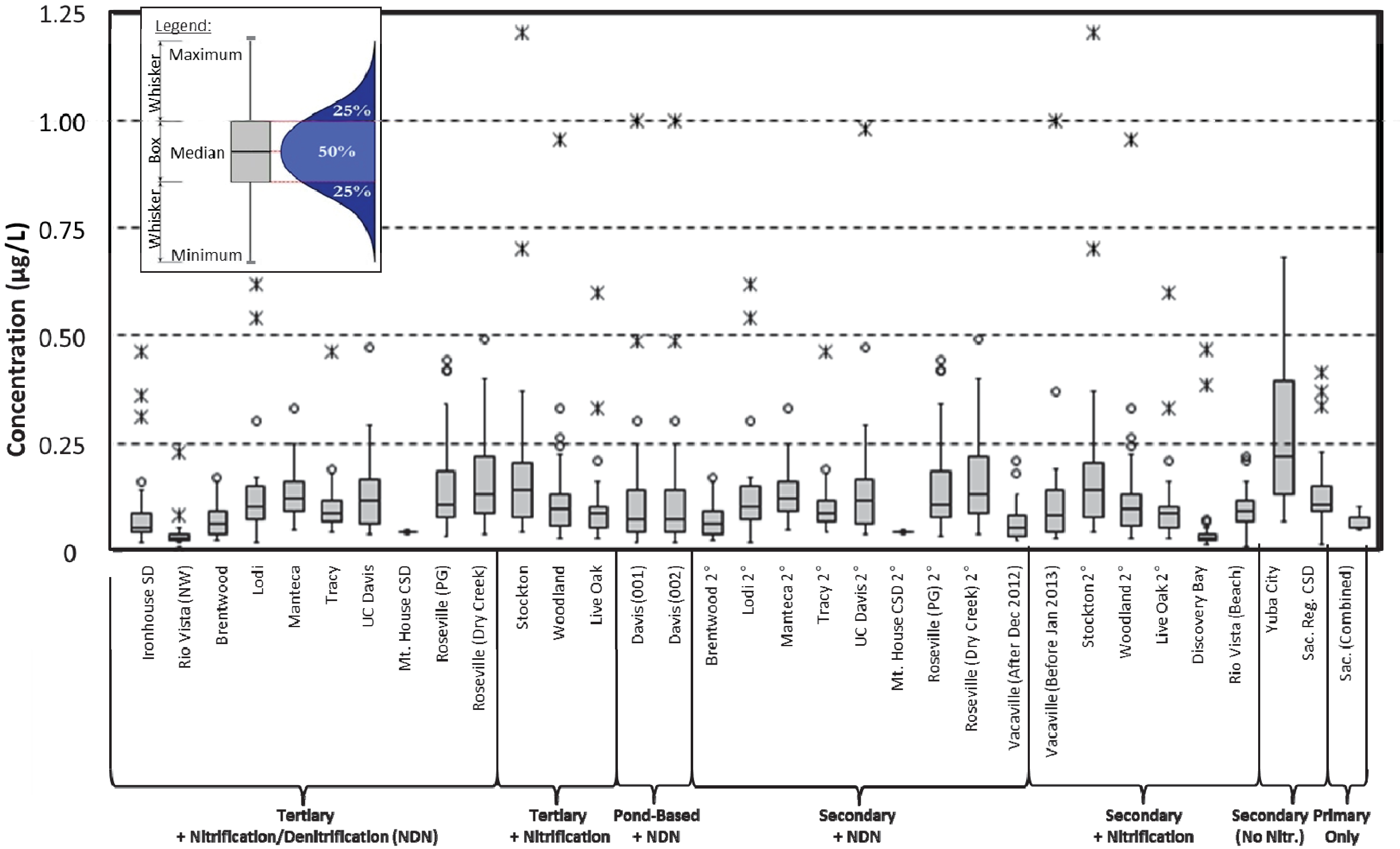
(a) Values in red were calculated using a log-normal distribution and italicized values were directly calculated assuming all ND values are equal to half the MDL.
(b) Data unavailable.
(c) This facility was not in operation during the 2004-2005 period.
(d) No secondary effluent collected.
(e) Outside TMDL Program Area.
(f) There is one Primary Only facility wihtin the SPG, the City of Sacramento Combined Wastewater Collection and Treatment System (Combined WWCTS). This complex of facilities, which serves the downtown Sacramento area, is designed to collect both wastewater and stormwater in a single collection system (i.e. combined sewer system), and convey the flow to the Sacramento Regional County Sanitation District Wastewater Treatment Plant for treatment and disposal. The maximum allowed conveyance capacity to SRCSD is 60MGD, which is roughly four times the average daily flow. The system is designed to store and attenuate the peak flows above 60 MGD in a storm event. When storm events have excessive intensity and/or duration and the system reaches storage capacity, the flow id directed to two treatment plants that provide primary treatment, chlorine disinfection, and dechlorination. Discharges from this system to receiving waters occurs only for a few hours a day, three to five days each year (if at all). Because of the unique storm dependent and intermittent operation of the treatment facilities, these facilities cannot rely on the biological treatment processes that are being evaluated under this study for the remaining SPG Facilities. Therefore, control strategies for discharges from the City of Sacramento CWCTS are not likely to be the same as the other SPG Facilities. Nevertheless, the majority of flows in the City of Sacramento's combined system are routed to and treated at the Sacramento Regional County Sanitation District Wastewater Treatment Plant , which is also part of the MeHg Control Study. In addition, the City of Sacramento is preparing a MeHg control study specific to the CWCTS and is also participating in addition to MeHg control studies being completed by the stormwater dischargers under the Delta MeHg Control Program.

Table 1 also indicates the percent of values that were non-detect and whether the average value was calculated using the Robust Method. As shown, the majority of the influent and effluent Hg averages are directly calculated because all data are either detected or estimated concentrations. Graphs showing the results of the "Robust method" calculations identified by the red-colored font in **Tables 1** are provided in **Attachment A** of this TM.

Individual Facility Graphical Summary by Treatment Level

Graphical summaries of the available influent and secondary/final effluent Hg data collected between October 2009 and September 2014 at each SPG Facility are provided on **Figure 1** and **Figure 2**, respectively. **Figure 3** shows the effluent Hg data without data for the Sacramento Combined Facility to allow for better resolution at a lower concentration scale. These data are grouped by treatment level, as follows:

- **Secondary Only:** Secondary treatment processes provided to achieve BOD reduction only, so average effluent ammonia concentrations are greater than 10.0 mg-N/L (mg as Nitrogen per liter).
- **Secondary plus Nitrification**: Secondary treatment with nitrification, where the average effluent ammonia concentrations are consistently less than 2.0 mg-N/L. Secondary effluent data collected from facilities that provide a tertiary plus nitrification treatment levels are also included in this grouping.
- **Secondary plus NDN:** Secondary treatment with nitrification and denitrification (NDN), where average effluent ammonia concentrations are consistently less than 2.0 mg-N/L and average effluent nitrate concentrations are consistently less than 10 mg-N/L. Secondary effluent data collected from facilities that provide a tertiary plus NDN treatment levels are also included in this grouping.
- **Tertiary plus Nitrification:** Secondary treatment with nitrification, followed by filtration, where average effluent ammonia concentrations are less than 1.5 mg-N/L, average effluent TSS concentrations less than 5 mg/L, and average turbidity of 2 NTU or less.
- **Tertiary plus NDN:** Secondary treatment with nitrification and denitrification, followed by filtration, where average effluent ammonia concentrations are less than 1.5 mg-N/L, average effluent nitrate concentrations are 1-10 mg-N/L, average effluent TSS concentrations less than 5 mg/L, and average turbidity of 2 NTU or less.



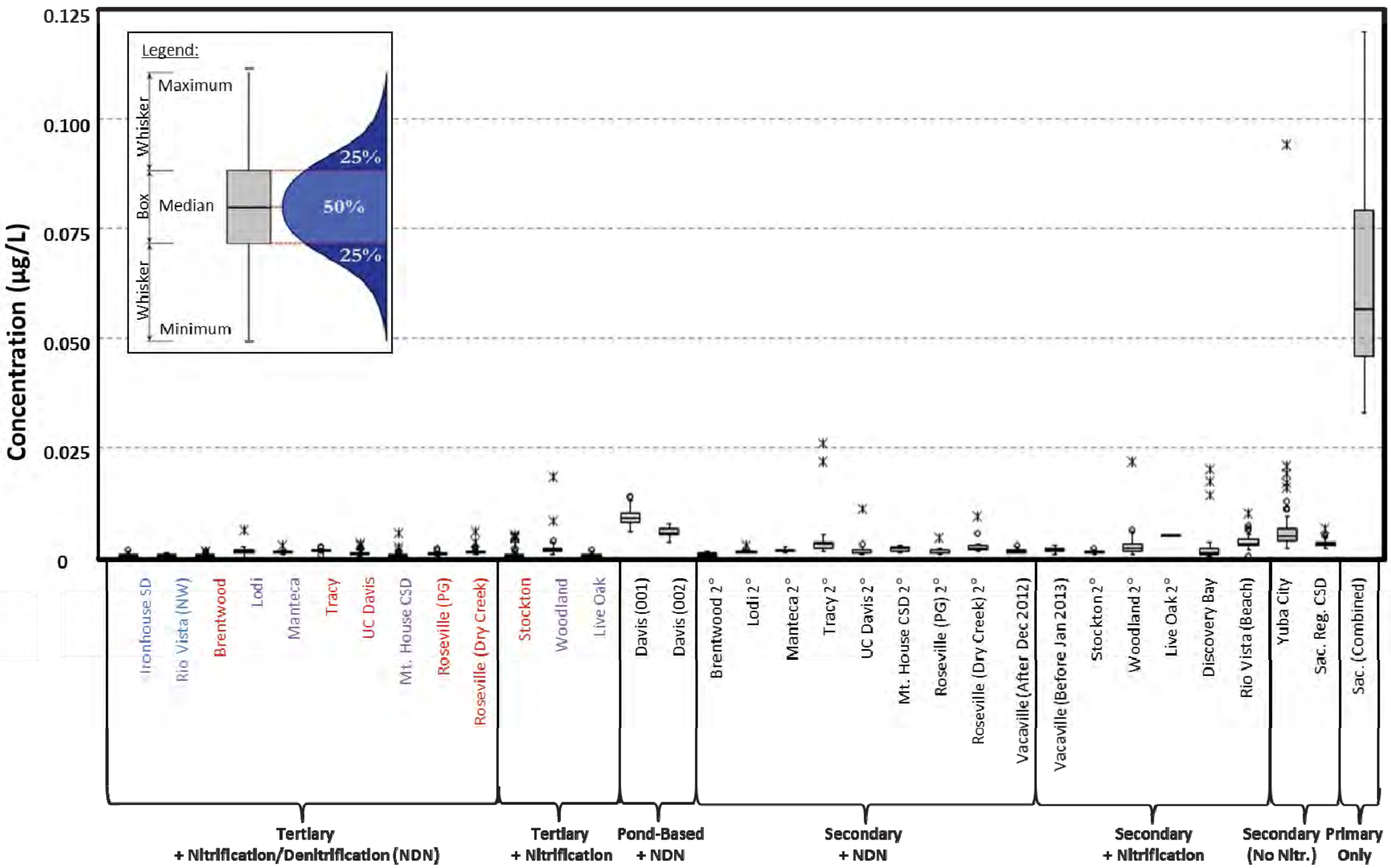
Notes:

1. Circles indicate possible outliers, which are outside the box by between 1.5 and 3 times the box size. Stars indicate probable outliers, which are outside the box by more than 3 times the box size.
2. Non-detect data is assumed to be equal to one half the reported method detection limit.
3. Yuba City outlier (2.1 µg/L)falls outside of the presented range
4. 2° refers to effluent sampled after secondary treatment and before tertiary treatment at a tertiary facility

Figure 1

SPG Facility Influent Hg Data Summary

Central Valley Clean Water Association
MeHg SPG



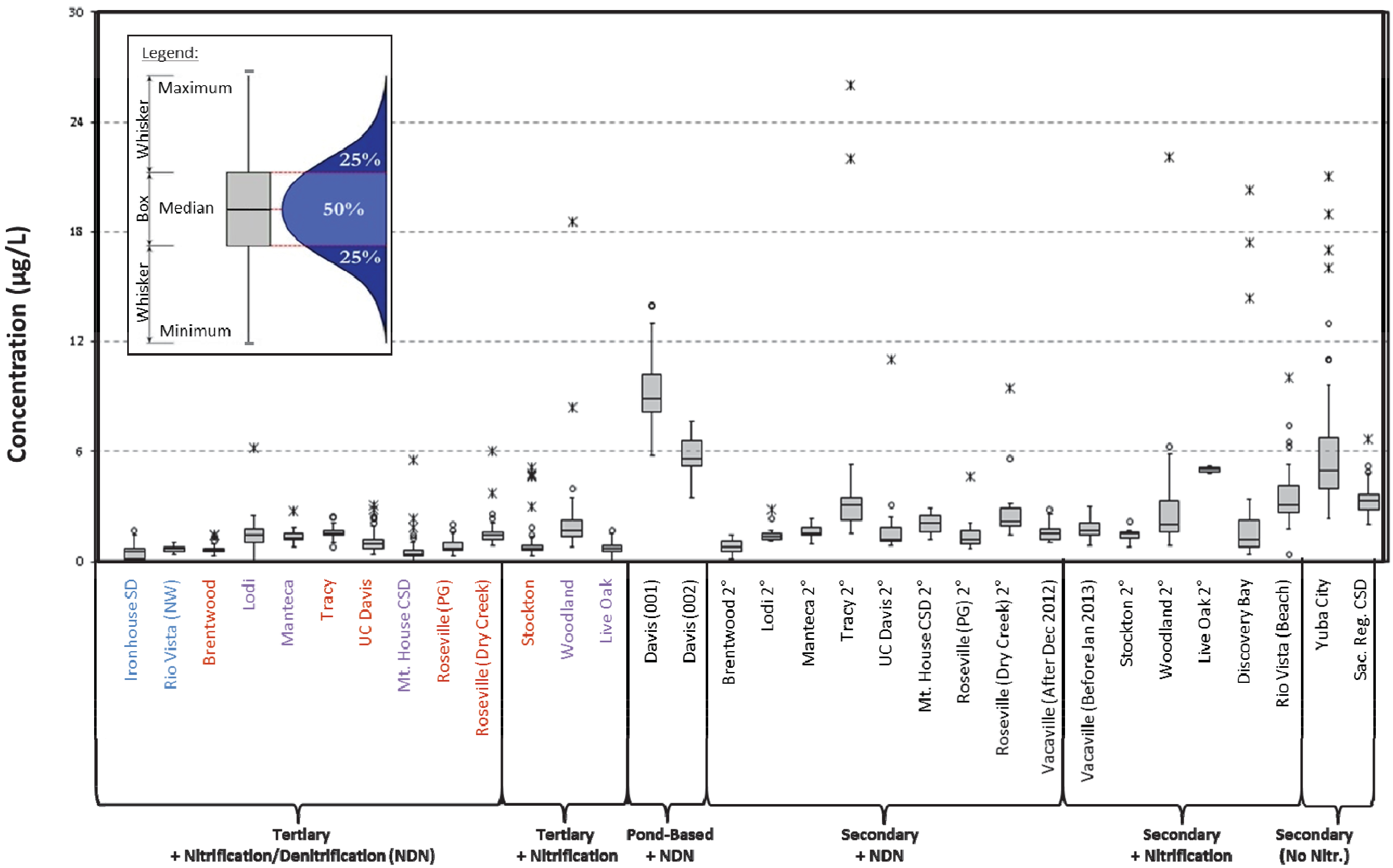
Notes:

1. City of Vacaville has the only nitrification facility with an anoxic selector.
2. City of Roseville's Dry Creek WWTP has an undersized anoxic selector for denitrification, limiting its denitrifying capacity.
3. Circles indicate possible outliers, which are outside the box by between 1.5 and 3 times the box size. Stars indicate probable outliers, which are outside the box by more than 3 times the box size.
4. Non-detect data is assumed to be equal to one half the reported method detection limit.
5. Filtration facilities are color-coded, as follows, to indicate the type of filtration media: Membranes, Granular Media Filtration, Cloth (UC Davis has primarily sand, but also a cloth filter.).
6. 2° refers to effluent sampled after secondary treatment and before tertiary treatment at a tertiary facility

Figure 2

SPG Facility Effluent Hg Data Summary

Central Valley Clean Water Association
MeHg SPG



Notes:

1. City of Vacaville has the only nitrification facility with an anoxic selector.
2. City of Roseville's Dry Creek WWTP has an undersized anoxic selector for denitrification, limiting its denitrifying capacity.
3. Circles indicate possible outliers, which are outside the box by between 1.5 and 3 times the box size. Stars indicate probable outliers, which are outside the box by more than 3 times the box size.
4. Non-detect data is assumed to be equal to one half the reported method detection limit.
5. Filtration facilities are color-coded, as follows, to indicate the type of filtration media: Membranes, Granular Media Filtration, Cloth (UC Davis has primarily sand, but also a cloth filter.).
6. 2° refers to effluent sampled after secondary treatment and before tertiary treatment at a tertiary facility
7. Yuba City outlier (.094 µg/L)falls outside of the presented range

Figure 3

SPG Facility Effluent Hg Data Summary (Without Sac. City)

Central Valley Clean Water Association
MeHg SPG

Effluent Data Variability by Treatment Level

The available individual facility secondary/final effluent data from October 2008 through September 2014 were combined for the facilities that represent each of the five treatment levels described above, and log-normal probability distribution plots were developed from these combined data sets. These plots, which demonstrate the variability in data observed over the monitoring period, are provided as **Figure 4** through **Figure 8**.

Graphical Comparison of Influent versus Effluent Data by Treatment Level

The combined treatment level data (as previously described) were used to develop scatter plots of paired daily influent and effluent concentrations. These plots are provided as **Figure 9** through **Figure 13**. Also shown on these plots are the results of a linear regression analysis, along with associated r^2 values. As indicated by these plots, there is limited correlation between the influent and effluent grab sample data collected under the MeHg Control Study.

Graphical Comparison of Hg versus MeHg Data by Treatment Level

The combined treatment level data (as previously described) were also used to develop scatter plots of paired effluent Hg and MeHg concentrations. These plots are provided as **Figure 14** through **Figure 18**.

Based on a review of available data on the California Environmental Data Exchange Network (CEDEN) for eight sites in the Delta, MeHg concentrations in the Delta are typically within 1 to 4 percent of the Hg concentration. Therefore, for comparative purposes, a one percent MeHg to Hg concentration and a four percent MeHg to Hg concentration line were plotted on **Figure 14** through **Figure 18** to demonstrate whether the effluent data fall within this typical one to four percent range. As shown, the ratio of effluent MeHg to Hg does generally fall within the expected one to four percent MeHg to Hg ratio with the exception of the Secondary Only facilities.

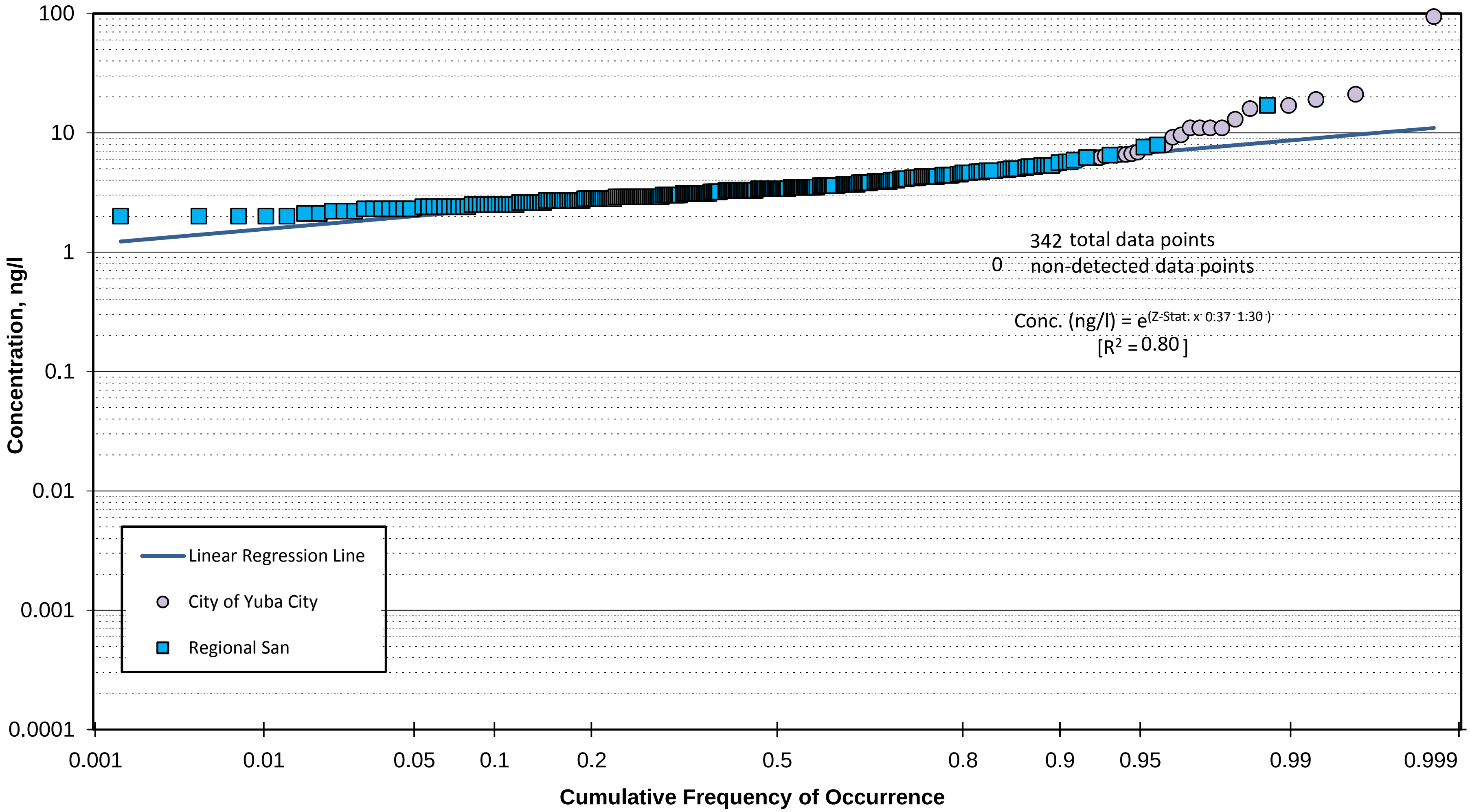


Figure 4

Hg Concentration Probability Plot for Secondary Only Facilities

Central Valley Clean Water Association
MeHg SPG

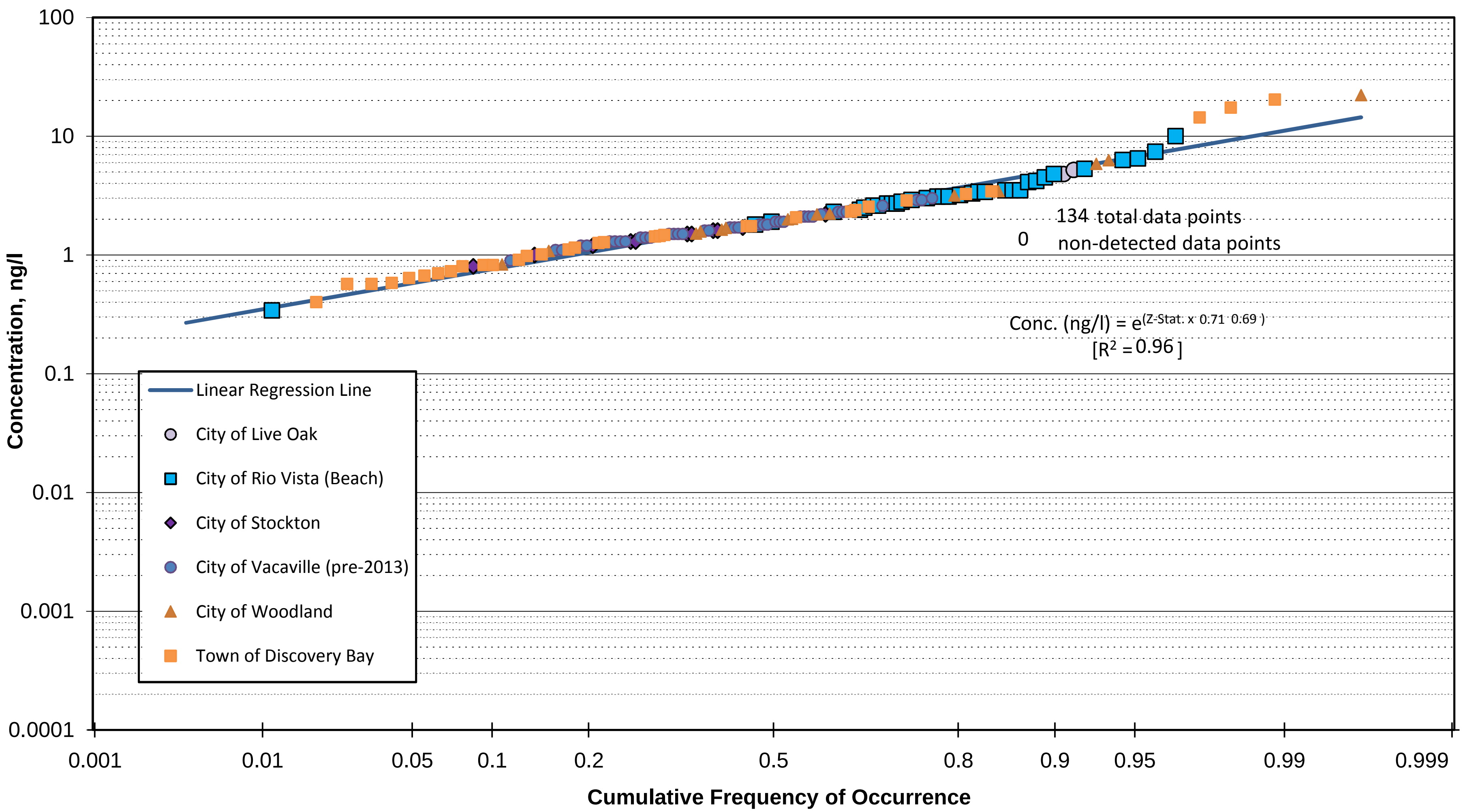


Figure 5

Hg Concentration Probability Plot for Secondary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

