CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley

Staff Report

FINAL

March 2010

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EXECUTIVE SUMMARY

Fish in the Sacramento-San Joaquin River Delta Estuary (Delta) have elevated levels of methylmercury that pose a risk for human and wildlife consumers. As a result, the Delta is on the Clean Water Act Section 303(d) List of Impaired Water Bodies.
Section 303(d)(1)(A) of the Clean Water Act requires the Central Valley Water Board to develop a water quality management strategy – a.k.a. total maximum daily load (TMDL) – to lower fish mercury levels in the Delta so that the beneficial uses of fishing and wildlife habitat are attained.

Although methylmercury is less than 1% of all mercury discharged to the Delta, methylmercury is the chemical that accumulates in the food web. Available science indicates that reducing methylmercury in ambient water is the most direct way to reduce methylmercury in biota. The need for methylmercury effluent data for facilities permitted by the National Pollutant Discharge Elimination System (NPDES) program arose during the development of the TMDL source analysis for the Delta. There was a substantial amount of concentration and load data for inorganic mercury; however, there was limited information about methylmercury. Although inorganic mercury in effluent is a concern because of the potential for it to be methylated in downstream aquatic ecosystems, methylmercury also is a concern because it is immediately available for uptake by aquatic biota.

The Central Valley Water Board issued a California Water Code Section 13267 Order (13267 Order) in 2004 that required municipal wastewater treatment plants (WWTPs) and other non-municipal NPDES-permitted dischargers located in the Delta and its source region to monitor their methylmercury discharges. Effluent methylmercury data were submitted by 111 facilities. Although not required by the 13267 Order, thirty-six of those facilities also submitted influent methylmercury data. In addition, the Sacramento Regional Count Sanitation District submitted influent and effluent methylmercury concentration data for a six-year period.

This report provides a literature review and summary of NPDES influent and effluent methylmercury and inorganic mercury data along with available treatment process information for municipal WWTPs. No policy or regulation is either expressed or intended. This report is not a required element of the Delta methylmercury TMDL. However, this report includes a wealth of effluent and influent data and treatment process information that may be useful for future characterization and control studies in the Central Valley and elsewhere nationwide.

Overall, NPDES facilities account for about 4% of the methylmercury load to the Delta; NPDES facilities within the Delta contribute about 205 grams per year (g/year) while facilities in upstream watersheds that are downstream of major dams contribute about 24 g/year. The Delta TMDL divides the Delta into hydrologically-defined subwatershed

areas; different sources supply the different areas. For example, NPDES facilities within the San Joaquin River and Sacramento River subareas contribute about 7-9% of all methylmercury loading to those subareas, while NPDES facilities within the Central Delta, West Delta, and Yolo Bypass subareas contribute less than 0.2% of all methylmercury loading to these subareas. This report evaluates how the different NPDES categories contribute to methylmercury loading to the Delta.

Twelve categories of non-municipal facilities submitted effluent data: aggregate, aquaculture, drinking water treatment, food processing, groundwater remediation, heating/cooling, manufacturing, mines, paper/saw mill, power generation, power generation/domestic WWTP and a miscellaneous category. A few of the aquaculture and power generation facilities were neither significant sources nor sinks of methylmercury. More influent and effluent data are necessary to determine if other facilities in these two categories and heating/cooling facilities are net methylmercury sources or sinks. Aggregate, drinking water treatment, groundwater remediation, paper/saw mills and the other non-municipal facilities were sources of methylmercury but typically had low effluent methylmercury concentrations (average of 0.05 nanograms per liter [ng/l]). Eight of the twelve categories of non-municipal facilities had average effluent methylmercury concentrations less than or equal to 0.05 ng/l (the lowest calibration standard for methylmercury). Of the 198 effluent methylmercury samples submitted by all non-municipal facilities, 134 were less than or equal to 0.05 ng/l, and 80 of those were below the method detection limit (typically < 0.025 ng/l). The highest effluent methylmercury concentration observed at a non-municipal facility was 1.19 ng/l from a stormwater detention pond at the Sierra Pacific Industries Shasta Lake Mill, which is in the paper/saw mill category; all other samples from the paper/saw mills and other non-municipal facilities were less than 0.2 ng/l.

In contrast, municipal WWTPs contribute the most discharge (by discharge volume and methylmercury load) to the Delta source region of any one of the NPDES discharger categories monitored and have the most variability in effluent methylmercury concentrations. Individual effluent samples collected from WWTPs had methylmercury concentrations that ranged from below the detection limit to 4 ng/l, a 200-fold difference. Twenty of the 61 WWTPs that submitted effluent data had an average concentration less than or equal to 0.05 ng/l, and 13 of the WWTPs had an average concentration less than 0.03 ng/l. In contrast, 18 WWTPs had an average effluent methylmercury concentration greater than 0.2 ng/l, and seven had mean concentrations greater than 1 ng/l.

Staff grouped the municipal WWTPs into mutually exclusive treatment categories based on their secondary, tertiary and disinfection treatment types to determine if trends existed between treatment processes and effluent methylmercury concentrations. The facilities that use treatment pond systems (oxidation, facilitative, settling or stabilization ponds) had the highest effluent methylmercury concentrations. The median effluent

methylmercury values of all pond treatment categories were statistically higher than all other treatment categories, with one exception; the “Pond + Filtration + Chlorination/Decholorination” category did not have significantly higher effluent methylmercury concentrations than the “Secondary + Chlorination/Decholorination” (secondary treatment without nitrification/denitrification and filtration) category. WWTPs that use one or more of the following treatment processes generally had lower effluent methylmercury concentrations: nitrification/denitrification, filtration, and ultraviolet (UV) disinfection. Treatment categories that include one or more of these processes had statistically lower effluent methylmercury concentrations than both the pond and “Secondary + Chlorination/Dechlorination” categories.

Seasonal variability was observed in effluent methylmercury concentrations at several municipal WWTPs in the Central Valley and elsewhere. Studies were conducted at the City of Winnipeg WWTP (Canada) and Onondaga County WWTP (New York); both WWTP studies demonstrated that effluent methylmercury concentrations increase as ambient temperatures increase, particularly when treatment ponds are used. Effluent methylmercury concentrations were also higher in the warm season (e.g., May through November) than the cool season at several of the Central Valley WWTPs. The Central Valley WWTPs that showed seasonal patterns in their effluent methylmercury concentrations had many different types of treatment processes, indicating that there was no trend between the type of treatment process and seasonality.

These and other possible trends between treatment processes and effluent methylmercury concentrations identified by the Central Valley facility data and literature reviews merit additional investigation. There are many factors that affect the concentrations of methylmercury in effluent and subsequent methylation/demethylation processes in the receiving waters. Additional studies are required to understand the mercury/methylmercury relationships between different treatment processes and mercury methylation/demethylation processes in the receiving water. Chapter 5 of this report suggests preliminary ideas for future analyses and key questions to be addressed by treatment plant analyses.

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ACRONYMS

Basin Plan	Central Valley Region Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
CTR	California Toxics Rule
CVRWQCB	Central Valley Regional Water Quality Control Board (a.k.a. Central Valley Water Board)
CWA	Federal Clean Water Act
EC	Electrical conductivity
GIS	Geographic Information System
GW	Groundwater
Hg	Mercury
ID	Irrigation District
mgd	Million gallons per day
MeHg	Monomethyl mercury (also referred to as methylmercury in this report)
NPDES	National Pollutant Discharge Elimination System
O	Oxygen
PUD	Public Utilities District
SD	Sanitation District
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board (a.k.a. San Francisco Bay Water Board)
SFEI	San Francisco Estuary Institute
SRCSD	Sacramento Regional County Sanitation District
TMDL	Total maximum daily load
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
UV	Ultraviolet radiation
WTP	Water treatment plant (drinking water filtration or groundwater treatment)
WWTP	Wastewater treatment plant
WY	Water Year[1]

[1] A "water year" (WY) is defined as the period between 1 October and 30 September of the following year; for example, WY2001 is the period between 1 October 2000 and 30 September 2001. The California Department of Water Resources (DWR) developed the Hydrologic Classification Index (HCI) to evaluate the distribution of wet and dry years in the Central Valley. DWR classifies water year types according to the natural water production of the major basins. See the following website for more information about the HCI: http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST

UNITS OF MEASURE

μg	microgram
μg/g	microgram per gram
μg/l	microgram per liter
μm	micrometer
cfs	cubic feet per second
cm	centimeter
g	Gram
g/day	gram per day
g/l	gram per liter
in/yr	inches per year
kg	kilogram
L	Liter
m	Meter
mg	milligram
mg/g	milligram per gram
ml	milliliter
mm	millimeter
ng	nanograms
ng/l	nanograms per liter
o/oo	parts per thousand (salinity)
ppb	parts per billion; usually µg/kg
ppm	parts per million; usually mg/kg or μg/g
ppt	parts per trillion; usually ng/kg

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1 INTRODUCTION

In 1990, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) identified the Delta as impaired by mercury because fish had elevated levels that posed a risk for human and wildlife consumers. This is a concern because fishing is a popular activity in the Delta. About 300,000 licensed sport and subsistence anglers fish in the Delta each year, along with an unknown number of unlicensed anglers. Wildlife species of concern that consume Delta fish include California least tern, bald eagle, and river otter. Eating fish with high levels of mercury is a problem, especially for the young, because mercury is a potent neurotoxicant that impairs nervous systems in both humans and wildlife (National Research Council (NRC), 2000). In addition, it affects their reproductive and immune system function; examples of negative effects include deficits in memory and motor control in humans and reductions in physical abilities in wildlife (Wolfe *et al.*, 1998; Whitney, 1991 in Huber, 1997; Dansereau *et al*., 1999; Huber, 1997; Wiener and Spry, 1996).

As stated in CalFed's 2003 Mercury Strategy: "The problem with mercury in the Delta's aquatic ecosystems can be defined as biotic exposure to methylmercury." Methylmercury is the most toxic and bioaccumulated form of mercury. Methylmercury concentrations in aquatic ecosystems are the result of two competing processes: methylation and demethylation. Methylation is the addition of a methyl group to an inorganic mercury molecule. Sulfate reducing bacteria in sediment are the primary agents responsible for the methylation of mercury in aquatic ecosystems. Maximum methylmercury production occurs at the oxic-anoxic boundary in sediment, usually several centimeters below the surface. Although less common, methylmercury also may be formed in anaerobic water (Regnell *et al.*, 1996 and 2001).

Demethylation is both a biotic and abiotic process. Both sulfate reducing and methanogen-type bacteria have been reported to demethylate mercury in sediment with maximum demethylation co-occurring in the same zone where maximum methylmercury production is located (Marvin-DiPasquale *et al*., 2000). Photodegradation of methylmercury in the water column also has been observed (Sellers *et al*., 1996; Byington *et al*., 2005; Gill, 2008). The rate of both biotic and abiotic demethylation appear quantitatively important in controlling net methylmercury concentrations in aquatic ecosystems (Sellers and Kelly, 2001; Marvin-DiPasquale *et al*., 2000; Foe *et al*., 2008).Several published papers provide comprehensive reviews of the methylmercury cycle in the Delta and elsewhere (e.g., Wiener *et al.*, 2003a and 2003b; Tetra Tech, Inc., 2005; Larry Walker Associates (LWA), 2002). Board staff and others have found that in some waterways, processes of methylmercury production and transport downstream in the water column are dominant (e.g., in the lower Sacramento and San Joaquin Rivers upstream of the Delta) and in others, processes that remove

methylmercury from the water column such as photodegradation and sedimentation are dominant (e.g., in the Central Delta) (Stephenson *et al.*, 2008).

Once in the water column, methylmercury bioaccumulates in the food web. That is, very low methylmercury levels in water lead to high methylmercury levels in fish. For example, largemouth bass in the Delta have more than 6 million times the methylmercury as the water in which they swim. As a result, human and wildlife exposure to methylmercury is primarily through consumption of fish and shellfish, rather than drinking water.

Although processes that remove methylmercury from the water column may be dominant in some water bodies, there is no information that suggests that methylmercury discharged into a water body would disappear so rapidly that none of it would be accumulated, at least in part, into the food chain immediately downstream of the discharge. For example, in its Localized Mercury Bioaccumulation Study, SRCSD concluded that SRCSD WWTP effluent contributes about the same percentage of methylmercury to Sacramento River biota downstream of its discharge as it does to the methylmercury loading in the river. SRCSD found that four out of six fish and clams species sampled had methylmercury concentrations about 10% greater downstream from the discharge than upstream. The ratio of SRSCD WWTP methylmercury loads to river methylmercury loads was also about 10% during the study period. Also, as demonstrated by extensive spatial and temporal sampling of large and small fish in the Delta and its tributary watersheds (e.g., Slotton *et al*., 2003 and 2007; Davis *et al*., 2000, 2003 and 2008), methylmercury persists long enough in tributary and Delta waters to be reflected in fish uptake with regional patterns that stay consistent over years.

Although methylmercury is less than 1% of the inorganic mercury input to the Delta (Wood *et al*., 2010b), methylmercury is the form of mercury that accumulates in the food web. Available science indicates that reducing methylmercury in ambient water is the most direct way to reduce methylmercury in biota. Methylmercury produced by many modern-day activities may potentially be managed so that less methylmercury is discharged. Chapters 3 and 5 in the February 2008 draft staff TMDL report (Wood *et al*., 2010b) provides information about the relationship between methylmercury in Delta fish and water and potentially controllable methylation processes in the Delta region. Methylmercury in Delta waterways comes from many sources, such as wetlands, agricultural drains, urban runoff, wastewater treatment plant effluent and tributary inflows, in addition to methylmercury production in and flux from open-water sediments in Delta waterways.

Section 303(d)(1)(A) of the federal Clean Water Act requires States to establish a “Total Maximum Daily Load” (TMDL) for each impaired water body to attain water quality standards. Section 13240 of the State of California Porter-Cologne Water Quality

Control Act requires Regional Boards to develop water quality control plans to meet reasonable protection of beneficial uses, including establishing water quality objectives and a program of implementation to achieve the water quality objectives. A TMDL represents the maximum load (usually expressed as a rate, such as kilograms per day (kg/day) or other appropriate measure) of a pollutant that a water body can receive and still meet water quality objectives. A TMDL describes the reductions needed to meet water quality objectives and allocates those reductions among the sources in the watershed. Central Valley Water Board staff has proposed a mercury TMDL control program for the Delta that addresses sources of both inorganic mercury and methylmercury (Wood *et al.*, 2010a and 2010b). The proposed program focuses on methylmercury source reduction because available information indicates that methylmercury levels in water may be a primary factor determining methylmercury concentrations in fish. A inorganic mercury load reduction strategy also is part of the proposed program for several reasons: to reduce sediment mercury levels and associated water methylmercury levels in the Delta; to maintain compliance with the USEPA's criterion of 50 ng/l; and to comply with the San Francisco Bay mercury control program adopted by the San Francisco Bay Regional Water Quality Control Board.

The need for methylmercury data for discharges permitted by the National Pollutant Discharge Elimination System (NPDES) arose during the development of the source analysis for the Delta methylmercury TMDL. At the beginning of the TMDL development, only one NPDES-permitted facility in the Central Valley had collected effluent methylmercury data. Between December 2000 and June 2003, the Sacramento Regional County Sanitation District (SRCSD) collected 60 samples to characterize its effluent methylmercury levels. In February and March 2004, Central Valley Water Board staff conducted two sampling events at four other municipal facilities to determine whether the SRCSD data are representative of other WWTPs. The 2004 sampling results, along with data available in the published literature, indicated that the effluent methylmercury data for the SRCSD facility might not be representative of all facilities in the Delta. Therefore, the Central Valley Water Board issued a California Water Code Section 13267 Order (13267 Order) in 2004 that required NPDES dischargers, including municipal WWTPs and non-municipal facilities to monitor methylmercury discharges for one year.

Specifically, the 13267 Order required the following:

- Instantaneous, unfiltered grab samples collected from the facilities effluent for one year (generally September 2004 to August 2005) at a monthly, quarterly or biannual frequency, depending on facility size and whether there was a discharge to surface water;
- Use of clean hands/dirty hands sampling procedures and U.S. Environmental Protection Agency (USEPA) Method 1630/1631 (Revision E) with a method detection limit of 0.02 ng/l;

- Analysis of a matrix spike and matrix spike duplicate with either the first or second set of samples to ensure an acceptable methylmercury recovery rate; and
- Analysis of a travel blank with every other set of samples.

The 13267 Order did not require the collection of inorganic mercury data. However, if the facility was already collecting samples for inorganic mercury analysis, then it was required to collect the methylmercury samples concurrently. Also all inorganic mercury data and any other methylmercury monitoring data collected by a facility must be reported to the Central Valley Water Board. While not required by the 13267 Order, collection of instantaneous grab samples from the facilities' upstream receiving water and main influent were recommended to calculate methylmercury treatment efficiency. Appendix A provides an example of the 13267 Order letter and a list of facilities that received the Order.

This technical staff report presents a summary of the methylmercury data submitted by the NPDES dischargers. Because of the file size, data for individual facilities are not attached to this report; a Microsoft Excel file containing all data is available upon request. This report also includes an evaluation of the quality assurance/quality control results, a literature review, a description of the treatment processes in place at the municipal WWTPs when their methylmercury data were collected, a discussion of treatment processes and their possible relation to effluent methylmercury levels, and recommendations for further research. An administrative draft report was sent in December 2008 to all of the NPDES facilities whose data was summarized in this report. Staff addressed comments submitted for the December 2008 draft report and made the revised draft report available for public review in May 2009. Staff incorporated corrections and comments on the December 2008 and May 2009 draft reports into this final version of the report. Comments submitted by facilities and staff responses are in Appendix D.

As part of the proposed Delta mercury control program (Wood *et al.*, 2010a), Central Valley Water Board staff is currently recommending that methylmercury dischargers in the Delta and its source region conduct collaborative methylmercury control studies to develop methods to reduce their methylmercury discharges. This report and the associated database are a first step in that process, particularly for the municipal WWTPs.

The literature review of studies that investigated methylmercury in WWTPs is presented in Chapter 2. The quality assurance/quality control evaluation is presented in Chapter 3. The summary of effluent and influent methylmercury data is provided in Chapter 4. In response to comments from the Sacramento Regional County Sanitation District on the May 2009 draft report, an additional chapter (Chapter 5) was added to this report to assess the relative contribution of methylmercury load to the Delta by NPDES facilities in and upstream of the Delta. The discussion of treatment processes

and their possible relation to effluent methylmercury levels and recommendations for further research are provided in Chapter 6.

In this report, mercury, inorganic mercury, and total mercury are used synonymously.

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2 LITERATURE REVIEW

Several published reports have evaluated wastewater treatment plant mercury fate and transport. Results and conclusions from these studies are summarized below and in Table 1.

2.1 San Jose / Santa Clara Water Pollution Control Plant

From October 2004 to March 2006, the City of San Jose conducted a sampling program to study the fate and transport of mercury within its wastewater treatment facility in compliance with its NPDES waste discharge permit (SJ/SC, 2007). The treatment process of the San Jose/Santa Clara Water Pollution Control Plant (SJ/SC WPCP) consists of screening and grit removal, primary sedimentation, secondary treatment (activated sludge with nitrification/denitrification), secondary clarification, filtration, chlorination, and dechlorination before the wastewater is discharged. During the secondary treatment process the waste stream is split between two parallel units, which are identical in function. Aqueous samples were collected from the raw influent after grit removal, primary effluent, settled sewage influent to nitrification units (secondary influent), secondary effluent, tertiary filter influent and effluent, and final effluent. City staff collected and analyzed over 140 aqueous samples for total and dissolved mercury, methylmercury, and parallel samples for total suspended solids (TSS), sulfide, chloride, and sulfate. Total and dissolved mercury and methylmercury results for the aqueous sampling are summarized in Table 2.

In addition, City staff collected and analyzed 32 biosolids samples for inorganic mercury, methylmercury, sulfide, sulfate, pH and moisture content. Sludge samples were collected from the primary sludge, waste activated sludge from secondary units, returned activated sludge, thickened activated sludge and digested sludge. Inorganic mercury concentrations in sludge were higher than in the water due to the strong particle association of mercury. Inorganic mercury and methylmercury concentrations in sludge were roughly uniform throughout the treatment process.

In this study, the removal of TSS corresponded with the removal of inorganic mercury. Raw influent contained approximately 190 mg/l TSS and 168 ng/l inorganic mercury. After primary settling, the TSS concentration was approximately 85 mg/l and the inorganic mercury concentration was 92 ng/l. Secondary effluent, which is a combined flow from identical and parallel activated sludge units, continued to show a close correlation between TSS and inorganic mercury removal with concentrations of about 5 mg/l and 5.2 ng/l, respectively. The TSS was reduced to approximately 2 mg/l in the treated tertiary effluent, but increased to 3 mg/l in the final effluent. The corresponding inorganic mercury concentration for the tertiary treated effluent was 1.6 ng/l, and for the final effluent was 2.0 ng/l. The study states that this slight increase in inorganic mercury

and TSS in the final effluent may be attributed to the addition of the filter backwash water, treated by flocculation and clarification, to the filter effluent prior to disinfection. The final effluent represented an overall removal of 99% of the inorganic mercury.

The secondary treatment process proved to be a catalyst for the removal of methylmercury, indicated by a primary effluent concentration of 1.5 ng/l and a reduction to 0.05 ng/l in the secondary effluent. Although anoxic conditions are present during some process steps of secondary treatment, the conditions were not sufficient to promote methylation of mercury. The authors of the study noted that little apparent sulfate reduction occurred within the treatment process, which could explain why significant methylation did not occur. Final effluent concentrations of methylmercury showed a decrease to 0.04 ng/l, representing an overall removal efficiency of 97%.

The study found no significant seasonal trend in influent inorganic mercury concentrations; however, the study observed a diurnal trend, with higher concentrations in the afternoon and early evening. There were no observed diurnal patterns for methylmercury in the influent. The study concluded that methylmercury concentrations in the influent were relatively uniform over the course of a day. The study did not discuss seasonal or diurnal patterns or variability in effluent inorganic mercury and methylmercury concentrations.

2.2 Sacramento Regional County Sanitation District Wastewater Treatment Plant

The Sacramento Regional County Sanitation District (SRCSD) WWTP is a 181 mgd pure oxygen activated sludge secondary treatment plant (Parmer *et al.*, 2005). The SRCSD also operates a 5 mgd tertiary treatment plant for water recycling. The SRCSD study investigated both inorganic mercury and methylmercury fate and transport for the wastewater and solids treatment trains. The tertiary effluent (recycled water) was not tested. This study used a two-phased approach, identified as Phase 1A and 1B.

Phase 1A included nine sampling days that occurred from October to November 2004. Samples were taken from the influent, primary effluent, secondary effluent prior to chlorination, dechlorinated final effluent, and solids storage basin return flow to the plant influent structure. The liquid supernatant from the digested sludge and three different solids storage basins (SSB) named green, black and harvest were also sampled. The parameters measured in Phase 1A were inorganic mercury (total and dissolved), methylmercury (total and dissolved), total dissolved solids, TSS, pH and dissolved oxygen.

Phase 1B involved more extensive sampling of the treatment process from the end of Phase 1A to May 2005. Phase 1B sampling locations included all locations sampled in Phase 1A, except for the supernatant from the SSB Ponds. In addition, the mixed liquor (mixture of the influent flow to the secondary clarifiers and the return activated sludge),

the waste activated sludge from the secondary clarifiers, the biosolids recycling facility (BRF) influent from the sludge digesters and the BRF return flow to the plant influent structure were sampled during Phase 1B. The same analytes were measured in both Phases 1A and 1B. The concentrations, mass loads and particulate concentrations for the inorganic mercury and methylmercury samples collected during both phases of the study are summarized in Tables 3 and 4.

There was a strong correlation between solids removal and inorganic mercury removal. The inorganic mercury concentration was reduced by an average of 94% from the influent to the secondary effluent, and 95% from the influent to the final dechlorinated effluent. The TSS was reduced by an average of 95% from the influent to the secondary effluent, and 96% from the influent to the final effluent. Overall, it appeared that the treatment process removed inorganic mercury more efficiently than methylmercury. The methylmercury concentration was reduced by an average of 75% from the influent to the secondary effluent, and 70% from the influent to the dechlorinated final effluent.

The highest methylmercury loading in the liquid train of the plant occurred in the mixed liquor channel, which comprises primary effluent and 40% return activated sludge. The highest methylmercury concentration (not including digested sludge and return flows) of about 31 ng/l occurred in the return activated sludge stream, which is recycled to the mixed liquor (activated sludge unit process). The secondary process achieved the greatest reduction of methylmercury concentrations and loads in the liquid train as observed from the primary and secondary effluents; however, it also had the greatest methylmercury concentration (in the waste activated sludge stream) of all the liquid train unit processes in this study.

An increase in methylmercury concentration occurred between the secondary effluent (0.38 ng/l) and the dechlorinated final effluent (0.55 ng/l). The study authors noted the increase was consistent with the slightly increased TSS concentration in the final effluent. According to the authors, no backwash or other return flow is added to the waste stream between the secondary effluent and the dechlorinated final effluent. The report authors concluded that both inorganic mercury and methylmercury removals correlated with TSS removal due to strong particle affinity.

2.3 Concentrations and Fluxes of Inorganic mercury and Methylmercury within the Onondaga County Metropolitan Wastewater Treatment Plant

The Onondaga County Metropolitan Wastewater Treatment Plant discharges its effluent to Onondaga Lake, a mercury-contaminated lake in Syracuse, New York (McAlear, 1996). A study at the Onondaga County Metropolitan WWTP investigated the concentrations and fluxes of inorganic mercury and methylmercury within the plant and in its discharge. The WWTP treatment processes consist of screening and grit removal,

primary clarification, conventional activated sludge, secondary clarification, chlorination, and phosphorous removal (coagulation by addition of iron salts followed by clarification) before the wastewater is discharged.

Monthly samples were collected from the plant influent, primary effluent, secondary effluent, “tertiary” effluent from the phosphorous removal clarifiers and final plant effluent between October 1995 and September 1996 and analyzed for inorganic mercury and methylmercury. Daily composite total dissolved solids concentrations and daily inorganic mercury concentrations in sludge also were evaluated. The average concentrations of inorganic mercury, methylmercury and TSS at each treatment process are summarized in Table 5.

The authors determined that seasonal conditions play an important role in the methylation process, and in particular, that warm temperatures may be a catalyst for methylation. The influent methylmercury concentrations were much lower during cold weather (November through April) than during warm weather (May through October), and further, methylmercury concentrations remained relatively constant throughout the treatment process during cold weather (Table 6). However, during the warm weather months, an increase in the average methylmercury concentrations occurred between primary effluent and secondary effluent (from 1.8 ng/l to 3.5 ng/l), followed by a decrease in the “tertiary” and final effluents (2.9 ng/l and 1.6 ng/l, respectively). Despite this apparent methylation during secondary treatment in warm weather months, the study found that the average final effluent methylmercury concentration in the warm weather months was only slightly higher than during the cold weather months (1.6 ng/l compared to 1.4 ng/l).

There was a strong correlation between the mean concentrations of inorganic mercury and TSS throughout the treatment processes. In contrast, a weak correlation was evident between the mean methylmercury and TSS concentrations. The ratios of methylmercury versus inorganic mercury concentrations for the entire study period (includes warm and cold weather months) were highest during secondary treatment at 20.5%, decreasing to 8.3% in the final effluent.

During the cold weather months, November through April, the influent and final effluent methylmercury averaged 2.3 and 1.4 ng/l, respectively. Primary and secondary treatment effluent had concentrations near 2.0 ng/l. The highest methylmercury concentration during the cold weather months was in the “tertiary” effluent (2.4 ng/l). The percentage of inorganic mercury as methylmercury during the same period increased gradually throughout the treatment process from about 1% (influent), 2% (primary), 6% (secondary), and 12% (“tertiary”), before decreasing in the outfall to 3%.

The influent and final plant effluent methylmercury averaged 7.8 and 1.6 ng/l, respectively, in the warm weather months. The percentage of inorganic mercury as

methylmercury during warm weather months varied from approximately 2 to 3% in the influent and primary effluent, to a high of 35% in secondary treatment, and then decreasing to 15% in tertiary treatment and 13% in the final effluent measured at the outfall. Although activated sludge is an aerobic treatment process, the study author hypothesized that methylation of mercury likely occurred during secondary treatment in anaerobic microenvironments.