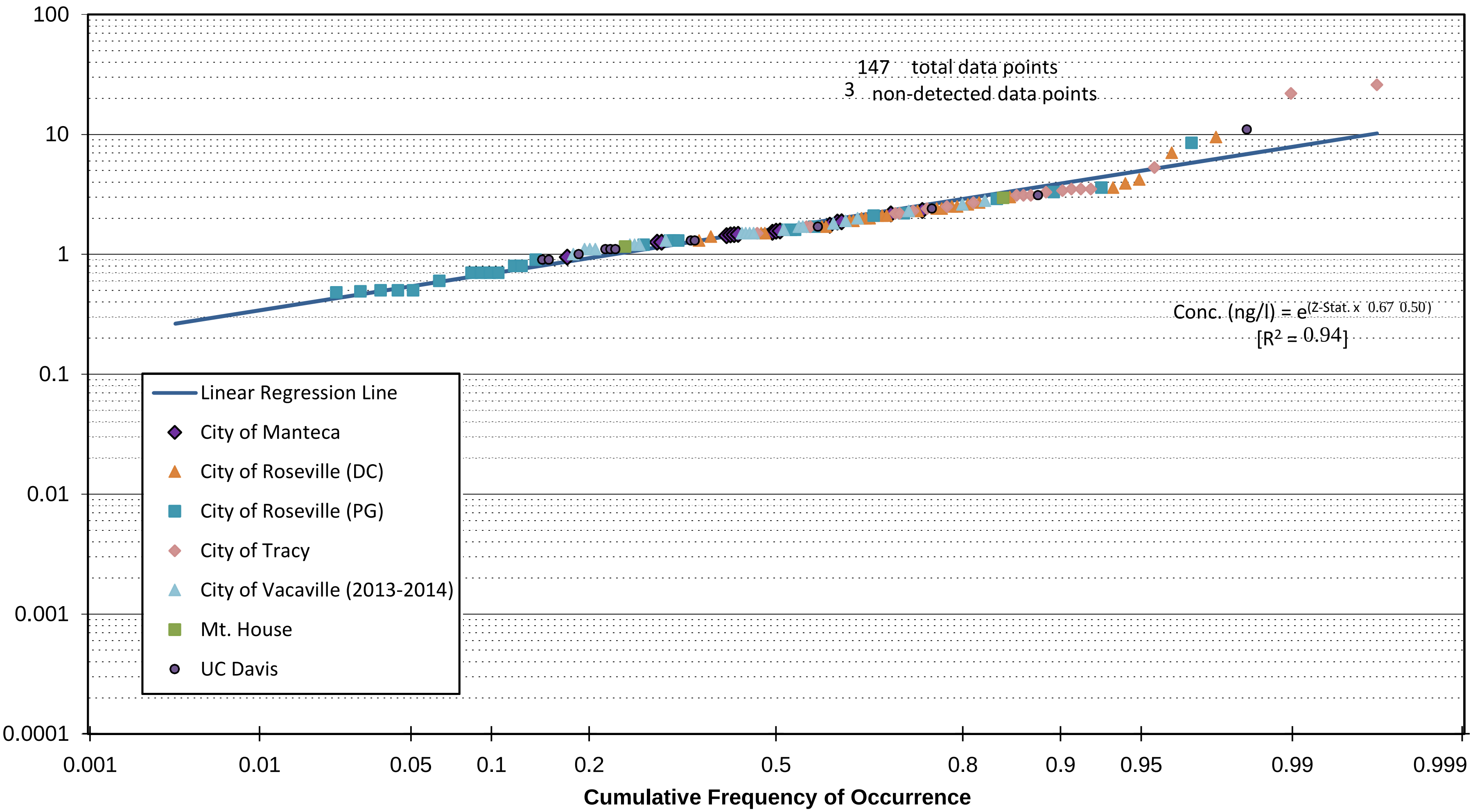


Figure 6

Hg Concentration Probability Plot for Secondary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

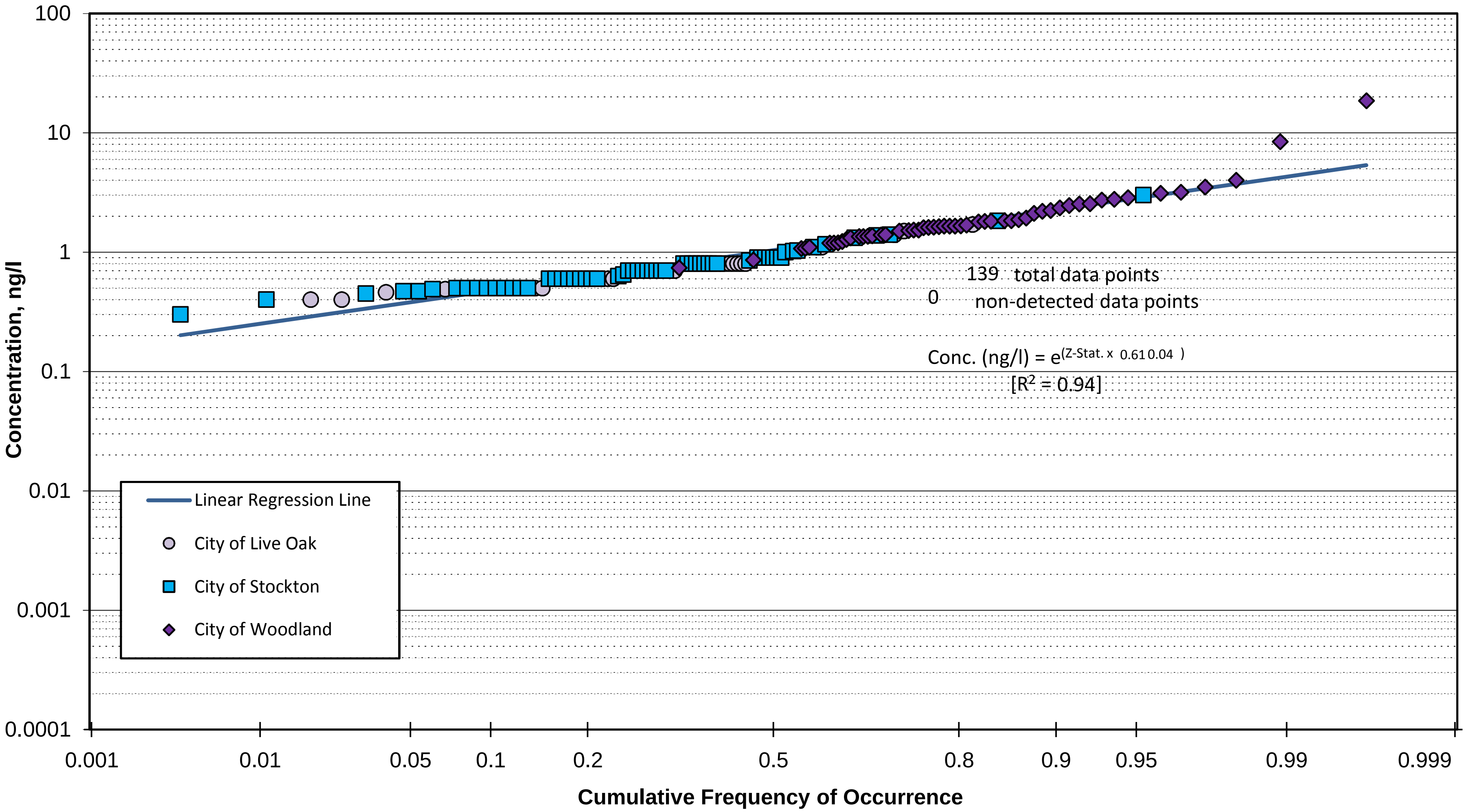


Figure 7

Hg Concentration Probability Plot for Tertiary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

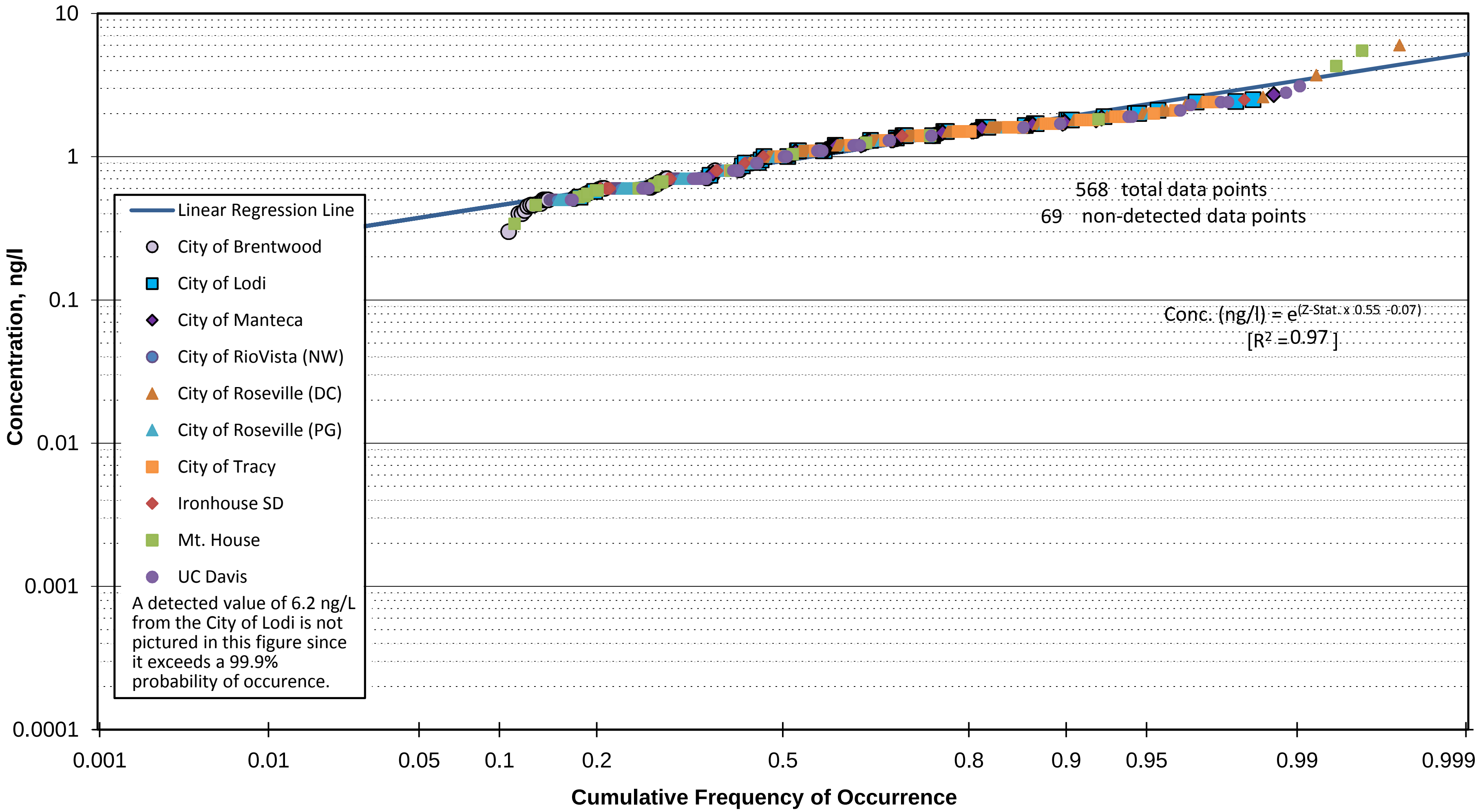


Figure 8

Hg Concentration Probability Plot for Tertiary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

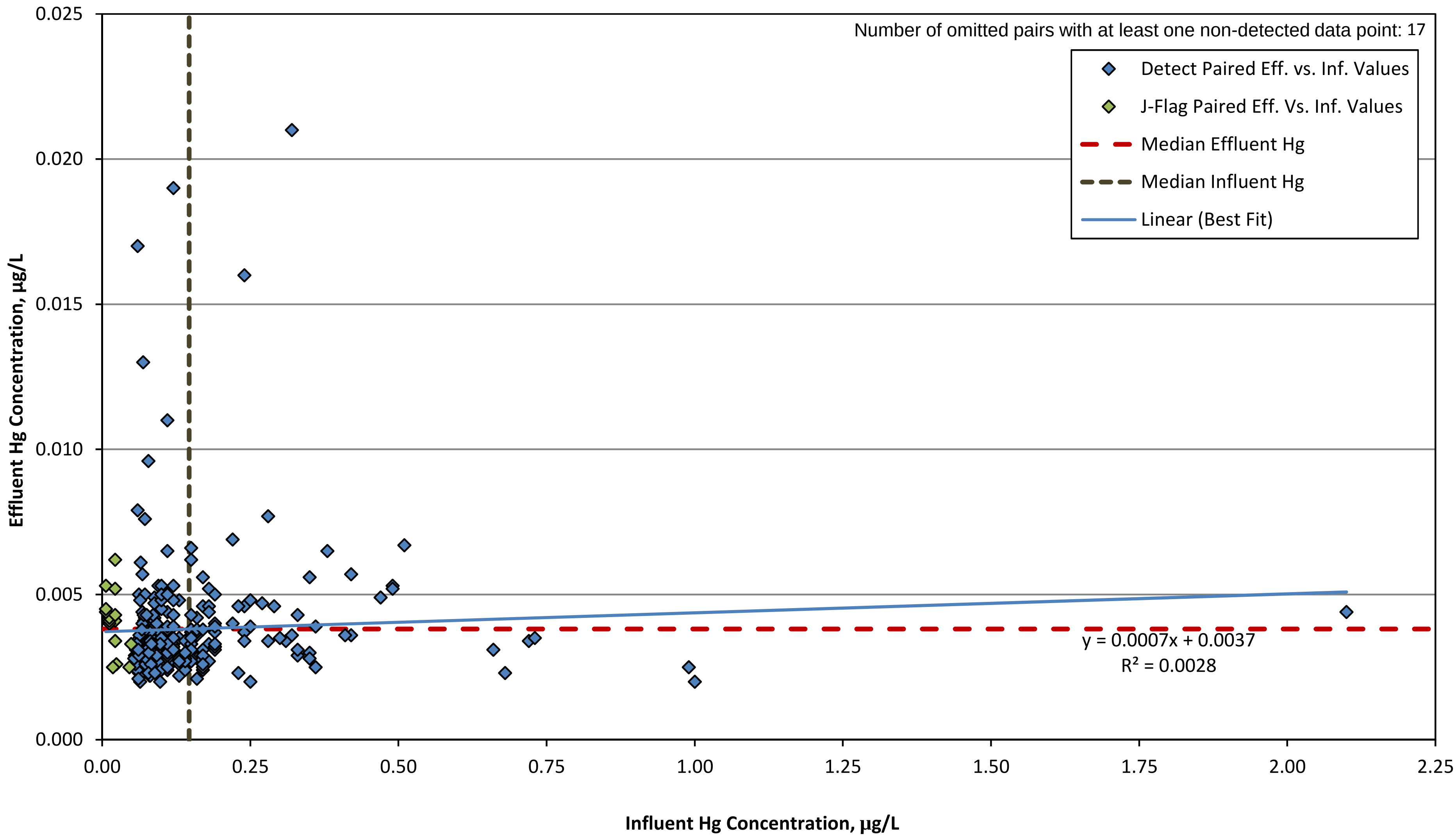


Figure 9

Comparison of Paired Influent vs. Effluent Hg Concentrations for Secondary Only Facilities

Central Valley Clean Water Association
MeHg SPG

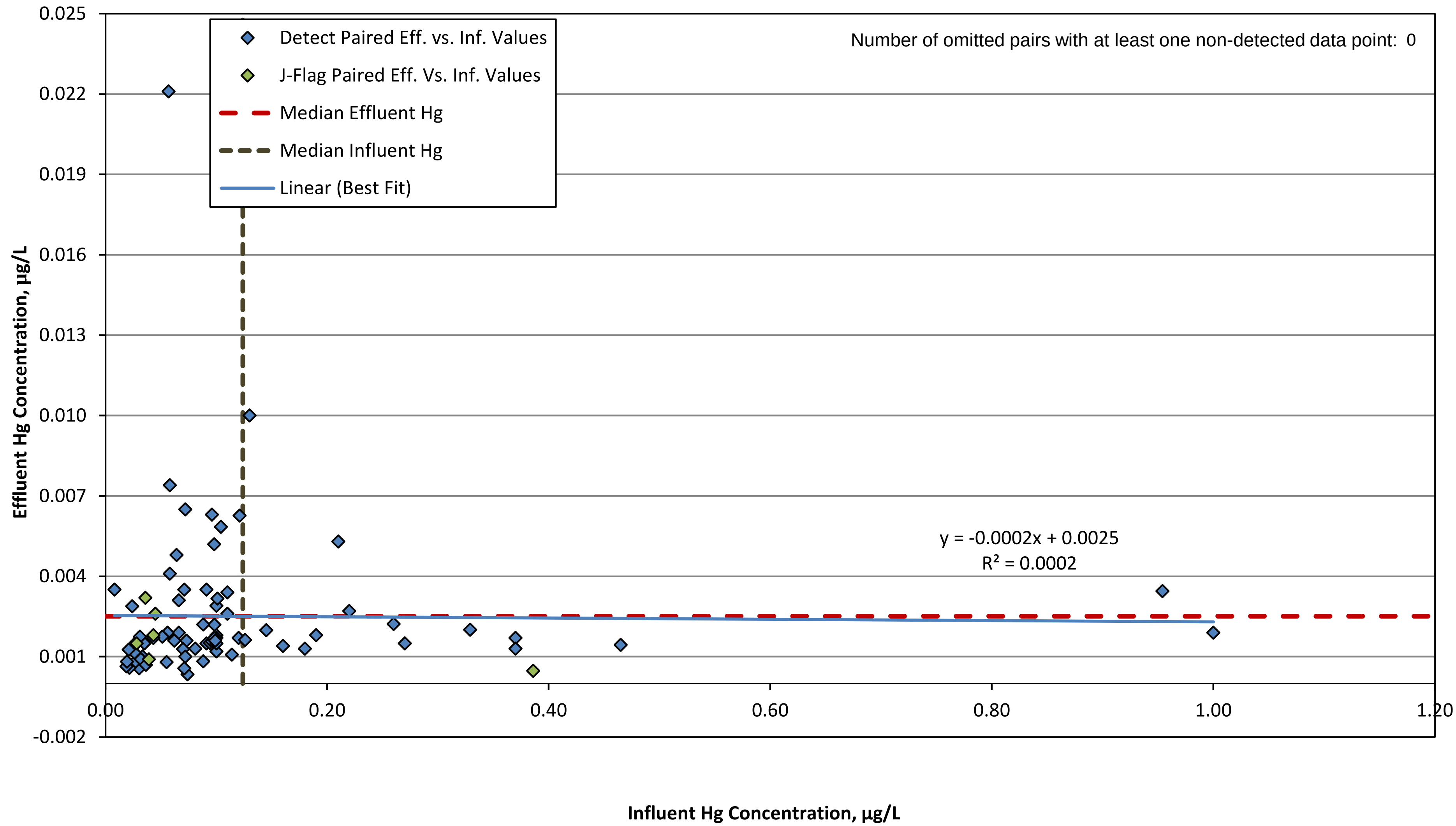


Figure 10

Comparison of Paired Influent vs. Effluent Hg Concentrations for Secondary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

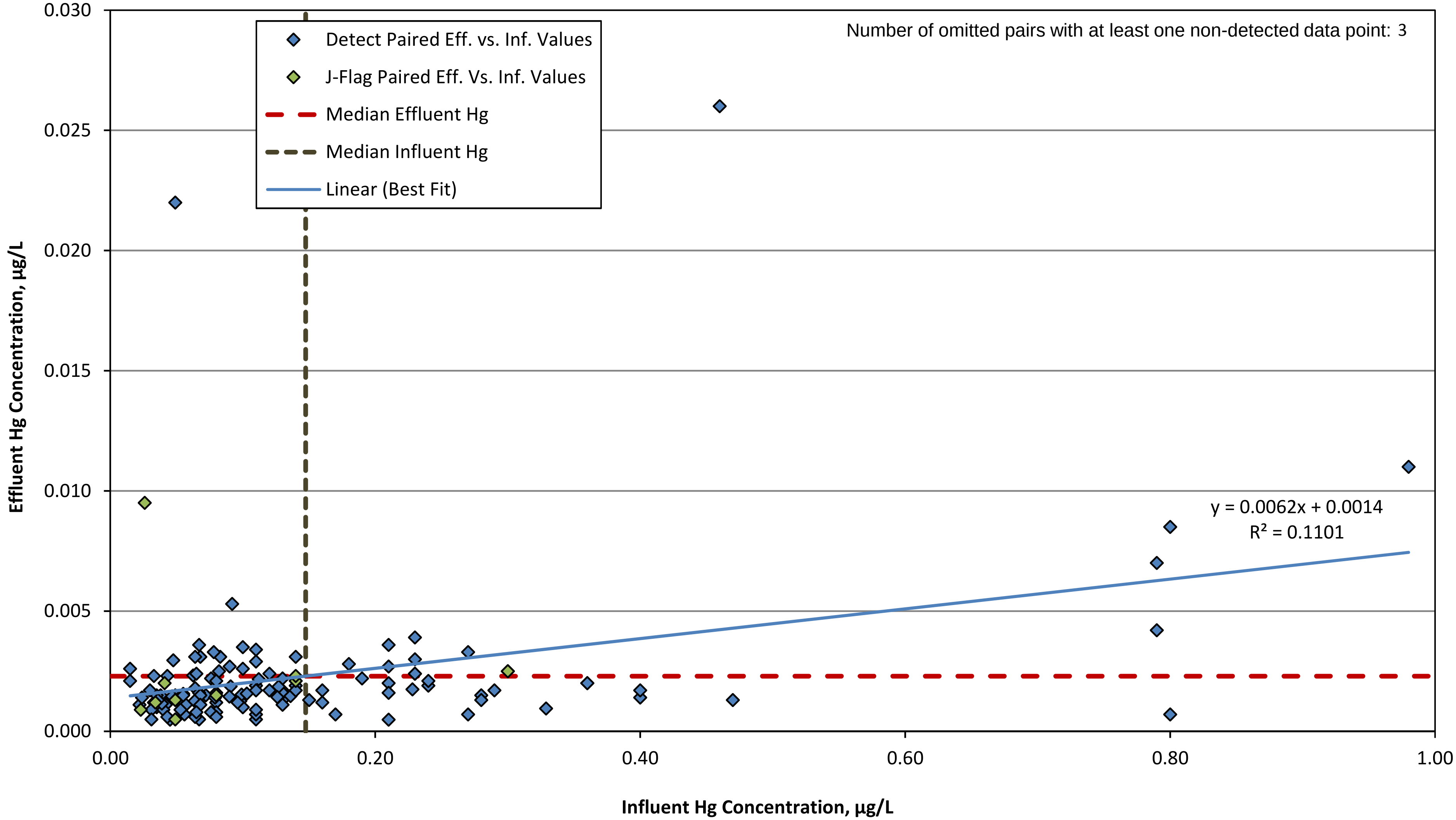


Figure 11

Comparison of Paired Influent vs. Effluent Hg Concentrations for Secondary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

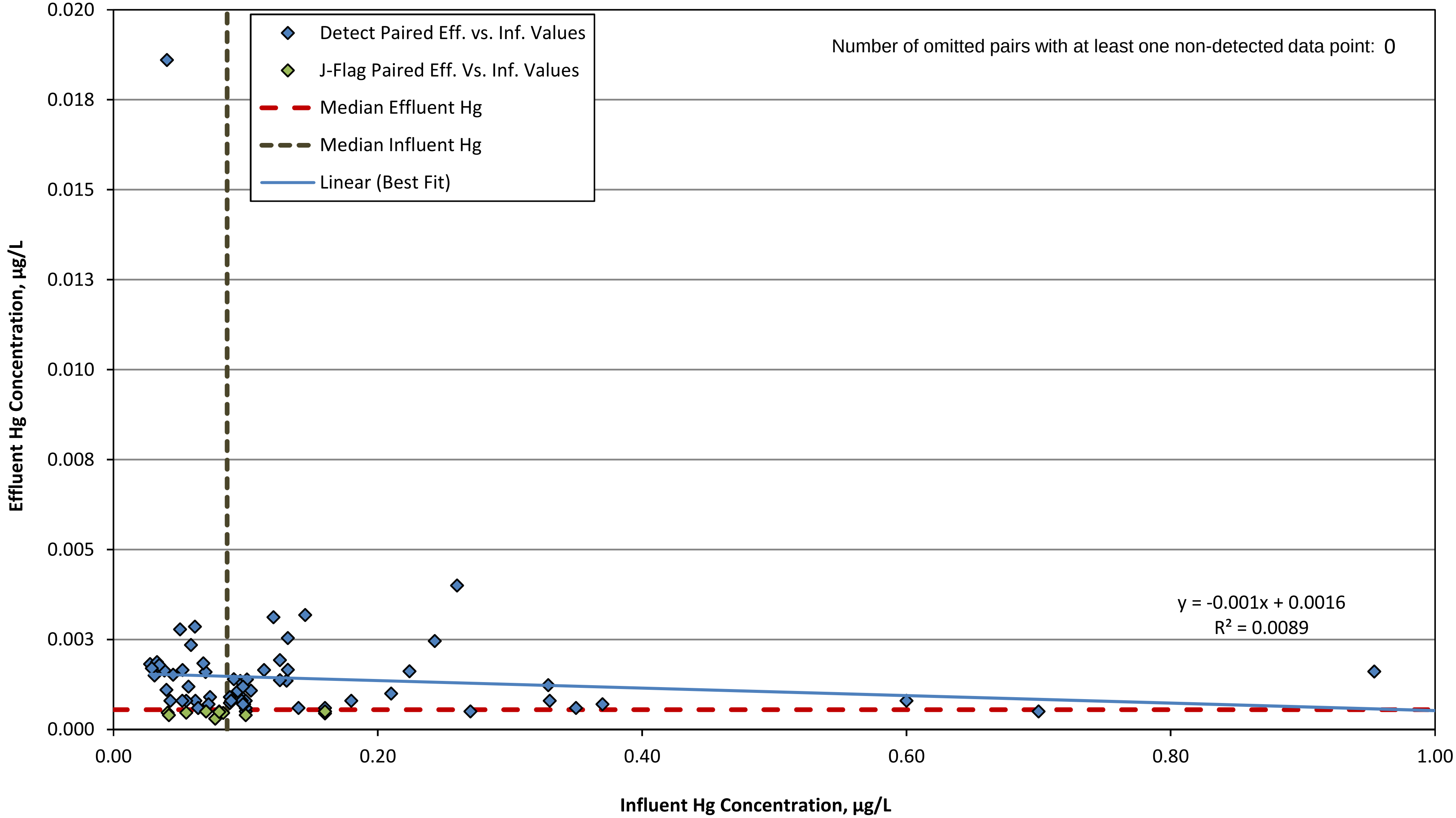


Figure 12

Comparison of Paired Influent vs. Effluent Hg Concentrations for Tertiary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

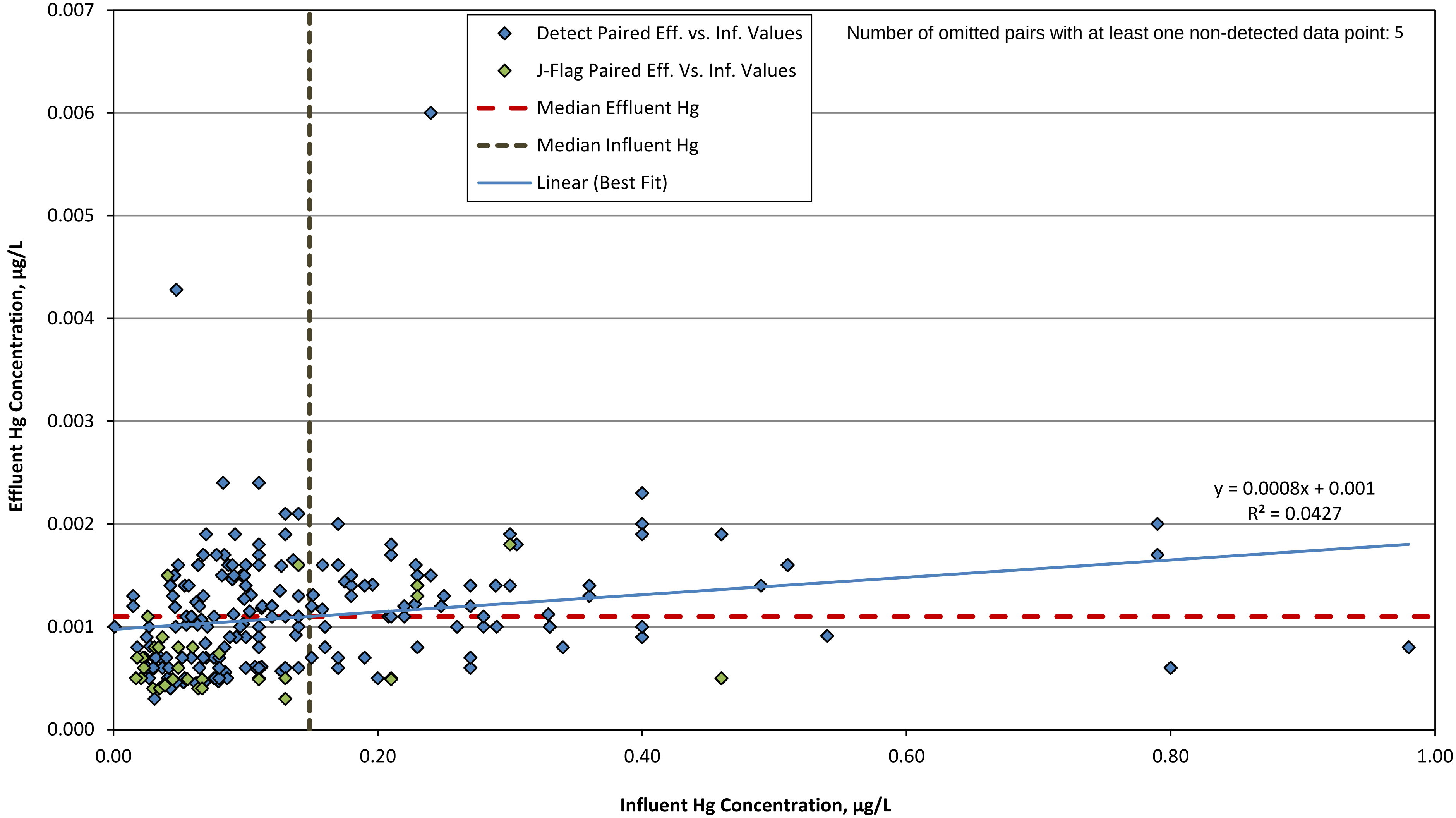


Figure 13

Comparison of Paired Influent vs. Effluent Hg Concentrations for Tertiary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

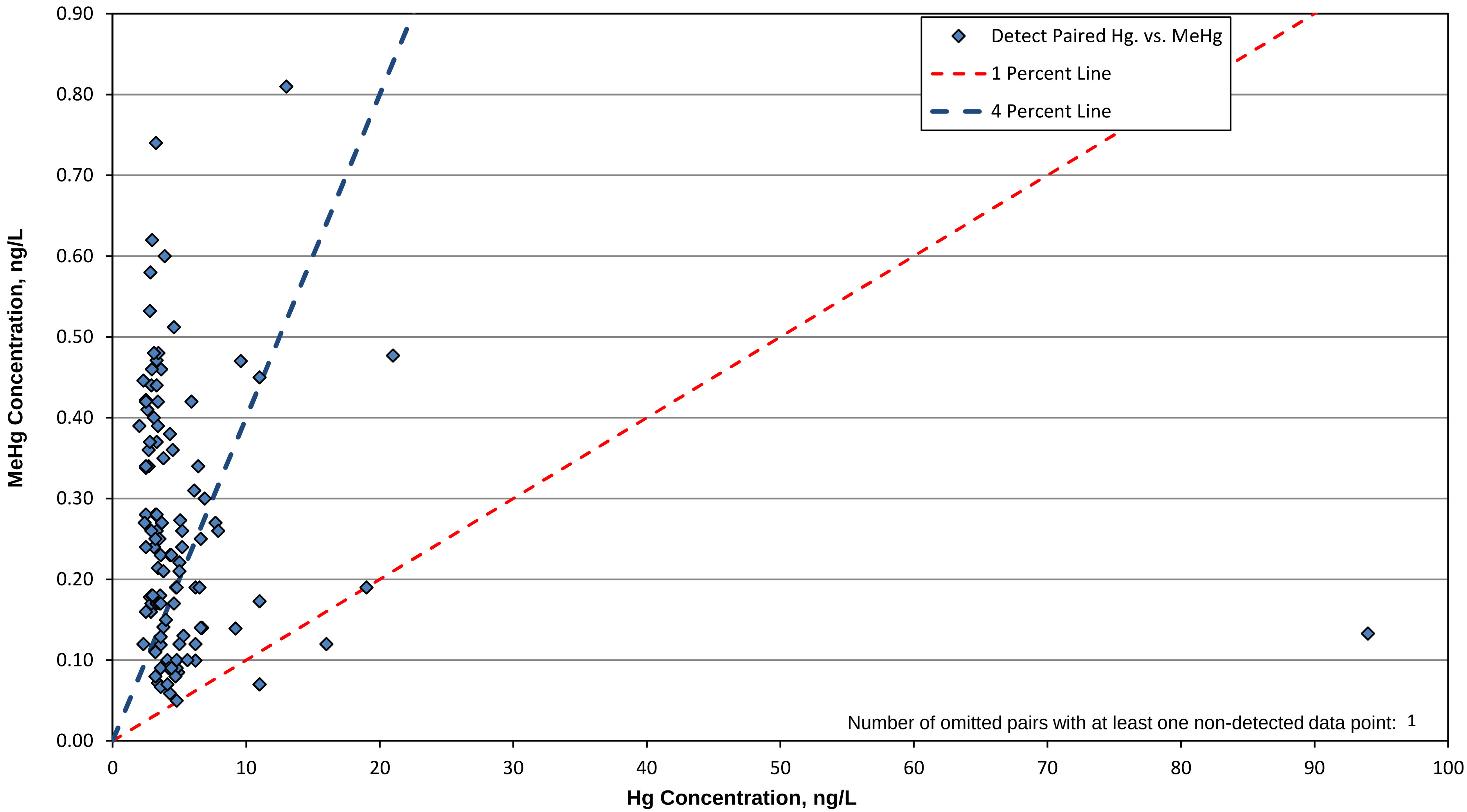


Figure 14

Comparison of Paired Hg vs. MeHg Concentrations for Secondary Only Facilities

Central Valley Clean Water Association
MeHg SPG

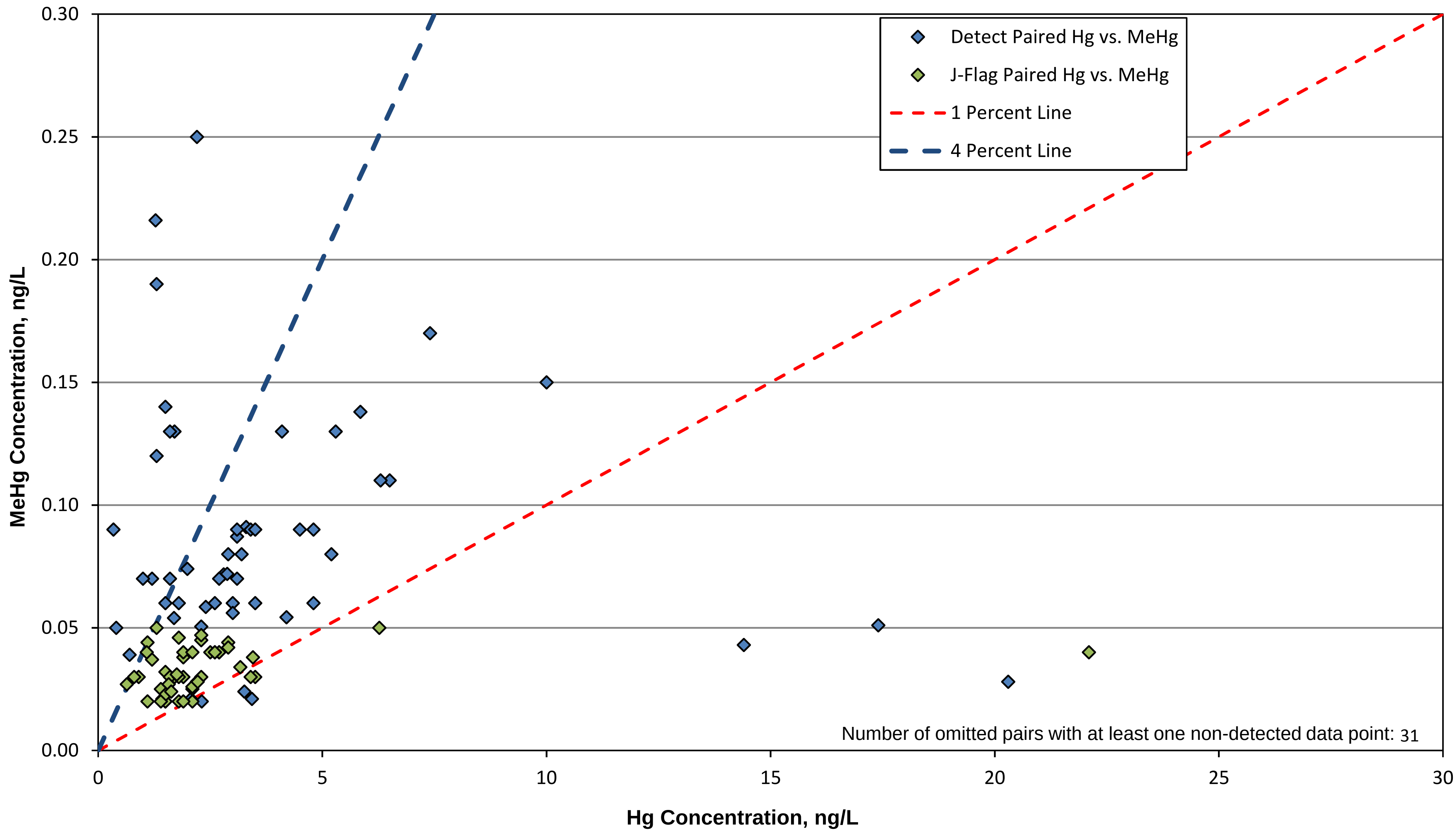


Figure 15

Comparison of Paired Hg vs. MeHg Concentrations for Secondary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

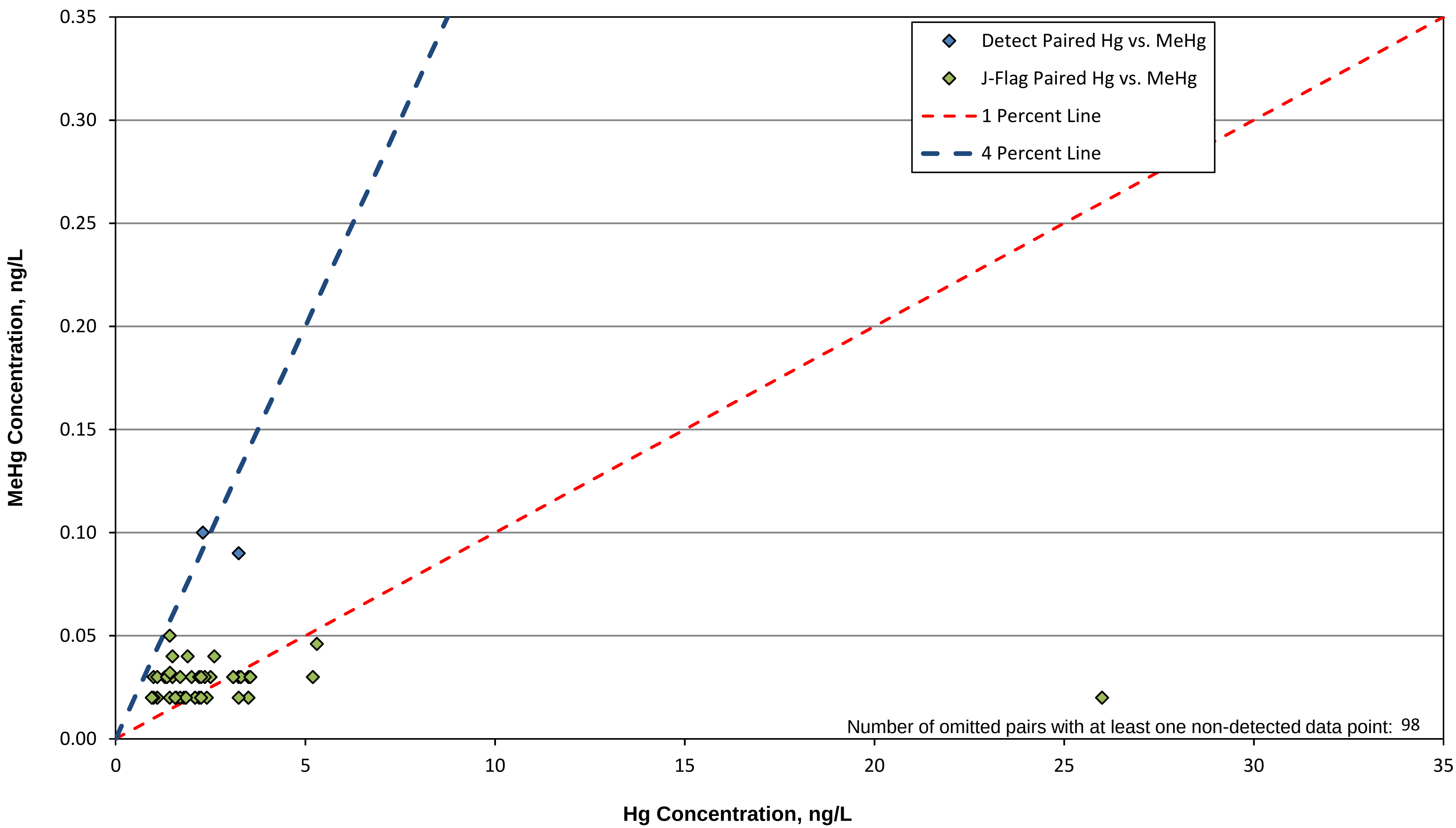


Figure 16

Comparison of Paired Hg vs. MeHg Concentrations for Secondary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

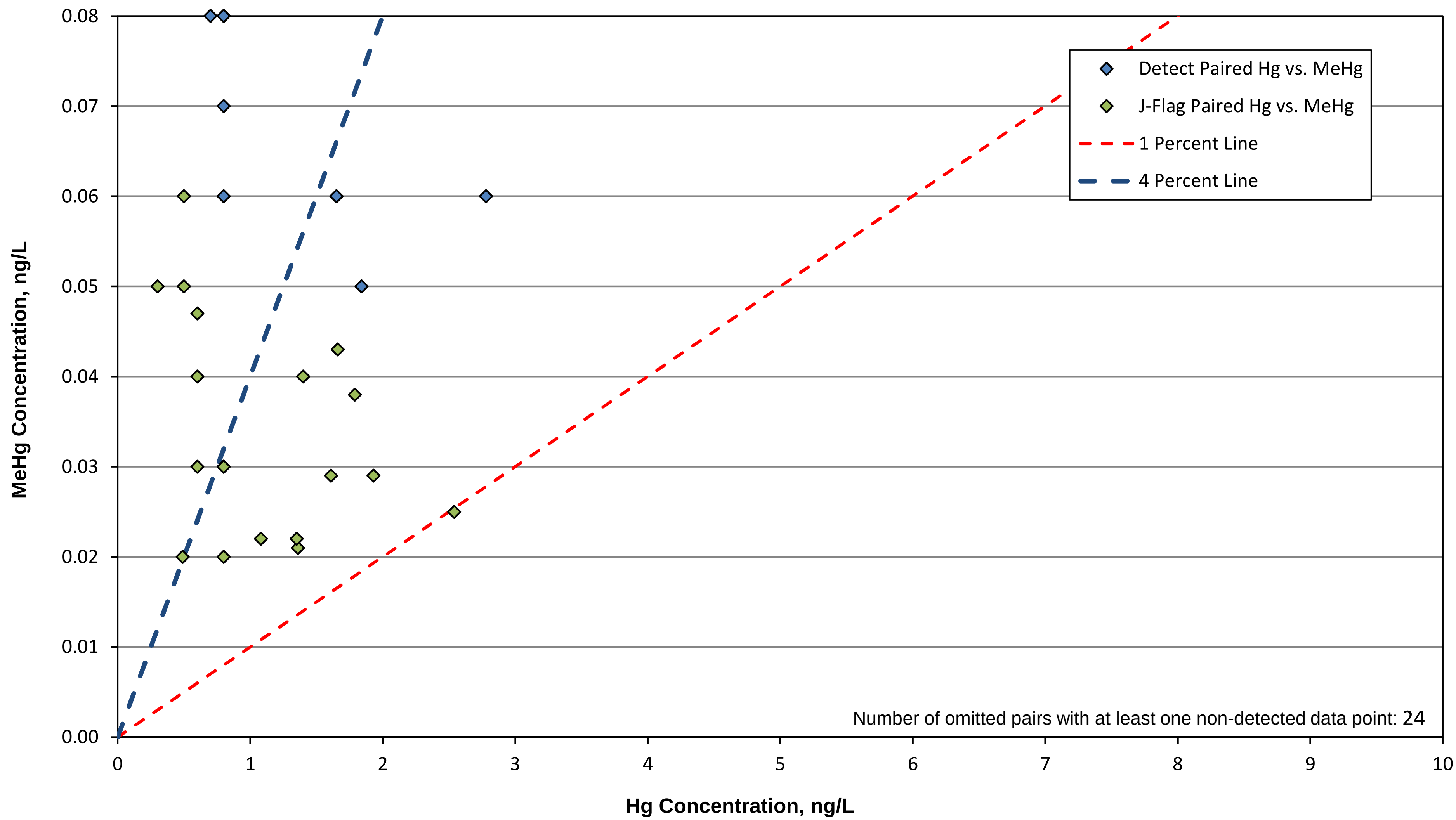


Figure 17

Comparison of Paired Hg vs. MeHg Concentrations for Tertiary plus N Facilities

Central Valley Clean Water Association
MeHg SPG

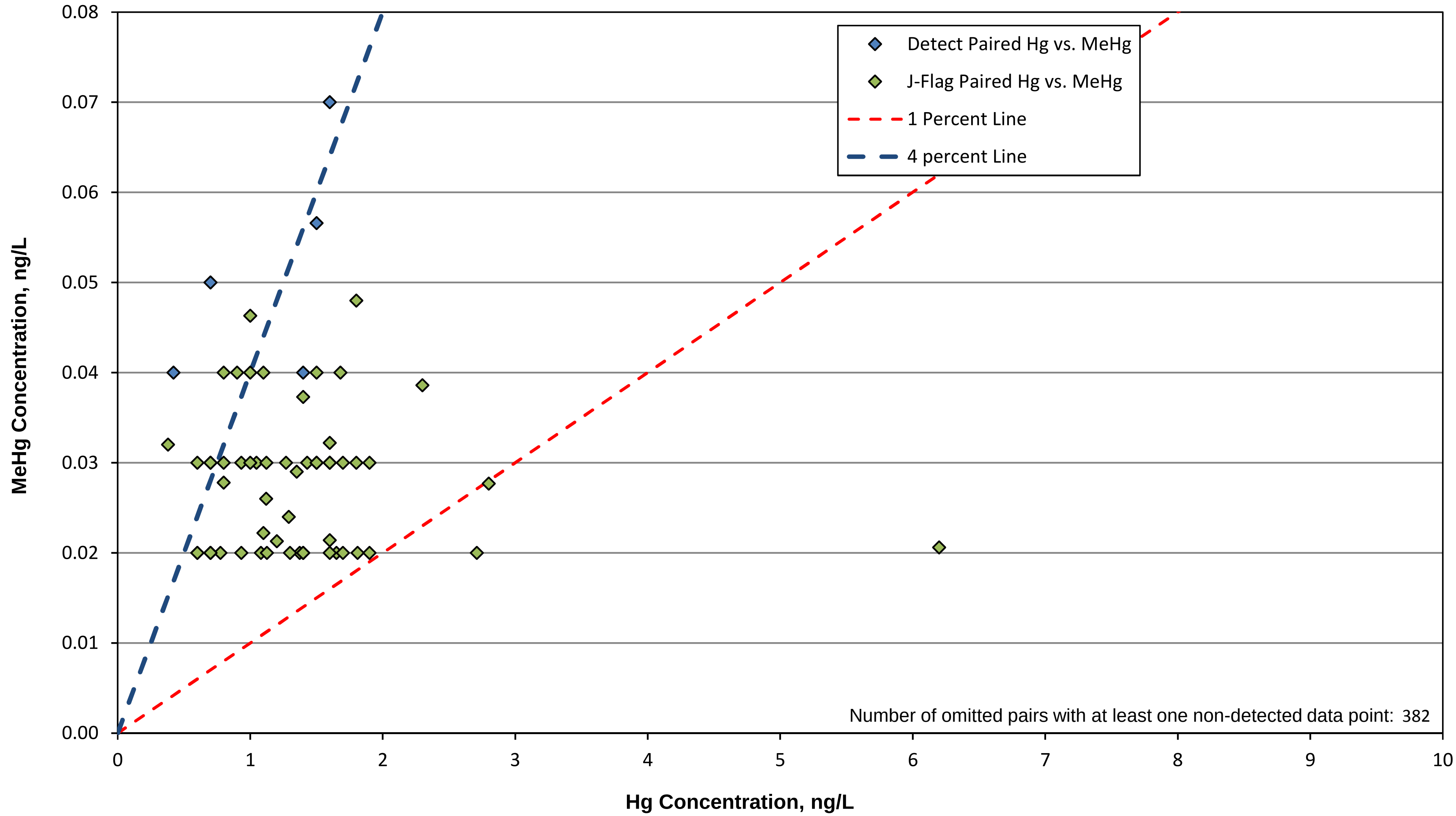


Figure 18

Comparison of Paired Hg vs. MeHg Concentrations for Tertiary plus NDN Facilities

Central Valley Clean Water Association
MeHg SPG

Hg SUMMARY TM
ATTACHMENT A

Robust Method Log Plots for Individual SPG Faculty
Hg Concentration Averages

Hg CONCENTRATION PROBABILITY PLOTS FOR INFLUENT

City of Roseville Pleasant Grove WWTP
City of Roseville Dry Creek WWTP
Sacramento Regional County Sanitation District Regional WWTP