2.4 City of Winnipeg, Manitoba, Canada

The City of Winnipeg, Manitoba operates three secondary treatment plants that discharge to two local rivers, the Red and Assiniboine Rivers (Bodaly *et al.*, 1998). Two of the plants (the North End and South End plants) use pure oxygen activated sludge in their secondary treatment process. The West End plant, in contrast, uses conventional activated sludge with diffusers. The West End facility also is the only WWTP of the three to use lagoons after secondary treatment and before final effluent discharge.

Samples were collected from the influent and effluent of the three plants. Five sampling events took place from early summer to autumn 1994 and one event took place in spring 1995, for a total of six sampling events. The unfiltered water samples were analyzed for inorganic mercury and methylmercury.

Influent methylmercury concentrations observed at the three treatment plants ranged from 0.5 to greater than 4 ng/l and averaged 2.2 ng/l. Effluent methylmercury concentrations observed at the North and South End plants ranged from 0.13 to 0.56 ng/l. However, effluent methylmercury concentrations observed at the West End Plant, which utilizes conventional activated sludge and lagoons after secondary treatment, were significantly higher, varying from about 0.2 to greater than 2 ng/l. A seasonal trend was apparent only in the West End facility; effluent methylmercury concentrations increased as ambient temperatures increased, with the highest concentration occurring in August. The authors noted that the high concentrations of methylmercury in 1994 may have been related to the fact that the West End facility had begun operations within the year and experienced start-up problems. Also, this facility was the only one of the three plants to use final polishing lagoons, which could be sites of substantial methylmercury production, especially if anoxic conditions exist.

Overall removal rates for the three treatment plants were 88% of inorganic mercury and 90% of methylmercury. However, this methylmercury removal rate does not include the summer period at the West End Plant when methylmercury concentrations in the effluent were elevated. The study authors did not observe a seasonal pattern in the concentration of inorganic mercury in effluent from any of the plants.

2.5 Fritz Island Wastewater Treatment Plant

The City of Reading signed a consent decree with the State of Pennsylvania agreeing to remove three mercury-filled trickling filter center column seals used in the Fritz Island WWTP (Gilmour and Bloom, 1995). This allowed researchers to examine the extent of inorganic mercury and methylmercury contamination within the plant and its receiving water body, the Schuylkill River. Each filter seal initially contained 340 kg of mercury, some of which was lost from the seals due to excessive pressure and equipment failures and escaped to the rock media and underbed of the trickling filters. The mobility and fate of the mercury contaminating the Fritz Island WWTP was determined by evaluating inorganic mercury and methylmercury concentrations of the inflow to and outflow from a number of individual treatment components in the WWTP.

The Fritz Island WWTP is a secondary treatment facility that employs trickling filters (TFs) for secondary treatment. The treatment process consists of primary settling before the 1st stage TFs, 1st stage trickling filters (TF# 1-3), intermediate settling before the 2nd stage TFs, 2nd stage trickling filters (TF# 4-6), settling after the 2nd stage TFs, aeration and then a final settling process. There are six trickling filters involved in the treatment process. Four of these (TF# 1, 3, 5 and 6) originally used mercury-containing center seals. The contaminated seal in trickling filter #5 was replaced with a mechanical seal in 1984, and the rock media and underbed was cleaned or replaced.

Researchers collected aqueous samples from the plant influent and effluent, and sludge samples from the belt press, from July to December 1993. The aqueous and sludge samples were analyzed for inorganic mercury and methylmercury. A summary of the inorganic mercury and methylmercury concentration data and calculated mass balances are presented in Tables 7 and 8, respectively. During a one-time sampling event in August 1993, researchers collected inorganic mercury and methylmercury samples from the inputs and outputs from each treatment process within the WWTP. A summary of those results is provided in Table 9.

With the exception of TF# 5, all of the trickling filters were measurable sources of both inorganic mercury and methylmercury, demonstrated by greater concentrations in the effluent than in the influent of the contaminated trickling filters. In TF# 1, the inorganic mercury concentration of the effluent was 25 times higher than the influent, and the methylmercury concentration was four times higher. Inorganic mercury in the wastewater was lost to the sludge during the settling steps. More than 90% of the inorganic mercury in the effluent of the first stage trickling filters was removed to the sludge during the intermediate settling process. A similar trend was observed in the post 2nd stage and final settling processes.

An average of 157 grams of inorganic mercury was released from the plant per day, with less than 10% in the effluent and more than 90% released in the sludge. Only

about 20 grams of the 157 grams was derived from the plant influent, with the remainder generated inside the plant. However, the WWTP was an overall sink for inorganic mercury in the wastewater, demonstrated by lower inorganic mercury concentrations and loads in the plant effluent than in the plant influent.

Methylmercury production was closely related to the mercury concentration in each of the trickling filters. The contaminated trickling filters were the main sites of methylmercury production. Methylmercury concentrations decreased during aeration, which the study authors hypothesized was attributed to chemical or microbial demethylation of methylmercury to inorganic mercury during this process. Overall, about 0.4 g/day of methylmercury was released from the plant, with about 25% of this amount introduced from the plant influent and the rest generated inside the plant. Of the 0.4 g/day of methylmercury released from the plant, 30% was in the sludge, and 70% was released to the river in the effluent. The WWTP was an overall source of methylmercury in the wastewater. Both the methylmercury concentrations and loads in the effluent were higher than in the plant influent.

2.6 Whitlingham Sewage Treatment Works

Between May 1986 and June 1988, a study was conducted at Whitlingham Sewage Treatment Works in Norwich, England to evaluate the behavior of heavy metals during wastewater treatment and to investigate the occurrence of mercury methylation throughout the treatment plant (Goldstone *et al.*, 1990). The wastewater treatment processes at the Whitlingham facility consisted of primary clarification followed by secondary activated sludge treatment before discharge as effluent.

The study consisted of two sampling events, the first in May 1986 and the second in October 1987. The constituents evaluated during both sampling events were inorganic mercury, dissolved mercury, total solids and total suspended solids (TSS). Methylmercury was sampled throughout the treatment process only during the second sampling event. Raw sewage (influent), settled sewage (primary effluent), picket fence thickener overflow, returned activated sludge, and final effluent were sampled during the second event. Table 10 provides a summary of the inorganic mercury and methylmercury concentration results for the second sampling event.

Methylation of mercury within the treatment plant was observed, especially in the presence of bacterial solids. Methylmercury and inorganic mercury concentrations were highest in the return activated sludge. However, the average methylmercury concentration of the final effluent was below the 10 ng/l detection limit; the study authors assumed that the seven samples with methylmercury concentrations below the detection limit were equal to zero when they calculated the average methylmercury concentration of the final effluent.

The effects of centrifugation and filtration on additional return activated sludge samples were investigated to determine whether methylmercury has a greater affinity for the soluble or particulate phase of the return activated sludge. Results indicated that methylmercury was predominantly associated with solids. The study authors determined that the absence of detectable methylmercury in the influent and primary effluent indicates that all methylmercury in the return activated sludge had been produced by *in situ* biological methylation. However, the authors noted that the aerobic conditions of the activated sludge could be considered unfavorable to the production and accumulation of methylmercury. The authors hypothesized that the high concentrations of bacterial solids and other organic material in the waste activated sludge may have outweighed the aerobic conditions and permitted the establishment of an equilibrium concentration of methylmercury. Correlations performed on the data confirmed a relationship between high concentrations of biological solids and aerobic methylation.

2.7 Determination of Methylmercury in a Pilot-Scale Activated Sludge Wastewater Treatment Plant

Pavlogeorgatos and others (2006) investigated methylation in a pilot-scale activated sludge plant supplied with synthetic wastewater enriched with mercury. The wastewater was spiked with mercury concentrations of 10, 100 and 500 µg/l. The initial methylmercury concentration of the synthetic wastewater was not evaluated. Duplicate samples from the aeration tank, treatment plant effluent, and sludge were analyzed for inorganic mercury and methylmercury. The results indicated that all of the samples had methylmercury concentrations below the detection limit of 0.07 µg/l. The highest inorganic mercury concentration of 17.8 mg/l was found in the sludge sample associated with the 500 µg/l mercury spike. On average, 82.8% of the mercury entering the treatment plant was adsorbed to the particulate matter in the aeration tank.

While no conclusion could be drawn regarding methylation because of the high method detection limit (0.7 µg/l, compared to the MDL of 0.02 ng/l required for the 13267 Order monitoring), this investigation confirmed that the reduction and volatilization of mercury is the primary pathway to its removal. In the aeration tank, this pathway becomes secondary when the microorganisms and mercury reach equilibrium. Adsorption of mercury onto the biosolid flocs becomes the primary removal mechanism. The study theorized that methylmercury was not detectable because the conditions were aerobic, or because demethylation predominated. Methylation may have occurred but was not detectable given the method detection limit used in the study. The authors also discovered that spiking the wastewater with increased mercury concentrations reduced the removal effectiveness of organic matter in the treatment process.

3 QUALITY ASSURANCE AND QUALITY CONTROL

The 13267 Order required NPDES facilities to submit effluent methylmercury monitoring data collected using the clean hands/dirty hands technique described in USEPA Method 1669 and analyzed using USEPA Method 1630/1631 (Revision E) with a method detection limit (MDL) of 0.02 ng/l. In addition, the facilities were required to have a matrix spike/matrix spike duplicate (MS/MSD) performed on their first or second set of effluent samples, and travel blanks performed with every other set of samples. The MS/MSD is designed to determine if the effluent matrix causes interferences in methylmercury recovery and to provide an estimate of analytical precision. The travel blank is used to determine if there is any contamination during transport. Other quality assurance/quality control (QA/QC) parameters not required by the 13267 Order but evaluated by some of the facilities include field duplicates, MS/MSD of other matrixes, and field blanks. Staff used guidelines described in the CALFED Mercury Program Quality Assurance Project Plan (Puckett, 2000) to assess the quality of the data presented in this report.

3.1 Method Detection Limit

Since Frontier GeoSciences laboratory has a minimum reporting limit of 0.025 ng/l and Frontier conducted many of the analyses for the facilities, staff considered non-detects to be reported as less than 0.025 ng/l or lower. Only on six occasions were MDLs greater than 0.025 ng/l; the maximum MDL reported was 0.05 ng/l. The concentration data submitted by the dischargers overall appear to be of high quality and analyzed by laboratories able to perform the latest methods for analyzing methylmercury.

3.2 Sample Handling and Preservation

USEPA Method 1630 requires samples to be preserved with acid within 48 hours to a pH of less than two. The analytical laboratories verify the pH of the samples upon receipt, and the laboratories acid-preserve the samples if the pH is found to be greater than two. The laboratories flag samples when the samples are preserved after the 48-hour hold time. Thirty-four percent of the samples analyzed for methylmercury were preserved before being received by the analytical laboratories (field), 37% were preserved at the laboratories, and 29% of the samples had no acid preservation information provided (unknown). All data from samples known to have pH hold time exceedences were flagged so. Data for samples whose hold times exceeded 60 hours were flagged and excluded from calculations made in this report. Table 11 shows the data for these excluded samples. All samples with no preservation information provided were assumed to meet their pH hold times and their data were accepted.

Twenty-two samples exceeded the 48-hour hold time, and of those, 21 samples exceeded 60 hours (Table 11). Acid preservation stops the bacterial activity in the water that produces methylmercury from inorganic mercury. Samples without preservation may not be representative of the conditions at the time of sampling if bacterial activity continues after sampling. However, because bacterial activity is believed to be minimal in samples that are kept cold (0 to 4°C), data from samples with minimal hold time exceedences (<60 hours) were considered acceptable.

The USEPA Method 1630 states that unpreserved samples should be kept at 0 to 4°C until preserved, after which samples can be stored at cool temperatures. The analytical laboratory reports state the optimal temperature is 4 ±2°C for unpreserved samples; as a result, all data derived from samples received by the laboratories above 6°C and unpreserved were flagged for being out of optimal temperature range. A review of the data indicated that temperature did not likely affect the samples; therefore, staff incorporated the flagged data in this report's calculations.

3.3 Matrix Spike/Matrix Spike Duplicates

MS/MSD results were submitted by 93 facilities (see Appendix C, Table C.1). The facilities were not required to submit the laboratory reports from the analysis laboratories; consequently, eight facilities submitted summaries only of their methylmercury data. Ninety-two facilities had MS/MSDs performed on their effluent at least once for a total of 161 effluent MS/MSDs performed. On eight occasions, the MS/MSDs were not within the criteria of acceptability.[2] For three events the MS/MSD had relative percent differences (RPD) greater than 25%, and the associated effluent data were flagged "not reproducible" for high variability. In addition, there were three times where the MS/MSD had recoveries below 70% and twice the recovery was greater than 130%, hence the associated effluent data were flagged "low bias" for low recoveries and "high bias" for high recoveries, respectively.

Influent and receiving water had MS/MSDs performed on 25 and 32 occasions, respectively. One of the influent MS/MSDs exhibited a recovery above 130%, and the data were flagged "high bias". Five of the influent MS/MSDs (20% of the MS/MSDs performed on influent samples) exhibited recoveries below 70%, and their data were flagged "low bias". The USEPA Method 1630 may underestimate the methylmercury concentration in wastewater influent samples. Receiving water MS/MSD experienced recoveries below 70% once and above 130% once, hence the associated data were flagged accordingly. In all instances that the MS/MSDs experienced recoveries below 70% or above 130%, the laboratories' analyses of laboratory control samples were

[2] Acceptable MS/MSD recovery per the CalFed QAPP: >70% and <130% recovery.
Acceptable MS/MSD RPD: ≤25%.

within acceptable limits, indicating that the laboratories performed the method appropriately.

One laboratory reported that high levels of chloride in effluent could interfere with recoveries, and that a special preparation of the sample could remedy the problem. However, the small occurrence of low recoveries in effluent indicates that there is little interference caused by the effluent matrix. In addition, the low occurrence of MS/MSD RPD exceedences greater than 25% indicates the high precision of the laboratory analyses and the high quality of data produced.

3.4 Travel Blanks

The facilities were required to submit travel blanks with every other set of samples submitted. Some facilities submitted trip blanks or field blanks, in addition to or instead of travel blanks. Travel blanks are bottles filled with deionized (DI) water that are transported to the site but not opened (CDFG, 2002). Travel blanks are synonymous to trip blanks, which is defined by USEPA as, "A clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without being exposed to the sampling procedures" (USEPA, 2002). Conversely, one of the laboratories contracted to collect water samples defined trip blanks as, "…Trip blanks should be handled the same as the sample; however, they only need to be exposed to the atmosphere. Do not put sample in the bottle. Trip blanks are designed to measure the amount of methyl mercury in the air…" This suggests that this laboratory's trip blanks were performed to test parameters typically assessed with field blanks. Field blanks are considered acceptable substitutes because they assess contamination introduced by field sampling conditions in addition to all of the contamination assessed by travel blanks.

Approximately 85% of the facilities that submitted data fulfilled their requirements for blanks submittal, 4% partially fulfilled their requirements, and 11% did not submit any blank analysis. Approximately 5% of the combined number of trip and field blanks had methylmercury concentrations detected above the MDL; however, the majority of the detections were less than two times the detection limit or less than five times the sample concentration. These deviations are not considered to affect the quality of the sample concentration data. The analytical laboratories reported that concentration detections less than two times the MDL have high variability and are considered estimates. Only 3% of the blank concentration detections were greater than two times the MDL and proportionately high when compared to their respective sample concentrations. Because these data could be affected by contamination they were flagged. Blanks are designed to be used as an interactive QA/QC tool, where sources of reoccurring contaminations can be identified and eliminated. Because most of the contaminations

were isolated events, the concentration data accuracy should not be greatly affected; therefore, the flagged data were used in this report's calculations.

3.5 Field Duplicates

Field duplicates are used to examine field homogeneity and sampling handling. Though not required by the 13267 Order, field duplicates were collected on 35 occasions (Table 12). Field duplicate mean RPD was 12.7%. On four occasions the RPD was greater than 25%; however, the methylmercury concentrations for each of the samples and their duplicates were less than 10 times the MDL. Sample concentrations at or near the MDL have higher variability, suggesting that these field duplicates' high RPD cannot be completely attributed to field variability. All of the field duplicates met the criterion for data acceptability, indicating that the facilities performing field duplicates had acceptable field collection precision. Field duplicates were not incorporated into the calculations of this report.

3.6 Anomalous Values

Several anomalous values were observed in the methylmercury and inorganic mercury dataset when compared to the remainder of the values observed at a facility (Table 13). When an analytical laboratory report was available, staff was able to confirm the anomalous values. None of the available laboratory reports indicated that contamination or any other error or misreporting occurred. Otherwise, if no laboratory information was provided, staff assumed that all data including anomalous values were correct. As a result, Board staff included all anomalous values in the report calculations since staff could not conclude definitively that errors were made.

SRCSD staff identified three methylmercury results that failed their quality assurance review. Influent and effluent samples collected on 13 July 2001 had methylmercury concentrations of 1.05 and 2.93 ng/l, respectively; SRCSD staff commented in their data review notes, "highly unlikely that there is more MeHg in effluent than influent". Likewise, an effluent sample collected on 18 June 2006 had a methylmercury concentration of 0.077 ng/l; SRCSD noted, "highly unlikely that effluent concentration is this low". As a result, these three samples were not included in the calculations in this report.

There were three instances when a municipal WWTP had a higher effluent methylmercury concentration than the influent value collected on the same day. This occurred one time at each of the Colusa, SRCSD Walnut Grove and Mariposa WWTPs. Staff carefully reviewed available information to determine the likelihood of some type of data or reporting error. The influent and effluent values were confirmed by analytical

laboratory reports and chain of custody documents; hence, staff assumed that the data was correct and the data was included in the report calculations.

3.7 Summary

The data presented in this report meets the overall QA/QC requirements of the NPDES 13267 Order. Less than 1% of the analyses for methylmercury had method detection limits greater than 0.025 ng/l, with 0.05 ng/l being the highest, indicating that the samples were analyzed using the latest methods. Only 3% of the effluent matrix spikes resulted in recoveries exceeding the criterion, and less than 2% of the MS/MSD analyses resulted in RPDs greater than 25%. Wastewater treatment plant effluent appears to exhibit little to no interference with Method 1630. These results agree with Caltest Analytical Laboratory staff's review of Method 1630 performance on wastewater they have analyzed, where their last 200 matrix spikes averaged 93% recovery in matrix and MS/MSD relative percent differences averaged 9% in their last 100 MS/MSD performed (SFEI, 2007). In contrast, 20% of the MS/MSD performed on influent samples submitted by Central Valley facilities exhibited low recoveries; therefore, Method 1630 may underestimate the methylmercury concentration in wastewater influent samples. Less than 3% of the combined travel and field blanks resulted in detections above the criterion of acceptability, suggesting that there was little cross contamination between bottles and/or contamination from field procedures.

Twenty-five methylmercury samples were excluded from calculations and graphs in this report. Twenty-two of these excluded samples had acid preservation hold times that exceeded 60 hours. In addition, 6 of the samples excluded due to hold time exceedences, were also contaminated with mercury in the laboratory and were not believed to be representative of site influent or effluent. These contaminated samples were from General Electric Co. GWCS (NPDES No. CA0081833) and were collected on 18 October 2004. The three other methylmercury samples excluded from calculations in this report failed the SRCSD staff quality assurance review.

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4 REVIEW OF METHYLMERCURY CONCENTRATION DATA FROM CENTRAL VALLEY DISCHARGERS

There are currently 124 NPDES-permitted dischargers in the Delta source region[3] representing a variety of discharger types, primarily: aggregate, aquaculture, food processing, heating/cooling, manufacturing, mines, municipal WWTPs, paper/saw mills, power generation, water filtration (e.g., for drinking water), and groundwater remediation. The approximate discharge volumes of each of these NPDES categories are provided in Table 14.

A total of 134 Central Valley NPDES-permitted dischargers received the 13267 Order (see Appendix A, Table A.1). Staff did not send the 13267 Order to every NPDES-permitted discharger in the Delta source region. In addition, some of the facilities that received the Order discharge upstream of major dams, some were not discharging to surface waters during the study period, and some no longer discharge. Of the 134 dischargers that received the Order, 18 facilities discharge upstream of major dams, 22 facilities discharge directly to the Delta/Yolo Bypass, 17 discharge to other waterways that are 303(d)-listed as mercury impaired as of 2006, and 12 discharge to small waterways that, although not 303(d)-listed, drain directly to the Delta/Yolo Bypass. Table 15 summarizes the number of facilities that received the Order, categorized by discharger type and geographical region.

Effluent methylmercury data were submitted by 111 facilities as a result of the 13267 Order monitoring requirements. Although not required by the Order, thirty-six of those facilities also submitted influent methylmercury data. In addition, the Sacramento Regional County Sanitation District submitted influent and effluent methylmercury concentration data for a six-year period (December 2000 – March 2007). Central Valley Water Board staff compiled influent and effluent inorganic mercury concentration data available in SRCSD monitoring reports. The abundance of inorganic mercury and methylmercury data for the SRCSD Sacramento River WWTP influent and effluent allowed for more analysis of the SRCSD data. Figures 1, 2 and 3 illustrate the locations of the Central Valley facilities that submitted methylmercury data and Table 16 provides the map codes, receiving water information, approximate discharge volumes and facility types discussed in this report.

Tables G.3a and G.3b in Appendix G of the Delta methylmercury TMDL report summarize the number of effluent methylmercury samples collected by each facility, along with their average, minimum and maximum methylmercury concentrations. Tables in the Delta methylmercury TMDL report appendix provide average concentrations only for discharges to surface water. The graphs and calculations in this

[3] The "Delta Source Region" is a geographic area that includes the Delta and the watershed areas upstream that drain into the Delta but are downstream of major dams.

report incorporate all available data, including samples collected when facilities did not discharge to surface water. Of the approximately 700 effluent methylmercury samples collected, nine samples were taken from reclaimed effluent that was not discharged to surface water.

Available influent and effluent data are summarized by discharger type in the following sections. Summaries of effluent and influent methylmercury data for each NPDES facility are presented in Appendix B, Tables B.1 through B.4, at the end of this report.

4.1 Non-Municipal Discharges

Section 4.1 is divided into six subsections that describe non-municipal discharges:

1. Aggregate;
2. Aquaculture, power generation and heating/cooling;
3. Paper, pulp and saw mills;
4. Groundwater remediation;
5. Drinking water treatment; and
6. Food processing, manufacturing, and other non-municipal discharges.

A summary of the effluent methylmercury concentration data categorized by discharger type for the non-municipal NPDES facilities is provided in Table 17.

4.1.1 Aggregate

Discharge from aggregate plants, which process rock and gravel from quarries, is typically storm water after it is settled in sedimentation basins. These facilities were a small source of methylmercury with an average effluent concentration of 0.026 ng/l (Table 17). Five aggregate facilities submitted discharge methylmercury concentration data; one of the facilities is no longer active. Six of the eight samples collected by the active aggregate plants had methylmercury concentrations less than the method detection limit, and the other two samples had concentrations of 0.062 and 0.081 ng/l. Discharges from aggregate plants comprise about 2% of NPDES discharges (by volume) to the Delta source region.

The Oakwood Lake Subdivision Mining Reclamation NPDES permit (CA0082783; formerly known as the Brown Sand, Inc., Manteca Aggregate Sand Plant) allows for the discharge of water from Oakwood Lake to the San Joaquin River for flood control. Oakwood Lake is a former excavation pit filled primarily by groundwater. The results from discharge sampling in August and November 2004, nondetect (<0.02 ng/l) and 0.043 ng/l, respectively, are comparable to results for groundwater remediation plant discharges (Section 4.1.4). Furthermore, these effluent values are substantially lower

than the monthly average methylmercury concentrations observed in the adjacent San Joaquin River at Vernalis during August and November (0.167 and 0.130 ng/l, respectively; Wood *et al.*, 2010b).

4.1.2 Aquaculture, Power Generation & Heating/Cooling

Aquaculture, power generation, and heating/cooling facilities typically use ambient surface water, domestic water or groundwater for hatchery flow-through water or cooling water. Wastewater from these types of facilities may be untreated, filtered to remove solids and/or metals, or clarified in sedimentation basins prior to discharge. The combined discharge volume from all of these facility categories is about 50% of the total discharged by NPDES facilities to the Delta source region (Table 14).

Aquaculture, power generation and heating/cooling facilities had average effluent methylmercury concentrations of 0.041 ng/L, 0.061 ng/L and 0.11 ng/L, respectively (Table 17). The intake water of many of these facilities is taken from the same water body that the effluent is discharged to; therefore, a comparison of intake and effluent concentrations is necessary to determine whether a facility is a net source or sink of methylmercury.

Ten of the twenty-four facilities that submitted methylmercury data collected paired intake/outfall samples (Table 18). The power and heating/cooling facilities did not appear to be a source of methylmercury to the Delta. However, staff was unable to do statistical analyses of the paired influent-effluent samples of these facilities because sample sizes were too small for all facilities except for Mirant Delta CCPP (CA0004863), a power generation facility. Furthermore, many of these facilities had influent and effluent samples that were below the detection limit, making it impossible to statistically compare those paired samples. Methylmercury concentrations of outfalls 1 and 2 from Mirant Delta CCPP were not significantly different than intake 2 when compared individually (Outfall 1 vs. Intake 2: $p=0.26$; Outfall 2 vs. Intake 2: $p=0.37$, paired t-test). Therefore, outfalls 1 and 2 were neither significant sources nor sinks of methylmercury. More data is necessary to determine if the other power and heating/cooling facilities are methylmercury sources or sinks.

Effluent methylmercury concentrations of the aquaculture facilities were not significantly different than the paired influent concentrations ($p=0.21$, paired t-test). Even though the effluent concentrations typically exceeded intake concentrations (see Table 18), aquaculture facilities were neither a source nor sink of methylmercury. This comparison is based upon five paired influent-effluent samples from three facilities; therefore, more paired data is necessary to determine if aquaculture facilities are net sources or sinks. Almost all the aquaculture facilities had average effluent methylmercury concentrations equal to or less than 0.05 ng/l.

Until recently, the SMUD Rancho Seco Nuclear Generating Station (CA0004758) discharged a combination of treated liquid radioactive wastewater, secondary treated domestic wastewater, stormwater and irrigation runoff. It is the only facility in the power generation/ domestic WWTP category and was a small source of methylmercury. Methylmercury concentrations in the combined effluent ranged from nondetect (<0.025 ng/l) to 0.104 ng/l with an average of 0.040 ng/l.

4.1.3 Paper, Pulp & Saw Mills

Paper, pulp and saw mills discharge a combination of process wastewater and storm water after it is typically clarified in settling basins. These facilities were a source of methylmercury with an average effluent concentration of 0.117 ng/l (Table 17). However, 15 of the 21 effluent samples collected at these facilities were less than 0.10 ng/l. Paper, pulp and saw mills account for about 0.4% of the volume discharged by NPDES facilities to the Delta source region.

Five of the 12 effluent samples collected at the Pactiv Molded pulp mill (CA0004821) had methylmercury concentrations less than the method detection limit, and the other seven samples were between the detection limit and 0.085 ng/l. Eight of the nine samples collected at the two other mills had concentrations between the detection limit and 0.18 ng/l. The SPI Shasta Lake saw mill (CA0081400) had the highest effluent methylmercury concentration of 1.19 ng/l, collected from “Discharge 002” on 30 December 2004. The concentration of the other effluent sample collected from “Discharge 002” on 23 March 2005 at this facility was 0.023 ng/l. Discharge 002 is from a stormwater retention pond, and rainfall occurred on both sample dates and on previous days; it is conceivable that a “first flush” effect could be the cause of the highly variable results.

4.1.4 Groundwater Remediation

Groundwater remediation facilities extract contaminated groundwater for treatment prior to discharge to surface waters. These facilities had very low levels of methylmercury in their discharge. Nineteen of the 20 effluent samples collected by four facilities had methylmercury concentrations less than the method detection limit, and one sample was just slightly above the detection limit (0.033 ng/l). One plant collected nine influent samples, all of which had methylmercury concentrations less than the detection limit. Groundwater remediation plants account for about 1.4% of the volume discharged by PDES facilities to the Delta source region.

4.1.5 Drinking Water Treatment

Drinking water treatment plants account for about 0.1% of the volume discharged by NPDES facilities to the Delta source region. Drinking water treatment plants typically

discharge settled filter backwash water from their treatment process to surface waters. Six drinking water treatment facilities submitted effluent methylmercury concentration data and two of those submitted influent data. These facilities had an average effluent concentration of 0.033 ng/l (Table 17). Five of the facilities had effluent samples with methylmercury concentrations ranging from below the detection limit to 0.043 ng/l. One of these facilities collected an intake sample with a methylmercury concentration of 0.084 ng/l. The other facility had two effluent samples with methylmercury concentrations measuring 0.045 ng/l and 0.066 ng/l, and two influent samples with concentrations measuring less than the detection limit (0.02 ng/l) and 0.033 ng/l.

4.1.6 Food processing, Manufacturing, and other Non-Municipal Discharges

Food processing, manufacturing, and publishing facilities were not a substantial source of methylmercury. Fifteen of the 20 effluent samples collected by facilities in these categories had methylmercury concentrations less than the method detection limit, and the other five samples had concentrations between the detection limit and calibration standard (0.05 ng/l). One of the manufacturing facilities collected 12 influent samples. Eleven of these samples had methylmercury concentrations less than the detection limit, and one was just above the detection limit.

The one laboratory and one mine facility that submitted data were both small sources of methylmercury. The three samples collected by the laboratory facility had methylmercury concentrations between 0.038 ng/l and 0.082 ng/l. The four samples collected by the mine ranged from 0.025 ng/l to 0.091 ng/l. Permitted discharges from food processing, mining, publishing, and laboratory facilities comprise about 0.3% of the total NPDES discharge volume to the Delta source region. The two manufacturing plants in the Delta source region have since ceased discharge to surface waters.

4.2 Municipal WWTPs

More information is available for municipal WWTPs than for other types of NPDES facility discharges, so staff was able to conduct a more extensive data analysis for WWTPs. Municipal WWTPs contribute about 44% of the total discharge volume (see Table 14) and about 99% of methylmercury loading contributed to the Delta source region by NPDES facilities (see Chapter 5 and Table 36). While the loads from all WWTPs may be a small fraction of the total and methylmercury loads from tributary and Delta sources (see Chapter 5 and Tables 35, 36 and 37), some municipal WWTPs may contribute substantial methylmercury loads to individual water bodies. For example, a six-year comparison of the SRCSD Sacramento River WWTP effluent methylmercury loads as a percentage of its receiving water loads was as high as 30 to 43% during the warm seasons of 2001 and 2002 and less than 1% during the wet seasons of 2005 and 2006 (Figure 4; Bosworth, 2008), ranging from 4.2% to 17% on an annual basis.

Between October 2002 and October 2006 most of the loading was less than 10% during the winter through summer seasons. For some receiving waters, reducing municipal WWTP methylmercury discharges, along with reductions from other point and nonpoint sources, may be an important component in reducing methylmercury levels in Delta water.

Sixty-one municipal WWTPs submitted effluent methylmercury concentration data representing 63 discharges (two facilities had two discharge locations). Twenty-three treatment plants also submitted influent methylmercury data. In addition, inorganic mercury influent and effluent data are available for 9 and 29 discharges, respectively. Hence, Section 4.2 is divided into subsections describing the different types of concentration data and data comparisons:

1. Effluent methylmercury;
2. Influent methylmercury;
3. Effluent inorganic mercury;
4. Influent inorganic mercury;
5. Ratio between effluent methylmercury and influent methylmercury;
6. Ratio between effluent methylmercury and effluent inorganic mercury;
7. Ratio between effluent methylmercury and influent inorganic mercury; and
8. Ratio between effluent inorganic mercury and influent inorganic mercury.

To begin the process of evaluating methylmercury discharges from municipal WWTPs, Board staff conducted a preliminary evaluation of municipal treatment process information available in NPDES permits and project files. Table 20 provides treatment process information with the WWTPs sorted by average effluent methylmercury concentration. Using this treatment process information, staff grouped the Central Valley WWTPs into mutually exclusive categories based on the maximum level of wastewater treatment that the facilities were using in 2005, including the secondary, tertiary and disinfection treatment types (Table 21). A description of the treatment categories is provided in Table 22 and descriptive statistics for these categories are provided in Table 23. For calculations involving inorganic mercury and methylmercury concentration results that were less than the method detection limit (MDL), one half of the MDL was used for those results.

Staff attempted to identify obvious differences and seasonal trends in influent and effluent data between facilities and evaluated those differences in terms of the treatment categories. Identifying the reasons why some WWTPs discharge effluent with higher methylmercury concentrations than others, and why some facilities have seasonal or other treatment-related variability in their methylmercury discharges, could be critical components to the development of methylmercury controls.

4.2.1 Effluent Methylmercury

Municipal WWTPs had the most variability in effluent methylmercury concentrations of any of the NPDES discharger categories evaluated. Individual effluent methylmercury concentrations ranged from nondetect (<0.02 ng/l at 31 WWTPs) to 4 ng/L at the Colusa WWTP, a 200-fold difference. As illustrated by Figure 5, 20 (33%) of the WWTPs had average effluent methylmercury concentrations less than 0.05 ng/l, and 13 (21%) plants had average concentrations less than 0.03 ng/l. In contrast, 18 (30%) WWTPs had average effluent methylmercury concentrations greater than 0.2 ng/l, and 7 of these averaged between 1 and 2.9 ng/l. The highest average effluent methylmercury concentration (2.86 ng/l) observed at a facility was nearly 150 times that of the lowest average concentrations (e.g., facilities with effluent concentrations approaching or less than the detection limit). As shown in Table 1, the variability in the methylmercury concentrations observed in effluent from different municipal WWTPs in the Central Valley is comparable to WWTP effluent concentrations observed elsewhere.

Municipal WWTPs with higher average effluent methylmercury concentrations generally had higher variability, as indicated by a positive relationship ($R^2 = 0.7167$, $p<0.0001$) between the WWTPs' average methylmercury concentrations and corresponding standard deviations (Figure 6).

Seasonal variability was observed in effluent methylmercury concentrations at several municipal WWTPs. Anderson, Cottonwood, Davis, Grass Valley, Lincoln, Oroville, Placer Co. SMD #1, Redding Clear Creek and SRCSD Sacramento River WWTPs had higher effluent methylmercury concentrations in the warm season (e.g., May through November) than the cool season (see Figures 7 and 8). The exception was the Stockton WWTP, which had higher concentrations in the cool season. No obvious relationship between seasonality and treatment processes exists.

The SRCSD Sacramento River WWTP has a six-year methylmercury monitoring record for both the influent and effluent. Monthly averages of all the effluent methylmercury concentrations collected during the six-year period were higher during the warm season than during cold weather (Figure 8). However, the most recent data collected during WY2005-2007 show much less seasonal variability and lower methylmercury concentrations during warm months (May – November) than in earlier years ($p<0.0001$ for both the non-parametric Mann-Whitney U test and the parametric two sample t-test). Overall, SRCSD effluent methylmercury concentrations showed a marked decrease from WY2001 to 2007 (Figure 9).

Staff used statistical tests to determine if significant differences in effluent methylmercury concentrations exist between the treatment categories. Descriptive statistics and normality tests indicate that the treatment categories do not meet the assumptions of parametric hypothesis tests, including homoscedasticity (constant

variance) among all groups and data normality (Table 23). Differences in effluent methylmercury concentrations between the treatment categories were analyzed with non-parametric statistics as transformations could not be found to produce homoscedasticity and data normality among the all of the categories. The "Statistica" software was employed for all the statistical analyses.[4]

Statistically significant differences in effluent methylmercury concentrations exist among the treatment categories ($p<0.0001$, Kruskal-Wallis test). A pair-wise multiple comparison test was conducted to determine which treatment categories had higher concentrations. The two-sided significance levels (p-values) for each treatment category are presented in Table 24.

Facilities that use treatment pond systems as part of their treatment process had the highest effluent methylmercury concentrations (Figures 10 and 11; Table 23). The "Pond + Chlorination/Dechlorination (C/D)" and "Pond + Filtration + C/D" treatment categories had median effluent methylmercury concentrations of 0.52 ng/l and 0.81 ng/l, respectively. Conversely, facilities that have some combination of nitrification/denitrification (N/D), filtration, and ultraviolet (UV) disinfection generally had lower effluent methylmercury concentrations. The "N/D + Filtration + C/D", "Secondary w/ N/D + UV", "N/D + Filtration + UV", "Filtration + UV", "Secondary w N/D + C/D" and "Filtration + C/D" categories had median effluent methylmercury concentrations of 0.06 ng/l or less (Table 23).

These observed trends are confirmed by the multiple comparison p-values for the treatment categories. The "Pond + C/D" and "Pond + Filtration + C/D" categories had significantly higher effluent methylmercury concentrations than the "N/D + Filtration + C/D", "Secondary w/ N/D + UV", "N/D + Filtration + UV", "Filtration + UV", "Secondary w/ N/D + C/D" and "Filtration + C/D" categories ($p<0.00001$; Table 24). In addition, the "Secondary + C/D" category had significantly higher concentrations than every other category ($p<0.01$), excluding the "Pond + C/D" and "Pond + Filtration + C/D" categories (Table 24). Other statistically significant differences in effluent methylmercury concentrations include: the "Pond + C/D" category had higher values than the "Secondary + C/D" category, and the "N/D + Filtration + C/D" category had lower values than the "Secondary w/ N/D + C/D" and "Filtration + C/D" categories.

As indicated by Figure 10, two WWTPs had different effluent methylmercury concentrations than other WWTPs in the same treatment category:

- The Modesto WWTP had lower effluent methylmercury concentrations than other WWTPs in the "Pond + C/D" category ($p<0.0001$ for both the Mann-Whitney U test and the two sample t-test);

[4] Statistica StatSoft, http:// www.statsoft.com

- The Rio Alto WWTP had higher effluent methylmercury concentrations than other WWTPs in the “Filtration + C/D” category. Since only two effluent samples were collected at this WWTP, more data is needed to determine if these concentrations are representative of this facility’s effluent.

These differences suggest that other unique processes are acting at these two facilities that significantly modify methylmercury production or degradation. Staff’s review of the other treatment processes and data for these facilities (e.g., Tables 20 and 21, Figure 7) gave no straightforward reasons for the differences. The Rio Alto WWTP had more variability (i.e., coefficient of variation) than all but one of the 17 WWTPs in the "Filtration +C/D" category. The Modesto WWTP had the lowest average effluent methylmercury concentration and coefficient of variation of all of the 11 WWTPs in the “Pond + C/D” category. It could be helpful to obtain more information about conditions during each of the sampling events for these WWTPs (e.g., variations in treatment methods and differences in nitrate concentrations and temperature) and, in the future, to sample both influent and effluent to assess whether the variability in effluent is due to influent variability or treatment variability.

Nitrification/denitrification, filtration, ultraviolet disinfection or a combination of these treatments may play a role in decreasing effluent methylmercury concentrations. The “N/D + Filtration + C/D” category had significantly lower effluent methylmercury concentrations than the “Secondary w/ N/D + C/D” and “Filtration + C/D” categories (Table 24). This suggests that both filtration and nitrification/denitrification treatment processes may have been responsible for the lower concentrations discharged by the facilities in the “N/D + Filtration + C/D” category.

During the nitrification process, aerobic bacteria convert ammonia to nitrate with the assistance of oxygen (Metcalf and Eddy, Inc., 1972). The denitrification process involves anoxic bacteria converting nitrate to nitrogen gas with the help of a carbon source such as methanol (Metcalf and Eddy, Inc., 1972). The denitrification bacteria potentially could assist in the demethylation of methylmercury to inorganic mercury, because the methyl group is the best carbon source for the conversion of nitrate to nitrogen gas (Pirondini, 2008a). This potential methylmercury demethylation could occur in a fully-nitrified wastewater (low ammonia), but likely not in a partially-nitrified or non-nitrified wastewater (high ammonia) (Pirondini, 2008a). Additional analysis that directly evaluates effluent ammonia/nitrate/nitrite levels and effluent methylmercury concentrations needs to take place.

The “Filtration + C/D” and “Secondary + C/D” treatment categories both contained numerous WWTPs with a variety of secondary treatment types. Staff assigned the WWTPs in each of these groups into three mutually exclusive subcategories based upon their secondary treatment (Table 25). The three subcategories were “Activated Sludge” (includes conventional, pure oxygen and extended aeration activated sludge,

oxidation ditch and sequencing batch reactor treatments), “Activated Sludge + Trickling Filter” and “Fixed Media” (includes trickling filter and rotating biological contactor treatments). Descriptive statistics and normality tests indicate that the subcategories within each treatment grouping do not meet the assumptions of parametric hypothesis tests (Table 26). Differences in effluent methylmercury concentrations between the treatment subcategories were analyzed with non-parametric statistics as transformations could not be found to produce homoscedasticity and data normality among the all of the categories.

Within the “Secondary + C/D” category, no significant differences in effluent methylmercury concentrations exist between the three subcategories ($p=0.07$, Kruskal-Wallis test). However, within the “Filtration + C/D” category, significant differences exist between the subcategories ($p<0.01$, Kruskal-Wallis test). A pair-wise multiple comparison test indicated that the “Activated Sludge” subcategory had lower effluent methylmercury concentrations than the “Fixed Media” subcategory ($p<0.01$; Table 27). Descriptive statistics for the subcategories within each treatment category are presented in Table 26.

Each subcategory within the “Filtration + C/D” category had lower average and median effluent methylmercury concentrations than the same subcategory within the “Secondary + C/D” category (Table 25). These differences are statistically significant as shown by the two-sided significance levels (p-values) in Table 28. This indicates that the filtration treatment process may have assisted in the reduction of methylmercury in the effluent of these facilities.

4.2.2 Influent Methylmercury

A seasonal pattern was observed in influent methylmercury concentrations at a few municipal WWTPs. Several plants appeared to experience a decrease in influent methylmercury concentrations during cool weather months (Chico, Deer Creek and El Dorado Hills WWTPs); while some showed a sharp increase in the spring (Williams and Woodland WWTPs) or the summer (Rio Vista and UC Davis WWTPs) (see Figure 13). The approximately six-year influent methylmercury monitoring record for the SRCSD Sacramento River facility also showed an increase in average influent concentrations during the summer months (Figure 14). As for effluent methylmercury, there appeared to be a decreasing trend in influent methylmercury concentrations at the SRCSD Sacramento River facility between WY2001 to WY2007 (Figure 9).

Average influent methylmercury concentrations ranged from 0.068 at Mariposa WWTP to 14.6 ng/l at Maxwell WWTP, a 215-fold difference (Figure 12). Of the 23 municipal WWTPs that collected influent methylmercury data, three had average influent methylmercury concentrations less than 1 ng/l, ten had average concentrations between 1 ng/l and 2 ng/l, and two had average concentrations greater than 7 ng/l.

4.2.3 Effluent Inorganic Mercury

Effluent inorganic mercury concentrations ranged from non-detect (less than 0.2 ng/l) at the Modesto WWTP to 53.1 ng/l at the Woodland WWTP, which is about a 260-fold difference (Figure 15). The high value observed at the Woodland WWTP was an anomaly when compared to the remainder of the Woodland WWTP data. Of the 28 WWTPs where effluent inorganic mercury data were collected, 10 had average effluent inorganic mercury concentrations less than 3 ng/l, 11 had average concentrations between 3 ng/l and 7 ng/l, and two had average concentrations greater than 10 ng/l. The highest average effluent inorganic mercury concentration (22 ng/l) observed at a WWTP was about 44 times that of the lowest average concentration (0.5 ng/l; Figure 15).

Several WWTPs had higher effluent inorganic mercury concentrations during the winter (Davis [Discharge 1], Manteca, Placer County SMD #1 and Stockton WWTPs) or spring (Redding Stillwater WWTP) (see Figure 16). No obvious relationship between seasonality and treatment processes seemed to exist. The effluent inorganic mercury monitoring record for the SRCSD Sacramento River facility showed relatively constant monthly averages (between 5 ng/l and 7 ng/l) with no apparent seasonal trend (Figure 17). However, effluent inorganic mercury data collected from December 2000 to March 2007 showed an obvious decreasing trend, particularly after 2004 (Figure 18). Furthermore, the effluent inorganic mercury concentrations from 2005 to 2007 had much less variability than the prior years.

4.2.4 Influent Inorganic Mercury

Of the 61 municipal WWTPs that monitored effluent methylmercury, nine WWTPs monitored influent inorganic mercury. Influent inorganic mercury concentrations ranged from 29.0 ng/l at Roseville Pleasant Grove WWTP to 6,100 ng/l at SRCSD Sacramento River WWTP, which is about a 210-fold difference (Figure 19). Two of the nine facilities that collected data had average influent inorganic mercury concentrations less than 100 ng/l, four facilities were between 100 ng/l and 300 ng/l, and 3 facilities had average influent concentrations greater than 300 ng/l. The highest average influent inorganic mercury (2,100 ng/l) observed at a municipal WWTP was about 60 times that of the lowest average concentration (35.5 ng/l).

Because of the limited data set, there was not enough information to discern any seasonal patterns. The Lodi White Slough WWTP had higher influent inorganic mercury concentrations in the fall and winter, the Roseville Pleasant Grove WWTP had higher concentrations in the summer, and two WWTPs (Roseville Dry Creek and Woodland WWTPs) had no discernable pattern (Figure 20).

Board staff compiled influent inorganic mercury data for the SRCSD Sacramento River WWTP collected from December 2000 – December 2004 that were available in a variety of monitoring reports and special study documents in the permit files (SRCSD, 2004; SRCSD, 2005). The influent inorganic mercury data for this four-year period had no interannual (Figure 21) or seasonal trends (Figure 22). The monthly averages for the SRCSD Sacramento River WWTP varied between 120 ng/l and 300 ng/l, with the exception for two months, January and March (Figure 22). These were observably higher than other months as a result of two anomalously high values. One of these two values was collected on 6 January 2004 (6,100 ng/l) and the other on 11 March 2004 (3,400 ng/l). Three other influent samples collected during the four-year period had inorganic mercury concentrations greater than 1,000 ng/l, one each in 2001, 2002 and 2004.

4.2.5 Ratio between Effluent Methylmercury and Influent Methylmercury

The ratios between paired effluent and influent methylmercury concentrations were calculated to determine the methylmercury removal efficiencies of the municipal WWTPs. A percent value less than 100% for a given municipal WWTP indicates that its treatment processes caused a net reduction in methylmercury; a percent value greater than 100% indicates that the plant was a net methylmercury source. Average ratios ranged from 1.1% at El Dorado Hills WWTP (Discharge 2) to 803% at Mariposa WWTP. Of the 23 WWTPs where both effluent and influent methylmercury data were collected, 14 had average effluent:influent methylmercury ratios less than or equal to 10%, and 11 of those had average ratios less than or equal to 5% (Figure 23). In contrast, five WWTPs had average ratios greater than 30%. Municipal WWTPs in the “Secondary + C/D” and “Pond + C/D” treatment categories had lower methylmercury removal efficiencies indicated by higher effluent:influent ratios than WWTPs in all other treatment categories (Figure 24; Table 29; $p<0.04$, Kruskal-Wallis test).

Three facilities (Colusa, Mariposa and SRCSD Walnut Grove WWTPs) had average ratios greater than 100%, indicating that these facilities were net producers of methylmercury. As seen in Figure 23, two of these average effluent:influent methylmercury ratios (254% for Colusa and 803% for Mariposa) were much higher than the average ratios of the remainder of the facilities. The closest value to these is from the SRCSD Walnut Grove WWTP, which had an average ratio of 101%. The Colusa and SRCSD Walnut Grove WWTPs are both in the “Pond + C/D” treatment category, while the Mariposa WWTP is in the “Secondary + C/D” category. These average ratios are based upon one or two paired influent and effluent samples collected at the WWTP. More data is needed to determine if these removal efficiencies are representative of these facilities.

Several facilities exhibited seasonal variability in methylmercury removal (Figures 25 and 26). Lower removal efficiencies indicated by higher ratios occurred during the

summer or fall for some facilities (Grass Valley, Rio Vista, Roseville Dry Creek, Roseville Pleasant Grove and SRCSD Sacramento River WWTPs), and during winter for others (Chico, Deer Creek and El Dorado Hills [Discharge 1] WWTPs). No relationship was apparent between seasonal variability and the type of treatment process.

The methylmercury removal efficiency for SRCSD Sacramento River WWTP's six-year record showed an increasing trend indicated by a decrease in its ratios (Figure 27). These ratios differed temporally, in that the WY2001-2004 period showed much more seasonal variability with higher ratios in the warm season (May – November) than did the ratios for the WY2005-2007 period (Figure 26; $p<0.001$ for both the Mann-Whitney U test and the two sample t-test). This trend between earlier and later time periods was similarly seen in the effluent methylmercury concentrations for SRCSD Sacramento River WWTP and may be the reason for the observed trend in the ratios (Figure 8).

As mentioned in sections 4.2.1 and 4.2.2, decreasing trends were observed both in influent and effluent methylmercury concentrations for the SRCSD Sacramento River WWTP between WY2001 and WY2007 (Figure 9). The decrease in effluent methylmercury concentrations could be partially due to the concurrent decrease in influent concentrations; however, the regression for effluent methylmercury has a steeper decreasing slope (-0.0001) than does the influent line (-0.00008) indicating an improved methylmercury removal efficiency since WY2001 (Figure 9). Furthermore, Figure 27 shows an increasing trend in methylmercury removal efficiency between WY2001 and WY2007.

Staff reviewed scatter plots of paired influent and effluent methylmercury concentrations to determine whether there was a relationship between the two. The paired samples may not represent the same parcels of water due to in-plant residence time. The scatter plot of all paired data from all WWTPs excluding SRCSD Sacramento River WWTP showed a significant positive relationship ($R^2 = 0.1347$, $p<0.0001$; Figure 28a). The scatter plot including data from SRCSD Sacramento River WWTP also showed a statistically significant positive relationship ($R^2 = 0.0715$, $p<0.0001$; Figure 28b). Staff analyzed scatter plots with and without data from SRCSD Sacramento River WWTP because the number of paired data points from the SRCSD Sacramento River WWTP ($n=107$) was relatively high compared to other WWTPs ($n=1$ to 16). These significant relationships indicate that reductions in methylmercury in the effluent were in part due to lower influent concentrations. However, only 7-13% of the variability in effluent methylmercury concentrations was explained by influent concentrations, indicating that effluent concentrations were substantially affected by other factors. Influent methylmercury concentrations alone were not a good predictor of effluent concentrations.

Of the 23 WWTPs that submitted both influent and effluent methylmercury concentration data, 10 WWTPs submitted paired data for five or more sampling events (Figures 29 and 30). When analyzed individually, none of these facilities had significant relationships between influent and effluent methylmercury concentrations except Lodi WWTP ($R^2 = 0.404$, $p<0.03$), UC Davis WWTP ($R^2 = 0.388$, $p<0.04$) and SRCSD Sacramento River WWTP ($R^2 = 0.174$, $p<0.0001$; see Table 30 for R^2 and p-values for each WWTP). All three facilities exhibited positive relationships; however, the significant positive relationship for Lodi WWTP appeared to be driven by one paired data point collected on 13 April 2005 (influent 2.74 ng/l, effluent 1.24 ng/l). When this point was removed, no significant relationship exists ($R^2 = 0.090$, $p>0.05$). Influent versus effluent methylmercury scatter plots for SRCSD Sacramento River WWTP indicated a significant positive relationship for the paired data collected during the cool season (December through April; $R^2 = 0.262$, $p<0.001$), but not during the warm season (May through November; $R^2 = 0.015$, $p>0.05$; Figure 30). Again, only about 26% of the variability in cool season effluent methylmercury concentrations was explained by influent concentrations, which indicates that effluent methylmercury concentrations were affected by other factors as well.

4.2.6 Ratio between Effluent Methylmercury and Effluent Inorganic Mercury

The ratios between paired effluent methylmercury and effluent inorganic mercury concentrations were calculated to estimate the percentage of inorganic mercury as methylmercury in the effluent and to see if differences exist between treatment types. Average ratios ranged from 0.60% at Discovery Bay WWTP to 28% at Nevada County Sanitation District #2 Lake of the Pines WWTP. Of the 28 WWTPs where both methylmercury and inorganic mercury were analyzed in the effluent, 24 had average effluent methylmercury:inorganic mercury ratios less than or equal to 10%, and 19 of those had average ratios less than or equal to 5% (Figure 31). Only four discharges had average ratios greater than 10%. The average effluent methylmercury:inorganic mercury ratio for SRCSD Sacramento River WWTP was 10%; the ratio appeared to increase slightly from WY2001 to WY2007 (Figure 32).

Municipal WWTPs in the “Pond + Filtration + C/D” maximum treatment category had higher effluent methylmercury:inorganic mercury ratios than WWTPs in all other treatment categories except for the “Pond + C/D” category (Figure 33; Table 31; $p<0.03$, Kruskal-Wallis test). In addition, the “Pond + C/D” and “Secondary + C/D” categories had higher ratios than the “Secondary w/ N/D + UV”, “N/D + Filtration + C/D” and “Filtration + UV” categories ($p<0.01$, Kruskal-Wallis test).

Five municipal WWTPs appeared to have well-defined seasonal variability in their effluent methylmercury:inorganic mercury ratios (Figures 34 and 35). The following WWTPs appeared to experience an increase in their ratio in the spring and/or summer: Davis (Discharges 1 and 2), Manteca, Placer County SMD #1, SRCSD Sacramento

River, and Stockton. No discernable relationship between the seasonal variability of the ratios and the types of treatment processes were apparent.

Staff reviewed scatter plots to determine whether there was a relationship between effluent methylmercury and inorganic mercury concentrations. The scatter plot of all paired data from all WWTPs excluding SRCSD Sacramento River WWTP showed a significant positive relationship ($R^2 = 0.0431$, $p<0.01$; Figure 36a). The anomalous value collected at Woodland WWTP on 9 December 2004 (THg: 53.1 ng/l, MeHg: below detection limit of 0.025 ng/l) appeared to strongly influence the trend-line. The scatter plot after removing the anomalous paired data-point continued to indicate a statistically significant positive relationship ($R^2 = 0.0779$, $p<0.0001$). The scatter plots including data from SRCSD Sacramento River WWTP also showed significant positive relationships with ($R^2 = 0.0704$, $p<0.0001$) and without the Woodland WWTP outlier ($R^2 = 0.1155$, $p<0.0001$; Figure 36b). Only 4-12% of the variability in effluent methylmercury concentrations was explained by effluent total mercury concentrations for the different WWTPs, indicating that effluent concentrations were substantially affected by other factors.

Of the 28 WWTPs that submitted effluent methylmercury and inorganic mercury concentration data for a total of 29 discharges, 20 WWTPs submitted paired data for five or more sampling events (Figures 37 and 38). Some WWTPs appeared to have positive relationships between effluent methylmercury and inorganic mercury, however only four facilities (Discovery Bay, Stockton, SRCSD Sacramento River and Davis WWTPs) had a statistically significant relationship (Discovery Bay : $R^2 = 0.551$, $p<0.03$; Stockton: $R^2 = 0.67$, $p<0.01$; SRCSD: $R^2 = 0.0775$, $p<0.01$; Davis: $R^2 = 0.4445$, $p<0.02$; Table 32). Seasonal scatter plots for SRCSD Sacramento River WWTP did not indicate significant positive relationships for all of the paired data collected from WY2001 to WY2007 for both the warm (May through November; $R^2 = 0.061$, $p>0.05$) and cool (December through April; $R^2 = 0.071$, $p>0.05$) seasons (Figure 38).

4.2.7 Ratio between Effluent Methylmercury and Influent Inorganic Mercury

The ratios between paired effluent methylmercury and influent inorganic mercury concentrations were calculated to determine if a relationship existed between influent inorganic mercury and effluent methylmercury, and to explore how the ratios may relate to treatment processes. Ultimately, it would be very useful to know whether reducing influent inorganic mercury concentrations (e.g., by implementing mercury source minimization measures[5]) would result in reductions in effluent methylmercury, and if so, by how much.

[5] For example, residential drop-off programs for mercury-containing products and best management practices for hospitals, dentists, other medical facilities, laboratories, and pottery studios.