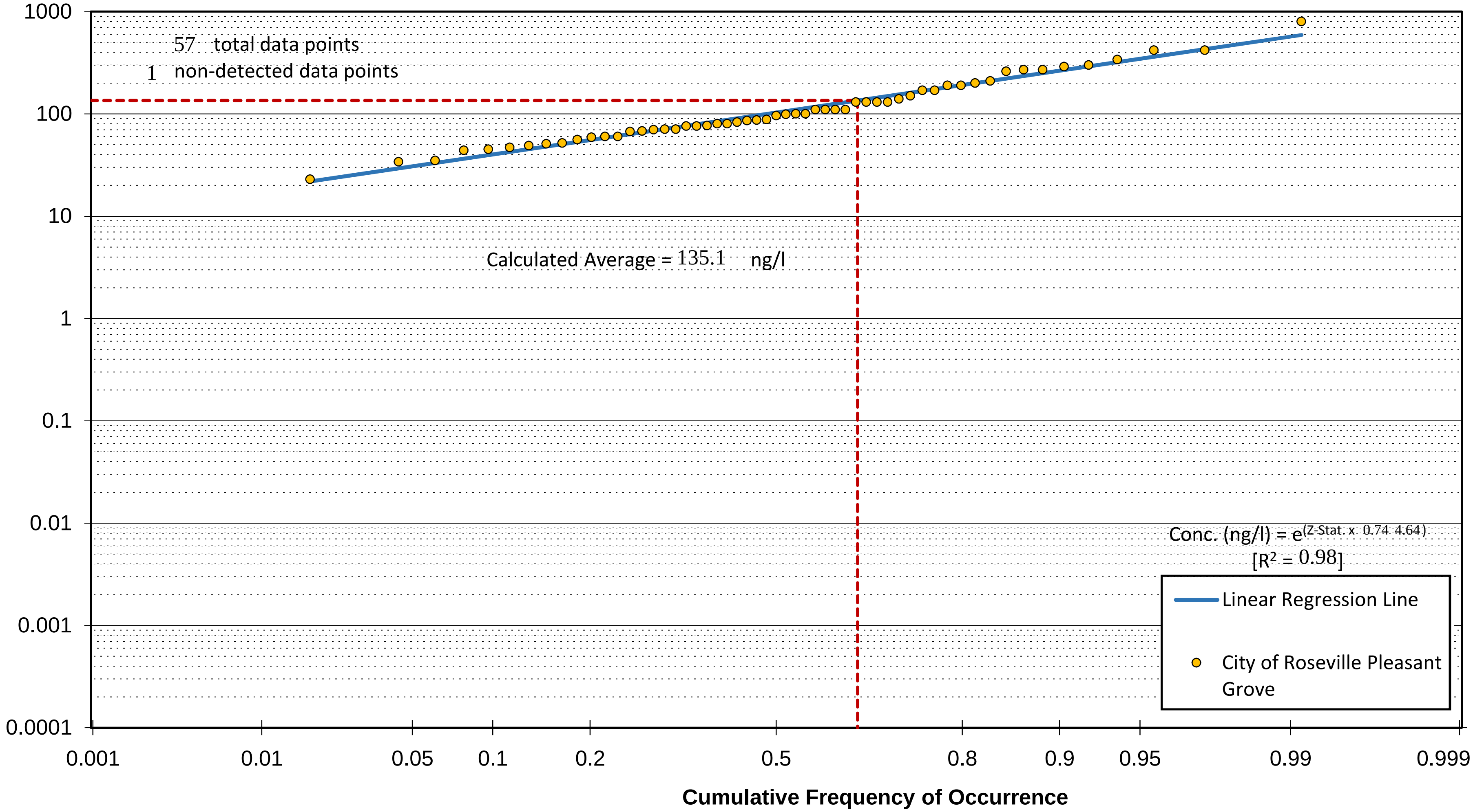


Figure A-1

Hg Concentration Probability Plot for City of Roseville Pleasant Grove WWTP Current Influent

Central Valley Clean Water Association
MeHg SPG

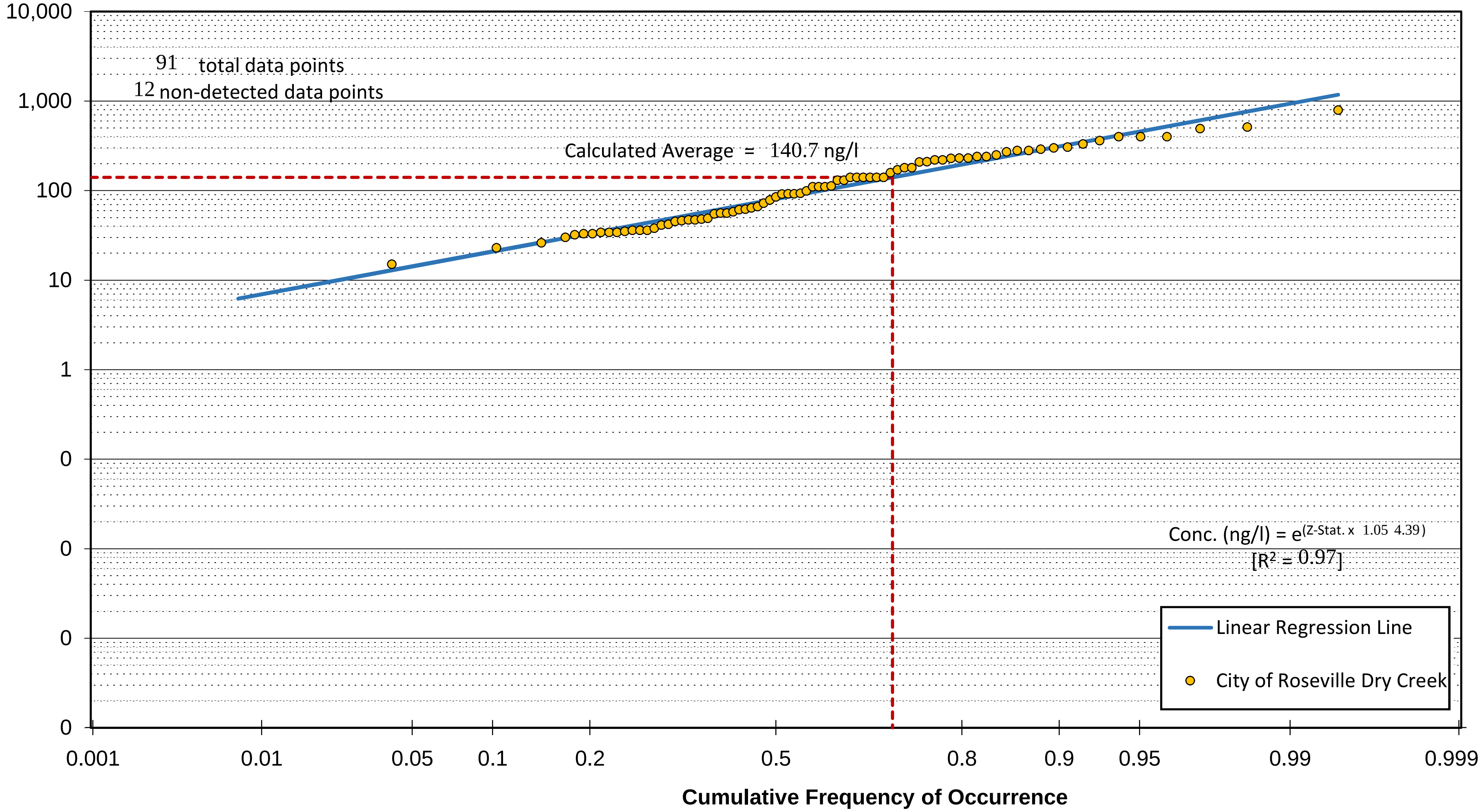


Figure A-2

Hg Concentration Probability Plot for City of Roseville Dry Creek WWTP Current Influent

Central Valley Clean Water Association
MeHg SPG

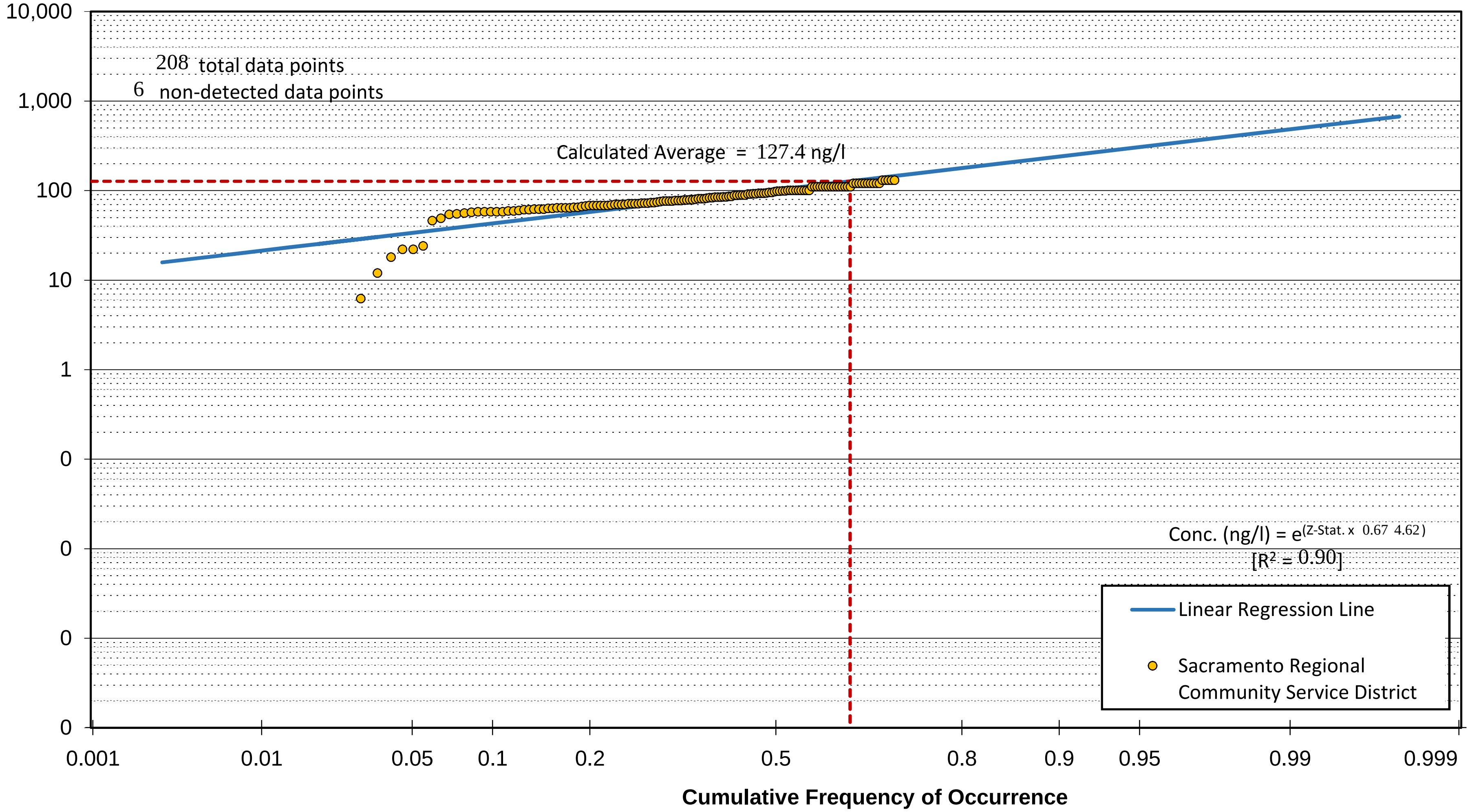


Figure A-3

Hg Concentration Probability Plot for
Sacramento Regional County Sanitation District WWTP Current Influent

Central Valley Clean Water Association
MeHg SPG

Hg CONCENTRATION PROBABILITY PLOTS FOR CURRENT SECONDARY EFFLUENT

City of Brentwood WWTP

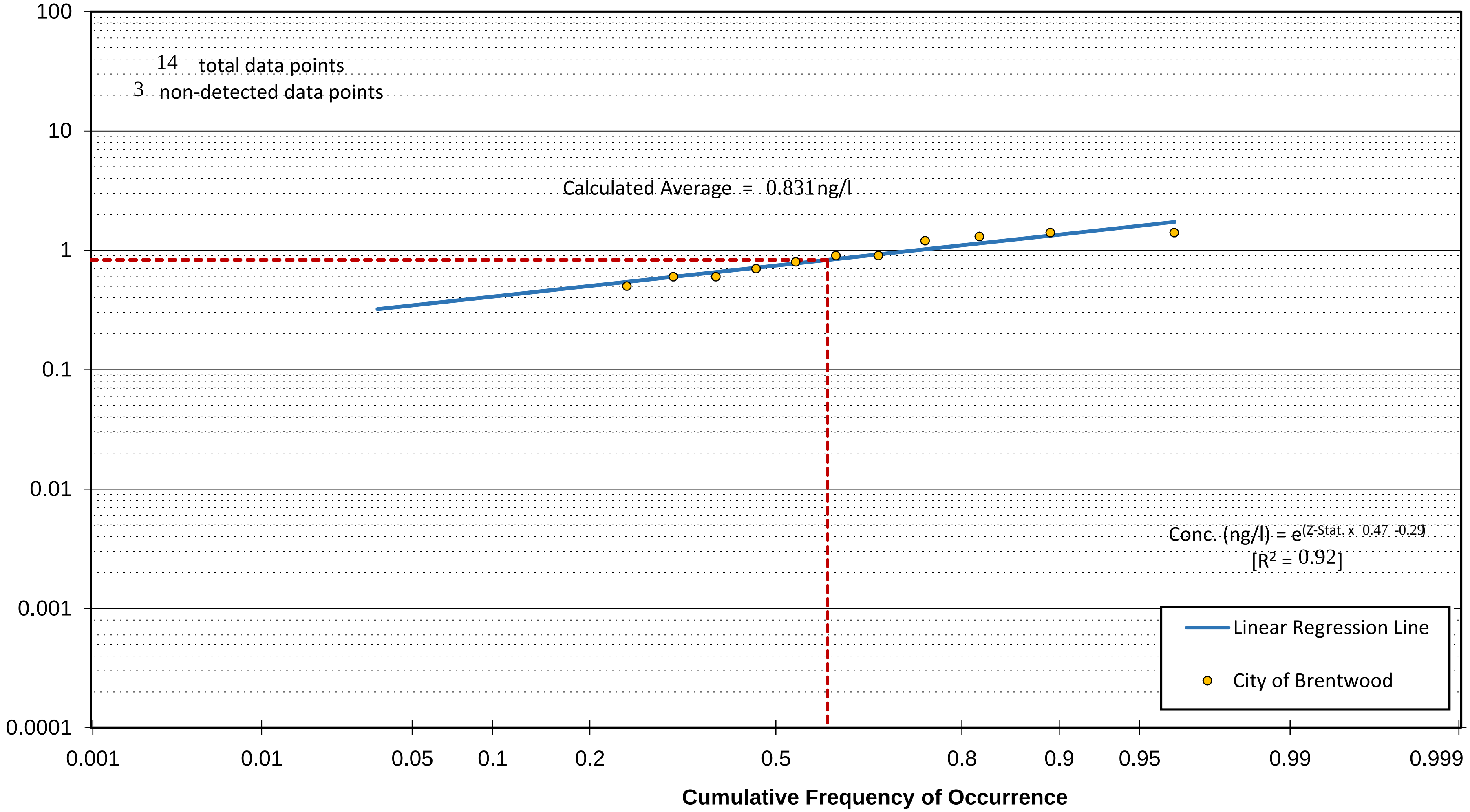


Figure A-4

Hg Concentration Probability Plot for City of Brentwood WWTP Current Secondary Effluent

Central Valley Clean Water Association
MeHg SPG

Hg CONCENTRATION PROBABILITY PLOTS FOR CURRENT FINAL EFFLUENT

City of Brentwood WWTP
Ironhouse Sanitary District WWTP
Mountain House Community Services District Mountain House WWTP
City of Davis WWTP (001)

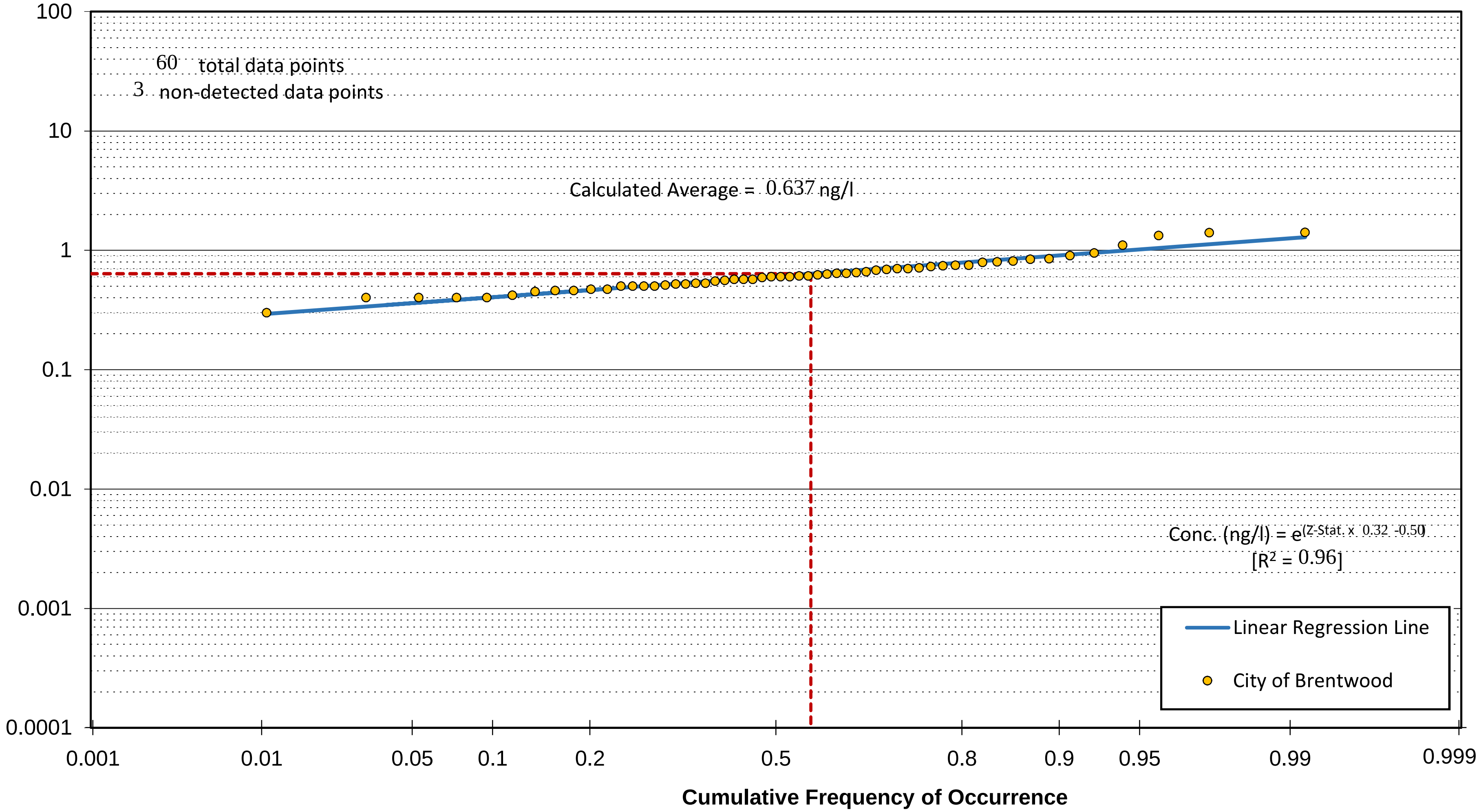


Figure A-5

Hg Concentration Probability Plot for City of Brentwood WWTP Current Final Effluent

Central Valley Clean Water Association
MeHg SPG

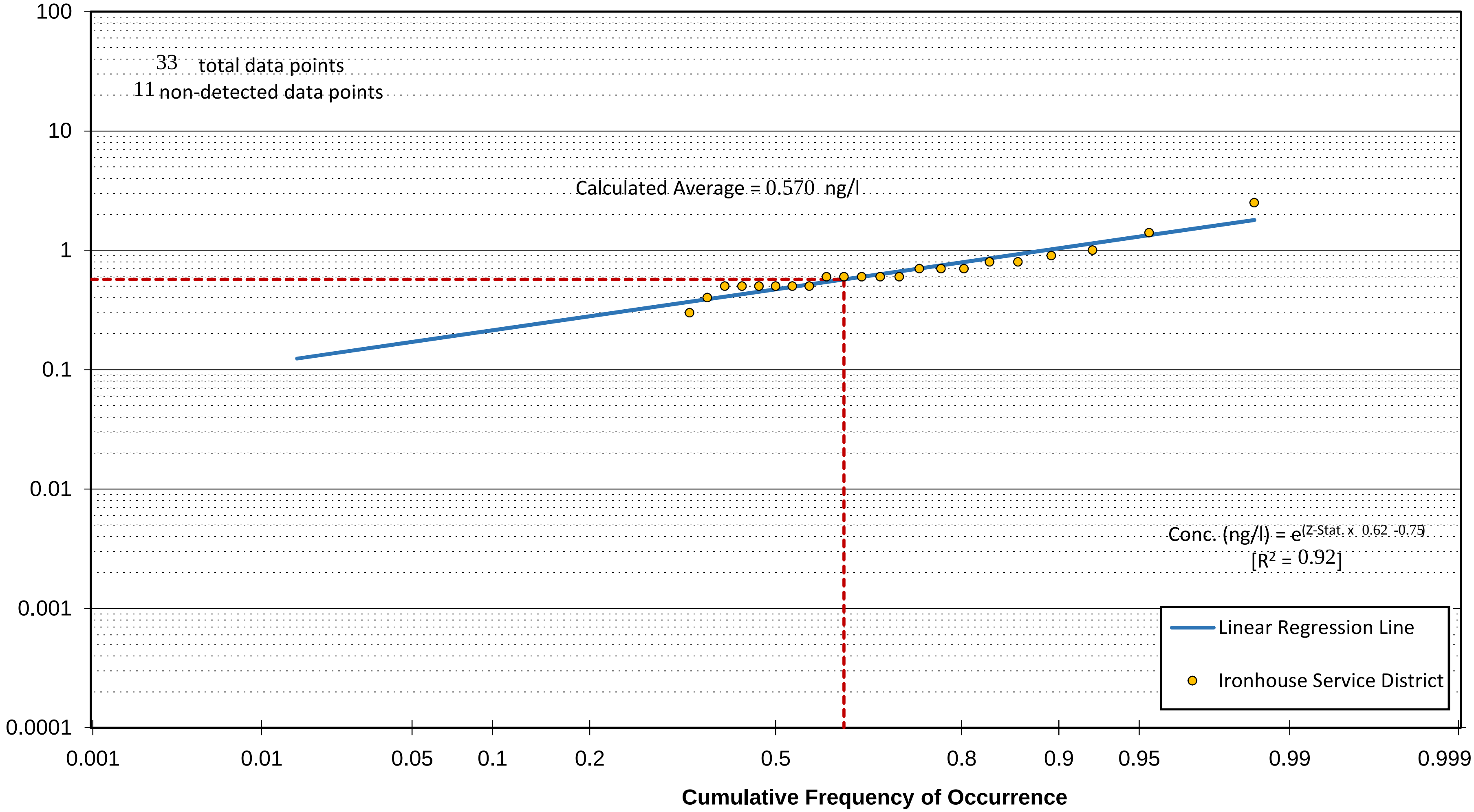


Figure A-6

Hg Concentration Probability Plot for Ironhouse Sanitary District WWTP Current Final Effluent