Average ratios ranged from 0.0005% at the Lincoln WWTP to 1.85% at the Davis WWTP (Discharge 1) (Figure 39). The average effluent methylmercury:influent inorganic mercury ratio for SRCSD Sacramento River WWTP was 0.45%; the ratio did not appear to change from December 2000 to December 2004 (Figure 40). Two of the five facilities with more than six paired samples (Lodi White Slough and SRCSD Sacramento River WWTPs) had an apparent seasonal pattern, with an increase in effluent methylmercury:influent inorganic mercury ratio in the summer (see Figures 41 and 42).

Staff reviewed scatter plots to determine whether there was any relationship between effluent methylmercury and influent inorganic mercury concentrations. The scatter plots of all paired data for all WWTPs with and without the SRCSD Sacramento River WWTP data showed no relationship (with SRCSD: $R^2 = 0.0026$, $p>0.05$, Figure 43a; without SRCSD: $R^2 = 0.0206$, $p>0.05$, Figure 43b). The relationship between effluent methylmercury and influent inorganic mercury loads may present a different conclusion, but was not assessed in this report.

Of the nine municipal WWTPs that submitted effluent methylmercury and influent inorganic mercury concentration data, five facilities submitted paired data for five or more sampling events. No relationships between effluent methylmercury and influent inorganic mercury were observed for any of these five facilities individually (Figures 44 and 45a; Table 33). Scatter plots for SRCSD Sacramento River WWTP showed no relationship for data collected from December 2000 to December 2004 (all data: $R^2 = 0.0017$, $p>0.05$; warm season: $R^2 = 0.0311$, $p>0.05$; cool season: $R^2 = 0.0182$, $p>0.05$; Figure 45a). After removing the paired data that included the anomalously high value collected on 6 January 2004 (6,100 ng/l) at the SRCSD Sacramento River WWTP, the scatter plots still indicated no significant relationships (all data: $R^2 = 0.0045$, $p>0.05$; warm season: $R^2 = 0.0311$, $p>0.05$; cool season: $R^2 = 0.0044$, $p>0.05$; Figure 45b).

The SRCSD District Engineer presented a chart of annual influent inorganic mercury and effluent methylmercury loads for 2001 through 2007 during testimony for the April 2008 hearing for the Delta mercury control program (see Figure 46). The SRCSD District Engineer indicated that the WWTP's effluent inorganic mercury and methylmercury decreased as a result of influent inorganic mercury decreases associated with the initiation of their "Be Mercury Free" source control program. This additional influent inorganic mercury data from 2005 to 2007 was not available at the time this report was written.

4.2.8 Ratio between Effluent Inorganic Mercury and Influent Inorganic Mercury

The ratios between paired effluent and influent inorganic mercury concentrations were calculated to determine by how much the municipal WWTPs reduced inorganic mercury- the lower the ratio, the higher the removal efficiency. Average ratios ranged

from 0.6% at the Woodland WWTP to 27% at the Merced WWTP (Figure 47). Of the eight WWTPs that submitted paired influent and effluent inorganic mercury data, five of the facilities had average effluent:influent inorganic mercury ratios less than or equal to 5%, and two had average ratios greater than 15%. No discernable relationship between removal efficiency and the types of treatment processes were observed.

Two of the five facilities with six or more paired samples had an apparent seasonal pattern (Figures 48 and 49). The Lodi White Slough WWTP appeared to have a lower inorganic mercury removal efficiency during the summer, while the Roseville Dry Creek appeared to have a lower removal efficiency during the winter-spring. The ratios for the SRCSD Sacramento River WWTP showed no seasonal patterns (Figure 49).

Scatter plots of all paired data for all WWTPs with and without the SRCSD Sacramento River WWTP data showed no relationships between effluent and influent inorganic mercury concentrations (with SRCSD: $R^2 = 0.0004$, $p>0.05$; without SRCSD: $R^2 = 0.0029$, $p>0.05$; Figure 50). No relationships were indicated by individual WWTP scatter plots as well, though some facilities were more effective at removing inorganic mercury (Figure 51 and Table 34). Scatter plots for SRCSD Sacramento River WWTP showed no significant relationships for the paired data collected from December 2000 to December 2004 (all data: $R^2 = 0.0004$, $p>0.05$; warm season: $R^2 = 0.0038$, $p>0.05$; cool season: $R^2 = 0.0045$, $p>0.05$; Figure 52); however, the scatter plots indicate that as influent concentrations increased, effluent concentrations did not increase.

The average effluent:influent inorganic mercury ratio for SRCSD Sacramento River WWTP was 5.1%; the ratio did not appear to change from December 2000 to December 2004 (Figure 53). The inorganic mercury removal efficiency during this period was consistently high with an average of about 95%, indicating that the SRCSD Sacramento River WWTP was effective in removing most of the inorganic mercury from the waste stream. As mentioned in Section 4.2.3, there was an observed decreasing trend in effluent inorganic mercury from WY2001-2007, particularly from 2005 to 2007. However, as indicated earlier, Board staff does not have influent inorganic mercury data after 2004 and was unable to compare effluent and influent concentrations during this later period.

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5 ESTIMATION OF METHYLMERCURY LOADS FROM CENTRAL VALLEY DISCHARGERS

In response to comments from the Sacramento Regional County Sanitation District on the May 2009 draft report, an additional chapter was added to this report to assess the relative contribution of methylmercury loading to the Delta from NPDES facilities in and upstream of the Delta. This chapter describes the methods used to calculate methylmercury and total mercury loads discharged by the different types of NPDES facilities and provides a brief review of loads by facility type and watershed.

All of the mass load calculations are based on the following equation:

$$M_x = C_x * V$$

Where: M_x = Mass of constituent, X

C_x = Concentration of constituent, X, in mass per volume

V = Volume of effluent

For example, the annual methylmercury load discharged for the Stockton WWTP was calculated as follows:

$$M_x = (0.935 \text{ ng/l} \div 10^9) * (28 \text{ mgd} * 365 * 10^6 * 3.7854118) = \mathbf{36\ g/year}$$

Where: M_x = Mass of methylmercury (grams per year)

C_x = Concentration of methylmercury (ng/l) converted to grams per liter

V = Volume of effluent (million gallons per day) converted to liters per year

Not all facilities in the Central Valley were required to collect methylmercury and/or total mercury by the 2004 13267 Order or by their existing permit requirements. In addition, some facilities only recently began to discharge to surface water; some of these have collected effluent methylmercury and total mercury data and others have not. Table B.5 in Appendix B includes the effluent concentration and volume values used to estimate the loads discharged by each facility. For facilities that have not yet collected effluent total mercury or methylmercury concentration data, staff used the average of concentration data available for similar facilities to calculate the loads and noted where this was done in Table B.5.

Some facilities have ceased to discharge to surface water since effluent methylmercury and total mercury concentration data were collected. Data for such facilities, as well as data for facilities upstream of major dams, were included in the calculation of average methylmercury and total mercury concentrations by facility type used to estimate effluent loads for facilities with no effluent concentration data. Table B.5 does not

include all facilities located upstream of major dams because few of these were required to collect methylmercury data by the 2004 13267 Order. Also, Table B.5 includes several facilities for which total mercury data were available but methylmercury data were not, especially in the tributary watersheds upstream of major dams.

Tables 35 and 36 provide the sums of the annual total mercury loads and methylmercury loads, respectively, discharged by NPDES facilities within each discharger category in the Delta/Yolo Bypass and its tributary watersheds downstream of major dams. Table 37 compares the sum of annual methylmercury loads discharged by NPDES facilities to the sum of all point and nonpoint source methylmercury loading to each Delta subarea identified in the February 2010 Delta TMDL Staff Report (Wood *et al.*, 2010b, Table 8.4). As noted earlier, power, heating/cooling, and aquaculture facilities that use ambient water for cooling water do not appear to act as a net source of methylmercury to receiving waters and therefore are not included. GWF Power Systems is included because it acquires its intake water from sources other than ambient surface water. Only facilities that were discharging during the TMDL methylmercury load evaluation period (WY2000-2003) and/or the total mercury load evaluation period (WY1984-2003) were included in Tables 35, 36 and 37.

Effluent total mercury concentration data were not available for any of the facilities within the food, laboratories, and port terminal categories, and consequently these categories are not included in the load summaries described in Table 35. Because these facilities account for only about a quarter of a percent of the discharge volume from NPDES facilities in the Delta source region, they likely do not affect our understanding of relative contributions from different point and nonpoint sources.

As shown in Tables 35 and 36, about 96% (3,435 g/yr) of the total mercury loading from all NPDES facilities (3,586 g/yr) and more than 99% (228 g/yr) of the methylmercury loading from all NPDES facilities (229 g/yr) comes from municipal WWTPs. About 67% of the total mercury loading from all NPDES facilities and about 89% of the methylmercury loading from all NPDES facilities comes from facilities within the Delta/Yolo Bypass. A comparison of Table 36 to Table B.5 in Appendix B indicates that nearly 90% of the methylmercury loading from the 61 municipal WWTPs that discharge to the Delta and its tributary watersheds downstream of major dams comes from two WWTPs, the SRCSD Sacramento River WWTP (161 g/yr, 71%) and Stockton WWTP (36 g/yr, 16%). This is not surprising given the most populous urban areas in the Sacramento and San Joaquin Basins (the Delta's primary source region) – Sacramento in Sacramento County and Stockton in San Joaquin County – are adjacent to and within the Delta (CDOF, 2007; Wood *et al*., 2010b, Figure 6.9).

The Delta methylmercury TMDL divides the Delta into eight subareas based on the hydrologic characteristics and mixing of the source waters (Wood *et al.*, 2010b). A separate methylmercury reduction strategy was developed for each subarea because

the levels of impairment and the methylmercury sources in the subareas are substantially different (Wood *et al.*, 2010a and 2010b). Table 37 compares the methylmercury loads discharged by NPDES facilities within the Delta and its tributary watersheds downstream of major dams to the total methylmercury loading to each subarea from point and nonpoint sources within the Delta and its tributary inputs.

Overall, NPDES facilities account for about 4% of the methylmercury load to the Delta; NPDES facilities within the Delta contribute about 205 grams per year (g/year) while facilities in upstream watersheds that are downstream of major dams contribute about 24 g/year. The Delta TMDL divides the Delta into hydrologically-defined subwatershed areas; different sources supply the different areas. For example, NPDES facilities within the San Joaquin River and Sacramento River subareas contribute about 7-9% of all methylmercury loading to those subareas, while NPDES facilities within the Central Delta, West Delta, and Yolo Bypass subareas contribute less than 0.2% of all methylmercury loading to these subareas. For some receiving waters (e.g., in the Sacramento and San Joaquin subareas), reducing municipal WWTP methylmercury discharges, along with reductions from other point and nonpoint sources, may be an important component in reducing methylmercury levels in ambient water. For example, the Sacramento River is the largest river in California and drains a 27,000 square-mile area – almost one fifth of the State of California and about one half of the Central Valley – that contains numerous reservoirs and a myriad of point and nonpoint sources downstream of the reservoirs. As noted as early as 1997 in the Sacramento River Mercury Control Planning Project report prepared for SRCSD by Larry Walker Associates, "… mercury sources in the study area appear to be diffusely distributed without any significant "hotspots" …" (LWA, 1997, page 31). As a result, any individual discharge from a point or nonpoint source that provides a notable percentage (e.g., more than 1%) of methylmercury loading to the Sacramento River warrants evaluation.

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6 DISCUSSION & NEXT STEPS

The non-municipal NPDES facilities in the Delta source region typically had low effluent methylmercury concentrations (Table 17). Aquaculture and power generation facilities appeared to be neither significant sources nor sinks of methylmercury. More data is necessary to determine if the other facilities in these two categories and heating/cooling facilities are net methylmercury sources or sinks. The aggregate, paper/saw mills, groundwater remediation, drinking water treatment, and other non-municipal facilities were sources of methylmercury but typically had very low effluent methylmercury concentrations (average of 0.05 ng/L; see Table 17). Of the 198 effluent methylmercury samples submitted by non-municipal facilities, 134 were less than or equal to 0.05 ng/l, and 80 of those were below the method detection limit (typically less than 0.025 ng/l). The highest effluent methylmercury concentration observed in the non-municipal facilities was 1.91 ng/l from a stormwater detention pond at the SPI Shasta Lake Mill; all other sample results from the mill and other non-municipal facilities were less than 0.2 ng/l.

Municipal WWTPs contribute the most discharge (by volume and methylmercury load) to the Delta source region of any one facility category and had average effluent methylmercury concentrations that ranged from non-detect (<0.02 ng/l) to 2.9 ng/l, about a 150-fold difference. Twenty of the 61 Central Valley municipal WWTPs that submitted effluent data had average effluent concentrations less than 0.05 ng/l, and 13 WWTPs had averages less than 0.03 ng/l. In contrast, 18 WWTPs had average effluent methylmercury concentrations greater than 0.2 ng/l, and seven had averages greater than 1 ng/l.

To begin the process of evaluating whether and how methylmercury discharges from municipal WWTPs may be reduced, Board staff conducted a literature review. In addition, staff evaluated treatment process information for Central Valley municipal WWTPs and available methylmercury and inorganic mercury concentration data for influent and effluent. The reviews indicate several trends that merit additional investigation:

- Central Valley WWTPs that use treatment pond systems (oxidation, facilitative, settling or stabilization ponds) as a significant part of their treatment process had the highest effluent methylmercury concentrations. The “Pond + C/D” and “Pond + Filtration + C/D” treatment categories had significantly higher effluent methylmercury values than all other treatment categories, with one exception. The “Pond + Filtration + C/D” category did not have significantly higher effluent methylmercury concentrations than the “Secondary + C/D” category. Similarly in Canada, the West End WWTP, which was the only facility of the three City of Winnipeg treatment plants that has treatment ponds in its treatment process, also had higher effluent methylmercury concentrations than the other two City of Winnipeg treatment plants.

- Municipal WWTPs in the “Secondary + C/D” and “Pond + C/D” treatment categories had lower methylmercury removal efficiencies indicated by significantly higher effluent:influent ratios than WWTPs in all other treatment categories.
- Mercury-contaminated trickling filters at the Fritz Island WWTP in Pennsylvania acted as a substantial source of both inorganic mercury and methylmercury to the plant’s effluent. The average effluent methylmercury concentration at the Fritz Island WWTP was approximately 4 ng/l. Likewise in Central Valley WWTPs, within the “Secondary + C/D” and “Tertiary + C/D” treatment categories, the “Fixed Media” subcategory, which includes trickling filters, had average effluent methylmercury concentrations of 0.22 ng/l and 0.12 ng/l, respectively. Within the “Filtration + C/D” category, the “Fixed Media” subcategory had significantly higher effluent methylmercury concentrations than the “Activated Sludge” subcategory.
- Central Valley WWTPs that have some combination of nitrification/denitrification (N/D), filtration, and ultraviolet (UV) disinfection generally had lower effluent methylmercury concentrations. The “N/D + Filtration + C/D”, “Secondary w/ N/D + UV”, “N/D + Filtration + UV”, “Filtration + UV”, “Secondary w N/D + C/D” and “Filtration + C/D” treatment categories all had significantly lower effluent methylmercury concentrations than the “Secondary + C/D”, “Pond + C/D” and “Pond + Filtration +C/D” categories. In addition, the “N/D + Filtration + C/D” category had significantly lower effluent methylmercury concentrations than the “Secondary w/ N/D + C/D” and “Filtration + C/D” categories, suggesting that both the filtration and nitrification/denitrification treatment processes may have played a role in the decrease in the methylmercury concentrations of these facilities.
- Each secondary treatment subcategory within the “Filtration + C/D” category had significantly lower average and median effluent methylmercury concentrations than the same subcategory within the “Secondary + C/D” category, which suggests that the filtration treatment process may have assisted in the reduction of methylmercury in the effluent of these facilities.
- Several published studies investigated methylmercury at WWTPs that use conventional activated sludge treatment. The effluent methylmercury concentrations were variable with averages of 0.04 ng/l at the San Jose/Santa Clara WWTP, 0.2 ng/l to greater than 2 ng/l at the West End WWTP in Canada, and 1.53 ng/l at the Onondaga County Metropolitan WWTP in New York. Treatment ponds are used at the West End WWTP in Winnipeg, which could explain the elevated effluent methylmercury. The Onondaga County WWTP had an average influent methylmercury concentration of 5.05 ng/l and a removal efficiency of 70%. The methylmercury removal efficiency of the SJ/SC WWTP was 97%. The higher methylmercury removal efficiency of the SJ/SC WWTP could have been due to differences in other treatment processes. Nitrification and denitrification are incorporated in the activated sludge process of the SJ/SC WWTP and tertiary filtration is used as well, while neither is used in the Onondaga County WWTP.
- The SRCSD Sacramento River WWTP and SJ/SC WWTP had similar average influent methylmercury concentrations (1.55 ng/l and 1.6 ng/l, respectively).

However, the SJ/SC WWTP secondary treatment resulted in a much lower average secondary effluent methylmercury concentration (0.05 ng/l) than the SRCSD WWTP (0.38 ng/l). The secondary treatment process of the SRCSD Sacramento River facility is pure oxygen activated sludge without nitrification and denitrification. The differences in methylmercury removal efficiency between the two WWTPs may be either due to the pure oxygen activated sludge, nitrification/denitrification or both.

- The San Jose/Santa Clara WWTP study observed a methylmercury removal efficiency of 40% between the tertiary filter influent (0.05 ng/l) and final effluent (0.03 ng/l). Given the low concentrations, this is a small reduction when compared to the methylmercury removal efficiency of 96% between the secondary influent (1.3 ng/l) and secondary effluent (0.05 ng/l) (see Table 2). This suggests that most of the methylmercury removal occurred during the secondary treatment process.
- Significant relationships between influent and effluent methylmercury concentrations existed for all the paired data from the Central Valley WWTPs. This indicates that reductions in methylmercury in the effluent were in part due to lower influent concentrations. However, 7-13% of the variability in effluent methylmercury concentrations was explained by influent concentrations, indicating that effluent concentrations were affected by other factors as well.
- Seasonal variability was observed in effluent methylmercury concentrations at several Central Valley WWTPs, as well as WWTPs evaluated elsewhere. The City of Winnipeg's West End Plant, which utilizes conventional activated sludge and treatment ponds, had a seasonal trend in its effluent methylmercury concentrations, while its two other plants, which use pure oxygen activated sludge and no treatment ponds, did not have a seasonal trend. At the West End Plant, methylmercury concentrations increased as ambient temperatures increased, with the highest concentration occurring in August. The Onondaga County Metropolitan WWTP, which uses conventional activated sludge, demonstrated that warm temperatures were a catalyst for the methylation process to occur, apparently in both the environment as well as through the treatment process. For the several Central Valley WWTPs where seasonal variability was observed, the effluent methylmercury concentrations were higher in the warm season (e.g., May through November), and lower in the cool season. No obvious relationship between seasonality and the treatment processes of the Central Valley WWTPs seemed to exist.
- Methylmercury production occurred during the secondary activated sludge treatment process at the Onondaga County WWTP. McAlear (1996) hypothesized that mercury methylation occurred in anoxic micro-zones within the activated sludge flocs. A correlation between high concentrations of biological solids and mercury methylation during the activated sludge process was discovered at the Whitlingham Sewage Treatment Works (Goldstone *et al.*, 1990).
- The SRCSD study demonstrated that the removal of solids may have been a removal mechanism for methylmercury; however, inorganic mercury had a greater particle affinity than methylmercury and was removed more efficiently by solids

removal (Parmer *et al.*, 2005). In the Whitlingham Sewage Treatment Works study, the centrifugation and filtration of return activated sludge samples indicated that methylmercury had a greater affinity for the particulate phase of the return activated sludge than for the soluble phase. From the literature reviewed, it appears that the inorganic mercury and methylmercury removed from wastewater is partially due to the removal of solids, with the mechanism being more efficient for inorganic mercury. Board staff did not evaluate this relationship further for the Central Valley WWTPs because of their limited data set; however, this merits additional investigation.

- SRCSD WWTP's influent methylmercury concentrations and effluent inorganic mercury and methylmercury concentrations and loads decreased between 2001 and 2007. This decrease was attributed to a decrease in influent inorganic mercury associated with the initiation of SRCSD's "Be Mercury Free" source control program. No similar pattern was noted between influent inorganic mercury and effluent methylmercury at any other WWTP in the Central Valley.

Municipal WWTPs have multiple treatment processes and the factors affecting methylmercury production and degradation are complex. As a result, the differences in effluent methylmercury concentrations among the Central Valley WWTPs are most likely due to multiple factors and different combinations of treatment processes. Furthermore, a few of the treatment categories evaluated contained only one or two WWTPs, resulting in a limited data set for those categories. Therefore, the data of some of the treatment categories may not be representative of other WWTPs that utilize the same treatment processes. Also, of the 61 WWTPs that submitted effluent methylmercury data, only 23 submitted influent methylmercury data, and only nine submitted influent inorganic mercury data. Therefore, comparisons among WWTPs and treatment categories were done without correcting for influent inorganic mercury and methylmercury concentrations. In addition, influent inorganic mercury and methylmercury concentrations often had substantial day-to-day variability. As a result, comparisons between influent and effluent samples collected on the same day may not be appropriate, depending on the residence time of the wastewater in a particular plant.

The Central Valley Clean Water Association (CVCWA) has conducted a preliminary evaluation of effluent methylmercury data for a subset of WWTPs evaluated in this report. CVCWA's preliminary evaluation similarly found that WWTPs that incorporate any significant effluent storage (e.g., ponds) have higher methylmercury concentrations, and WWTPs with activated sludge treatment processes that result in a fully-denitrified, low ammonia effluent also have lower effluent methylmercury concentrations (Pirondini, 2008b). After completing the QA/QC review of the available effluent and influent methylmercury concentration data (see Chapter 3), Board staff forwarded the completed database to CVCWA so that they could continue a more detailed evaluation.

Additional analyses are needed to continue the evaluation of potential relationships between WWTP treatment processes, mercury minimization measures for mercury

sources to WWTP influent, and effluent methylmercury levels. Board staff and WWTP staff and consultants have informally discussed several ideas for future analyses and key questions to be addressed by those analyses. Some analyses would not require additional influent and effluent sampling, for example:

- Conduct more detailed, focused analyses of the data presented in this report.
- Gather more information about the influent and effluent samples described in this report, for example (but not limited to): specific sampling locations, depths, and time of day; influent inorganic mercury concentrations; pH, alkalinity, dissolved oxygen, temperature, and nitrate, sulfate and ammonia concentrations; and specific treatment processes in place at the time of sample collection.
- Do other factors impact reported concentrations, such as sampling protocols including location, time of day, holding time and composite vs. grab samples?

In addition, the data set presented in this report needs to be updated, with special attention given to facilities that have recently completed treatment process upgrades. For example, the City of Stockton WWTP was upgraded to meet new ammonia effluent limits and Title 22 (or equivalent) tertiary requirements since the data presented in this report were collected. The average effluent methylmercury and total mercury concentrations for January-July 2009 are about 91% and 83% lower than the annual average methylmercury and total mercury concentrations, respectively, observed in 2004/2005. It is not known if the treatment plant upgrades are responsible for the total mercury and methylmercury reductions, or if the reductions are a result of other operational or physical changes. Additional sampling may be needed to determine the cause of the decrease. In addition, methylmercury results for only seven monthly effluent samples have been submitted since the upgrades were completed. As more data are collected, Board staff will work with City of Stockton staff to evaluate whether the above trends are representative of current conditions.

Also, at the time this report was receiving final review, reports for Phases 1 and 2 of the WERF-funded project, "Estimation of Mercury Bioaccumulation Potential from Wastewater Treatment Plants in Receiving Waters", were released (Dean and Mason, 2009a and 2009b). This project assessed changes in mercury bioavailability in wastewater effluents and receiving waters and developed a guidance document for wastewater treatment professionals who want to assess the bioavailability of mercury in their wastewater, compare it to other point and nonpoint sources, and assess changes in bioavailability in their effluent when it is mixed in a receiving water body. The Phase 1 and 2 reports should be considered by future wastewater analyses and control studies, as well as when the Delta mercury TMDL control program goes through future reviews during its implementation.

After additional analyses of existing data are completed, it may be useful to conduct targeted monitoring and pilot scale studies where actual sewage flow may be used to evaluate specific treatment processes and variations.

Possible questions that could be addressed by future analyses include, but are not limited to, the following:

- Do relationships exist between nitrate, ammonia, sulfate, sulfite and TSS concentrations and methylmercury concentrations throughout the treatment process? If so, could treatment processes designed to reduce effluent ammonia also reduce effluent methylmercury?
- Are tertiary treatment processes effective in significantly reducing methylmercury concentrations within a WWTP? What are the affects of filtration and UV treatment on effluent methylmercury?
- Why do some WWTPs have seasonality in their effluent methylmercury concentrations and others do not? What are the causes behind the seasonality observed in methylmercury concentrations?
- Do influent and effluent methylmercury concentrations have any diurnal variability, and if so, what are the causes?
- Is it feasible to modify the biological secondary processes at some plants to increase methylmercury degradation? If so, can “real-time” indicators (e.g., pH or alkalinity) be developed so that plant operators can make immediate adjustments (versus having to wait several weeks for methylmercury analyses)?
- Do WWTPs that use pond systems or other treatments act as greater sources of inorganic mercury and/or methylmercury than WWTPs that utilize other treatment systems?
- How much are effluent inorganic mercury and methylmercury concentrations reduced by reducing influent inorganic mercury concentrations and/or loads (e.g., by implementing inorganic mercury source minimization measures)?

Several Central Valley WWTP staff and consultants have noted that it would be very helpful to establish a working group that coordinates efforts between CVCWA, San Francisco Bay area facilities, and other regional efforts to develop more detailed analyses of the existing information, further evaluate treatment processes, and design additional monitoring studies and pilot projects. Board staff is supportive of this concept and will work with dischargers and working groups to design and review studies.

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TABLES

Table 1: Summary of Literature Review

Facility	Citation	Secondary Treatment	Tertiary Treatment (if any)	Influent MeHg (ng/l)	Influent MeHg: TotHg Ratio [(a)]	Post-Secondary Treatment MeHg (ng/l)	Post-Secondary Treatment MeHg:TotHg Ratio [(a)]	Final Effluent MeHg (ng/l)	Final Effluent MeHg: TotHg Ratio [(a)]	Comments
San Jose / Santa Clara Water Pollution Control Plant	SJ/SC, 2007	Activated sludge with nitrification/ denitrification	Filtration	1.57	0.94%	0.05	0.87%	0.04	2.0%	
Sacramento Regional Wastewater Treatment Plant	Parmer and others, 2005	Pure oxygen activated sludge		1.55	0.80%	0.38	7.7%	0.55	12%	180 MGD activated sludge plant. Slight rise in final effluent MeHg.
City of Winnipeg: North End, West End & South End Water Pollution Control Centres	Bodaly and others, 1998	North and South End: Pure oxygen activated sludge West End: Conventional diffused air activated sludge	West End only: Treatment lagoons	Average of all three plants: 2.2 (range: 0.5 - >4)		Not reported		North and South End: 0.13 - 0.56 West End: 0.2 - >2		Pure oxygen aeration exhibited greater removal efficiency of MeHg in effluent.
Pilot-scale activated sludge plant	Pavlogeor-gatos and others, 2006	Activated sludge		<70 (MDL: 0.07 µg/l)				<70 (MDL: 0.07 µg/l)		Pilot scale activated sludge study using synthetic wastewater containing glucose and ammonia. Spiked Hg concentrations of 10, 100, and 500 µg/l added directly to aeration tanks. No RAS; secondary sludge returned to aeration tanks.
Onondaga County Metropolitan Wastewater Treatment Plant	McAlear, 1996	Activated sludge	Phosphorous removal (addition of $FeSO_4$)	5.05	1.84%	2.76	21%	1.53	8.3%	
Fritz Island Wastewater Treatment Plant	Gilmore and Bloom, 1995	Trickling filters		3.0	1.92%	9.1	3.2%	4.0	3.7%	

Table 1: Summary of Literature Review

Facility	Citation	Secondary Treatment	Tertiary Treatment (if any)	Influent MeHg (ng/l)	Influent MeHg: TotHg Ratio [(a)]	Post-Secondary Treatment MeHg (ng/l)	Post-Secondary Treatment MeHg:TotHg Ratio [(a)]	Final Effluent MeHg (ng/l)	Final Effluent MeHg: TotHg Ratio [(a)]	Comments
Whitlingham Sewage Treatment Works	Goldstone and others, 1990	Activated sludge		11		120		< 10		

[(a)] Staff calculated the MeHg:TotHg ratios for the SJ/SC WWTP and Fritz Island WWTP studies using the average inorganic mercury and methylmercury data provided in their respective reports. The ratios for the SRCSD WWTP and Onondaga County WWTP studies were obtained from the reports.