Central Valley Clean Water Association
MeHg SPG

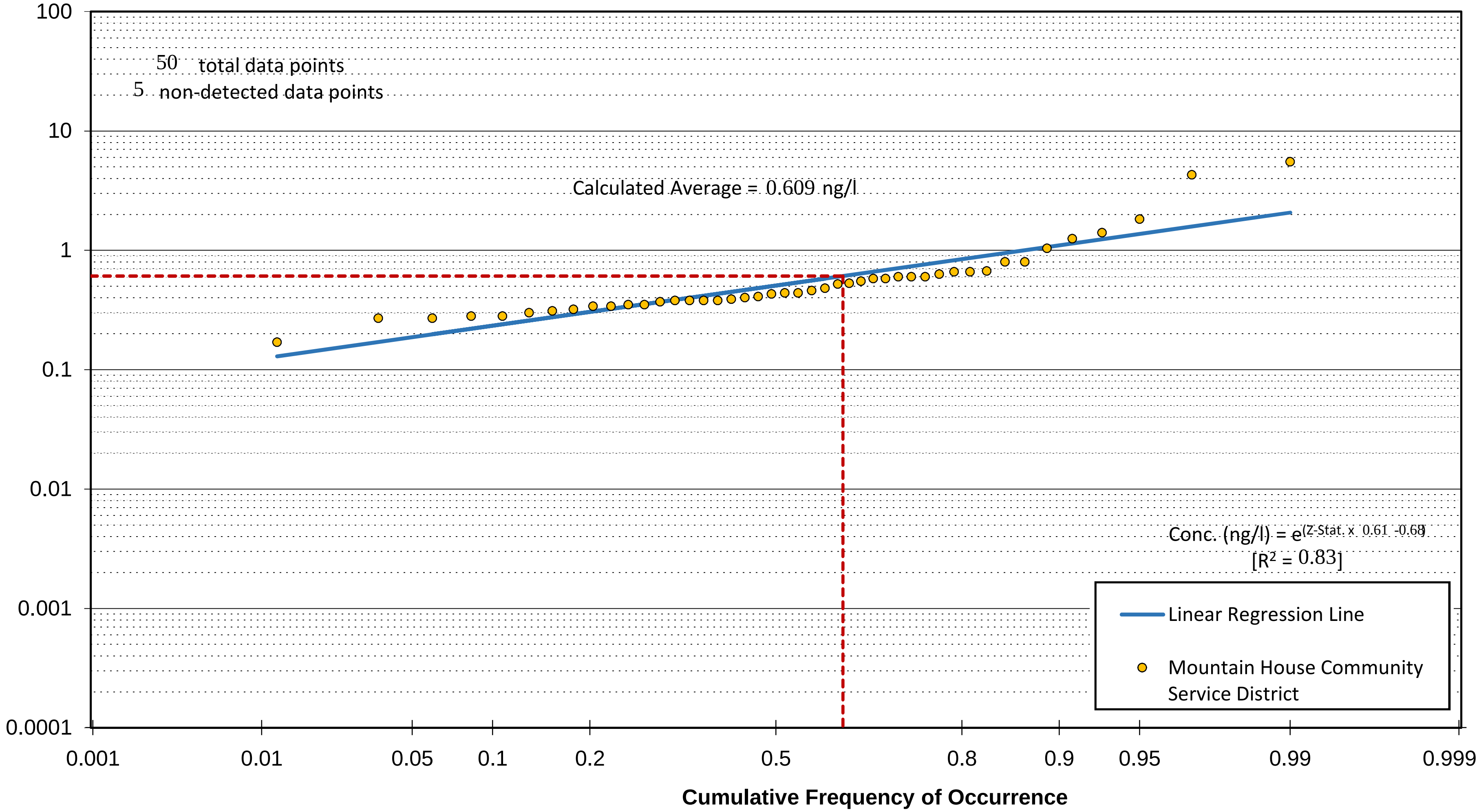


Figure A-7

Hg Concentration Probability Plot for Mountain House Community Services District WWTP Current Final Effluent

Central Valley Clean Water Association
MeHg SPG

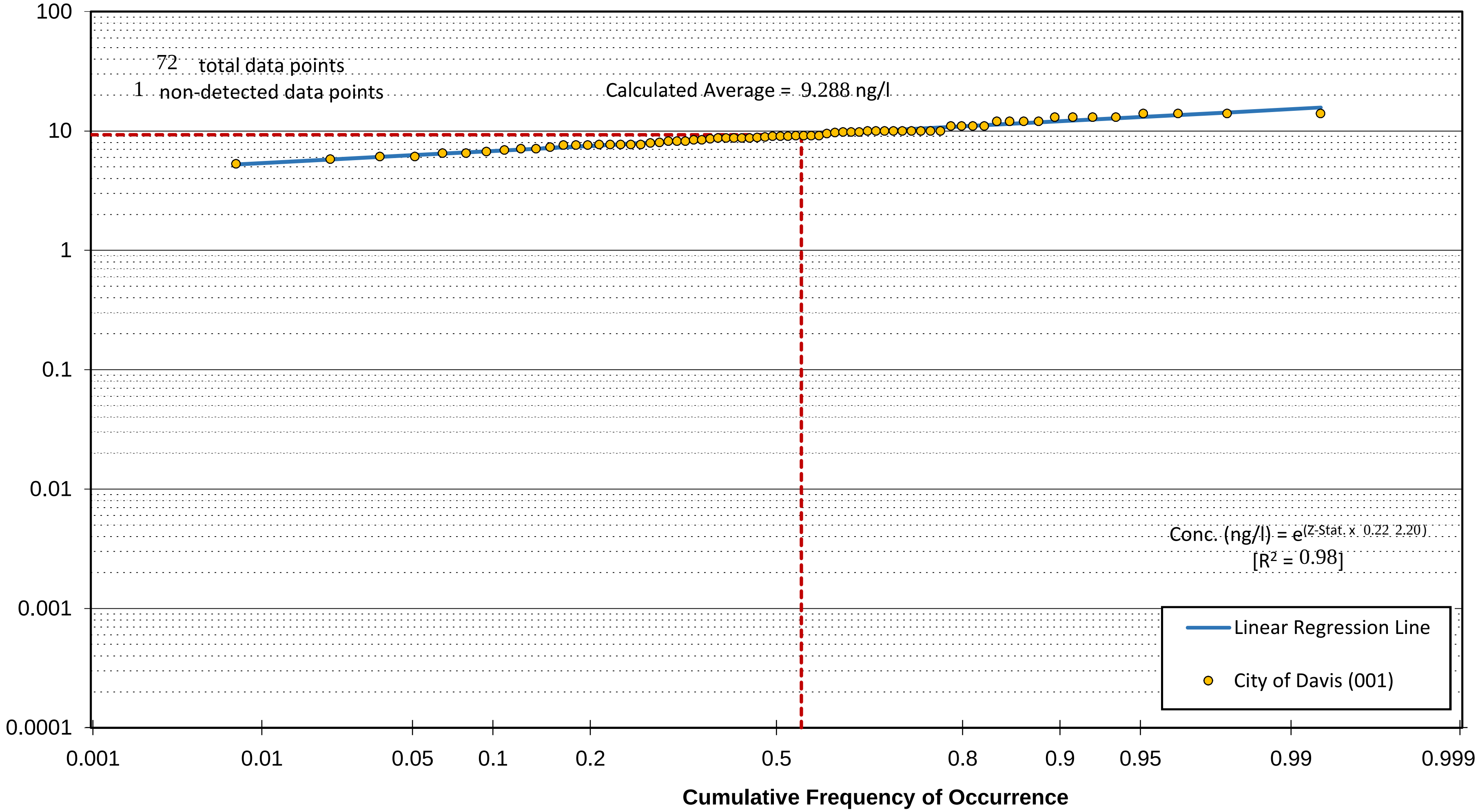


Figure A-8

Hg Concentration Probability Plot for City of Davis WWTP (001) Current Final Effluent

Central Valley Clean Water Association
MeHg SPG

Hg CONCENTRATION PROBABILITY PLOTS FOR 2004-2005 FINAL EFFLUENT

City of Manteca WQCF
City of Stockton Regional WWCF

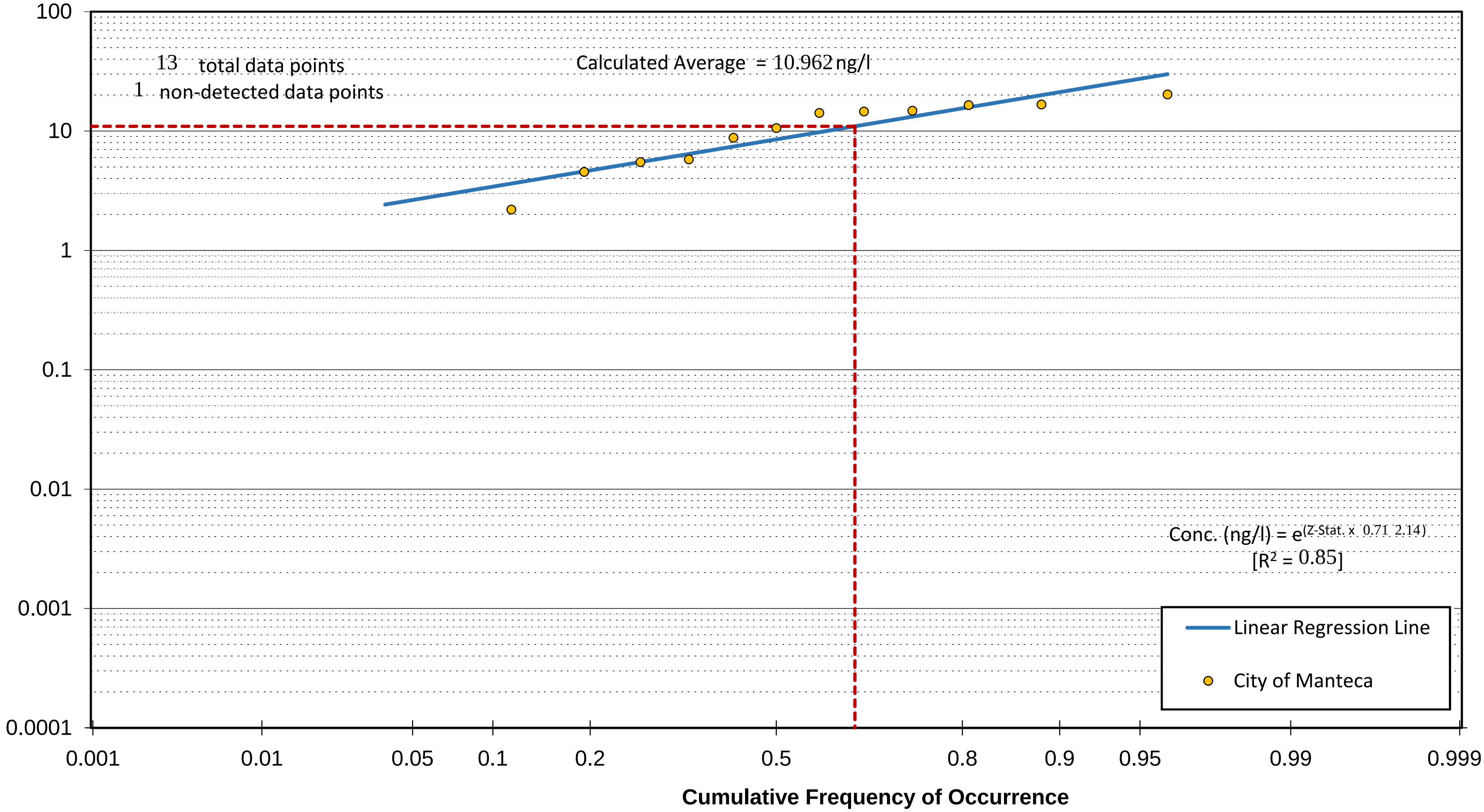


Figure A-9

Hg Concentration Probability Plot for City of Manteca WQCF 2004-2005 Final Effluent

Central Valley Clean Water Association
MeHg SPG

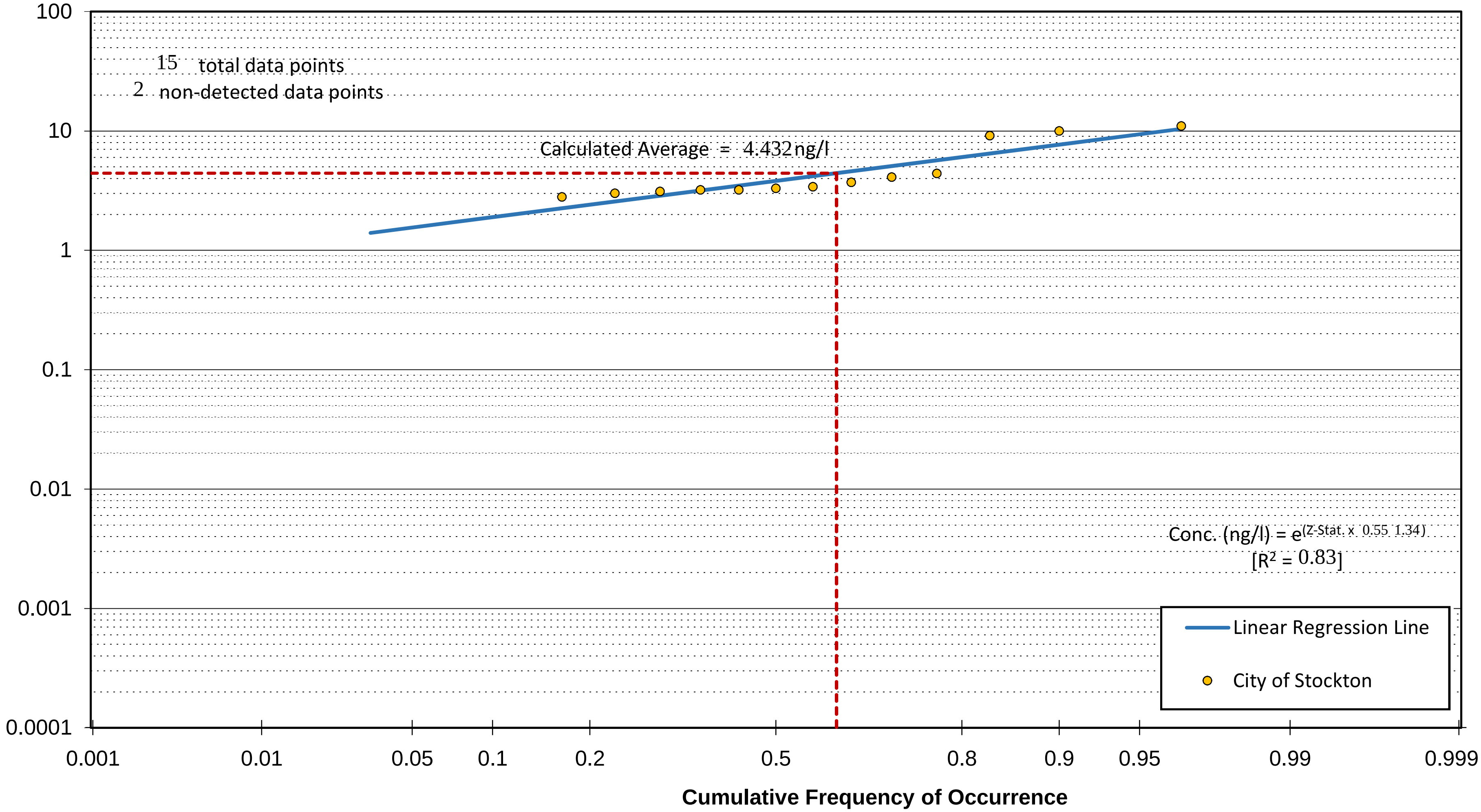


Figure A-10

Hg Concentration Probability Plot for
City of Stockton Regional WWCF 2004-2005 Final Effluent

Central Valley Clean Water Association
MeHg SPG

MeHg CONTROL STUDY PROGRESS REPORT
APPENDIX F

Robust Method Log Plots for Calculated Concentration Averages

MeHg CONCENTRATION PROBABILITY PLOTS FOR 2004-2005 FINAL EFFLUENT

City of Lodi White Slough WPCF
City of Tracy WWTP
City of Woodland WPCF
Town of Discovery Bay WWTP

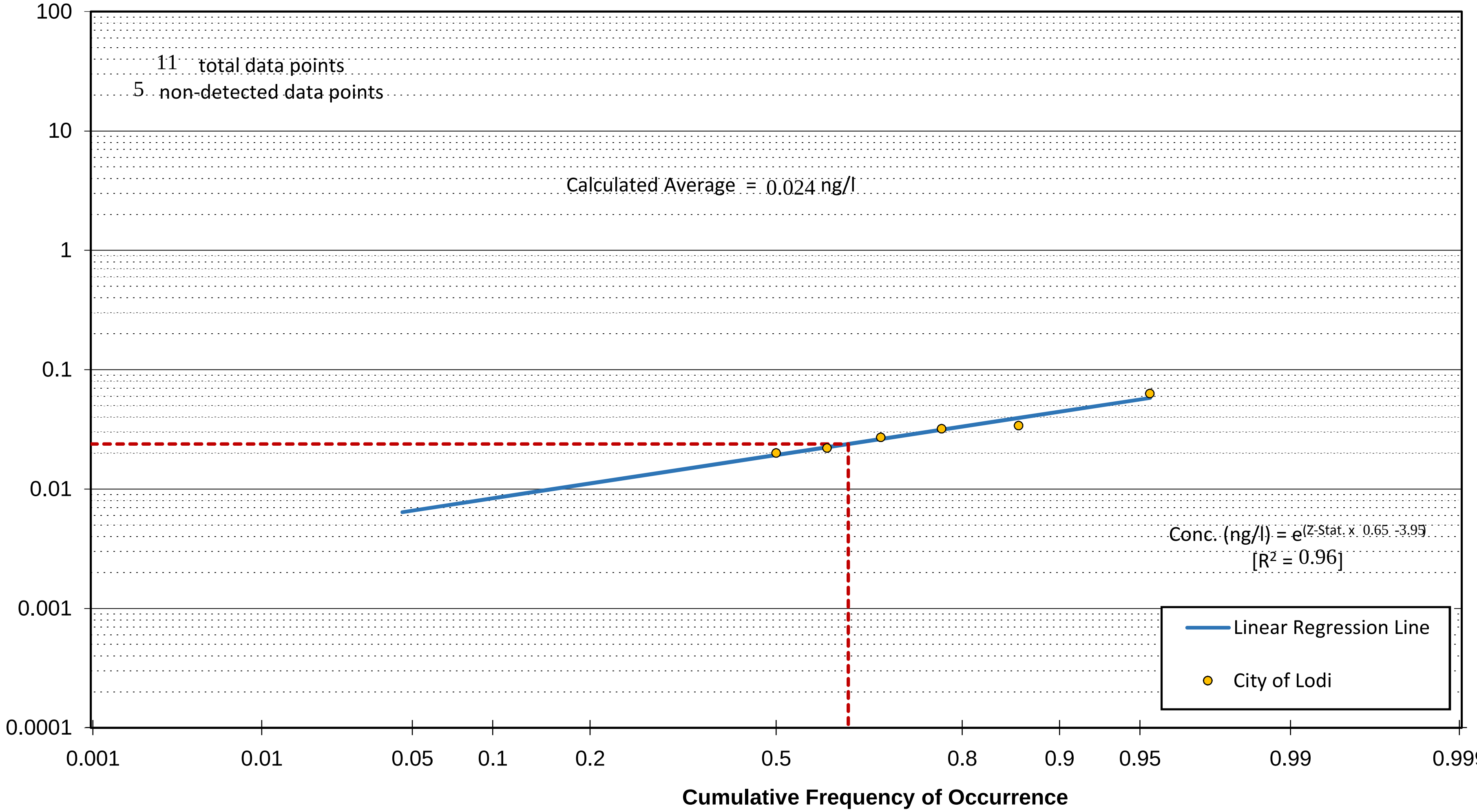


Figure F-1

MeHg Concentration Probability Plot for City of Lodi 2004-2005 Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

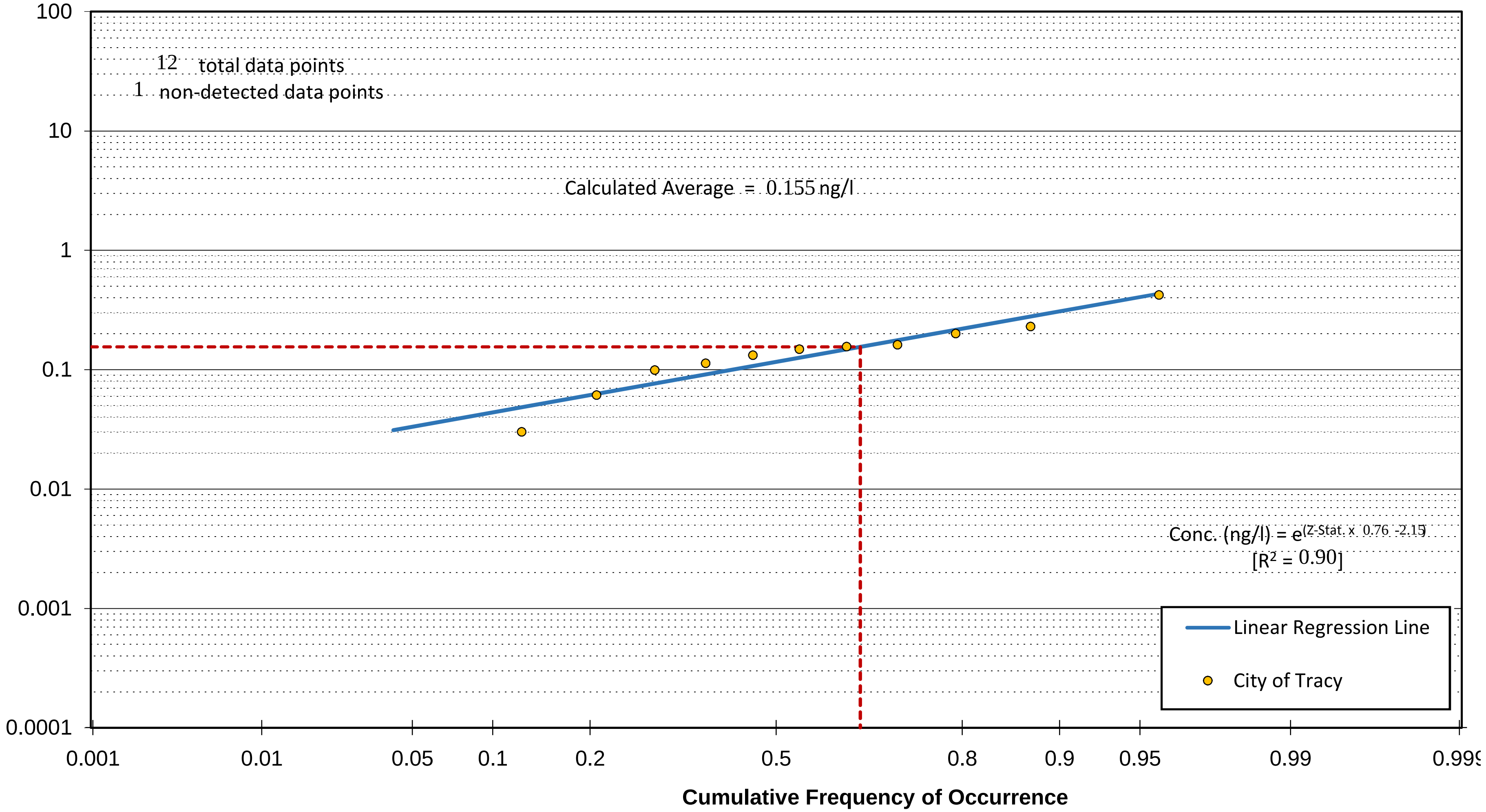


Figure F-2

MeHg Concentration Probability Plot for City of Tracy 2004-2005 Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