Table 2: Total Mercury and Methylmercury Concentrations at the San Jose/Santa Clara WWTP

Sample Location	Average TotHg Conc. (ng/l)	Average Dissolved TotHg Conc. (ng/l)	Average MeHg Conc. (ng/l)	MeHg:TotHg Ratio [c]
Raw Sewage	168	2.9	1.6	0.9%
Primary Effluent	92	4.0	1.5	1.6%
Secondary Influent [a]	79	3.6	1.3	1.6%
Secondary Effluent [b]	5.2	1.1	0.05	0.87%
Filter Influent	5.1	1.2	0.05	0.98%
Tertiary Filter Effluent	1.6	1.2	0.03	1.9%
Filter Backwash	1.9	2.1	0.11	5.8%
Final Effluent	2.0	1.4	0.04	2.0%

[a] The SJ/SC WWTP study refers to the secondary influent as "Settled Sewage Influent to Secondary Units".
[b] The secondary treatment process consists of two pathways that are identical in function (biological nutrient removal) and receive the same influent. These numbers are averages of the effluent concentrations of the two pathways.
[c] Staff calculated the MeHg:TotHg ratio from the inorganic mercury and methylmercury data provided in the report.

Table 3: Phase 1A and 1B Total Mercury Concentrations, Mass Loads and Particulate Concentrations at the SRCSD Sacramento WWTP

Location [a]	Average TotHg Conc. (ng/l)	TotHg Mass Load (g/day)	TotHg Particulate Concentration (ng/g) [b]
Influent	192.33	131	1100
Primary Effluent	50.91	35	490
Mixed Liquor	693.33	660	408
Secondary Effluent	4.92	3.3	300
Dechlorinated Final Effluent	4.64	3	305
Waste Activated Sludge	1800	35.13	
Digested Sludge	12,333	60.36	800
Green SSB	170		350
Black SSB	430		770
Harvest SSB	990		1700
BRF Influent	13,166.67	23.92	800
SSB Return Flow	253.33	4.24	740
BRF Return Flow	150.67	0.47	580

[a] SSB: Solids Storage Basins BRF: Biosolids Recycling Facility
[b] Inorganic mercury particulate concentrations obtained from Table 9 in the SRCSD report.

Table 4: Phase 1A and 1B Methylmercury Concentrations, Mass Loads and Particulate Concentrations at SRCSD

Location [a]	Average MeHg Conc. (ng/l)	MeHg Mass Load (g/day)	MeHg Particulate Conc. (ng/g) [b]	MeHg:TotHg Ratio
Influent	1.55	1.06	4.93	0.80%
Primary Effluent	1.34	0.91	7.3	2.6%
Mixed Liquor	11.77	11.2	6.5	
Secondary Effluent	0.38	0.26	20.4	7.7%
Dechlorinated Final Effluent	0.55	0.36	33	12%
Waste Activated Sludge	30.72	0.5988	6.2	
Digested Sludge	245.88	1.176	13.01	
Green SSB	4.66		9.5	
Black SSB	18.35		32.4	
Harvest SSB	13.05		22	
BRF Influent	208.2	0.3585	13.5	
SSB Return Flow	7.39	0.1207	19	2.9%
BRF Return Flow	7.21	0.0215	24.2	5.5%

[a] SSB: Solids Storage Basins BRF: Biosolids Recycling Facility
[b] Methylmercury particulate concentrations obtained from Table 9 in the SRCSD report.

Table 5: Average Total Mercury, Methylmercury and TSS concentrations at the Onondaga County WWTP for the Entire Sampling Period (October 1995 to September 1996)

Location	Average TotHg Conc. (ng/l)	Average MeHg Conc. (ng/l)	MeHg:TotHg Ratio	Average TSS Conc. (mg/l)
Plant Influent	308	5.05	1.8%	206
Primary Effluent	112	1.92	2.2%	88.5
Secondary Effluent	24.0	2.76	21%	26.2
“Tertiary” Effluent	32.9	2.63	14%	9.48
Final Effluent	36.8	1.53	8.3%	11.7

Table 6: Seasonal Average Methylmercury Concentrations at the Onondaga County WWTP [a]

Location	Average Cold Weather (November to April) MeHg Conc. (ng/l)	Average Warm Weather (May to October) MeHg Conc. (ng/l)
Plant Influent	2.34	7.76
Primary Effluent	2.03	1.77
Secondary Effluent	1.94	3.49
"Tertiary" Effluent	2.40	2.87
Final Effluent	1.43	1.63

[a] Staff calculated the primary, secondary and "tertiary" effluent average concentrations for both the warm and cold weather periods from raw data provided in the Appendix of the report.

Table 7: Total Mercury and Methylmercury Concentrations in the Fritz Island WWTP Inputs and Outputs

Location	Total Mercury			Methylmercury		
	# of Samples [a]	Conc. Range (ng/l)	Average Conc. (ng/l)	# of Samples [a]	Conc. Range (ng/l)	Average Conc. (ng/l)
Plant Influent	3	185 - 556	358	3	1.36 - 2.45	1.91
Plant Effluent	3	108 - 448	228	3	4.03 - 5.69	4.74
Plant Sludge	3	3.96 - 4.09 [b]	4.02 [b]	3	1.6 - 5.2 [b]	3.23 [b]

[a] Each sample was a triplicate sample.
[b] The unit of measure for the wet weight sediment concentrations is μg/g.

Table 8: Total Mercury and Methylmercury Loads in the Inputs and Outputs of the Fritz Island WWTP

Site	TotHg Load (g/day)	Percent of TotHg Output Load from WWTP [a]	MeHg Load (g/day)	Percent of MeHg Output Load from WWTP [a]
Plant Influent	19.3		0.104	
Effluent	12.8	8%	0.269	68%
Sludge	144	92%	0.125	32%
Output Load from WWTP (Effluent + Sludge)	157	100%	0.394	100%
Net Output Load generated inside the WWTP (Output - Influent)	138	88%	0.29	74%

[a] The output load from the WWTP is equal to the sum of the effluent and sludge loads.

Table 9: Total Mercury and Methylmercury Concentrations in the Influent and Effluent of Various Components of the Fritz Island WWTP Treatment Processes

Site	TotHg Conc. (ng/l)	MeHg Conc. (ng/l)	MeHg:TotHg Ratio [(a)]
Plant Influent	**156**	**3**	**1.9%**
1st Stage Trickling Filters			
Input	229	7.8	3.4%
Output TF# 1	5660	31.9	0.56%
Output TF# 3	1540	24	1.6%
Intermediate Settling			
Input	2670	29.4	1.1%
Output	215	13	6.1%
Sludge	114,000 mg/kg	71 mg/kg	0.06%
2nd Stage Trickling Filters			
Input	215	13	6.1%
Output TF# 4	629	33.9	5.4%
Output TF# 5	291	10.8	3.7%
Output TF# 6	394	13.1	3.3%
Post 2nd Stage Settling			
Input	288	9.1	3.2%
Output	167	11.1	6.7%
Sludge	39,600 mg/kg	287 mg/kg	0.72%
Aeration			
Input	167	11.1	6.7%
Output	148	4.7	3.2%
Final Settling			
Input	148	4.7	3.2%
Output	76	6.9	9.1%
Sludge	124,000 mg/kg	205 mg/kg	0.17%
Final Effluent	**108**	**4**	**3.7%**

[(a)] Staff calculated the MeHg:TotHg ratio from the inorganic mercury and methylmercury data provided in the report.

Table 10: Summary of Total and Methylmercury Concentrations in Samples Collected in October 1987 at the Whitlingham Sewage Treatment Works

Location	Average TotHg Conc. (ng/l)	Average MeHg Conc. [(a)] (ng/l)	MeHg Conc. Range (ng/l)	Number of MeHg Samples	Number of MeHg Results below the MDL [(a)]
Raw Sewage	200	11	< MDL - 83	11	9
Settled Sewage	100	<10	all < MDL	11	11
Picket Fence Thickener Overflow	300	23	16 - 36	5	0
Returned Activated Sludge	5900	120	68 - 200	4	0
Final Effluent	100	<10	< MDL - 20	13	7

[(a)] The method detection limit was 10 ng/l. The average concentrations were calculated by the study authors assuming that values below the detection limit were zero.

Table 11: Methylmercury Data Excluded from Calculations in this Report

NPDES #	Facility	Sample Date	Sample Location	MeHg Conc (ng/l)
CA0083861	Aerojet Interim GW WTP	11/18/05	EFF1	ND (<0.025)
CA0083861	Aerojet Interim GW WTP	11/18/05	EFF2	ND (<0.025)
CA0083861	Aerojet Interim GW WTP	11/18/05	EFF3	ND (<0.025)
CA0083861	Aerojet Interim GW WTP	11/18/05	EFF4	ND (<0.025)
CA0004111	Aerojet Sacramento Facility	3/18/05	EFF1	0.057
CA0004995	Corning Industries/ Domestic WWTP	9/22/04	EFF1	0.041
CA0078093	Deuel Vocational Institute WWTP	10/26/04	EFF1	ND (<0.02)
CA0078875	DGS Office of State Publishing	7/8/05	EFF1	ND (<0.02)
CA0078671	El Dorado Hills WWTP	8/9/05	EFF1	0.057
CA0078671	El Dorado Hills WWTP	8/9/05	INF1	1.41
CA0081833	General Electric Co. GWCS	10/8/04	EFF1	0.131
CA0081833	General Electric Co. GWCS	10/8/04	EFF2	0.184
CA0081833	General Electric Co. GWCS	10/8/04	EFF3	0.158
CA0081833	General Electric Co. GWCS	10/8/04	INF1	1.112
CA0081833	General Electric Co. GWCS	10/8/04	INF2	1.112
CA0081833	General Electric Co. GWCS	10/8/04	INF3	1.112
CA0084476	Lincoln WWTP	8/25/05	EFF1	0.034
CA0083801	Modesto ID Regional WTP	10/8/04	EFF1	0.038
CA0083801	Modesto ID Regional WTP	10/8/04	INF1	ND (<0.02)
CA0083143	South Feather Water & Power Agency Miners Ranch WTP	9/9/04	EFF1	ND (<0.025)
CA0078794	SRCSD Walnut Grove WWTP (CSD1)	12/29/04	EFF1	0.759
CA0078794	SRCSD Walnut Grove WWTP (CSD1)	12/29/04	INF1	1.15

Table 12: Relative Percent Differences (RPD) of Field Duplicate Samples Analyzed for Methylmercury

Sample Date	NPDES #	Facility Name	[MeHg] (ng/l)		RPD[a]
			Duplicate 1	Duplicate 2	
11/16/04	CA0004791	DFG Mokelumne River Fish Hatchery	< 0.020	< 0.020	---
2/4/04	CA0004863	Mirant Delta CCPP	0.084	0.080	4.9
3/3/04	CA0004863	Mirant Delta CCPP	0.120	0.122	1.7
3/8/05	CA0077691	Vacaville Easterly WWTP	0.057	0.055	3.6
8/18/04	CA0078956	Placerville Hangtown Creek WWTP	0.097	0.067	36.6
9/20/04	CA0078956	Placerville Hangtown Creek WWTP	0.063	0.043	37.7
4/28/05	CA0078956	Placerville Hangtown Creek WWTP	0.040	0.040	0.0
8/18/04	CA0079138	Stockton WWTP	1.290	1.380	6.7
9/8/04	CA0079138	Stockton WWTP	0.904	0.903	0.1
10/13/04	CA0079138	Stockton WWTP	0.392	0.384	2.1
11/10/04	CA0079138	Stockton WWTP	0.518	0.515	0.6
12/15/04	CA0079138	Stockton WWTP	1.640	1.830	11.0
1/19/05	CA0079138	Stockton WWTP	1.860	1.490	22.1
2/8/05	CA0079138	Stockton WWTP	2.090	2.080	0.5
3/9/05	CA0079138	Stockton WWTP	1.470	1.480	0.7
4/6/05	CA0079138	Stockton WWTP	0.627	0.703	11.4
5/10/05	CA0079138	Stockton WWTP	0.281	0.261	7.4
6/8/05	CA0079138	Stockton WWTP	< 0.020	< 0.020	---
7/6/05	CA0079138	Stockton WWTP	0.142	0.070	67.9
8/24/04	CA0079260	Yuba City WWTP	0.036	0.038	5.4
10/12/04	CA0079260	Yuba City WWTP	0.042	0.032	27.0
11/22/04	CA0079260	Yuba City WWTP	0.051	0.043	17.0
12/7/04	CA0079260	Yuba City WWTP	0.038	0.041	7.6
1/25/05	CA0079260	Yuba City WWTP	0.047	0.055	15.7
2/8/05	CA0079260	Yuba City WWTP	0.219	0.225	2.7
3/30/05	CA0079260	Yuba City WWTP	0.053	0.068	24.8
4/25/05	CA0079260	Yuba City WWTP	0.057	0.061	6.8
5/26/05	CA0079260	Yuba City WWTP	0.084	0.099	16.4
6/14/05	CA0079260	Yuba City WWTP	0.050	0.048	4.1
7/5/05	CA0079260	Yuba City WWTP	< 0.025	< 0.025	---
1/24/05	CA0081833	General Electric Co. GWCS	< 0.020	< 0.020	---
4/18/05	CA0081833	General Electric Co. GWCS	< 0.020	< 0.020	---
7/5/05	CA0081833	General Electric Co. GWCS	< 0.020	< 0.020	---
12/8/04	CA0081931	Defense Logistics Agency Sharpe GW Cleanup	0.022	< 0.020	---
6/6/06	CA0083861	Aerojet Interim GW WTP	< 0.025	< 0.025	---

[a] RPD = |(Duplicate 1 - Duplicate 2)| / ((Duplicate 1 + Duplicate 2)/2) x 100. The RPD was not calculated if one or both samples were reported as below the method detection limit (MDL). Mean RPD = 12.7.

Table 13: Anomalous Values Observed in the Methylmercury and Total Mercury Data

NPDES No.	Facility	Sample Date(s)	Value(s) (ng/l)	Range of values of all other data (ng/l)
Influent Methylmercury				
CA0079898	Grass Valley WWTP	11/4/2004	5.01	0.588 - 3.00
CA0077895	UC Davis WWTP	9/22/2004	11.1	0.074 - 4.92
CA0077950	Woodland WWTP	6/14/2005	7.07	0.767 - 3.94
Effluent Methylmercury				
CA0079049	Davis WWTP (Discharge 2)	6/7/2005	1.44	0.247 - 0.556
CA0078590	Discovery Bay WWTP	10/27/2004	2.03	ND - 0.059
CA0079243	Lodi White Slough WWTP	4/13/2005	1.24	ND - 0.063
CA0079898	Grass Valley WWTP	7/7/2005, 8/4/2005	0.932, 0.938	ND - 0.128
Influent Total Mercury				
CA0084573	Roseville Pleasant Grove WWTP	6/1/2005, 5/26/2005	590, 770	29.0 - 200
CA0079243	Lodi White Slough WWTP	11/9/2004	590	41.0 - 270
CA0079502	Roseville Dry Creek WWTP	10/25/2004	910	46.0 - 290
CA0077682	SRCSD Sacramento River WWTP	3/11/2004, 1/6/2004	3400, 6100	48.5 - 1280
Effluent Total Mercury				
CA0079103	Modesto WWTP	12/29/2004	19	ND - 6.50
CA0079731	Redding Clear Creek WWTP	10/18/2004	23.3	1.37 - 3.01
CA0077682	SRCSD Sacramento River WWTP	11/3/2004	29.5	2.40 - 20.0
CA0077950	Woodland WWTP	12/9/2004	53.1	0.91 - 2.98
CA0079367	Placer Co. SMD #3 WWTP	6/1/2005	7.97	0.88 - 3.12
CA0082589	Redding Stillwater WWTP	3/17/2005	6.19	0.92 - 3.25
CA0084573	Roseville Pleasant Grove WWTP	8/30/2004	3	0.70 - 1.80

Table 14: Sum of Annual Average Daily Discharges (mgd) for Facilities within Each Discharger Type for NPDES Facilities in the Delta Source Region [a]

Facility Type	Proximity to Delta		TOTAL	% of TOTAL
	Delta / Yolo Bypass	Downstream of Major Dam		
Aggregate & Lake Dewatering	9.2	3.9	**13.1**	**1.8%**
Aquaculture		256.5	**256.5**	**34.6%**
Drinking Water Treatment		1.0	**1.0**	**0.1%**
Food Processing		1.7	**1.7**	**0.2%**
Groundwater Remediation		10.5	**10.5**	**1.4%**
Heating/Cooling	5.3	0.02	**5.3**	**0.7%**
Mines		0.1	**0.1**	**0.01%**
Miscellaneous [b]		0.4	**0.4**	**0.05%**
Municipal WWTP	214.6	112.5	**326**	**44.1%**
Paper & Saw Mills		2.6	**2.6**	**0.4%**
Power Generation	124.0	0.02	**124.0**	**16.7%**
Total	**353.0**	**389.2**	**742.3**	**100%**

[a] The average daily discharges of the facilities in the Delta source region were calculated using information available in NPDES permits and monitoring reports, updated in September 2009 because several manufacturing, drinking water treatment, and municipal WWTP facilities recently ceased to discharge to surface waters.
[b] The "Miscellaneous" category includes publishing and laboratory facilities.

Table 15: Number of NPDES Facilities That Received the 13267 Order Categorized by Facility Type and Geographical Region

Facility Type	Proximity to Delta			TOTAL
	Delta / Yolo Bypass	Downstream of Major Dam	Upstream of Major Dam	
Aggregate & Lake Dewatering	1	4		**5**
Aquaculture		12	2	**14**
Drinking Water Treatment		7		**7**
Food Processing		4		**4**
Groundwater Remediation		7		**7**
Heating/Cooling	3	2	1	**6**
Landfill		1		**1**
Manufacturing		2		**2**
Mines			2	**2**
Miscellaneous [a]		3		**3**
Municipal WWTP	16	41	12	**69**
Paper/Saw Mills		4	1	**5**
Power Generation	2	6		**8**
Power Generation/ Domestic WWTP		1		**1**
Grand Total	**22**	**94**	**18**	**134**

[a] The "Miscellaneous" category includes publishing and laboratory facilities.

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0083861	Aerojet Interim Groundwater Treatment Plant	Groundwater Remediation	5.00	Buffalo Ck. / American R.	No	38.616667	-121.242777	60
CA0004111	Aerojet Sacramento Facility	Heating / Cooling	0.02	Buffalo Ck. / American R.	No	38.621	-121.2311	59
CA0077704	Anderson WWTP	Mun WWTP	1.40	Sacramento R.	No	40.468889	-122.279167	14
CA0079197	Atwater WWTP	Mun WWTP	3.40	Atwater Drain / Bear Ck. / San Joaquin R.	No	37.341111	-120.605556	108
CA0077712	Auburn WWTP	Mun WWTP	1.17	Auburn Ravine / East Side Canal / Cross Canal / Sacramento R.	No	38.8895	-121.1007	47
CA0083721	Bell Carter Olive Company Inc.	Food Processing	0.38	Sacramento R.	No	39.913889	-122.091667	23
CA0080799	Bella Vista Water District	Drinking Water Treatment	0.50	Boulder Ck. / Churn Ck. / Sacramento R.	No	40.6001	-122.3466	9
CA0078930	Biggs WWTP	Mun WWTP	0.38	Main Drainage Canal (near Biggs) / Butte Ck. / Sacramento R.	No	39.4072	-121.7241	28
CA0084891	Boeing Company Interim Groundwater Treatment System	Groundwater Remediation	0.56	drainage ditch on Mather Field / Morrison Ck. / Stone Lake / Sacramento R.	No [c]	38.56875	-121.302278	64
CA0082660	Brentwood WWTP	Mun WWTP	3.09	Marsh Ck.	Yes	37.960278	-121.69	88
CA0082082	CA Dairies, Inc. Los Banos Foods [b]	Food Processing	0.50	municipal storm drain / San Luis Canal / Mud Slough and Salt Slough / San Joaquin R.	No	37.0563	-120.8368	112
CA0078581	CA State of, Central Heating/Cooling Facility [b]	Heating / Cooling	5.26	Sacramento R.	Yes	38.573889	-121.51	63
CA0083968	CALAMCO - Stockton Terminal [b]	Heating / Cooling	5.06	Wine Slip portion of the Deep Water Channel in the Port of Stockton / San Joaquin R.	Yes	37.941389	-121.325	89
CA0081752	Calaveras Trout Farm (Rearing Facility)	Aquaculture	19.40	Merced R. / San Joaquin R.	Yes	37.5156	-120.3747	105
CA0081566	Calpine Corp. Greenleaf Unit One Cogen Plant [b]	Power Generation	0.11	unnamed trib / North Drain / E Sutter Bypass	No	39.043889	-121.674167	40

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0082040	Camanche Dam Powerhouse [b]	Power Generation	0.04	Mokelumne R.	No	38.22	-121.025278	80
CA0083682	Canada Cove LP French Camp Golf & RV Park	Mun WWTP	0.04	Lone Tree Ck. / Little Johns Ck. / French Camp Slough / San Joaquin R.	No [c]	37.874167	-121.225	93
CA0079081	Chico Regional WWTP	Mun WWTP	7.20	Sacramento R.	Yes	39.7	-121.95	25
CA0083828	Clear Creek CSD WTP	Drinking Water Treatment	0.16	Clear Ck. / Sacramento R.	No	40.597222	-122.538056	10
CA0079529	Colfax WWTP [a]	Mun WWTP	0.024	Smuthers Ravine / Bunch Canyon / N Fk. American R.	No	39.075	-120.941667	38
CA0078999	Colusa WWTP	Mun WWTP	0.66	Powell Slough / Colusa Basin Drain / Sacramento R.	No	39.180556	-122.03	35
CA0004995	Corning Industries/ Domestic WWTP	Mun WWTP	1.00	Sacramento R.	No	39.913889	-122.091667	22
CA0081507	Cottonwood WWTP	Mun WWTP	0.29	Cottonwood Ck. / Sacramento R.	No	40.377778	-122.270833	18
CA0082767	Crystal Creek Aggregate	Aggregate	0.002	Rock Ck. & Middle Ck. / Sacramento R.	No	40.609	-122.4601	8
CA0079049	Davis WWTP [d]	Mun WWTP	5.26	Willow Slough Bypass / Yolo Bypass	No [c]	38.59	-121.663889	62
CA0081931	Defense Logistics Agency Sharpe Groundwater Cleanup [b]	Groundwater Remediation	1.90	South San Joaquin Irrigation District Canal / French Camp Slough / San Joaquin R.	No [c]	37.8405	-121.2622	95
CA0078093	Deuel Vocational Institute WWTP	Mun WWTP	0.47	Deuel Drain / Paradise Cut / Old R.	Yes	37.750556	-121.326389	101
CA0004561	DFG Darrah Springs Fish Hatchery	Aquaculture	18.70	Baldwin Ck. / Battle Ck. / Sacramento R.	No	40.4329	-121.9967	15
CA0080055	DFG Merced River Fish Hatchery	Aquaculture	4.55	Merced R. / San Joaquin R.	Yes	37.5172	-120.372	104
CA0004804	DFG Moccasin Creek Fish Hatchery [a]	Aquaculture	19.62	Moccasin Ck. / Don Pedro Res.	No	37.8136	-120.3063	96

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NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0004791	DFG Mokelumne River Fish Hatchery	Aquaculture	21.00	Mokelumne R.	No	38.2254	-121.0306	79
CA0004774	DFG Nimbus Fish Hatchery	Aquaculture	40.00	American R.	Yes	38.6341	-121.2286	57
CA0004812	DFG San Joaquin Fish Hatchery	Aquaculture	22.60	San Joaquin R.	No	36.997222	-119.718889	113
CA0078875	DGS Office of State Publishing	Misc	0.30	American R.	Yes	38.602	-121.4941	61
CA0078590	Discovery Bay WWTP	Mun WWTP	1.54	Reclamation District 800 drainage ditch / Old R.	Yes	37.905556	-121.5875	92
CA0078662	El Dorado ID Deer Creek WWTP	Mun WWTP	2.52	Deer Ck. / Cosumnes R.	No	38.628333	-120.986389	58
CA0078671	El Dorado ID El Dorado Hills WWTP	Mun WWTP	1.08	Carson Ck. / Deer Ck. / Cosumnes R.	No	38.638333	-121.060556	56
CA0004057	Formica Corporation Sierra Plant [(b)]	Manufacturing	0.88	Unnamed trib. / Pleasant Grove Ck. / Cross Canal / Sacramento R.	No	38.8232	-121.3077	49
CA0081434	Galt WWTP	Mun WWTP	1.92	Laguna Ck. / Cosumnes R.	No	38.297222	-121.333333	77
CA0004847	Gaylord Container Corp. Antioch Pulp & Paper Mill [(b)]	Heating / Cooling	- - -	San Joaquin R.	Yes	38.025833	-121.7675	85
CA0081833	General Electric Co. GWCS	Groundwater Remediation	1.60	Doane Lateral Irrigation Canal (Merced Irrigation District) / Miles Ck. / San Joaquin R.	No	37.2918	-120.4234	109
CA0079898	Grass Valley WWTP [(a)]	Mun WWTP	2.10	Wolf Ck. / Indian Ck. / Bear R.	No	39.208333	-121.07	34
CA0082309	GWF Power Systems	Power Generation	0.05	Storm Drain / San Joaquin R.	Yes	38.025	-121.758333	86
CA0004146	Hershey Chocolate USA, Oakdale	Food Processing	1.03	Oakdale Irrigation District Riverbank Lateral Canal / Modesto Irrigation District Main Canal / Stanislaus R.	No	37.758333	-120.829722	100
CA0083097	J.F. Shea C Fawndale Rock and Asphalt	Aggregate	3.87	W. Fk. Stillwater Ck. / Stillwater Ck. / Sacramento R.	No	40.735	-122.307222	1

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0079391	Jackson WWTP [(a)]	Mun WWTP	0.71	Jackson Ck. / Dry Ck. / Mokelumne R.	No	38.344722	-120.783611	72
CA0081191	Lehigh Southwest Cement Co.	Aggregate		W Fk. Stillwater Ck. / Stillwater Ck. / Sacramento R.	No	40.733889	-122.320833	2
CA0084476	Lincoln WWTP	Mun WWTP	1.13	Auburn Ravine / East Side Canal / Cross Canal / Sacramento R.	No	38.891111	-121.324722	46
CA0079022	Live Oak WWTP	Mun WWTP	1.65	Reclamation District No. 777 Lateral Drain No. 1 / Main Canal / Sutter Bypass	No	39.258333	-121.677222	32
CA0079243	Lodi White Slough WWTP	Mun WWTP	4.51	Dredger Cut / White Slough	Yes	38.093056	-121.396667	84
CA0082783	Manteca Aggregate Sand Plant (Oakwood Lake Subdivision Mining Reclamation)	Aggregate	9.15	San Joaquin R.	Yes	37.7794	-121.2993	98
CA0081558	Manteca WWTP	Mun WWTP	4.63	San Joaquin R.	Yes	37.7794	-121.2993	99
CA0079430	Mariposa PUD WWTP	Mun WWTP	0.245	Mariposa Ck. several miles u/s of Mariposa Ck. Dam	No	37.480278	-119.960833	106
CA0079987	Maxwell PUD WWTP	Mun WWTP	0.14	unnamed trib / Laurline Ck. / Colusa Basin Drain / Sacramento R.	No	39.266667	-122.183333	29
CA0079219	Merced WWTP	Mun WWTP	8.50	Hartley Slough / Owens Ck. / Bear Ck. / San Joaquin R.	No	37.243889	-120.541667	111
CA0004863	Mirant Delta CCPP	Power Generation	124	San Joaquin R.	Yes	38.019444	-121.7625	87
CA0083801	Modesto ID Regional WTP [(b)]	Drinking Water Treatment	0.04	Modesto Irrigation Main Canal / Stanislaus R. / Tuolumne R. / San Joaquin R.	No	37.653611	-120.6725	102
CA0079103	Modesto WWTP	Mun WWTP	11.8	San Joaquin R.	Yes	37.521944	-121.099444	103
CA0079901	Nevada City WWTP	Mun WWTP	0.43	Deer Ck. / Yuba R.	No	39.25975	-121.03075	31
CA0083241	Nevada Co SD #1 Cascade Shores WWTP [(a)]	Mun WWTP	0.026	Gas Canyon Ck. / Greenhorn Ck. / Rollins Res. / Bear R.	No	39.261111	-120.905556	30