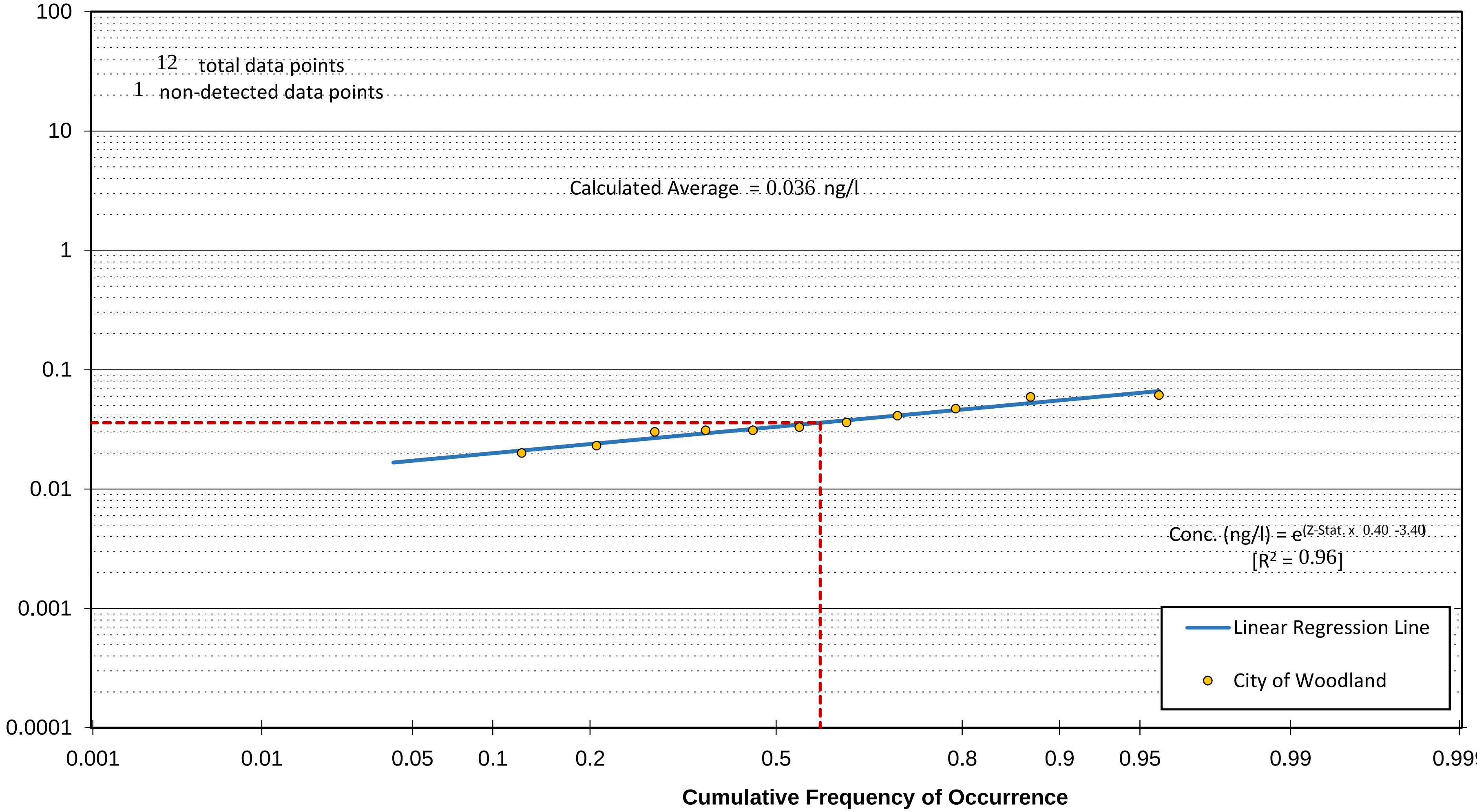


Figure F-3

MeHg Concentration Probability Plot for City of Woodland 2004-2005 Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

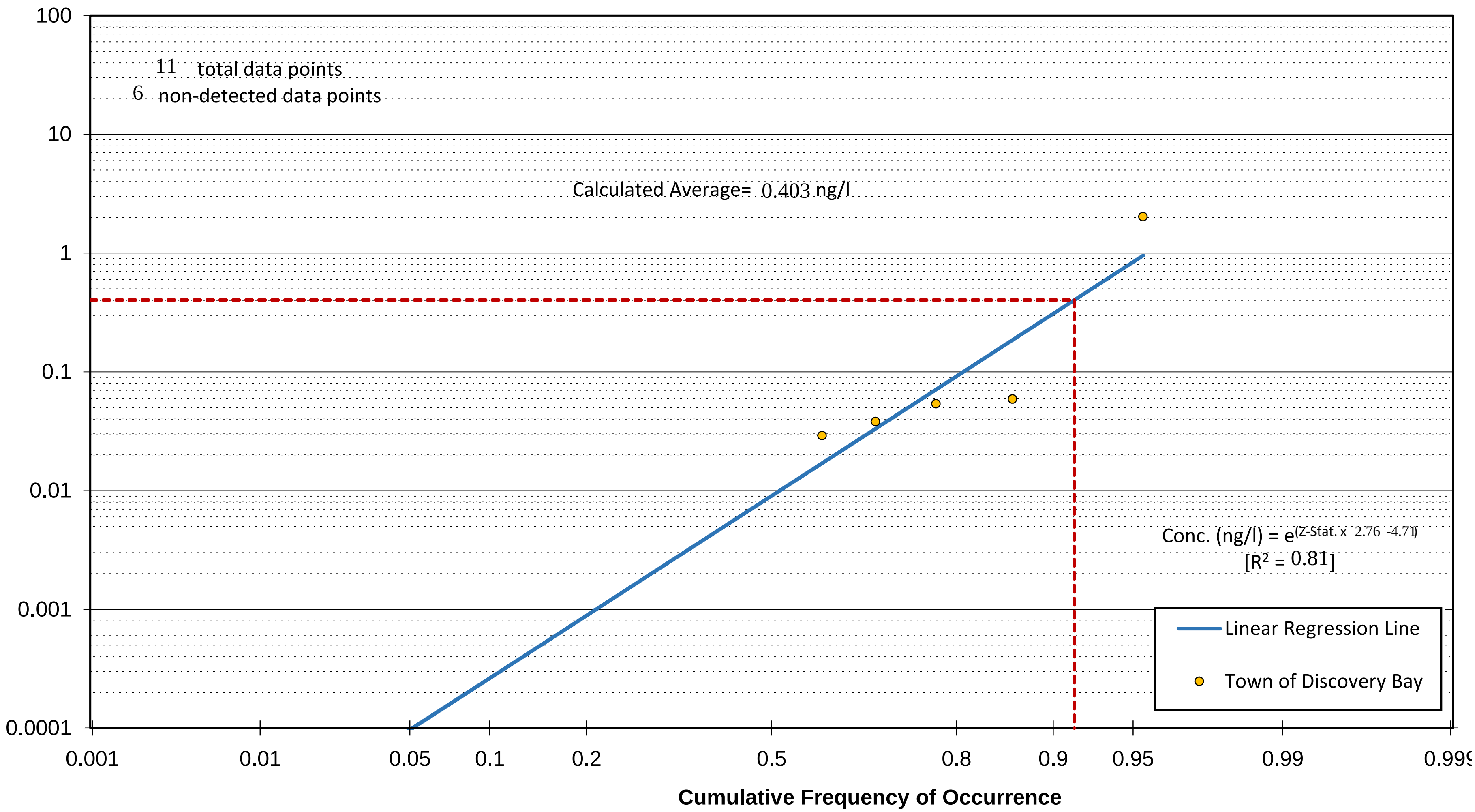


Figure F-4

MeHg Concentration Probability Plot for Town of Discovery Bay Community Service District 2004-2005 Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

MeHg CONCENTRATION PROBABILITY PLOTS FOR CURRENT INFLUENT

City of Rio Vista Northwest WWTF

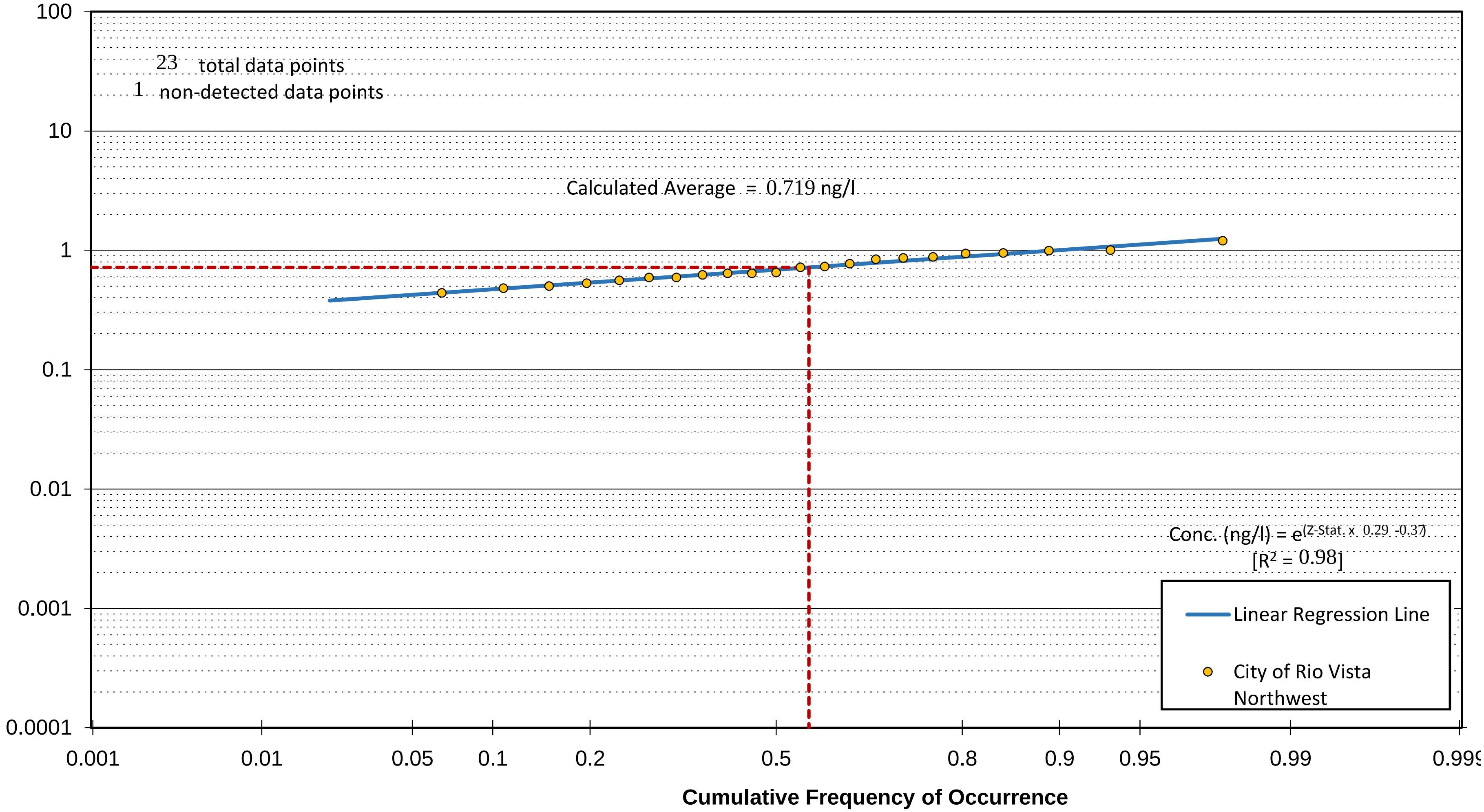


Figure F-5

MeHg Concentration Probability Plot for City of Rio Vista Northwest Current Influent

MeHg CONCENTRATION PROBABILITY PLOTS FOR CURRENT SECONDARY EFFLUENT

City of Roseville Dry Creek WWTP
City of Tracy WWTP
UC Davis Main WWTP
City of Woodland WPCF

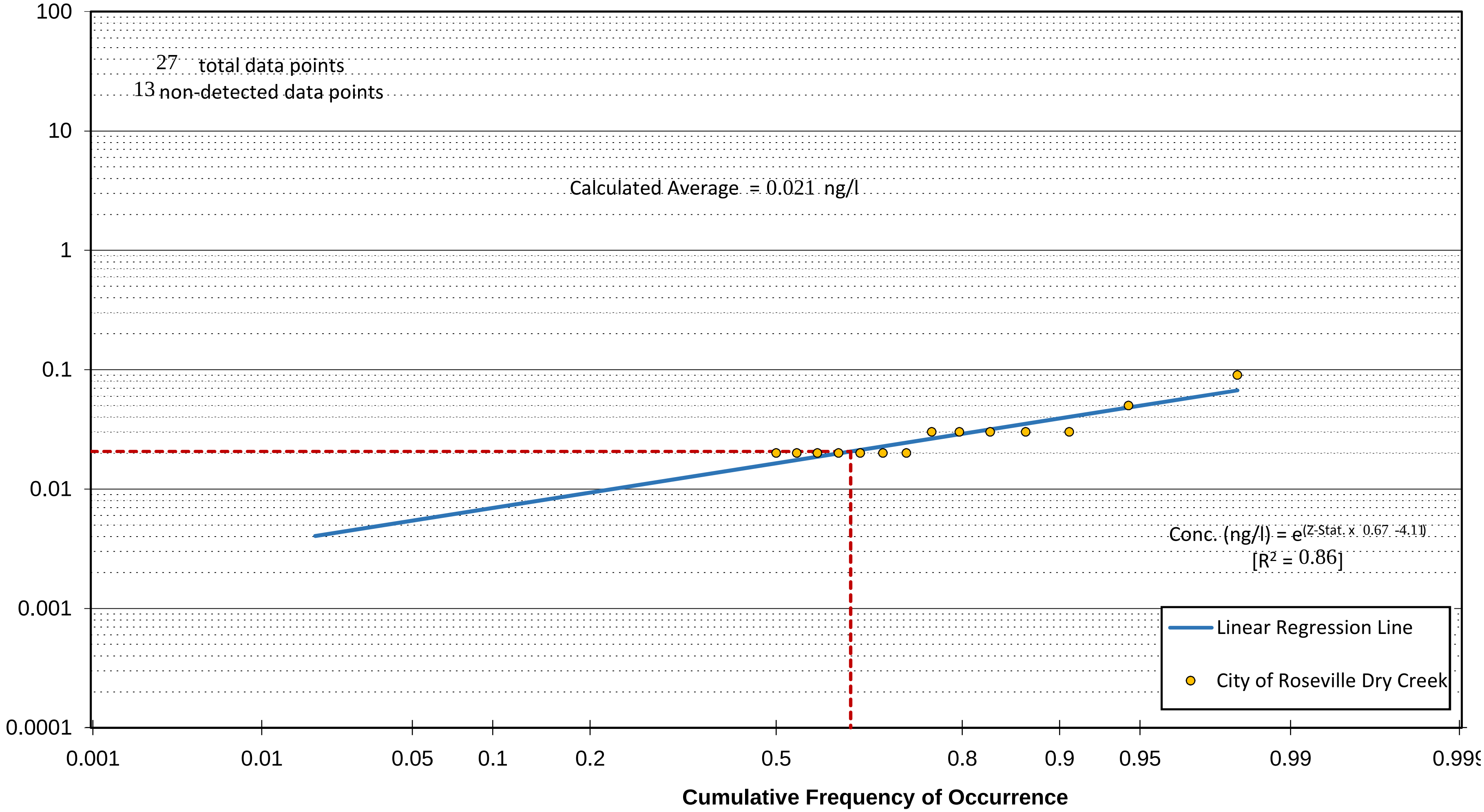


Figure F-6

MeHg Concentration Probability Plot for City of Roseville Dry Creek Current Secondary Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

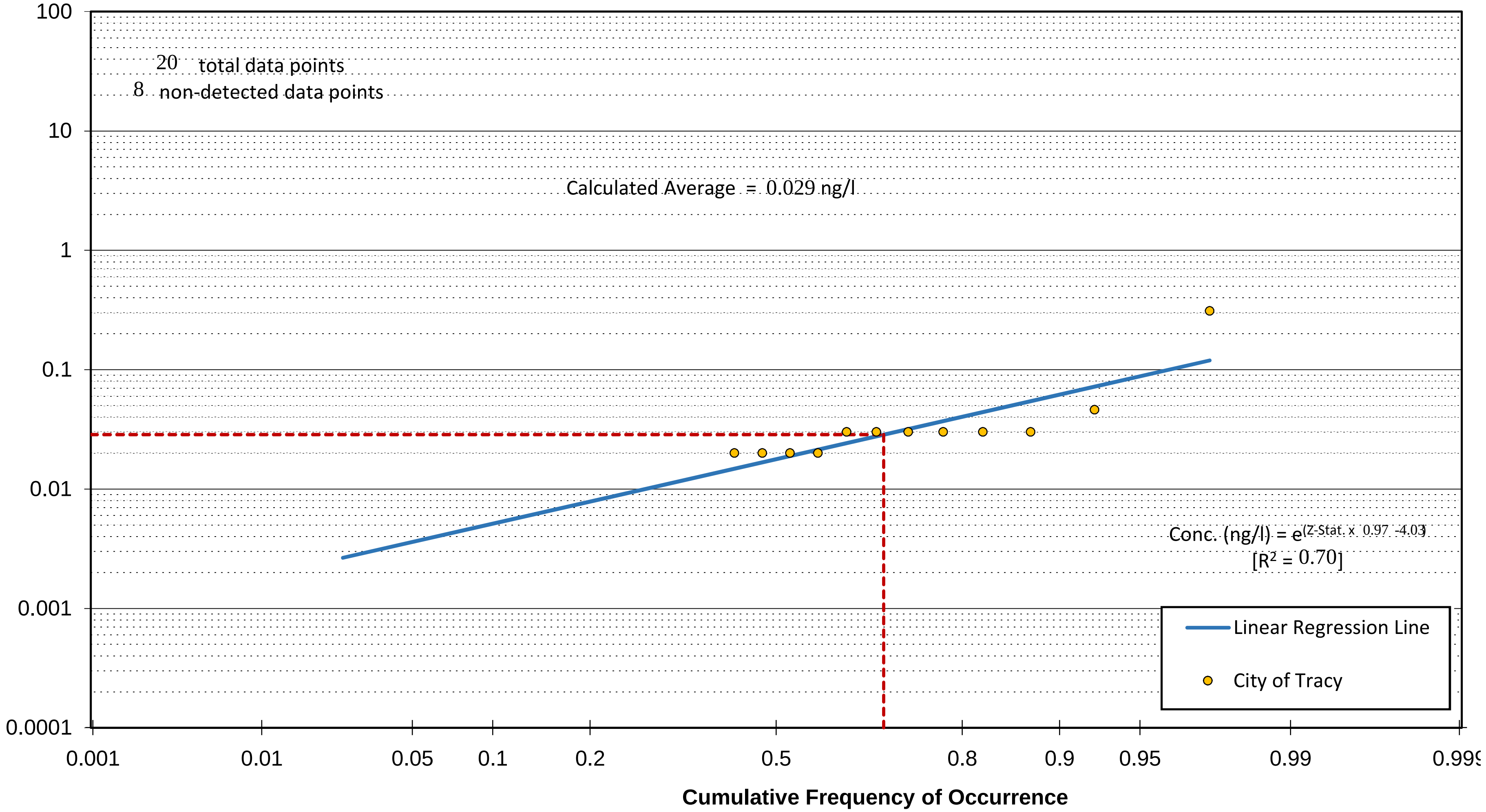


Figure F-7

MeHg Concentration Probability Plot for City of Tracy Current Secondary Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

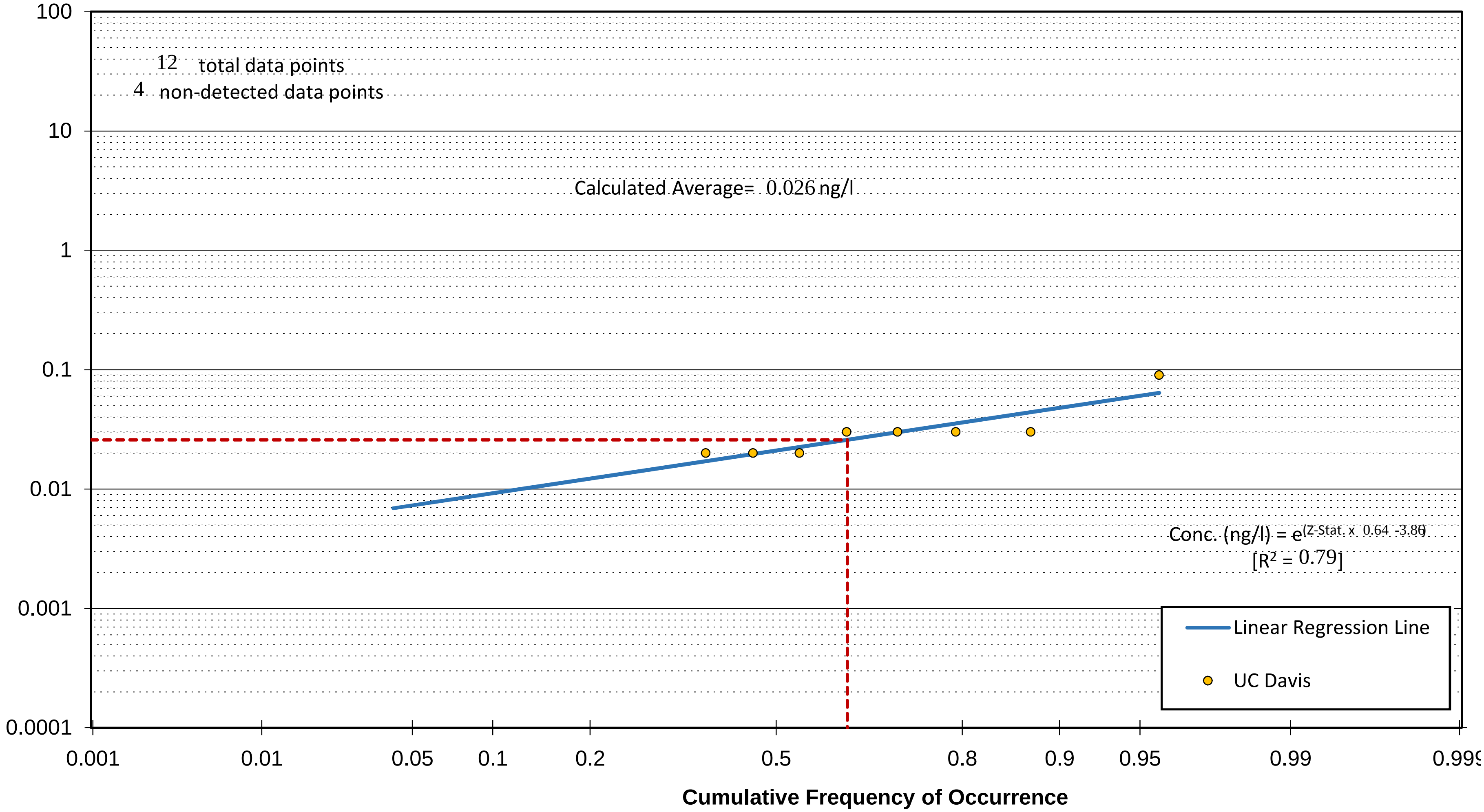


Figure F-8

MeHg Concentration Probability Plot for UC Davis Current Secondary Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

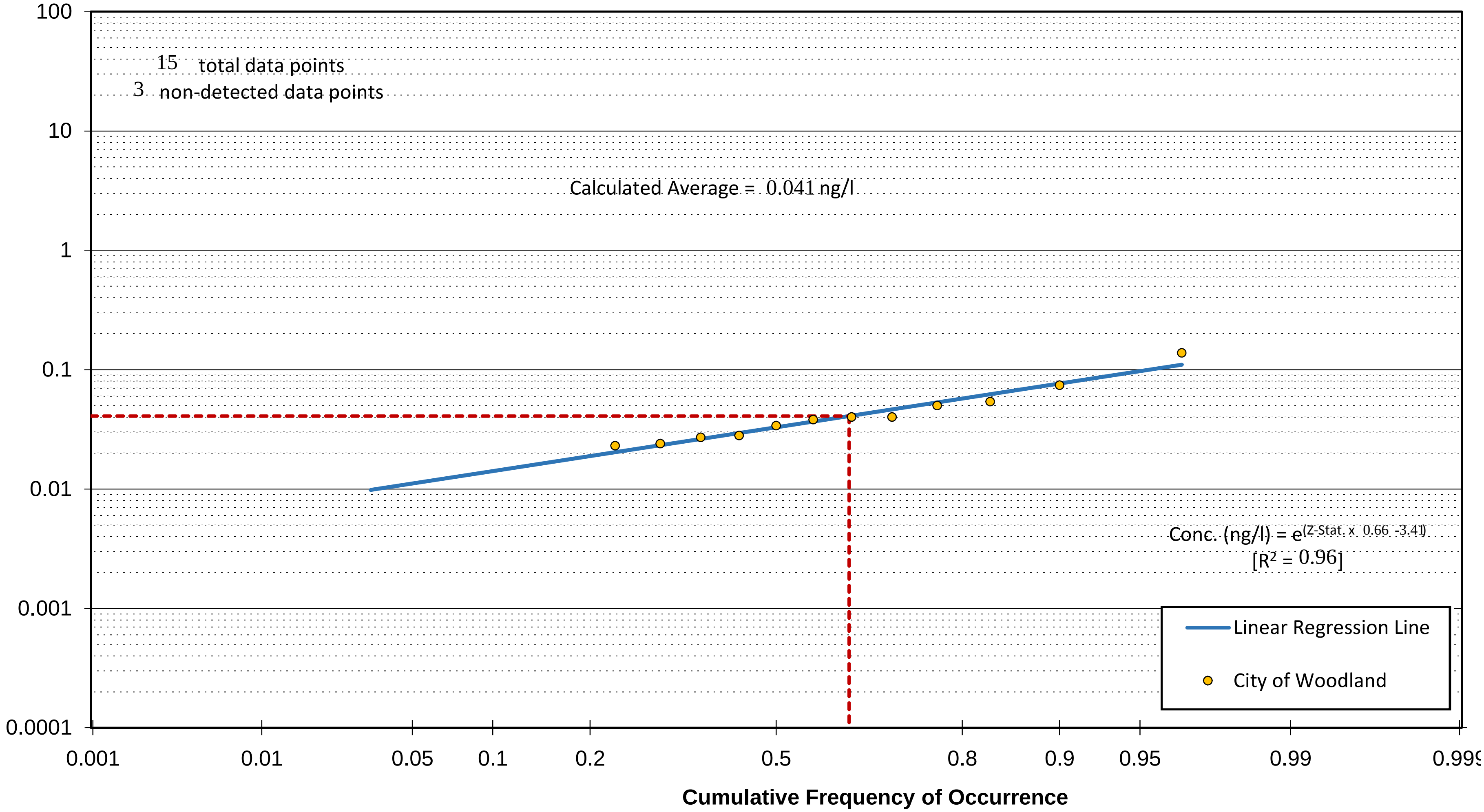


Figure F-9

MeHg Concentration Probability Plot for City of Woodland Current Secondary Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

MeHg CONCENTRATION PROBABILITY PLOTS FOR CURRENT FINAL EFFLUENT

City of Lodi White Slough WPCF
City of Manteca WQCF
City of Rio Vista Northwest WWTF
City of Roseville Dry Creek WWTP
City of Tracy WWTP
UC Davis Main WWTP
City of Live Oak WWTP
City of Stockton Regional WWCF
City of Woodland WPCF
City of Vacaville (After 2012) Easterly WWTP
Town of Discovery Bay WWTP
City of Vacaville (Before 2013) Easterly WWTP
City of Yuba City WWTF

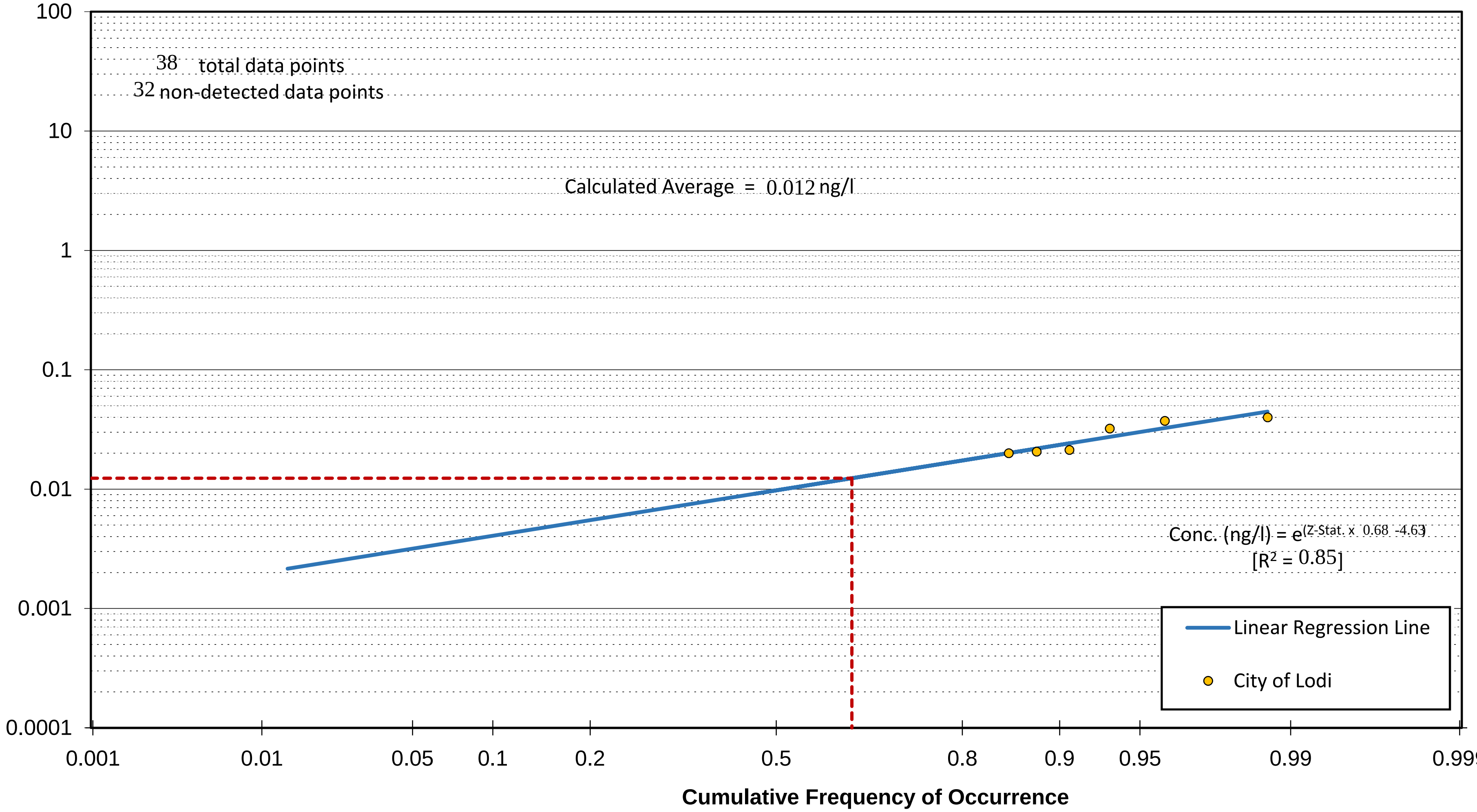


Figure F-10

MeHg Concentration Probability Plot for City of Lodi Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

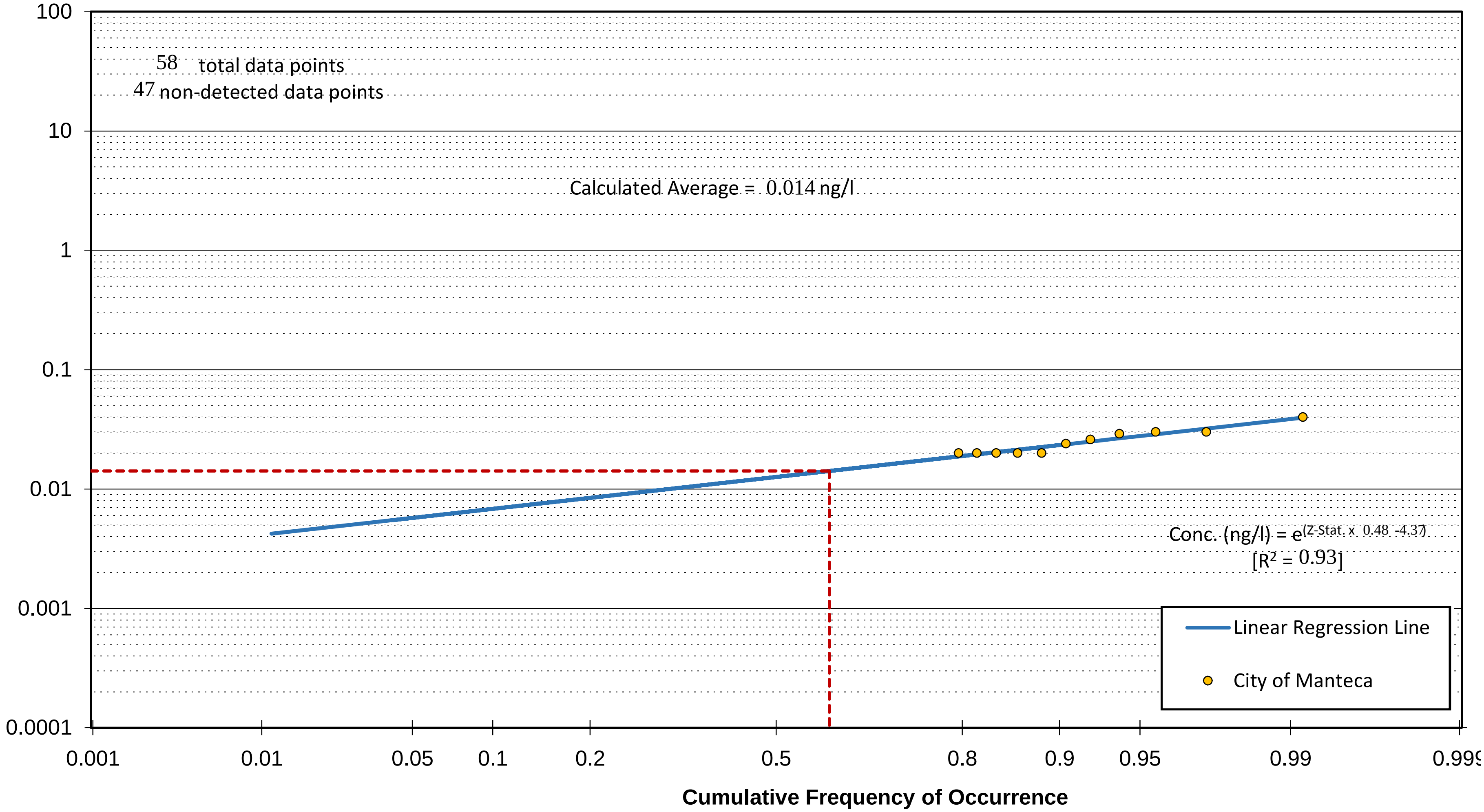


Figure F-11

MeHg Concentration Probability Plot for City of Manteca Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

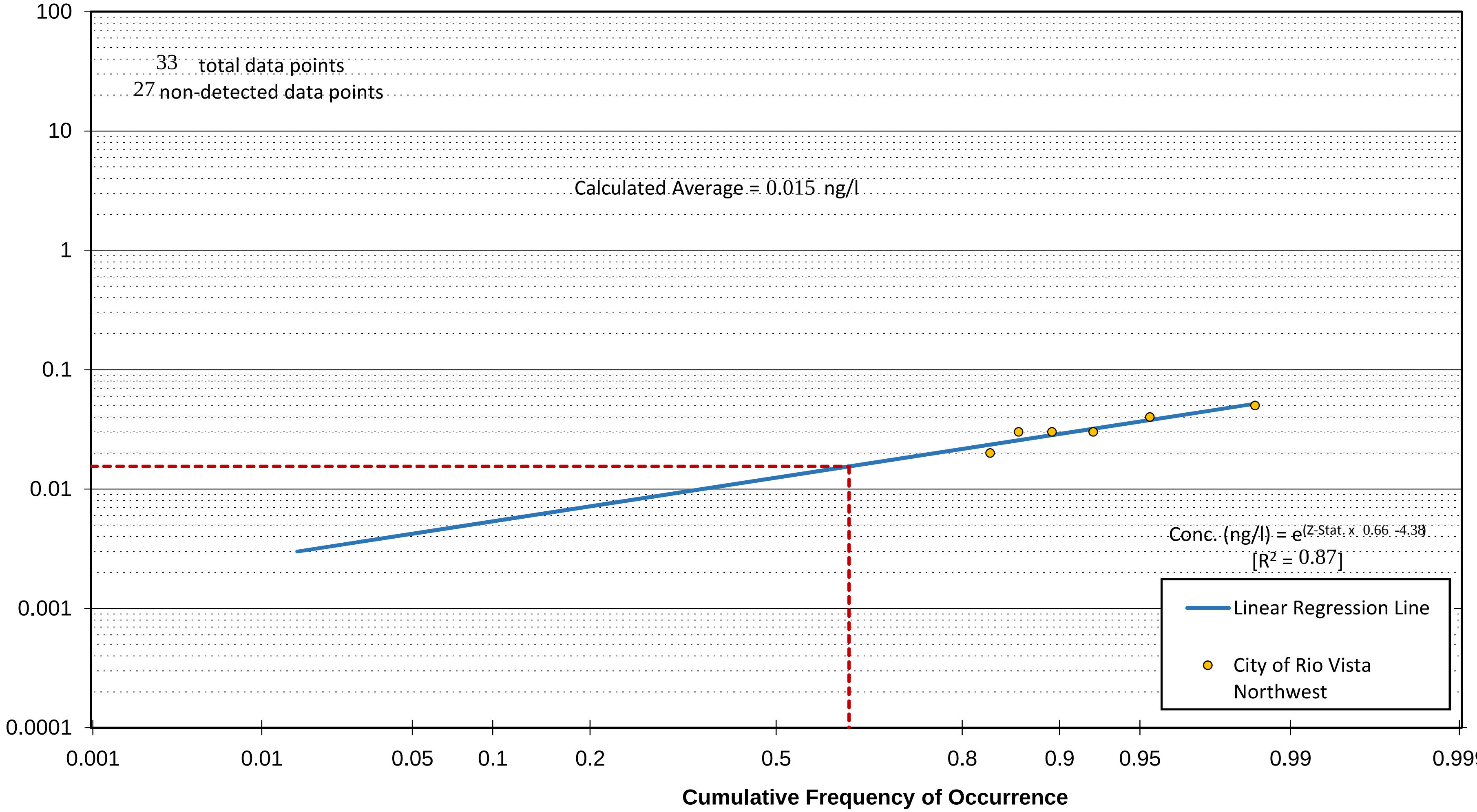


Figure F-12

MeHg Concentration Probability Plot for City of Rio Vista North West Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

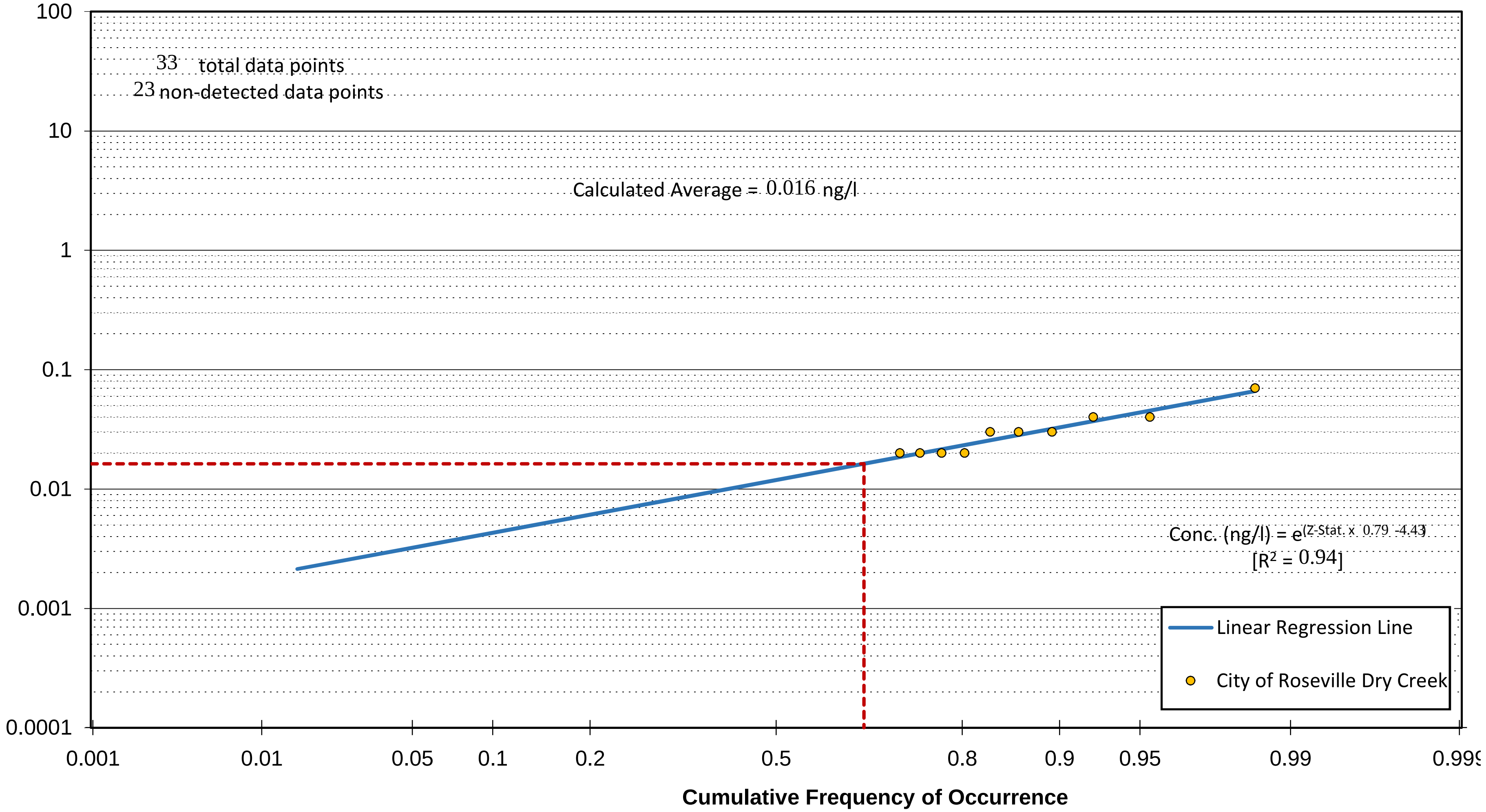


Figure F-13

MeHg Concentration Probability Plot for City of Roseville Dry Creek Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

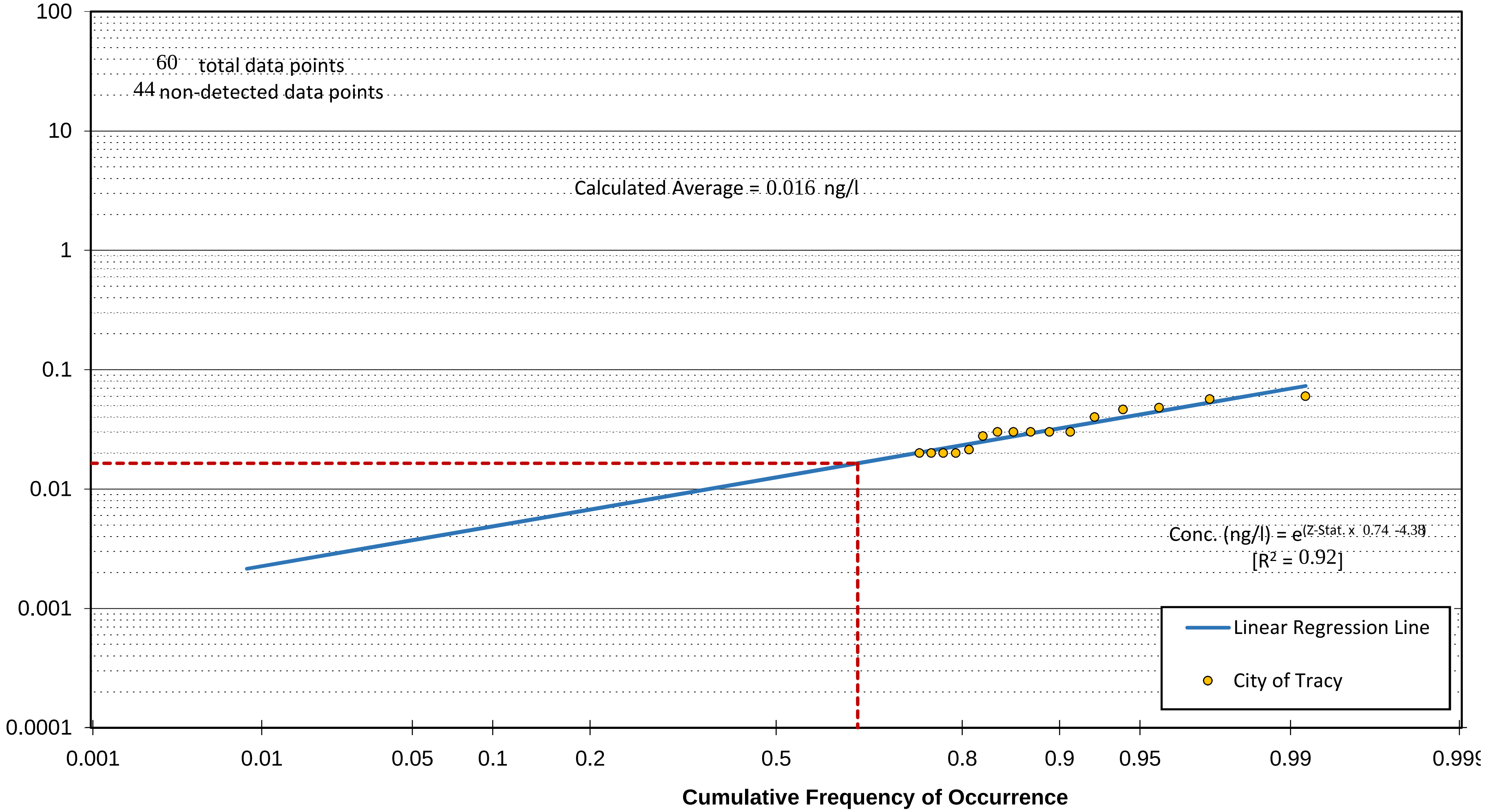


Figure F-14

MeHg Concentration Probability Plot for City of Tracy Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

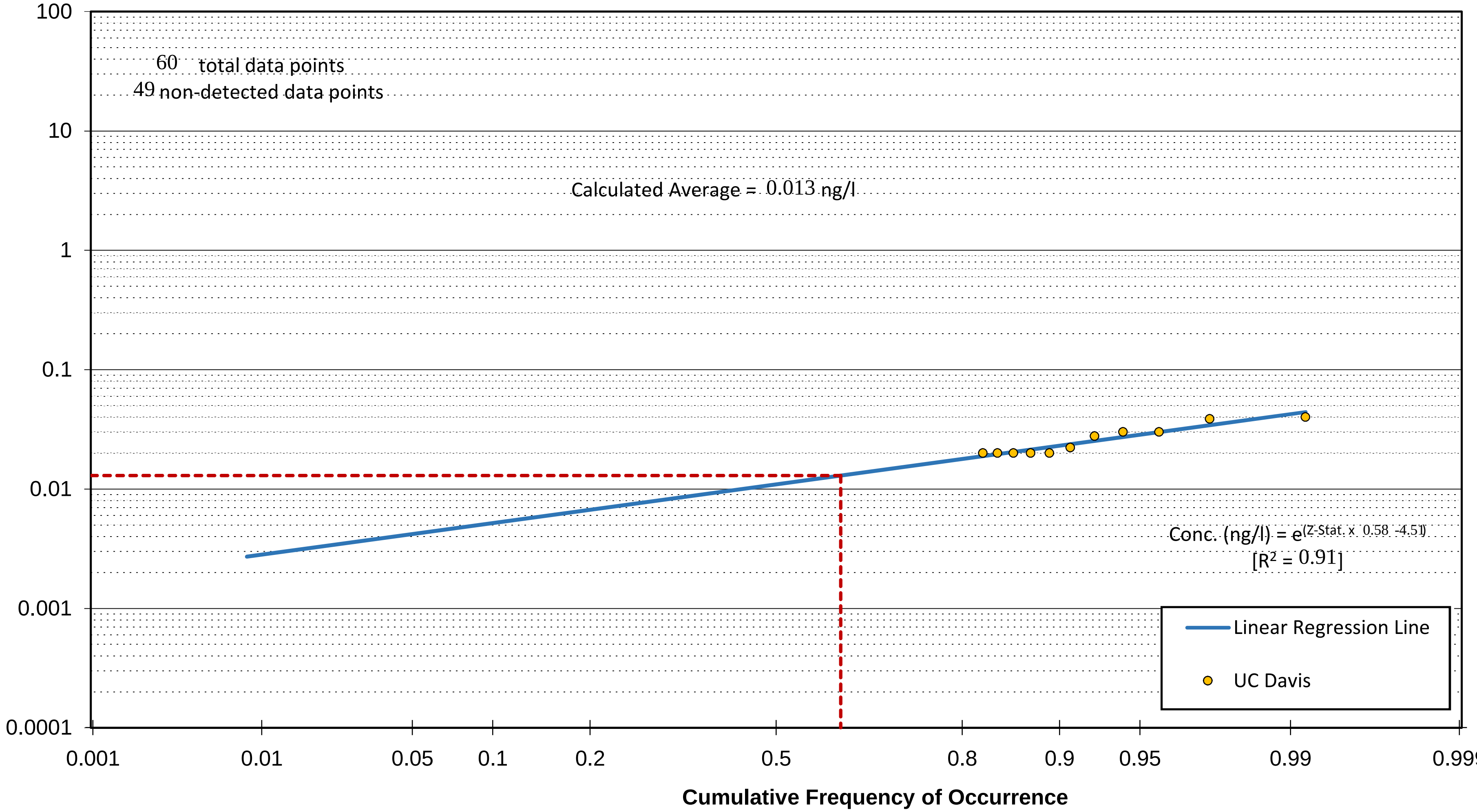


Figure F-15

MeHg Concentration Probability Plot for UC Davis Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