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NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0077828	Nevada Co SD #1 Lake Wildwood WWTP [(a)]	Mun WWTP	0.50	Deer Ck. / Yuba R.	No	39.233333	-121.222778	33
CA0081612	Nevada Co SD #2 Lake of the Pines WWTP [(a)]	Mun WWTP	0.54	Magnolia Ck. / Bear R.	No	39.033333	-121.083611	41
CA0077836	Olivehurst PUD WWTP	Mun WWTP	1.20	Western Pacific Interceptor Drainage Canal / Bear R. / Feather R.	No	39.065278	-121.552222	39
CA0079235	Oroville WWTP	Mun WWTP	3.00	Feather R.	Yes	39.453056	-121.636944	27
CA0082961	Pacific Coast Sprout Farms, Inc. (Sacramento Facility)	Aquaculture	0.10	Morrison Ck.	No [(c)]	38.5197	-121.3789	70
CA0004821	Pactiv Molded Pulp Mill	Paper/Saw Mill	1.90	Sacramento R.	No	40.1553	-122.2095	21
CA0083488	Paradise Irrigation District	Drinking Water Treatment	1.5	Magalia Reservoir / Little Butte Ck. / Butte Ck. / Sacramento R.	No	39.816389	-121.580556	24
CA0079341	Placer Co. SA #28 Zone #6 [(b)]	Mun WWTP	0.01	Drainage Ditch / Yankee Slough / Bear R.	No	38.9754	-121.3709	42
CA0079316	Placer Co. SMD #1 WWTP	Mun WWTP	1.90	Coon Ck. / Main Canal / Cross Canal / Sacramento R.	No	38.958333	-121.116667	43
CA0079367	Placer Co. SMD #3 WWTP	Mun WWTP	0.12	Miners Ravine / Dry Ck. / Natomas East Main Drainage Canal / Bannon Slough / Sacramento R.	No	38.797222	-121.118056	50
CA0078956	Placerville Hangtown Creek WWTP [(a)]	Mun WWTP	1.30	Hangtown Ck. / Weber Ck. / S. Fk. American R. / Folsom Lake / American R.	No	38.733333	-120.841667	52
CA0078950	Planada Comm. Service Dist. WWTP	Mun WWTP	0.38	Miles Ck. / Owens Ck. / Bear Ck. / San Joaquin R.	No	37.276389	-120.333333	110
CA0004316	Proctor & Gamble Co. WWTP [(b)]	Manufacturing	5.50	Morrison Ck.	No [(c)]	38.5315	-121.4088	65
CA0078891	Red Bluff WWRP	Mun WWTP	1.40	Sacramento R.	No	40.1625	-122.216667	20
CA0079731	Redding Clear Creek WWTP	Mun WWTP	7.50	Sacramento R.	No	40.498889	-122.360278	11

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0082589	Redding Stillwater WWTP	Mun WWTP	3.46	Sacramento R.	No	40.473611	-122.267222	13
CA0077852	Rio Alto WD- Lake CA WWTP	Mun WWTP	0.15	Sacramento R.	No	40.3319	-122.2101	19
CA0079588	Rio Vista Main WWTP	Mun WWTP	0.47	Sacramento R.	Yes	38.154167	-121.677778	82
CA0079502	Roseville Dry Creek WWTP	Mun WWTP	13.0	Dry Ck. / Natomas East Main Drainage Canal / Bannon Slough / Sacramento R.	No	38.731389	-121.316111	53
CA0084573	Roseville Pleasant Grove WWTP	Mun WWTP	4.82	Pleasant Grove Ck. / Pleasant Grove Ck. Canal / Cross Canal / Sacramento R.	No	38.795556	-121.379444	51
CA0083569	Sacramento Cogen Authority Procter & Gamble Plant [(b)]	Power Generation	- - -	Morrison Ck.	No [(c)]	38.530278	-121.4075	66
CA0034841	Sacramento International Airport [(b)]	Heating / Cooling	1.50	Lindbergh ditch / Meister canal / Reclamation District-1000 pump station / Sacramento R.	Yes	38.665833	-121.612778	55
CA0079464	San Andreas SD WWTP [(a)]	Mun WWTP	0.30	San Andreas Ck. / Murray Ck. / N Fk. Calaveras R.	No	38.203056	-120.688333	81
CA0082848	San Joaquin Co DPW – Flag City [(b)]	Mun WWTP	0.06	Highline Canal / White Slough, East of I-5	Yes	38.106944	-121.41	83
CA0004693	Shasta Lake WTP	Drinking Water Treatment	0.05	Churn Ck. / Sacramento R.	No	40.6929	-122.4025	4
CA0079511	Shasta Lake WWTP	Mun WWTP	0.64	Churn Ck. / Sacramento R.	No	40.661111	-122.375	6
CA0004758	SMUD Rancho Seco Nuclear Generating Station [(b)]	Power / Dom WWTP	0.09	Clay to Hadselville to Laguna Ck. / Cosumnes R.	No	38.343056	-121.126111	76
CA0083143	South Feather Water and Power	Drinking Water Treatment	0.25	Miners Ranch Res. / Feather R.	No	39.504722	-121.456389	26
CA0082066	SPI Anderson Division	Paper/Saw Mill		Sacramento R.	No	40.4787	-122.3231	12
CA0081400	SPI Shasta Lake	Paper/Saw Mill	0.15	unnamed trib / Churn Ck. / Sacramento R.	No	40.675278	-122.384722	5
CA0077682	SRCSD Sacramento River WWTP	Mun WWTP	151	Sacramento R.	Yes	38.4607	-121.5031	73

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0078794	SRCSD Walnut Grove WWTP (CSD1) [b]	Mun WWTP	0.08	unnamed agricultural ditch / Snodgrass Slough / Mokelumne R. / San Joaquin R.	Yes	38.2344	-121.4998	78
CA0084140	Stimpel Wiebelhaus Associates SWA at Mountain Gate	Aggregate	0.02	Stillwater Ck. / Sacramento R.	No	40.636944	-122.32	7
CA0081965	Stockton Cogen Co. [b]	Power Generation	1.17	North Little Johns Ck. / French Camp Slough / San Joaquin R.	No [c]	37.853889	-121.259722	94
CA0079138	Stockton WWTP	Mun WWTP	27.78	San Joaquin R.	Yes	37.9375	-121.334722	90
CA0079154	Tracy WWTP	Mun WWTP	9.49	Old R. / Middle R. / San Joaquin R.	Yes	37.801944	-121.400833	97
CA0084727	Tuolumne UD Sonora WWTP / Jamestown WWTP [a]	Mun WWTP	0.16	Woods Ck. / Slate Ck. / Don Pedro Res	No	37.922222	-120.431389	91
CA0078948	Turlock WWTP	Mun WWTP	11.71	Harding Drain / San Joaquin R.	Yes	37.463333	-121.031667	107
CA0083551	UA Local 38 Trust Fund Konocti Harbor Resort and Spa [a]	Heating / Cooling	0.22	Clear Lake	Yes	38.9405	-122.7378	45
CA0083348	UC Davis Center for Aquatic Biology & Aquaculture – Putah Ck Facility	Aquaculture	0.14	South Fk. Putah Ck. / Yolo Bypass	Yes	38.5275	-121.805	67
CA0083348	UC Davis Center for Aquatic Biology & Aquaculture – Aquatic Center	Aquaculture	0.67	South Fk. Putah Ck. / Yolo Bypass	Yes	38.525556	-121.788889	69
CA0084182	UC Davis Hydraulics Laboratory	Misc	0.01	North Fk. Putah Ck. / Putah Ck. / Yolo Bypass	No [c]	38.526389	-121.781944	68
CA0077895	UC Davis WWTP	Mun WWTP	1.92	South Fk. Putah Ck. / Yolo Bypass	Yes	38.517778	-121.756944	71
CA0084697	United Auburn Indian Community Casino WWTP	Mun WWTP	0.15	Unnamed trib. / Orchard Ck. / Auburn Ravine / East Side Canal / Cross Canal / Sacramento R.	No	38.841667	-121.316667	48
CA0084905	USDI BR Sliger Mine [a]	Mines	0.06	Middle Fk. American R.	No	38.940994	-120.932769	44

Table 16: NPDES Facility Receiving Water Information and Map Labels for Figures 1 through 3

NPDES No.	Facility	Facility Type	Annual Discharge (mgd)	Receiving Water	Discharges to 303(d) Hg Listed Waterway	LATITUDE (North)	LONGITUDE (West)	Map Code
CA0084298	USDI BR Winter Run Rearing Facility (Livingston Stone) [a]	Aquaculture	1.00	Sacramento R.	No	40.716667	-122.423889	3
CA0004201	USDI FWS Coleman Fish Hatchery	Aquaculture	40.08	Battle Ck. / Sacramento R.	No	40.3981	-122.1438	17
CA0077691	Vacaville Easterly WWTP	Mun WWTP	9.26	Old Alamo Ck. / Ulatis Ck.	No [c]	38.347222	-121.910278	75
CA0079171	West Sacramento WWTP [b]	Mun WWTP	5.60	Sacramento R.	Yes	38.436111	-121.526111	74
CA0081957	Wheelabrator Shasta Energy Co.	Power Generation	0.02	Anderson Cottonwood Canal / Cottonwood Ck.	No	40.430278	-122.275556	16
CA0077933	Williams WWTP	Mun WWTP	0.44	Salt Ck. / Glenn-Colusa Canal / Colusa Basin Drain / Sacramento R.	No	39.169722	-122.153611	36
CA0077950	Woodland WWTP	Mun WWTP	6.05	Tule Canal / Yolo Bypass	No [c]	38.680833	-121.643889	54
CA0079260	Yuba City WWTP	Mun WWTP	5.22	Feather R.	Yes	39.090556	-121.598056	37

[a] Facilities upstream of a major dam.
[b] Facilities for which NPDES permits were rescinded sometime after the facilities completed 13267 Order monitoring.
[c] Facilities that do not discharge to 303(d) Listed mercury-impaired waterways but do discharge to small tributaries that drain directly to the Delta.
[d] The City of Davis WWTP (CA0079049) has two seasonal discharge locations; wastewater is discharged from Discharge 001 to the Willow Slough Bypass upstream of the Yolo Bypass and from Discharge 002 to the Conaway Ranch Toe Drain in the Yolo Bypass. The latitude and longitude coordinates and other information provided in the table are for Discharge 001. The coordinates for Discharge 002 are 38.575833, -121.633889.

Table 17: Summary of all Effluent Methylmercury Concentration Data for the Non-Municipal Facility Categories [a]

Facility Type	# of Effluent MeHg Samples	Average MeHg Conc (ng/l) [b]	# of Nondetect samples	MeHg Conc. Range (ng/l)
Aggregate	10	0.026	7	ND - 0.081
Aquaculture	38	0.041	12	ND - 0.243
Drinking Water Treatment	10	0.033	3	ND - 0.066
Food Processing	12	0.014	9	ND - 0.027
Groundwater Remediation	20	0.012	19	ND - 0.033
Heating/Cooling	14	0.110	3	ND - 0.919
Manufacturing	5	0.023	3	ND - 0.050
Mines	4	0.064	1	ND - 0.091
Miscellaneous	6	0.034	3	ND - 0.082
Paper/Saw Mills	21	0.117	5	ND - 1.190
Power Generation	46	0.061	11	ND - 0.178
Power Generation/ Domestic WWTP	12	0.040	4	ND – 0.104

[a] This table summarizes all of the effluent methylmercury data submitted by non-municipal facilities including multiple discharge locations (e.g., effluents 1-4).

[b] One-half of the MDL was used in calculations for methylmercury concentration results that were less than the MDL.

Table 18: Available Intake and Outfall Methylmercury Concentration Data for Aquaculture, Power and Heating/Cooling Facilities in the Delta Region

Facility [NPDES #, Type]	Sample Date	Outfall 1 MeHg Conc. [(a)] (ng/l)	Outfall 1 MeHg Qual. [(b)]	Outfall 2 MeHg Conc. (ng/l)	Outfall 2 MeHg Qual. [(b)]	Outfall 2 Field Dup. MeHg Conc. (ng/l)	Outfall 2 Field Dup. MeHg Qual. [(b)]	Intake 1 MeHg Conc. [(a)] (ng/l)	Intake 1 MeHg Qual. [(b)]	Intake 1 Dup. MeHg Conc. (ng/l)	Intake 1 Dup. MeHg Qual. [(b)]	Intake 2 MeHg Conc. (ng/l)	Intake 2 MeHg Qual. [(b)]
CALAMCO - Stockton Terminal [CA0083968, Heating /Cooling]	8/26/2004	0.03	B					0.026	B				
Calaveras Trout Farm (Rearing Facility) [CA0081752, Aquaculture]	9/30/2004	0.027	B					0.067					
Camanche Dam Powerhouse [CA0082040, Power Generation]	1/19/2005	ND	<MDL					0.095	(ba)				
DFG Darrah Springs Fish Hatchery [CA0004561, Aquaculture]	9/15/2004	0.029	B, (nn)	0.043	B, X, (mm)			ND	<MDL, (nn)			ND	<MDL, (nn)
DFG Mokelumne River Fish Hatchery [CA0004791, Aquaculture]	11/16/2004	0.048	A					ND	<MDL, A	ND	<MDL, A		
DFG Nimbus Fish Hatchery [CA0004774, Aquaculture]	11/16/2004			0.129	A			0.051	A				
	2/17/2005	0.053										0.031	
	6/20/2005	0.085	A					0.052					
DFG San Joaquin Fish Hatchery [CA0004812, Aquaculture]	9/28/2004	0.073						0.021	B				
GWF Power Systems [CA0082309, Power Generation]	8/11/2004	ND	<MDL					ND	<MDL				
	11/4/2004	ND	<MDL					ND	<MDL				
	2/3/2005	ND	<MDL					0.263					
	5/5/2005	ND	<MDL					ND	<MDL				
Mirant Delta CCPP [CA0004863, Power Generation]	2/4/2004	0.081		0.0835		0.0799		0.296	(l)				
	3/3/2004	0.116		0.127				0.12	(l)	0.122	(l)		
	8/3/2004	0.020	J	0.07				ND	<MDL, (l)				
	9/1/2004	0.08		0.06				0.08	(l)				
	10/5/2004	0.049	B	0.06				0.038	(l), B				
	11/2/2004	0.047	B	0.042	B			0.04	(l), B				
	12/2/2004	0.03	B	0.063				0.07	(l)				

Table 18: Available Intake and Outfall Methylmercury Concentration Data for Aquaculture, Power and Heating/Cooling Facilities in the Delta Region

Facility [NPDES #, Type]	Sample Date	Outfall 1 MeHg Conc. [a] (ng/l)	Outfall 1 MeHg Qual. [b]	Outfall 2 MeHg Conc. (ng/l)	Outfall 2 MeHg Qual. [b]	Outfall 2 Field Dup. MeHg Conc. (ng/l)	Outfall 2 Field Dup. MeHg Qual. [b]	Intake 1 MeHg Conc. [a] (ng/l)	Intake 1 MeHg Qual. [b]	Intake 1 Dup. MeHg Conc. (ng/l)	Intake 1 Dup. MeHg Qual. [b]	Intake 2 MeHg Conc. (ng/l)	Intake 2 MeHg Qual. [b]
Mirant Delta CCPP [CA0004863, Power Generation]	1/11/2005	0.083		0.081				0.102	(l)				
	2/8/2005	0.097		0.12				0.098	(l)				
	3/8/2005	0.121		0.15				0.15	(l)				
	4/26/2005	0.083			Y			0.069	(l)				
	5/25/2005	0.091			Y			0.077	(l)				
Sacramento Cogen Authority Procter & Gamble Plant [CA0083569, Power Generation]	8/11/2004	0.056	A					ND	<MDL, A				
	10/6/2004	0.069						ND	<MDL				
	1/5/2005	0.07						0.08					
	5/4/2005	ND	<MDL					ND	<MDL				

[a] ND: nondetect (below method detection limit). Analytical method detection limits were 0.025 ng/l or less.
[b] < MDL: below method detection limit
A: Samples were received out of optimal temperature range.
B: Sample results above the MDL and below the ML; should be considered an estimate.
J: Detected but below the reporting limit; result is an estimated concentration.
X: Collected 9/14/04.
Y: No discharge.
(l): Mirant Delta CCPP Intake 002.
(mm): Darrah Springs Fish Hatchery - Lower Springs.
(nn): Darrah Springs Fish Hatchery - Upper Springs.
(ba): Camanche Dam Powerhouse receiving water received 200 feet upstream of discharge.

Table 19: Comparison of Delta Municipal WWTP Effluent Methylmercury Concentrations to Methylmercury Concentrations in Drinking Water Supplies for Delta Communities

Municipal Area	**Municipal WWTP Average MeHg Conc. in Effluent Discharged to Surface Water (ng/l)**	**Municipal Water Supply [a]**				**Local Surface Drinking Water Supply [b]**	
		Central Valley Project	State Water Project	Ground-water [m]	Local Streams / Reservoirs	Sampling Location	Average MeHg Conc. (ng/l)
Brentwood	0.01		X	X		SWP	0.054
Deuel Vocational Institute [c]	0.01			X		- - -	- - -
Discovery Bay [d]	0.19			X	X	CVP SWP X2	0.064 0.054 0.083
Lodi White Slough	0.15			X		- - -	- - -
Manteca [e]	0.22			X		- - -	- - -
Modesto [n]							
Rio Vista [f]	0.16			X		- - -	- - -
San Joaquin Co DPW CSA 31 Flag City [g]	0.08			X		- - -	- - -
SRCSD Sacramento River [l]	0.73			X	X	Sacramento R. @ Freeport American River	0.103 0.045
SRCSD Walnut Grove [h]	2.16			X		- - -	---
Stockton [j]	0.94			X	X	*No MeHg data available for New Hogan & New Melones Reservoirs*	
Tracy [e, i]	0.15	X		X	X	CVP Stanislaus River	0.064 0.119
West Sacramento [k]	0.05	X			X	Sacramento R. @ Veterans Bridge CVP	0.109 0.064
Woodland	0.03			X		- - -	---

Table 19 Footnotes:

[a] Except where otherwise noted, all water supply information was obtained from the Water Education Foundation's 2006 website, "Where does my water come from?" [http://www.water-ed.org/watersources/]. This site lists the drinking water sources for incorporated cities with a population of 10,000 or greater, as determined from the 2005 Water Education Foundation survey, water agencies, and annual water quality reports.

[b] If methylmercury data were not available for the local surface water supply, data for nearby waterways were included. Methylmercury data for the Central Valley Project (CVP), State Water Project (SWP) and Delta outflows to San Francisco Bay (X2) were used to represent drinking water intakes in the Central and West Delta, such as the Rock Slough and Old River intakes for the Randall-Bold Water Treatment Plant located in Oakley (see footnote "d"). Average methylmercury values were obtained from the February 2008 Delta TMDL draft staff report (Wood *et al.*, 2008b) for all surface water locations with four exceptions. Central Valley Water Board staff collected methylmercury samples from the American River at Discovery Park and Stanislaus River at Caswell State Park as part of a broader CalFed-funded study (Foe *et al.*, 2007; 2008 draft report in peer review). The Sacramento Coordinated Monitoring Program sampled the Sacramento River at Veteran's Bridge (CMP, 2004).

[c] The Deuel Vocational Institute WWTP services the Deuel Vocational Institute (DVI), which is about two miles south of Mossdale and ten miles south of Stockton. Information about its water supply was obtained from a case study described in: Corrollo Engineers, 2007, Drinking Water with Emphasis on Desalination and Membrane Softening Qualifications, available at: http://www.carollo.com/356/section.aspx/333

[d] Groundwater from eight active wells provides approximately 67% of the Discovery Bay water supply; the remaining water comes from the Randall-Bold Water Treatment Plant located in Oakley, which is jointly owned by Contra Costa Water District (CCWD) and Diablo Water District (DWD) and receives water from Rock Slough, Old River, and Los Vaqueros Reservoir. Information about the Discovery Bay water supply is from: Brown and Caldwell, 2006. City of Brentwood 2005 Urban Water Management Plan - Final. Prepared for the City of Brentwood by Department of Public Works by Brown and Caldwell, Walnut Creek, California. January 2006. Available at: http://www.ci.brentwood.ca.us/pdf/new/publicworks/2005_urban_water_plan.pdf

[e] The Water Education Foundation listed Manteca water sources as both groundwater and local streams/reservoirs. The City of Manteca Water Division website [http://www.ci.manteca.ca.us/eng/water/] stated that as of 2005, 100% of the Manteca drinking water supply came from groundwater sources and that in the near future some of its supply will come from the South County Surface Water Supply Project, which will draw water from Woodward Reservoir. The Woodward Reservoir is supplied by the Stanislaus River. The South County Surface Water Supply Project is a project to supply the cities of Tracy, Lathrop, Manteca and Escalon with water from the South San Joaquin Irrigation District and includes construction of a new water treatment plant at Woodward Reservoir and pipelines to supply water to the cities. Currently no methylmercury data are available for Woodward Reservoir.

[f] The City of Rio Vista relies on groundwater sources and has the right to obtain a specified amount of North Bay Aqueduct (NBA, a component of the State Water Project) water in the future, but as of 2003, had no facility to take NBA water. [Information from: Solano County Water Agency, 2002. SWCA Briefing Book. January 2002. Available at: http://www.scwa2.com/briefing_book.html]

[g] County Service Area 31 is an 80-acre parcel that includes Flag City, a collection of hotels, gas stations and restaurants at Interstate 5 and Highway 12 near Lodi.

[h] Per California American Water's 2005 Annual Water Quality Report for Walnut Grove [PWS ID: 3410047], water in the Walnut Grove system comes from wells that pump groundwater from aquifers in the Walnut Grove area. [Report available at: http://www.illinoisamerican.com/awpr1/caaw/pdf/CA-WalnutGrove-web.pdf]

Table 19 Footnotes, *continued*:

[i] According to the City of Tracy Public Works website, 2005 sources of the City of Tracy's water supply include the Delta-Mendota Canal [a.k.a. Central Valley Project] (50%), the Stanislaus River (17%), and groundwater pumped from wells (33%). [http://www.ci.tracy.ca.us/departments/public_works/water_quality/]

[j] In 2005, the City of Stockton obtained about 58% of their drinking water from surface water supplied by the Stockton East Water District (SEWD) and 42% from groundwater sources [City of Stockton / OMI Thames Water 2005 Annual Drinking Water Quality Report, California Water System No. 3910012.] SEWD obtains water from the New Hogan Reservoir in the Calaveras River watershed, and from the New Melones Reservoir in the Stanislaus River watershed. [Report available at: http://www.stocktongov.com/MUD/General/water/documents/2005CCRWaterQualityReport.pdf] Currently no methylmercury data are available for the reservoirs.

[k] The West Sacramento 2006 Water Quality Consumer Confidence Report states that the City of West Sacramento's main water supply is the Sacramento River, with an intake structure at Bryte Bend, upstream of the confluence of the Sacramento and American rivers. The City maintains water supply contracts with the federal Bureau of Reclamation, the Central Valley Project and the North Delta Water Agency. In addition to surface water, the City has five ground water wells that are available to supply additional water during emergencies. The City did not utilize ground water in 2005.

[l] The 2005 City of Sacramento Water Quality Report states that 85% of its water supply comes from the American and Sacramento Rivers and 15% comes from groundwater. [Report available at: http://www.cityofsacramento.org/utilities/pubs/DOU_CCR_2005.pdf] According to the November 2006 City of Sacramento Urban Water Management Plan prepared by West Yost Associates, the City diverts water from the American River downstream from the Howe Avenue Bridge, and from the Sacramento River downstream of the confluence of the American and Sacramento Rivers. [Report available at: http://www.cityofsacramento.org/utilities/urbanwater/] According to available water quality reports for urban areas outside of the City of Sacramento serviced by other water districts and private corporations, water supply for unincorporated areas is a mixture of surface water (e.g., Sacramento River, American River, and Folsom Lake) and groundwater. The effluent methylmercury data used in this analysis was collected from December 2000 to June 2003, since the surface drinking water supply data was collected during the same time period.

[m] Groundwater treatment plant intake and discharge monitoring (Tables B.1 through B.4) indicate that methylmercury concentrations in groundwater are at or below method detection limits (typically < 0.02 ng/l).

[n] The Modesto Irrigation District (ID) Water Treatment Plant (WTP), which supplements groundwater drinking water supplies for the Modesto community, obtains water from the Tuolumne River at Modesto Reservoir. The Modesto ID collected intake samples and analyzed them for methylmercury as part of their 13267 Order monitoring effort (see Table B.3). Modesto ID WTP water supply information is available at: http://www.mid.org/water/drnkwtr.htm

Table 20: Municipal WWTP Treatment Processes in Place at the Time of Methylmercury Sampling

Agency (NPDES No.)	Ave EFF1 MeHg Conc (ng/l) [a]	Title 22 [b]	1. Primary Clarification	2. Activated Sludge	3. Pure Oxygen Act. Sludge	4. RBC's [c]	5. SBR's [c]	6. Fixed Film Reactors	7. Trickling Filters	8. Extended Aeration	9. Settling Ponds	10. Oxidation Ditch	11. Oxidation Ponds	12. Facultative Ponds	13. Lemna/Overland Flow	14. Nitrify / Denitrify	15. Secondary Clarification	16. Dissolved Air Flotation	17. Coagulation / Polymer	18. Microfiltration	19. Filtration	20. Chlorination	21. Chlorination / Dechlor.	22. Ultraviolet Radiation	23. Ozonation	Average Flow (mgd)	Design Maximum Flow (mgd) [e]	Systems in Place during MeHg 13267 sampling [d]
Brentwood WWTP (CA0082660)	0.010	X	X							X		X				X	X		X		X	X				3.1	4.5	Y
Deuel Vocational Institute WWTP (CA0078093)	0.010											X				X	X				X	X				0.47	0.62	Y
United Auburn Indian Comm. Casino WWTP (CA0084697)	0.010	X		X												X	X			X				X		0.15	0.35	Y
Redding Stillwater WWTP (CA0082589)	0.013			X																	X		X			3.5	4.0	Y
El Dorado ID Deer Creek WWTP (CA0078662)	0.015	X	X	X						X		X				X					X		X			2.5	2.5	Y
Roseville Pleasant Grove WWTP (CA0084573)	0.017	X		X								X				X	X		X		X		X			4.8	12	Y
El Dorado ID El Dorado Hills WWTP (CA0078671)	0.018	X	X	X												X		X			X	X				1.1	3.0	Y
Lincoln WWTP (CA0084476)	0.018	X										X				X		X	X		X			X		1.1	3.3	Y
Shasta Lake WWTP (CA0079511)	0.022											X					X				X		X			0.64	1.3	Y
Roseville Dry Creek WWTP (CA0079502)	0.023	X	X	X												X	X		X		X		X			13	18	Y
Vacaville Easterly WWTP (CA0077691)	0.024		X	X													X						X			9.3	10	Y
Red Bluff WWTP (CA0078891)	0.027		X	X													X				X		X			1.4	2.5	Y
Auburn WWTP (CA0077712)	0.028	X										X				X	X		X		X		X			1.2	1.67	Y
Woodland WWTP (CA0077950)	0.031	X										X					X						X			6.1	7.8	Y
Atwater WWTP (CA0079197)	0.034		X	X													X						X			3.4	6.0	N?
UC Davis WWTP (CA0077895)	0.038	X										X				X	X				X			X		1.9	2.7	Y
Redding Clear Creek WWTP (CA0079731)	0.042		X	X													X				X		X			7.5	8.8	Y
Corning Industries/ Domestic WWTP (CA0004995)	0.044											X					X						X			1.0	1.38	Y
Nevada City WWTP (CA0079901)	0.048	X					X														X		X			0.43	0.69	Y
West Sacramento WWTP (CA0079171)	0.050		X	X												X	X						X			5.6	7.5	Y
Placerville Hangtown Creek WWTP (CA0078956)	0.058	X	X	X					X								X				X		X			1.3	2.3	Y
Turlock WWTP (CA0078948)	0.059			X													X						X			11.71	20	Y
San Joaquin Co DPW - Flag City WWTP (CA0082848)	0.081									X							X				X		X			0.06	0.16	Y

Table 20: Municipal WWTP Treatment Processes in Place at the Time of Methylmercury Sampling

Agency (NPDES No.)	Ave EFF1 MeHg Conc (ng/l) [a]	Title 22 [b]	1. Primary Clarification	2. Activated Sludge	3. Pure Oxygen Act. Sludge	4. RBC's [c]	5. SBR's [c]	6. Fixed Film Reactors	7. Trickling Filters	8. Extended Aeration	9. Settling Ponds	10. Oxidation Ditch	11. Oxidation Ponds	12. Facultative Ponds	13. Lemna/Overland Flow	14. Nitrify / Denitrify	15. Secondary Clarification	16. Dissolved Air Flotation	17. Coagulation / Polymer	18. Microfiltration	19. Filtration	20. Chlorination	21. Chlorination / Dechlor.	22. Ultraviolet Radiation	23. Ozonation	Average Flow (mgd)	Design Maximum Flow (mgd) [e]	Systems in Place during MeHg 13267 sampling [d]
Anderson WWTP (CA0077704)	0.090			X													X				X		X			1.4	2.0	Y
Cottonwood WWTP (CA0081507)	0.096											X					X				X		X			0.29	0.43	Y
Placer Co. SMD #3 WWTP (CA0079367)	0.100		X						X								X		X		X		X			0.12	0.3	Y
Jackson WWTP (CA0079391)	0.108	X										X					X				X		X			0.71	0.71	Y
Nevada Co SD #1 Lake Wildwood WWTP (CA0077828)	0.109											X					X				X		X			0.50	1.1	Y*
Chico Regional WWTP (CA0079081)	0.126		X	X						X							X					X				7.2	9.0	Y
Lodi White Slough WWTP (CA0079243)	0.128		X	X													X				X			X		4.5	7.0	Y
Modesto WWTP (CA0079103)	0.130		X					X						X									X			7.2	70	Y
Galt WWTP (CA0081434)	0.139			X						X							X						X			1.9	3.0	Y**
Placer Co. SMD #1 WWTP (CA0079316)	0.141	X	X			X			X								X				X		X			1.90	2.18	Y
Nevada Co SD #1 Cascade Shores WWTP (CA0083241)	0.142	X		X													X				X		X			0.026	0.03	Y
Olivehurst PUD WWTP (CA0077836)	0.144	X	X	X													X						X			1.2	1.8	Y***
Tracy WWTP (CA0079154)	0.145		X	X					X								X						X			9.5	9 *upgrade to 16*	Y****
Canada Cove LP French Camp WWTP (CA0083682)	0.147						X										X				X				X	0.04	0.04	Y
Oroville WWTP (CA0079235)	0.147		X	X													X				X		X			3.0	6.5	Y
Grass Valley WWTP (CA0079898)	0.160	X	X	X												X	X						X			2.1	2.78	Y
Rio Vista Main WWTP (CA0079588)	0.164		X	X													X						X			0.47	0.65	Y
Tuolumne UD Sonora WWTP/ Jamestown WWTP (CA0084727)	0.182		X						X								X					X				0.16	2.6	Y
Discovery Bay WWTP (CA0078590)	0.191											X				X	X							X		1.5	2.1	Y
Colfax WWTP (CA0079529)	0.197	X												X									X			0.024	0.16	Y
Manteca WWTP (CA0081558)	0.216		X	X													X						X			4.6	8.11	Y***
San Andreas SD WWTP (CA0079464)	0.249		X						X								X						X			0.3	0.4	Y

Table 20: Municipal WWTP Treatment Processes in Place at the Time of Methylmercury Sampling

Agency (NPDES No.)	Ave EFF1 MeHg Conc (ng/l) [a]	Title 22 [b]	1. Primary Clarification	2. Activated Sludge	3. Pure Oxygen Act. Sludge	4. RBC's [c]	5. SBR's [c]	6. Fixed Film Reactors	7. Trickling Filters	8. Extended Aeration	9. Settling Ponds	10. Oxidation Ditch	11. Oxidation Ponds	12. Facultative Ponds	13. Lemna/Overland Flow	14. Nitrify / Denitrify	15. Secondary Clarification	16. Dissolved Air Flotation	17. Coagulation / Polymer	18. Microfiltration	19. Filtration	20. Chlorination	21. Chlorination / Dechlor.	22. Ultraviolet Radiation	23. Ozonation	Average Flow (mgd)	Design Maximum Flow (mgd) [e]	Systems in Place during MeHg 13267 sampling [d]
Yuba City WWTP (CA0079260)	0.295		X		X												X						X			5.22	7.0	Y
Merced WWTP (CA0079219)	0.386		X	X													X						X			8.5	10	Y
Mariposa PUD WWTP (CA0079430)	0.393											X					X						X			0.25	0.61	Y
Davis WWTP (CA0079049)	0.546	X	X										X		X								X			5.3	7.5	Y****
Live Oak WWTP (CA0079022)	0.591	X												X									X			1.65	1.6 / 5.9	Y
SRCSD Sacramento River WWTP (CA0077682)	0.613		X		X												X						X			151	181	Y
Placer Co. SA #28 Zone #6 WWTP (CA0079341)	0.668	X									X			X								X				0.01	0.1	Y
Stockton WWTP (CA0079138)	0.935		X						X				X								X		X			28	55	Y
Maxwell PUD WWTP (CA0079987)	0.993	X											X									X				0.14	0.2	Y****
Planada Comm. Service Dist. WWTP (CA0078950)	1.168										X			X							X	X				0.38	0.38	Y
Nevada Co SD #2 Lake of the Pines WWTP (CA0081612)	1.409	X												X			X		X		X		X			0.54	0.72	Y***
Williams WWTP (CA0077933)	1.553	X												X									X			0.44	0.5	Y****
Biggs WWTP (CA0078930)	1.605								X		X			X									X			0.38	0.53	Y
Rio Alto WD- Lake CA WWTP (CA0077852)	1.746											X					X				X		X			0.15	0.64	Y
SRCSD Walnut Grove WWTP (CSD1) (CA0078794)	2.155										X		X										X			0.08	0.5	Y
Colusa WWTP (CA0078999)	2.863	X									X				X								X			0.66	0.9	Y

[a] One-half of the method detection limit (MDL) was used in calculations for methylmercury concentration results that were less than the MDL.

[b] The California Department of Public Health (DPH) has developed reclamation criteria (CCR, Division 4, Chapter 3 (Title 22)) for the reuse of wastewater. Title 22 requires that for spray irrigation of food crops, parks, playgrounds, schoolyards, and other areas of similar public access, wastewater be adequately disinfected, oxidized, coagulated, clarified, and filtered, and that the effluent total coliform levels not exceed 2.2 MPN/100 mL as a 7-day median. The regulatory criteria include numerical limitations and requirements, treatment method requirements, and provisions and requirements related to sampling and analysis, engineering reports, design, operation, maintenance and reliability of facilities.

[c] RBC's: Rotating Biological Contactors SBR's: Sequencing Batch Reactors

[d] *Tertiary, no Title 22. ** No tertiary. *** No Title 22. **** No tertiary, no Title 22.

[e] If two values are provided, the first is design average dry weather flow and the second is design peak wet weather flow.

Table 21: Treatment Categories and Effluent Methylmercury Descriptive Statistics for the Municipal WWTPs

NPDES No.	WWTP	2005 Treatment Category [(a)]	# of Samples	# of Non-detect Samples	Average MeHg Conc. (ng/l)	Median MeHg Conc. (ng/l)	MeHg Conc. Range (ng/l)	Std. Deviation (ng/l)	Coefficient of Variation (%)
CA0077704	Anderson	Filtration + Chlor./ Dechlor.	12	2	0.090	0.067	ND - 0.271	0.084	93
CA0079197	Atwater	Secondary + Chlor./ Dechlor.	12	3	0.034	0.033	ND - 0.084	0.021	62
CA0077712	Auburn	N/D + Filtration + Chlor./ Dechlor.	12	6	0.028	0.023	ND - 0.072	0.021	75
CA0078930	Biggs	Pond + Chlor./ Dechlor.	2	0	1.605	1.605	0.150 - 3.060	2.058	128
CA0082660	Brentwood	N/D + Filtration + Chlor./ Dechlor.	13	13	*(all sample results < MDL)*				
CA0083682	Canada Cove LP French Camp	Filtration + Ozonation	4	0	0.147	0.134	0.029 - 0.291	0.127	86
CA0079081	Chico Regional	Secondary + Chlor./ Dechlor.	12	0	0.126	0.118	0.057 - 0.178	0.035	28
CA0079529	Colfax	Pond + Chlor./ Dechlor.	3	0	0.197	0.126	0.115 - 0.350	0.133	67
CA0078999	Colusa	Pond + Chlor./ Dechlor.	4	0	2.863	2.730	1.970 - 4.020	0.924	32
CA0004995	Corning Industries/ Domestic	Secondary + Chlor./ Dechlor.	2	0	0.044	0.044	0.034 - 0.053	0.013	31
CA0081507	Cottonwood	Filtration + Chlor./ Dechlor.	5	0	0.096	0.047	0.045 - 0.245	0.086	90
CA0079049	Davis (Discharge 1)	Pond + Chlor./ Dechlor.	7	0	0.546	0.533	0.305 - 1.040	0.252	46
CA0079049	Davis (Discharge 2)	Pond + Chlor./ Dechlor.	5	0	0.613	0.514	0.247 - 1.440	0.481	78
CA0078662	Deer Creek	N/D + Filtration + Chlor./ Dechlor.	13	11	0.015	0.013	ND - 0.032	0.006	41
CA0078093	Deuel Vocational Institute	Filtration + Chlor./ Dechlor.	3	3	*(all sample results < MDL)*				
CA0078590	Discovery Bay	Secondary w/ N/D + UV	12	7	0.191	0.013	ND - 2.030	0.579	303
CA0078671	El Dorado Hills (Discharge 1)	N/D + Filtration + Chlor./ Dechlor.	12	10	0.018	0.013	ND - 0.055	0.014	76
CA0078671	El Dorado Hills (Discharge 2)	N/D + Filtration + Chlor./ Dechlor.	2	2	*(all sample results < MDL)*				
CA0081434	Galt	Secondary + Chlor./ Dechlor.	6	0	0.139	0.142	0.027 - 0.220	0.068	49
CA0079898	Grass Valley	Secondary w/ N/D + Chlor./ Dechlor.	16	2	0.160	0.030	ND - 0.938	0.305	190
CA0079391	Jackson	Filtration + Chlor./ Dechlor.	4	0	0.108	0.104	0.061 - 0.161	0.041	38
CA0084476	Lincoln	N/D + Filtration + UV	7	6	0.018	0.010	ND - 0.068	0.022	120

Table 21: Treatment Categories and Effluent Methylmercury Descriptive Statistics for the Municipal WWTPs

NPDES No.	WWTP	2005 Treatment Category [(a)]	# of Samples	# of Non-detect Samples	Average MeHg Conc. (ng/l)	Median MeHg Conc. (ng/l)	MeHg Conc. Range (ng/l)	Std. Deviation (ng/l)	Coefficient of Variation (%)
CA0079022	Live Oak	Pond + Chlor./ Dechlor.	4	0	0.591	0.575	0.427 - 0.785	0.152	26
CA0079243	Lodi White Slough	Filtration + UV	12	4	0.128	0.025	ND - 1.240	0.351	275
CA0081558	Manteca	Secondary + Chlor./ Dechlor.	11	0	0.216	0.229	0.037 - 0.356	0.082	38
CA0079430	Mariposa PUD	Secondary + Chlor./ Dechlor.	4	0	0.393	0.309	0.040 - 0.912	0.417	106
CA0079987	Maxwell PUD	Pond + Chlor./ Dechlor.	4	0	0.993	1.104	0.044 - 1.720	0.849	86
CA0079219	Merced	Secondary + Chlor./ Dechlor.	12	0	0.386	0.369	0.130 - 0.672	0.156	40
CA0079103	Modesto	Pond + Chlor./ Dechlor.	9	0	0.130	0.118	0.108 - 0.170	0.025	19
CA0079901	Nevada City	Filtration + Chlor./ Dechlor.	4	2	0.048	0.018	ND - 0.146	0.066	137
CA0083241	Nevada Co SD #1 Cascade Shores	Filtration + Chlor./ Dechlor.	3	1	0.142	0.131	ND - 0.286	0.138	97
CA0077828	Nevada Co SD #1 Lake Wildwood	Filtration + Chlor./ Dechlor.	12	1	0.109	0.086	ND - 0.320	0.084	77
CA0081612	Nevada Co SD #2 Lake of the Pines	Pond + Filtration + Chlor./ Dechlor.	2	0	1.409	1.409	0.708 - 2.110	0.991	70
CA0077836	Olivehurst PUD	Secondary + Chlor./ Dechlor.	13	1	0.144	0.121	ND - 0.268	0.094	65
CA0079235	Oroville	Filtration + Chlor./ Dechlor.	12	0	0.147	0.148	0.061 - 0.280	0.072	49
CA0079341	Placer Co. SA #28 Zone #6	Pond + Chlor./ Dechlor.	2	0	0.668	0.668	0.474 - 0.862	0.274	41
CA0079316	Placer Co. SMD #1	Filtration + Chlor./ Dechlor.	12	0	0.141	0.142	0.042 - 0.350	0.092	65
CA0079367	Placer Co. SMD #3	Filtration + Chlor./ Dechlor.	12	0	0.100	0.069	0.037 - 0.381	0.095	95
CA0078956	Placerville Hangtown Creek	Filtration + Chlor./ Dechlor.	12	1	0.058	0.044	ND - 0.170	0.041	69
CA0078950	Planada Comm. Service Dist.	Pond + Filtration + Chlor./ Dechlor.	4	0	1.168	1.128	0.374 - 2.040	0.885	76
CA0078891	Red Bluff	Filtration + Chlor./ Dechlor.	12	6	0.027	0.025	ND - 0.057	0.018	67
CA0079731	Redding Clear Creek	Filtration + Chlor./ Dechlor.	12	3	0.042	0.039	ND - 0.084	0.024	57
CA0082589	Redding Stillwater	Filtration + Chlor./ Dechlor.	12	12	*(all sample results < MDL)*				
CA0077852	Rio Alto WD- Lake CA	Filtration + Chlor./ Dechlor.	2	0	1.746	1.746	0.141 - 3.350	2.269	130
CA0079588	Rio Vista Main	Secondary + Chlor./ Dechlor.	4	0	0.164	0.049	0.035 - 0.522	0.239	146
CA0079502	Roseville Dry Creek	N/D + Filtration + Chlor./ Dechlor.	12	4	0.023	0.021	ND - 0.055	0.014	60

Table 21: Treatment Categories and Effluent Methylmercury Descriptive Statistics for the Municipal WWTPs

NPDES No.	WWTP	2005 Treatment Category [(a)]	# of Samples	# of Non-detect Samples	Average MeHg Conc. (ng/l)	Median MeHg Conc. (ng/l)	MeHg Conc. Range (ng/l)	Std. Deviation (ng/l)	Coefficient of Variation (%)
CA0084573	Roseville Pleasant Grove	N/D + Filtration + Chlor./ Dechlor.	12	10	0.017	0.010	ND - 0.070	0.018	107
CA0079464	San Andreas SD	Secondary + Chlor./ Dechlor.	4	0	0.249	0.262	0.178 - 0.293	0.053	21
CA0082848	San Joaquin Co DPW - Flag City	Filtration + Chlor./ Dechlor.	3	1	0.081	0.078	ND - 0.152	0.070	86
CA0079511	Shasta Lake	Filtration + Chlor./ Dechlor.	2	1	0.022	0.022	ND - 0.034	0.017	77
CA0077682	SRCSD Sacramento River	Secondary + Chlor./ Dechlor.	108	0	0.613	0.551	0.118 - 1.640	0.336	55
CA0078794	SRCSD Walnut Grove	Pond + Chlor./ Dechlor.	2	0	2.155	2.155	0.949 - 3.36	1.705	79
CA0079138	Stockton	Pond + Filtration + Chlor./ Dechlor.	12	1	0.935	0.766	ND - 2.090	0.712	76
CA0079154	Tracy	Secondary + Chlor./ Dechlor.	13	1	0.145	0.132	ND - 0.422	0.104	72
CA0084727	Tuolumne UD Sonora / Jamestown	Secondary + Chlor./ Dechlor.	3	0	0.182	0.213	0.071 - 0.262	0.099	55
CA0078948	Turlock	Secondary + Chlor./ Dechlor.	12	1	0.059	0.062	ND - 0.079	0.019	32
CA0077895	UC Davis	N/D + Filtration + UV	12	3	0.038	0.030	ND - 0.078	0.025	65
CA0084697	United Auburn Indian Community Casino	N/D + Filtration + UV	2	2	*(all sample results < MDL)*				
CA0077691	Vacaville Easterly	Secondary + Chlor./ Dechlor.	12	4	0.024	0.024	ND - 0.057	0.014	57
CA0079171	West Sacramento	Secondary w/ N/D + Chlor./ Dechlor.	12	1	0.050	0.050	ND - 0.085	0.022	44
CA0077933	Williams	Pond + Chlor./ Dechlor.	4	0	1.553	1.775	0.560 - 2.100	0.691	45
CA0077950	Woodland	Secondary + Chlor./ Dechlor.	12	2	0.031	0.031	ND - 0.059	0.014	43
CA0079260	Yuba City	Secondary + Chlor./ Dechlor.	12	0	0.295	0.237	0.106 - 0.625	0.167	57

[(a)] Chlor./ Dechlor.: Chlorination and Dechlorination N/D: Nitrification/Denitrification UV: Ultraviolet radiation

Table 22: Description of Treatment Categories

2005 Treatment Category	Secondary Treatment	Nitrification/ Denitrification	Tertiary Treatment	Disinfection
Filtration + Chlor./ Dechlor.	Any	No	Yes	Chlorination/ Dechlorination
Filtration + Ozonation	Any	No	Yes	Ozonation
Filtration + UV	Any	No	Yes	Ultraviolet radiation
N/D + Filtration + Chlor./ Dechlor.	Any	Yes	Yes	Chlorination/ Dechlorination
N/D + Filtration + UV	Any	Yes	Yes	Ultraviolet radiation
Pond + Chlor./ Dechlor.	Treatment Pond (a)	No	No	Chlorination/ Dechlorination
Pond + Filtration + Chlor./ Dechlor.	Treatment Pond (a)	No	Yes	Chlorination/ Dechlorination
Secondary + Chlor./ Dechlor.	Any	No	No	Chlorination/ Dechlorination
Secondary w/ N/D + Chlor./ Dechlor.	Any	Yes	No	Chlorination/ Dechlorination
Secondary w/ N/D + UV	Any	Yes	No	Ultraviolet radiation

[(a)] The municipal WWTPs placed in the pond treatment categories use treatment pond systems (oxidation, facilitative, settling or stabilization ponds) as a significant part of their treatment process. These facilities may also use other types of secondary treatment in addition to the treatment ponds.

Table 23: Descriptive Statistics for the Effluent Methylmercury Concentrations for the Municipal WWTP Treatment Categories [a]

2005 Treatment Category	# of Facilities	# of samples	# of Non-detect samples	Ave. Effluent MeHg Conc. (ng/l)	Median Effluent MeHg Conc. (ng/l)	MeHg Conc. Range (ng/l)	Standard Error (ng/l) [b]	95% Conf. Interval (ng/l)	P_{25} (ng/l) [c]	P_{75} (ng/l) [d]	IQR (ng/l) [e]	g [f]	Shapiro-Wilk p-value[g]
Filtration + Chlor./ Dechlor.	17	134	33	0.105	0.056	ND - 3.350	0.025	0.050	0.025	0.113	0.088	10.39	<0.0001
Filtration + Ozonation	1	4	0	0.147	0.134	0.029 - 0.291	0.063	0.202	0.035	0.272	0.237	0.27	0.39
Filtration + UV	1	12	4	0.128	0.025	ND - 1.240	0.101	0.223	0.010	0.049	0.039	3.45	<0.00001
N/D + Filtration + Chlor./ Dechlor.	6	76	56	0.018	0.013	ND - 0.072	0.002	0.003	0.010	0.020	0.010	2.14	<0.00001
N/D + Filtration + UV	3	21	11	0.029	0.020	ND - 0.078	0.005	0.011	0.010	0.040	0.030	1.16	<0.001
Pond + Chlor./ Dechlor.	10	46	0	0.902	0.522	0.044 - 4.020	0.147	0.296	0.158	1.485	1.327	1.58	<0.00001
Pond + Filtration + Chlor./ Dechlor.	3	18	1	1.040	0.806	ND - 2.110	0.175	0.369	0.388	1.830	1.442	0.23	<0.05
Secondary + Chlor./ Dechlor.	17	252	12	0.351	0.243	ND - 1.640	0.021	0.042	0.076	0.537	0.461	1.39	<0.00001
Secondary w/ N/D + Chlor./ Dechlor.	2	28	3	0.113	0.045	ND - 0.938	0.044	0.091	0.028	0.085	0.057	3.41	<0.00001
Secondary w/ N/D + UV	1	12	7	0.191	0.013	ND - 2.030	0.167	0.368	0.013	0.050	0.037	3.99	<0.00001

[a] One-half of the MDL was used in calculations for methylmercury concentration results that were less than the MDL.
[b] The standard error is estimated standard deviation of the sample mean. It is calculated by dividing the sample standard deviation by the square root of the sample size.
[c] The 25th percentile (P_{25}) is a value which exceeds no more than 25 percent of the data and is exceeded by no more than 75 percent.
[d] The 75th percentile (P_{75}) is a value which exceeds no more than 75 percent of the data and is exceeded by no more than 25 percent.
[e] The interquartile range (IQR) is the 75th percentile minus the 25th percentile. The IQR is a measure of variability that is more resistant to outliers than the standard deviation.
[f] A positive coefficient of skewness (g) indicates that the distribution is right-skewed (i.e. the distribution is asymmetric with extreme values extending out longer to the right side or larger value side). Conversely, a negative coefficient of skewness indicates that the distribution is left-skewed. As the coefficient of skewness increases from zero in either the negative or positive direction, the more extreme the skewness of the distribution.
[g] If the Shapiro-Wilk W statistic is statistically significant (p-value is less than 0.05), then the hypothesis that the data distribution is normal is rejected. Therefore, a p-value less than 0.05 indicates that the distribution is most likely not normal.

Table 24: Kruskal-Wallis Multiple Comparison Results for Median Effluent Methylmercury Concentrations of the Treatment Categories

2005 Treatment Category [a]	Average Effluent MeHg Conc. (ng/l)	Median Effluent MeHg Conc. (ng/l)	Comparison p-values [b]								
			N/D + Filtration + Chlor./ Dechlor.	Secondary w/ N/D + UV	N/D + Filtration + UV	Filtration + UV	Secondary w/ N/D + Chlor./ Dechlor.	Filtration + Chlor./ Dechlor.	Secondary + Chlor./ Dechlor.	Pond + Chlor./ Dechlor.	Pond + Filtration + Chlor./ Dechlor.
N/D + Filtration + Chlor./ Dechlor.	0.018	0.013	--	1.0000	1.0000	1.0000	***0.0218***	***0.0000***	***0.0000***	***0.0000***	***0.0000***
Secondary w/ N/D + UV	0.191	0.013	1.0000	--	1.0000	1.0000	1.0000	1.0000	***0.0022***	***0.0000***	***0.0000***
N/D + Filtration + UV	0.029	0.020	1.0000	1.0000	--	1.0000	1.0000	0.2168	***0.0000***	***0.0000***	***0.0000***
Filtration + UV	0.128	0.025	1.0000	1.0000	1.0000	--	1.0000	1.0000	***0.0008***	***0.0000***	***0.0000***
Secondary w/ N/D + Chlor./ Dechlor.	0.113	0.045	***0.0218***	1.0000	1.0000	1.0000	--	1.0000	***0.0002***	***0.0000***	***0.0000***
Filtration + Chlor./ Dechlor.	0.105	0.056	***0.0000***	1.0000	0.2168	1.0000	1.0000	--	***0.0000***	***0.0000***	***0.0000***
Secondary + Chlor./ Dechlor.	0.351	0.243	***0.0000***	***0.0022***	***0.0000***	***0.0008***	***0.0002***	***0.0000***	--	***0.0488***	0.2101
Pond + Chlor./ Dechlor.	0.902	0.522	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0488***	--	1.0000
Pond + Filtration + Chlor./ Dechlor.	1.040	0.806	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	0.2101	1.0000	--

[a] Due to the small sample size and unusual treatment type, the "Filtration + Ozonation" treatment category was not included in this analysis.

[b] The comparison p-values between pairs were calculated with Statistica software. The p-values are two-sided significance levels multiplied by the number of possible combination pairs [k*(k-1)/2, where k is the total number of groups in the comparison]. The number of possible combination pairs in this comparison analysis is 36. P-values less than 0.05 are highlighted in ***bold and italics*** to identify statistically significant differences between treatment categories.

Table 25: Subcategories Based upon Secondary Treatment for the Municipal WWTPs

NPDES No.	WWTP	2005 Secondary Treatment Subcategory
Secondary + Chlor./ Dechlor.		
CA0079197	Atwater	Activated Sludge
CA0079081	Chico Regional	Activated Sludge
CA0004995	Corning Industries/ Domestic	Activated Sludge
CA0081434	Galt	Activated Sludge
CA0081558	Manteca	Activated Sludge
CA0079430	Mariposa PUD	Activated Sludge
CA0079219	Merced	Activated Sludge
CA0077836	Olivehurst PUD	Activated Sludge
CA0079588	Rio Vista Main	Activated Sludge
CA0079464	San Andreas SD	Fixed Media
CA0077682	SRCSD Sacramento River	Activated Sludge
CA0079154	Tracy	Activated Sludge + Trickling Filter
CA0084727	Tuolumne UD Sonora / Jamestown	Fixed Media
CA0078948	Turlock	Activated Sludge
CA0077691	Vacaville Easterly	Activated Sludge
CA0077950	Woodland	Activated Sludge
CA0079260	Yuba City	Activated Sludge
Filtration + Chlor./ Dechlor.		
CA0077704	Anderson	Activated Sludge
CA0081507	Cottonwood	Activated Sludge
CA0078093	Deuel Vocational Institute	Activated Sludge
CA0079391	Jackson	Activated Sludge
CA0079901	Nevada City	Activated Sludge
CA0083241	Nevada Co SD #1 Cascade Shores	Activated Sludge
CA0077828	Nevada Co SD #1 Lake Wildwood	Activated Sludge
CA0079235	Oroville	Activated Sludge
CA0079316	Placer Co. SMD #1	Fixed Media
CA0079367	Placer Co. SMD #3	Fixed Media
CA0078956	Placerville Hangtown Creek	Activated Sludge + Trickling Filter
CA0078891	Red Bluff	Activated Sludge
CA0079731	Redding Clear Creek	Activated Sludge
CA0082589	Redding Stillwater	Activated Sludge
CA0077852	Rio Alto WD- Lake CA	Activated Sludge
CA0082848	San Joaquin Co DPW - Flag City	Activated Sludge
CA0079511	Shasta Lake	Activated Sludge

Table 26: Descriptive Statistics for the Effluent Methylmercury Concentrations for the Municipal WWTP Subcategories [a]

2005 Secondary Treatment Subcategory	# of Facilities	# of samples	# of Non-detect samples	Ave. Effluent MeHg Conc. (ng/l)	Median Effluent MeHg Conc. (ng/l)	MeHg Conc. Range (ng/l)	Standard Error (ng/l) [b]	95% Conf. Interval (ng/l)	P_{25} (ng/l) [c]	P_{75} (ng/l) [d]	IQR (ng/l) [e]	g [f]	Shapiro-Wilk p-value [g]
Secondary + Chlor./ Dechlor.													
Activated Sludge	14	232	11	0.367	0.258	ND - 1.640	0.023	0.045	0.073	0.552	0.479	1.29	<0.00001
Activated Sludge + Trickling Filter	1	13	1	0.145	0.132	ND - 0.422	0.029	0.063	0.080	0.181	0.101	1.55	0.062
Fixed Media	2	7	0	0.220	0.239	0.071 - 0.293	0.029	0.071	0.178	0.285	0.107	-1.35	0.25
Filtration + Chlor./ Dechlor.													
Activated Sludge	14	98	32	0.107	0.048	ND - 3.350	0.034	0.068	0.013	0.100	0.087	9.20	<0.0001
Activated Sludge + Trickling Filter	1	12	1	0.058	0.044	ND - 0.170	0.012	0.026	0.039	0.062	0.023	2.14	<0.01
Fixed Media	2	24	0	0.121	0.078	0.037 - 0.381	0.019	0.040	0.050	0.151	0.101	1.64	<0.001

[a] One-half of the MDL was used in calculations for methylmercury concentration results that were less than the MDL.
[b] The standard error is estimated standard deviation of the sample mean. It is calculated by dividing the sample standard deviation by the square root of the sample size.
[c] The 25th percentile (P_{25}) is a value which exceeds no more than 25 percent of the data and is exceeded by no more than 75 percent.
[d] The 75th percentile (P_{75}) is a value which exceeds no more than 75 percent of the data and is exceeded by no more than 25 percent.
[e] The interquartile range (IQR) is the 75th percentile minus the 25th percentile. The IQR is a measure of variability that is more resistant to outliers than the standard deviation.
[f] A positive coefficient of skewness (g) indicates that the distribution is right-skewed (i.e. the distribution is asymmetric with extreme values extending out longer to the right side or larger value side). Conversely, a negative coefficient of skewness indicates that the distribution is left-skewed. As the coefficient of skewness increases from zero in either the negative or positive direction, the more extreme the skewness of the distribution.
[g] If the Shapiro-Wilk W statistic is statistically significant (p-value is less than 0.05), then the hypothesis that the data distribution is normal is rejected. Therefore, a p-value less than 0.05 indicates that the distribution is most likely not normal.