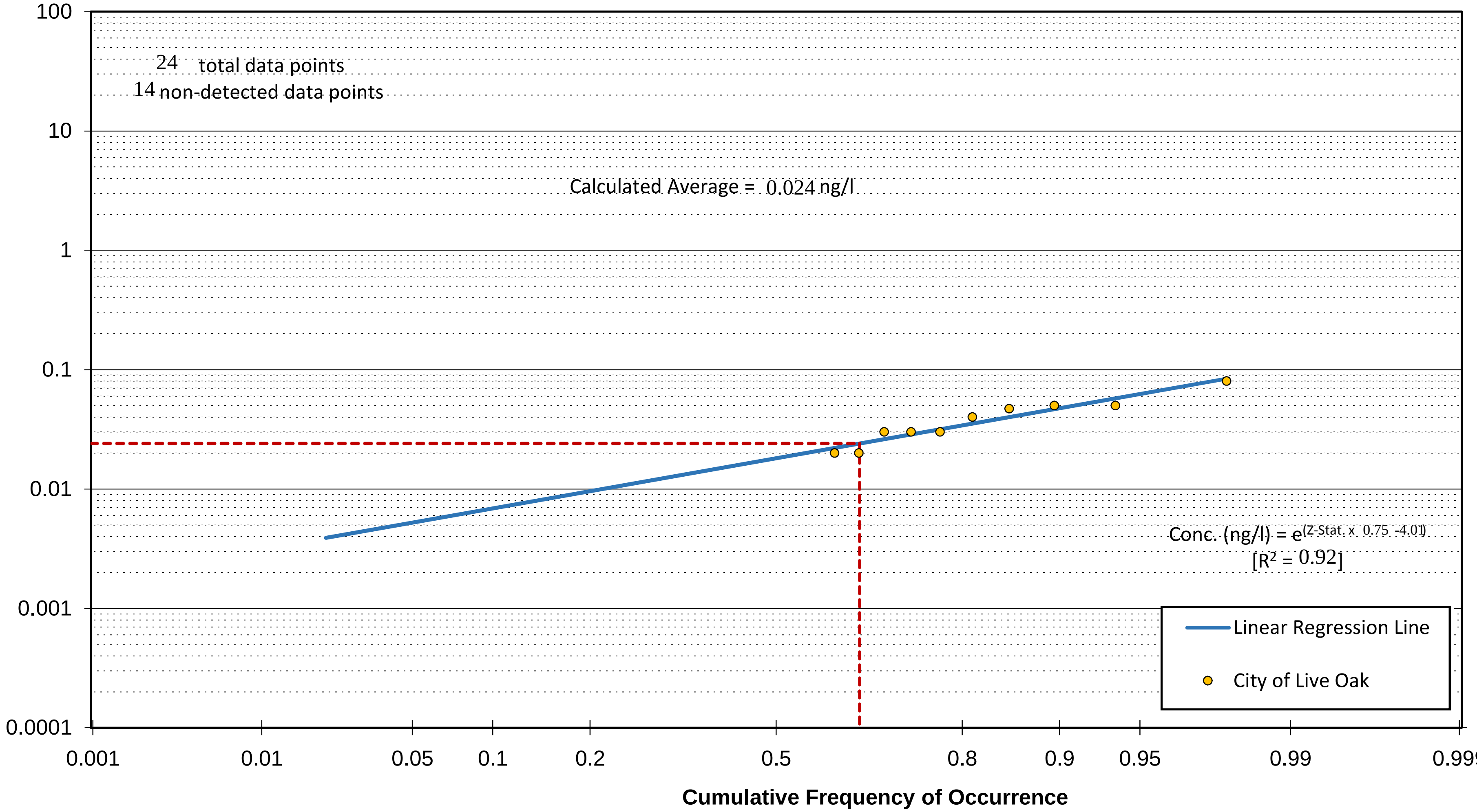


Figure F-16

MeHg Concentration Probability Plot for City of Live Oak Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

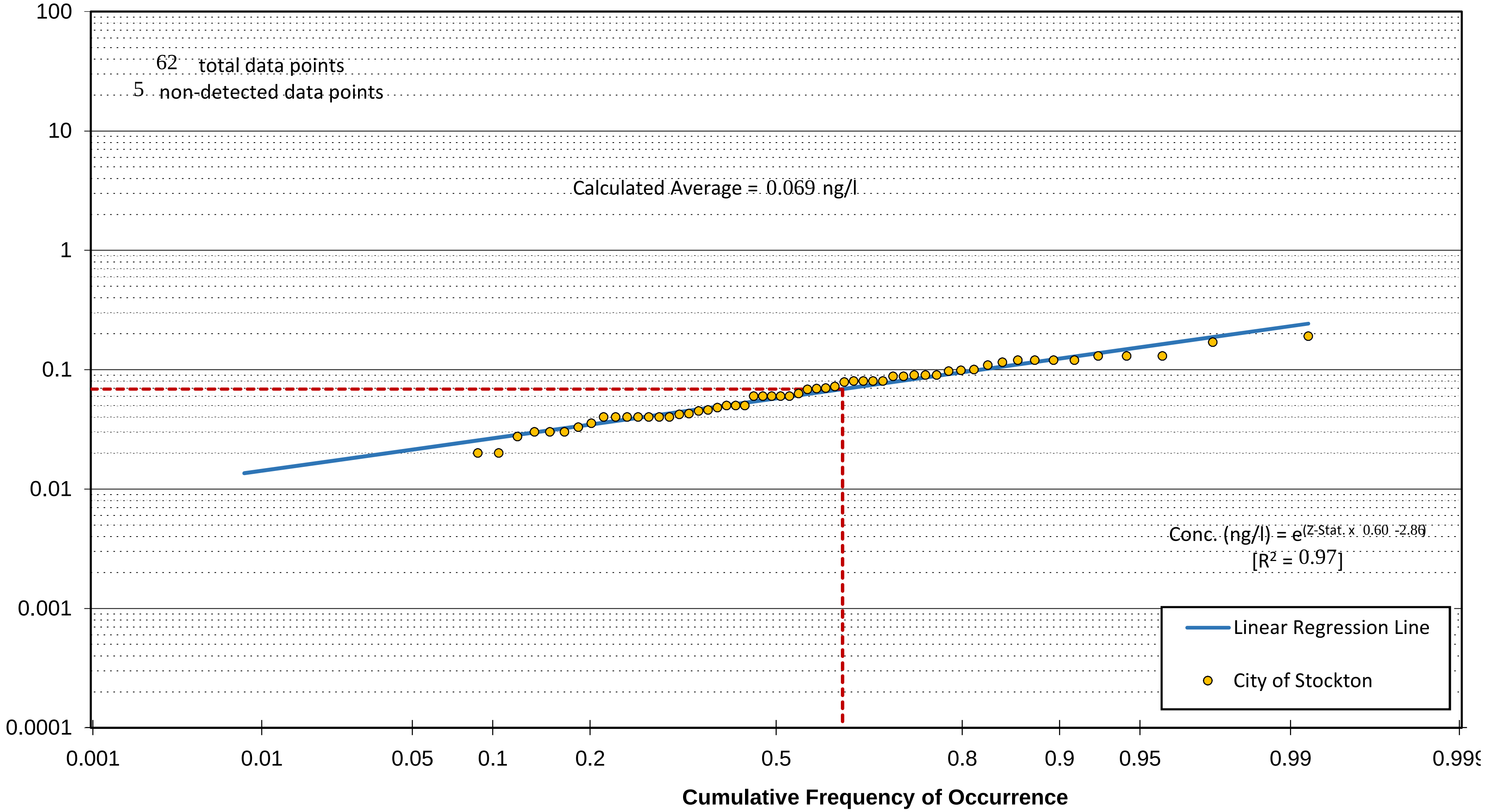


Figure F-17

MeHg Concentration Probability Plot for City of Stockton Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

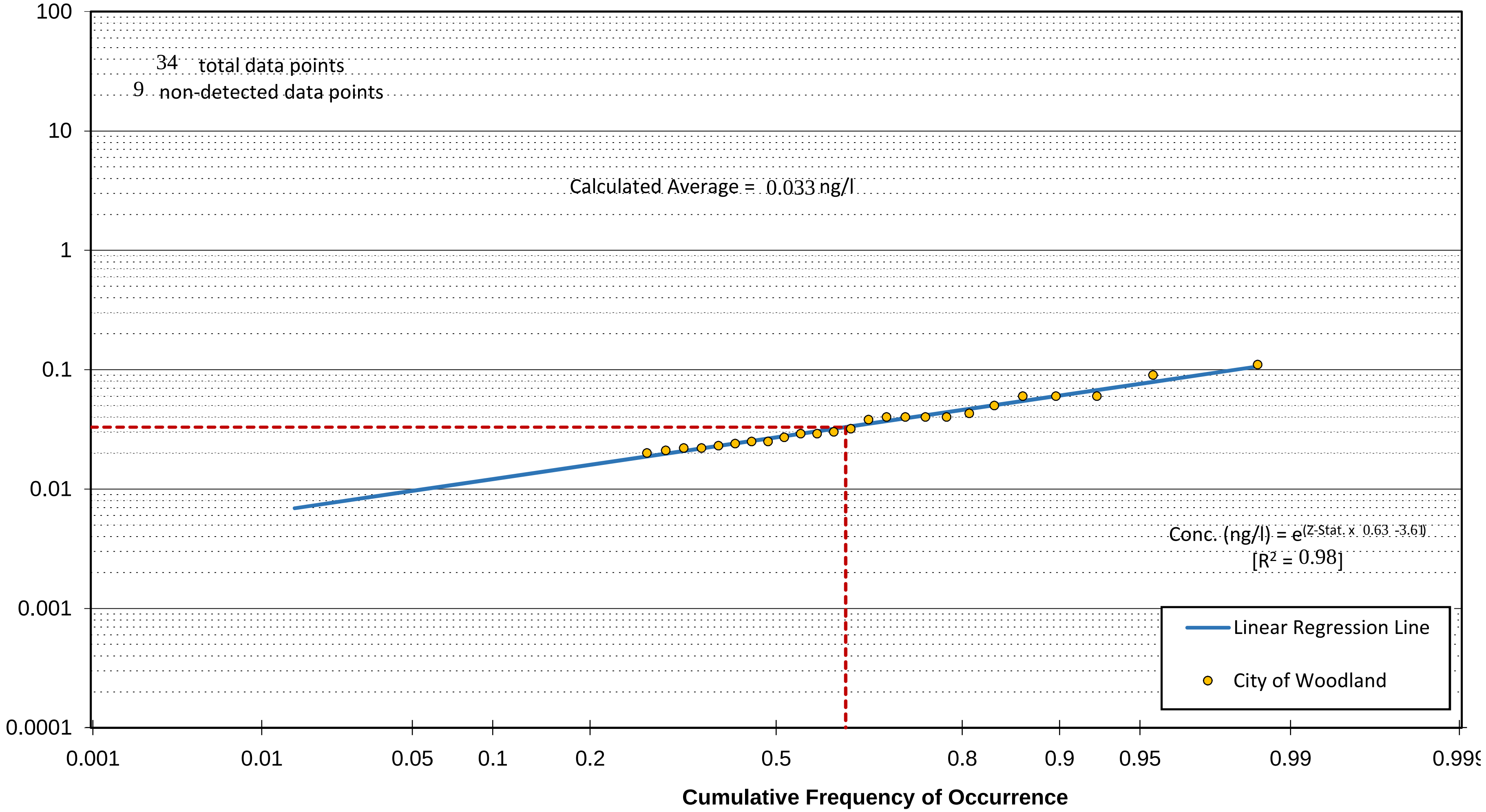


Figure F-18

MeHg Concentration Probability Plot for City of Woodland Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

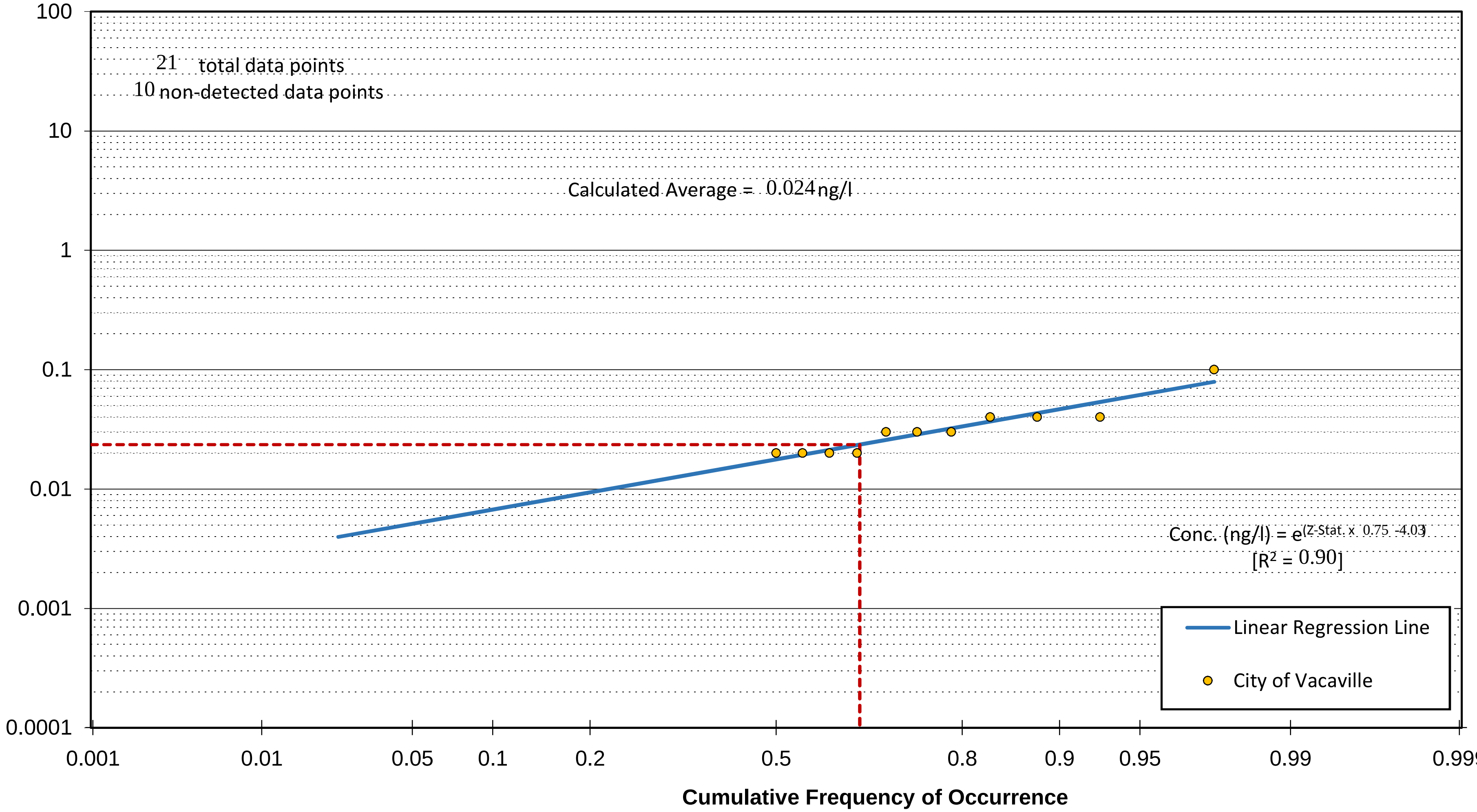


Figure F-19

MeHg Concentration Probability Plot for City of Vacaville Current Effluent (After 2012)

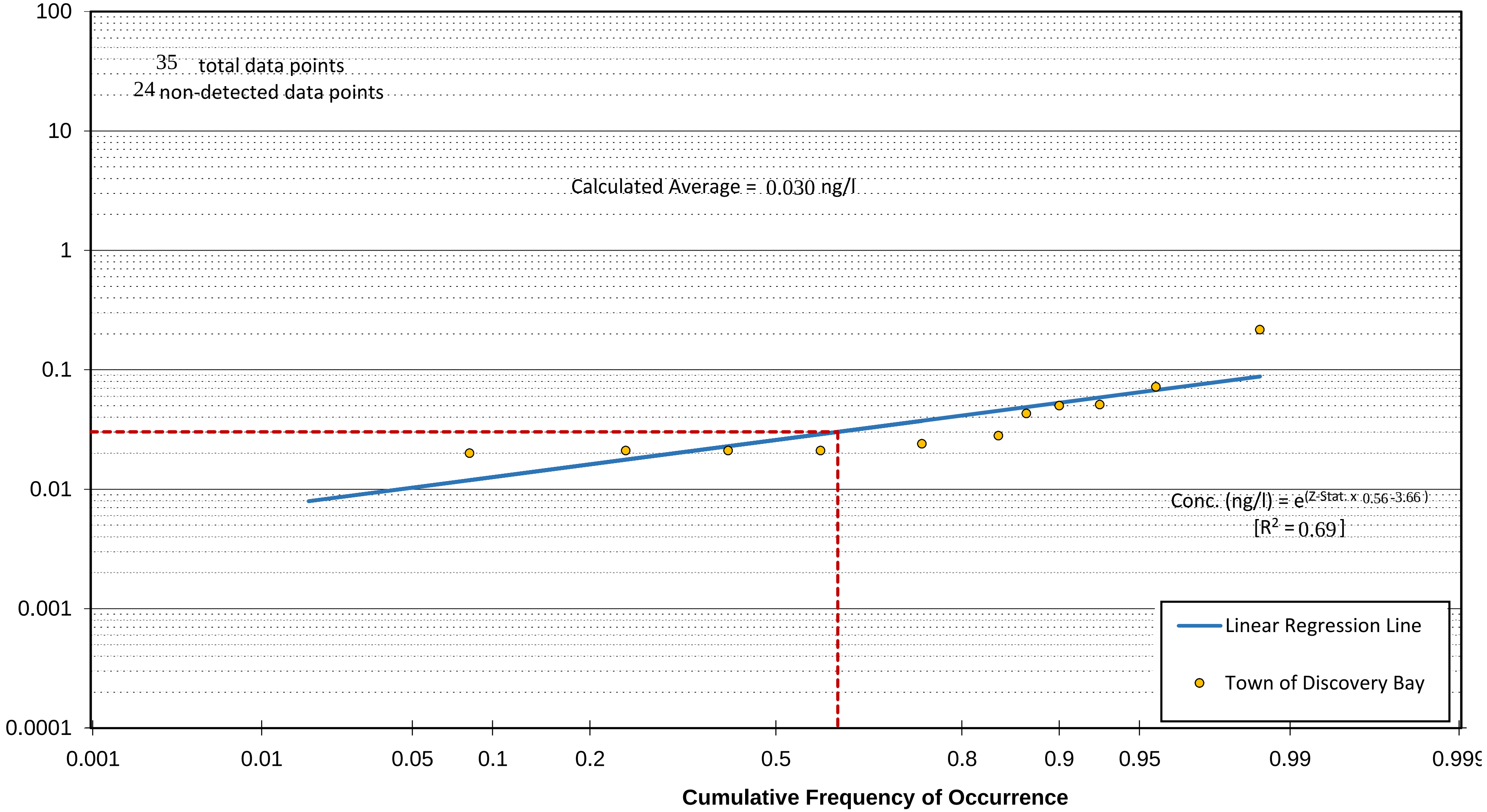


Figure F-20

MeHg Concentration Probability Plot for Town of Discovery Bay Community Service District Current Effluent

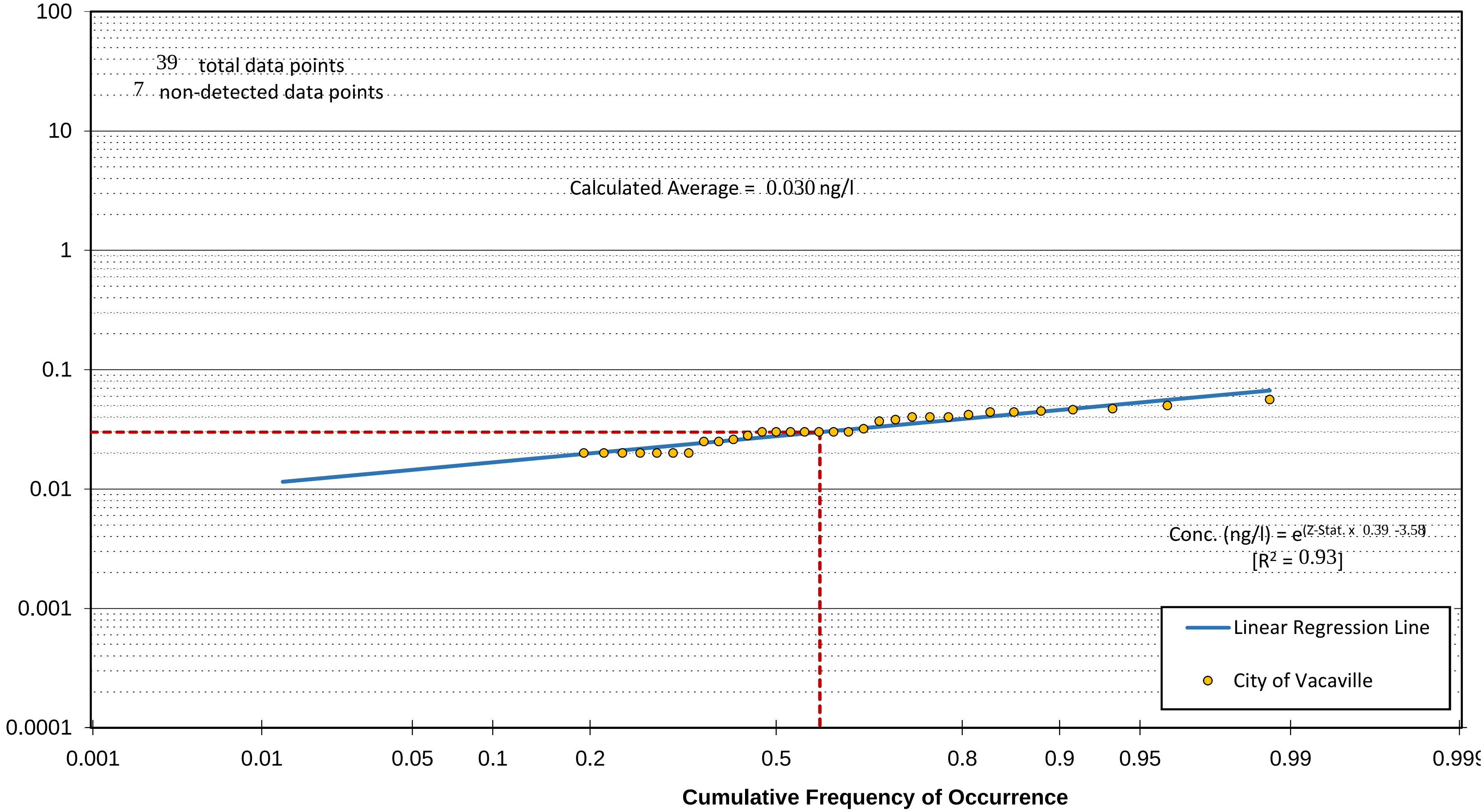


Figure F-21

MeHg Concentration Probability Plot for City of Vacaville Current Effluent (Before 2013)

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

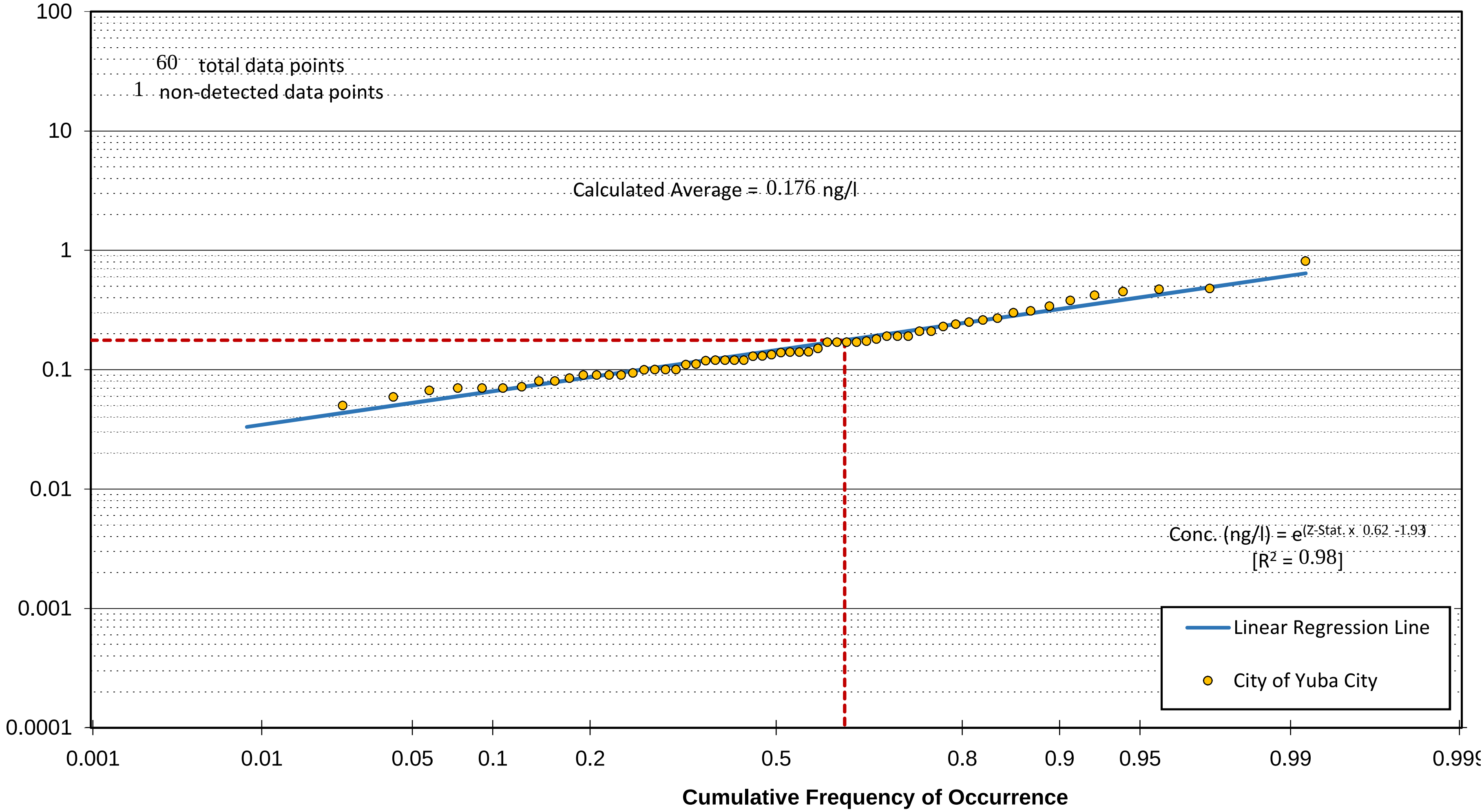


Figure F-22

MeHg Concentration Probability Plot for City of Yuba City Current Effluent

CVCWA MeHg Special Project Group
MeHg Control Study Progress Report

WEST YOST
ASSOCIATES