Table 27: Kruskal-Wallis Multiple Comparison Results for Median Effluent Methylmercury Concentrations of the Subcategories within the "Filtration + C/D" category

2005 Secondary Treatment Subcategory	Average (ng/l)	Median (ng/l)	Comparison p-values [a]		
			Activated Sludge + Trickling Filter	Activated Sludge	Fixed Media
Activated Sludge + Trickling Filter	0.058	0.044	--	1.0000	0.1556
Activated Sludge	0.107	0.048	1.0000	--	***0.0078***
Fixed Media	0.121	0.078	0.1556	***0.0078***	--

[a] The comparison p-values between pairs were calculated with Statistica software. The p-values are two-sided significance levels multiplied by the number of possible combination pairs [k*(k-1)/2, where k is the total number of groups in the comparison]. The number of possible combination pairs in this comparison analysis is 3. P-values less than 0.05 are highlighted in ***bold and italics*** to identify statistically significant differences between treatment categories.

Table 28: Two-sided Significance Levels (p-values) for WWTP Treatment Subcategories [a]

2005 Treatment Subcategory	Two sample t-test	Mann-Whitney U test
Activated Sludge	<0.0001 [b]	<0.0001
Activated Sludge + Trickling Filter	0.014 [c]	0.011
Fixed Media	0.015 [c]	0.009

[a] When comparing the same subcategory within the "Filtration + C/D" and "Secondary + C/D" categories.
[b] P-value for two sample t-test assuming equal variances.
[c] P-value for two sample t-test assuming unequal variances.

Table 29: Kruskal-Wallis Multiple Comparison Results for Median Effluent:Influent Methylmercury Ratios of the Treatment Categories

2005 Treatment Category [a]	Average Effluent:Influent MeHg Ratio	Median Effluent:Influent MeHg Ratio	Comparison p-values [b]						
			N/D + Filtration + Chlor./ Dechlor.	N/D + Filtration + UV	Filtration + Chlor./ Dechlor.	Filtration + UV	Secondary w/ N/D + Chlor./ Dechlor.	Secondary + Chlor./ Dechlor.	Pond + Chlor./ Dechlor.
N/D + Filtration + Chlor./ Dechlor.	2.4%	1.2%	--	1.0000	1.0000	1.0000	1.0000	***0.0000***	***0.0000***
N/D + Filtration + UV	2.7%	1.5%	1.0000	--	1.0000	1.0000	1.0000	***0.0000***	***0.0019***
Filtration + Chlor./ Dechlor.	4.1%	1.6%	1.0000	1.0000	--	1.0000	1.0000	***0.0109***	***0.0365***
Filtration + UV	6.0%	2.0%	1.0000	1.0000	1.0000	--	1.0000	***0.0004***	***0.0153***
Secondary w/ N/D + Chlor./ Dechlor.	10.2%	2.1%	1.0000	1.0000	1.0000	1.0000	--	***0.0006***	***0.0344***
Secondary + Chlor./ Dechlor.	36.8%	28.1%	***0.0000***	***0.0000***	***0.0109***	***0.0004***	***0.0006***	--	1.0000
Pond + Chlor./ Dechlor.	65.5%	36.4%	***0.0000***	***0.0019***	***0.0365***	***0.0153***	***0.0344***	1.0000	--

[a] The "Pond + Filtration + Chlor./ Dechlor." treatment category was not included in this analysis due to it having a sample size of one. Additionally, the “Secondary w/ N/D + UV” and "Filtration + Ozonation" treatment categories were not included since the facilities with these treatment types did not collect influent samples.

[b] The comparison p-values between pairs were calculated with Statistica software. The p-values are two-sided significance levels multiplied by the number of possible combination pairs [k*(k-1)/2, where k is the total number of groups in the comparison]. The number of possible combination pairs in this comparison analysis is 21. P-values less than 0.05 are highlighted in ***bold and italics*** to identify statistically significant differences between treatment categories.

Table 30: Regression Coefficients (R^2) and Two-sided Significance Levels (p-values) for Influent versus Effluent Methylmercury Concentration Scatter Plots for Each WWTP with Five or More Paired Data Points. [Significant relationships are in bold.]

NPDES #	WWTP	# of paired data points	R^2 value for linear regression	p-value for linear regression
CA0079081	Chico	11	0.026	0.636
CA0078662	Deer Creek	13	0.2374	0.091
CA0078671	El Dorado Hills (Discharge 1)	12	0.0832	0.363
CA0079898	Grass Valley	16	0.0092	0.724
CA0079243	**Lodi**	**12**	**0.4037**	**0.026**
CA0079502	Roseville Dry Creek	9	0.086	0.444
CA0084573	Roseville Pleasant Grove	9	0.02	0.717
CA0077682	**SRCSD Sacramento River**	**107**	**0.1739**	**0.000008**
CA0077895	**UC Davis**	**12**	**0.3875**	**0.031**
CA0077950	Woodland	12	0.0643	0.426

Table 31: Kruskal-Wallis Multiple Comparison Results for Median Effluent Methylmercury:Total Mercury Ratios of the Treatment Categories

2005 Treatment Category [a]	Average Effluent MeHg:THg Ratio	Median Effluent MeHg:THg Ratio	Comparison p-values [b]							
			Secondary w/ N/D + UV	N/D + Filtration + Chlor./ Dechlor.	Filtration + UV	Secondary w/ N/D + Chlor./ Dechlor.	Filtration + Chlor./ Dechlor.	Secondary + Chlor./ Dechlor.	Pond + Chlor./ Dechlor.	Pond + Filtration + Chlor./ Dechlor.
Secondary w/ N/D + UV	0.6%	0.5%	--	1.0000	1.0000	1.0000	***0.0415***	***0.0001***	***0.0002***	***0.0000***
N/D + Filtration + Chlor./ Dechlor.	1.2%	0.9%	1.0000	--	1.0000	1.0000	***0.0146***	***0.0000***	***0.0000***	***0.0000***
Filtration + UV	3.6%	1.0%	1.0000	1.0000	--	1.0000	1.0000	***0.0068***	***0.0095***	***0.0000***
Secondary w/ N/D + Chlor./ Dechlor.	1.8%	1.2%	1.0000	1.0000	1.0000	--	1.0000	0.1489	0.1196	***0.0002***
Filtration + Chlor./ Dechlor.	4.0%	2.9%	***0.0415***	***0.0146***	1.0000	1.0000	--	0.1234	0.3376	***0.0001***
Secondary + Chlor./ Dechlor.	6.7%	5.6%	***0.0001***	***0.0000***	***0.0068***	0.1489	0.1234	--	1.0000	***0.0225***
Pond + Chlor./ Dechlor.	11.0%	5.8%	***0.0002***	***0.0000***	***0.0095***	0.1196	0.3376	1.0000	--	0.7644
Pond + Filtration + Chlor./ Dechlor.	18.8%	16.9%	***0.0000***	***0.0000***	***0.0000***	***0.0002***	***0.0001***	***0.0225***	0.7644	--

[a] The "N/D + Filtration + UV" treatment category was not included in this analysis due to it having a sample size of one. Additionally, the "Filtration + Ozonation" treatment category was not included since the one facility with this treatment type did not collect influent samples.

[b] The comparison p-values between pairs were calculated with Statistica software. The p-values are two-sided significance levels multiplied by the number of possible combination pairs [k*(k-1)/2, where k is the total number of groups in the comparison]. The number of possible combination pairs in this comparison analysis is 36. P-values less than 0.05 are highlighted in ***bold and italics*** to identify statistically significant differences between treatment categories.

Table 32: Regression Coefficients (R^2) and Two-sided Significance Levels (p-values) for Inorganic Mercury versus Methylmercury Effluent Concentration Scatter Plots for Each WWTP with Five or More Paired Data Points. [Significant relationships are in bold.]

NPDES #	WWTP	# of paired data points	R^2 value for linear regression	p-value for linear regression
CA0082660	Brentwood	13	*all MeHg values are nondetect*	
CA0079049	**Davis (Discharges 1 & 2)**	**12**	**0.4445**	**0.018**
CA0078590	**Discovery Bay**	**9**	**0.551**	**0.022**
CA0079243	Lodi	12	0.0513	0.479
CA0081558	Manteca	11	0.2412	0.125
CA0079103	Modesto	9	0.0351	0.629
CA0079316	Placer Co. SMD #1	11	0.0383	0.564
CA0079367	Placer Co. SMD #3	12	0.0009	0.926
CA0079731	Redding Clear Creek	12	0.0055	0.819
CA0082589	Redding Stillwater	12	*all MeHg values are nondetect*	
CA0079502	Roseville Dry Creek	10	0.002	0.902
CA0084573	Roseville Pleasant Grove	11	0.0122	0.746
CA0077682	**SRCSD Sacramento River**	**106**	**0.0775**	**0.004**
CA0079138	**Stockton**	**12**	**0.67**	**0.001**
CA0079154	Tracy	13	0.0303	0.570
CA0078948	Turlock	12	0.0342	0.565
CA0077691	Vacaville Easterly	12	0.00009	0.977
CA0079171	West Sacramento	11	0.0161	0.710
CA0077950	Woodland	12	0.1906	0.156
CA0079260	Yuba City	12	0.1172	0.276

Table 33: Regression Coefficients (R^2) and Two-sided Significance Levels (p-values) for Influent Inorganic Mercury versus Effluent Methylmercury Concentration Scatter Plots for Each WWTP with Five or More Paired Data Points.

NPDES #	WWTP	# of paired data points	R^2 value for linear regression	p-value for linear regression
CA0079243	Lodi	12	0.0121	0.734
CA0079502	Roseville Dry Creek	9	0.1328	0.335
CA0084573	Roseville Pleasant Grove	9	0.1079	0.388
CA0077682	SRCSD Sacramento River	73	0.0017	0.729
CA0077950	Woodland	6	0.1403	0.464

Table 34: Regression Coefficients (R^2) and Two-sided Significance Levels (p-values) for Influent versus Effluent Inorganic Mercury Concentration Scatter Plots for Each WWTP with Five or More Paired Data Points

NPDES #	WWTP	# of paired data points	R^2 value for linear regression	p-value for linear regression
CA0079243	Lodi	12	0.1257	0.258
CA0079502	Roseville Dry Creek	9	0.0036	0.878
CA0084573	Roseville Pleasant Grove	9	0.1029	0.400
CA0077682	SRCSD Sacramento River	228	0.0004	0.764
CA0077950	Woodland	6	0.0117	0.838

Table 35: Sum of Annual Total Mercury Loads (g/yr) Discharged by Facilities within Each Discharger Category for NPDES Facilities in the Delta Source Region Downstream of Major Dams

Facility Type	Proximity to Delta/Yolo Bypass		Total
	Delta/ Yolo Bypass	Upstream of Delta/ Yolo Bypass	
Aggregate & Lake Dewatering	37	26	**63**
Drinking Water Treatment		6.4	**6.4**
Groundwater Remediation	0.36	48.3	**49**
Manufacturing		18	**18**
Municipal WWTP	2,348	1,085	**3,435**
Paper Mill / Saw Mills		16	**16**
Power Generation	0.27		**0.27**
Power/Domestic WWTP		0.10	**0.10**
Publishing		0.62	**0.62**
Total	**2,386**	**1,200**	**3,586**
% of Total Loads			
Aggregate & Lake Dewatering	1.0%	0.7%	**1.8%**
Drinking Water Treatment		0.2%	**0.18%**
Groundwater Remediation	0.01%	1.35%	**1.4%**
Manufacturing		0.5%	**0.5%**
Municipal WWTP	65.5%	30.3%	**95.7%**
Paper Mill / Saw Mills		0.45%	**0.45%**
Power Generation	0.008%		**0.008%**
Power/Domestic WWTP		0.003%	**0.003%**
Publishing		0.02%	**0.02%**
Total	**67%**	**33%**	**100%**

Table 36: Sum of Annual Methylmercury Loads (g/yr) Discharged by Facilities within Each Discharger Category for NPDES Facilities in the Delta Source Region Downstream of Major Dams

Facility Type	Proximity to Delta/Yolo Bypass		Total
	Delta/ Yolo Bypass	Upstream of Delta/ Yolo Bypass	
Aggregate & Lake Dewatering	0.38	0.055	**0.44**
Drinking Water Treatment		0.040	**0.040**
Food Processing		0.040	**0.040**
Groundwater Remediation	0.011	0.23	**0.24**
Laboratory		0.0047	**0.0047**
Manufacturing		0.14	**0.14**
Mines		0.0048	**0.0048**
Municipal WWTP	204.3	23.4	**228**
Paper Mill / Saw Mills		0.22	**0.22**
Power Generation	0.0019		**0.0019**
Power/Domestic WWTP		0.0050	**0.0050**
Publishing		0.0041	**0.0041**
Total	**204.7**	**23.7**	**229**
% of Total Loads			
Aggregate & Lake Dewatering	0.2%	0.02%	**0.2%**
Drinking Water Treatment		0.02%	**0.02%**
Food Processing		0.02%	**0.02%**
Groundwater Remediation	0.005%	0.1%	**0.1%**
Laboratory		0.002%	**0.002%**
Manufacturing		0.06%	**0.06%**
Mines		0.002%	**0.002%**
Municipal WWTP	89.3%	10.2%	**99.5%**
Paper Mill / Saw Mills		0.1%	**0.1%**
Power Generation	0.001%		**0.001%**
Power/Domestic WWTP		0.002%	**0.002%**
Publishing		0.002%	**0.002%**
Total	**89%**	**11%**	**100%**

Table 37: Comparison of Annual Methylmercury Loads (g/yr) Discharged by NPDES Facilities to The Sum of All Point and Nonpoint Source Methylmercury Loading to Each Delta Subarea Identified in The February 2010 Delta TMDL Staff Report (Wood *et al*., 2010b, Table 8.4)

Delta Subarea	**Proximity to Delta**		**Total NPDES Facility Load**	**Sum of MeHg Point and Nonpoint Source MeHg Loads to Each Subarea** [Delta TMDL Report Table 8.4]	**Total NPDES Facility Load as % of Sum of All Point and Nonpoint MeHg Loads**
	Delta/ Yolo Bypass	Upstream of Delta/ Yolo Bypass			
Central	1.3	*[none]*	1.3	668	0.2%
Marsh Creek	0.086	*[none]*	0.086	6.14	1.4%
Mokelumne	*[none]*	0.55	0.55	146	0.4%
Sacramento	163	13	176	2,475	7.1%
San Joaquin	39.6	8.6	48	528	9.1%
West	0.0019	none	0.0019	330	0.001%
Yolo Bypass	1.0	1.7	2.7	1,068	0.3%
TOTAL	**205**	**24**	**229**	**5,221**	**4.4%**

(a) Because calculations were completed prior to rounding, some columns may not add to totals shown in Table 36 of this report or Table 6.2 in the TMDL Report.

FIGURES

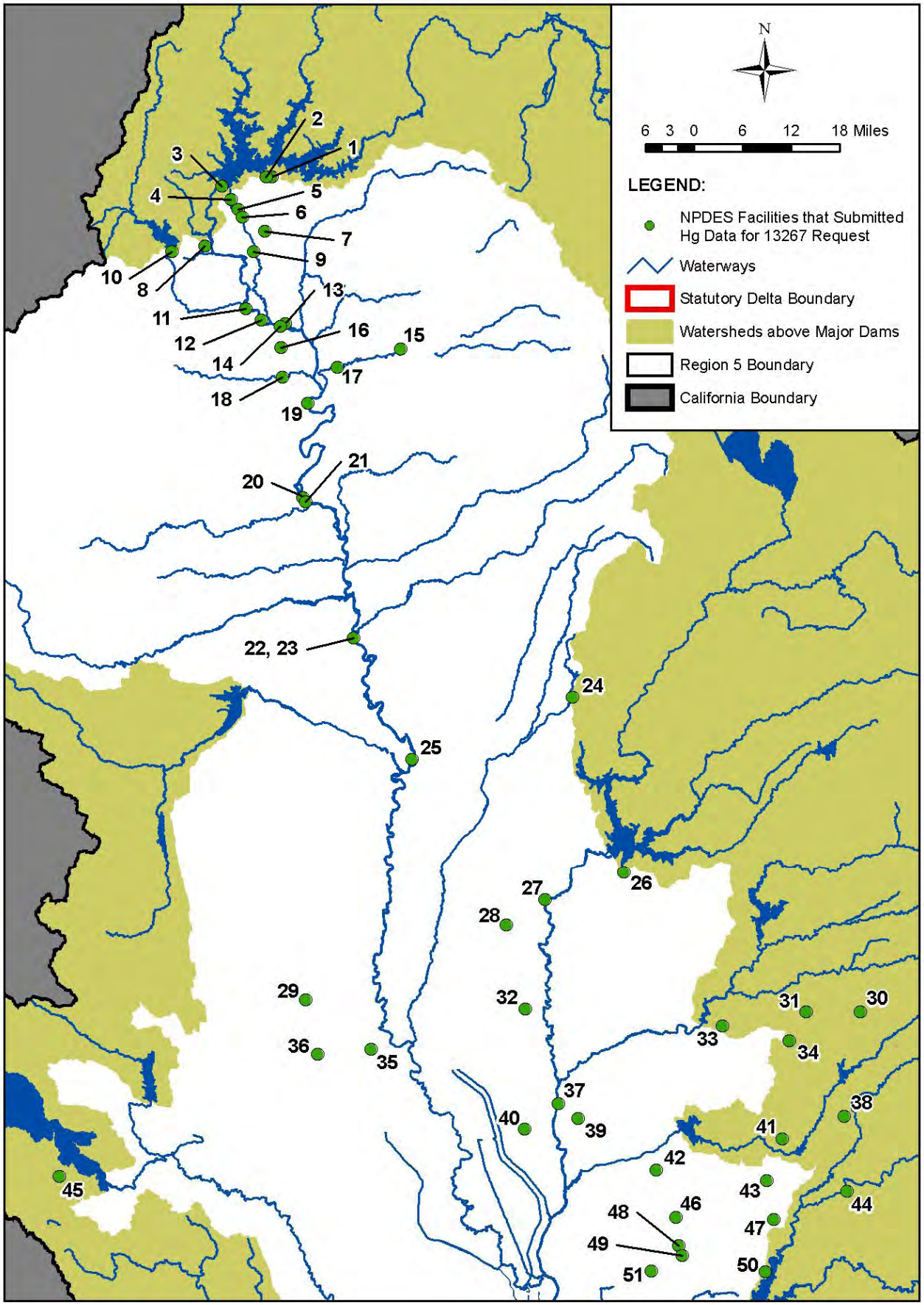

Figure 1: Location of NPDES Facilities (North Panel) [Table 16 defines facility codes]

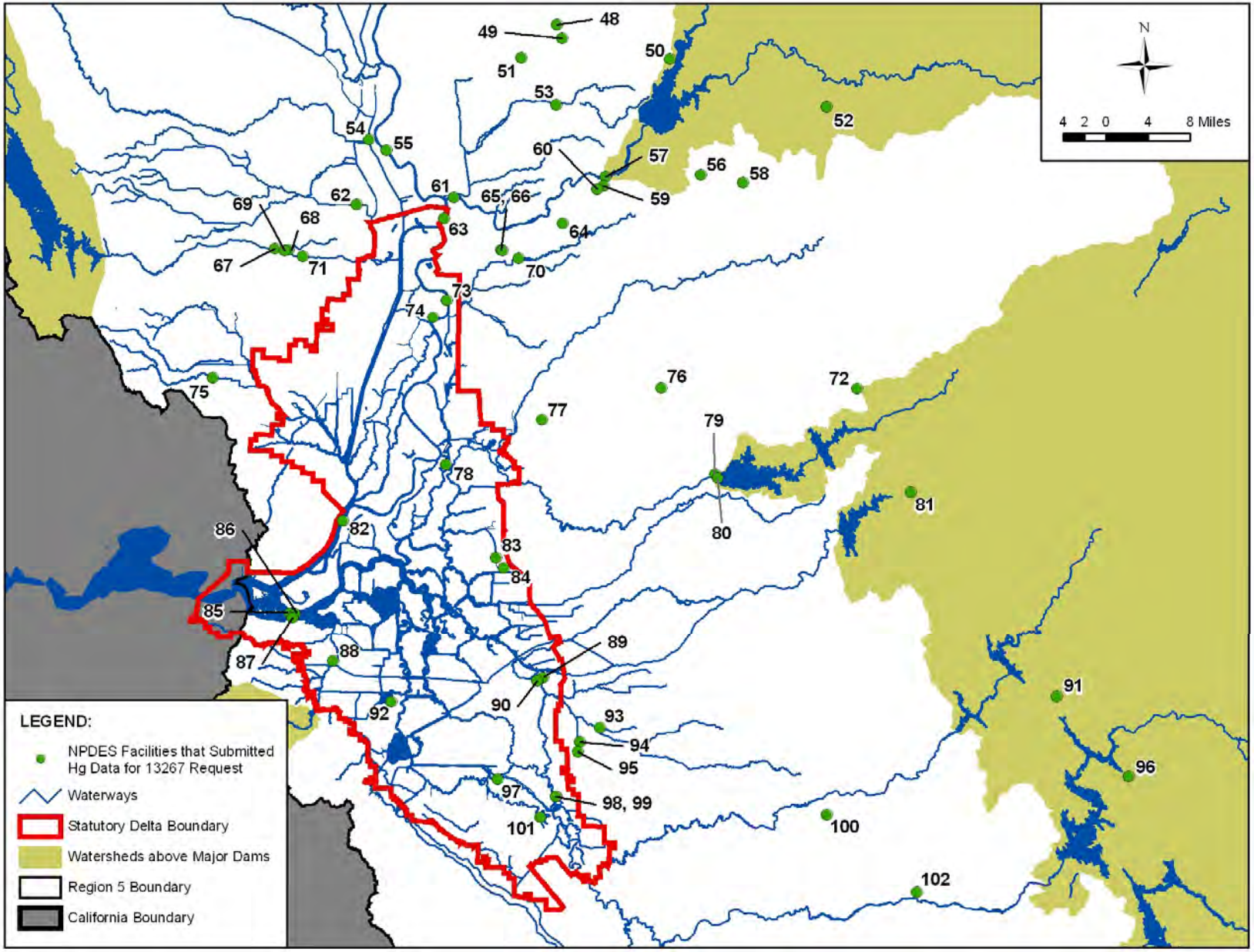

Figure 2: Location of NPDES Facilities (Central Panel) [Table 16 defines facility codes]

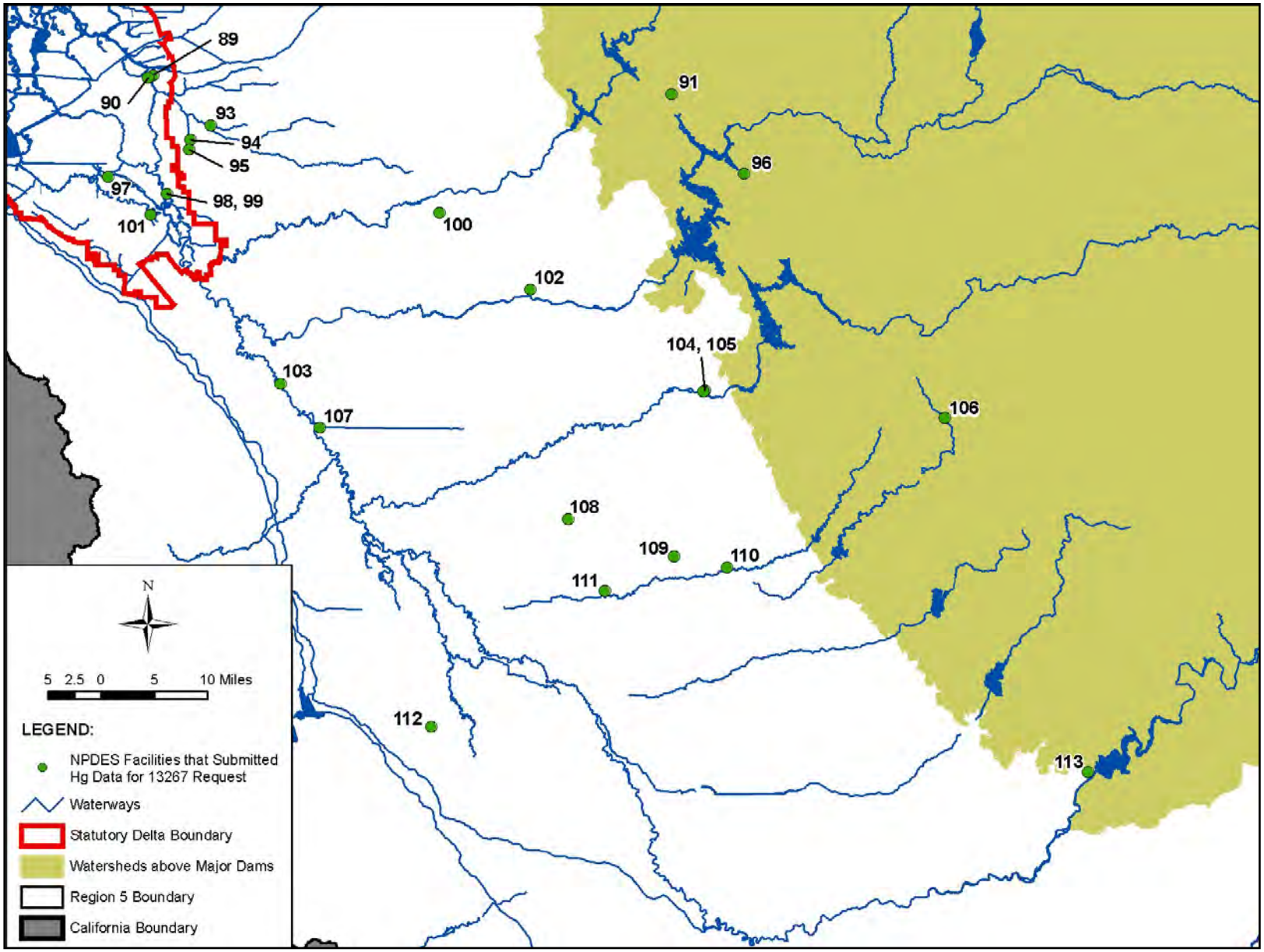

Figure 3: Location of NPDES Facilities (South Panel) [Table 16 defines facility codes]

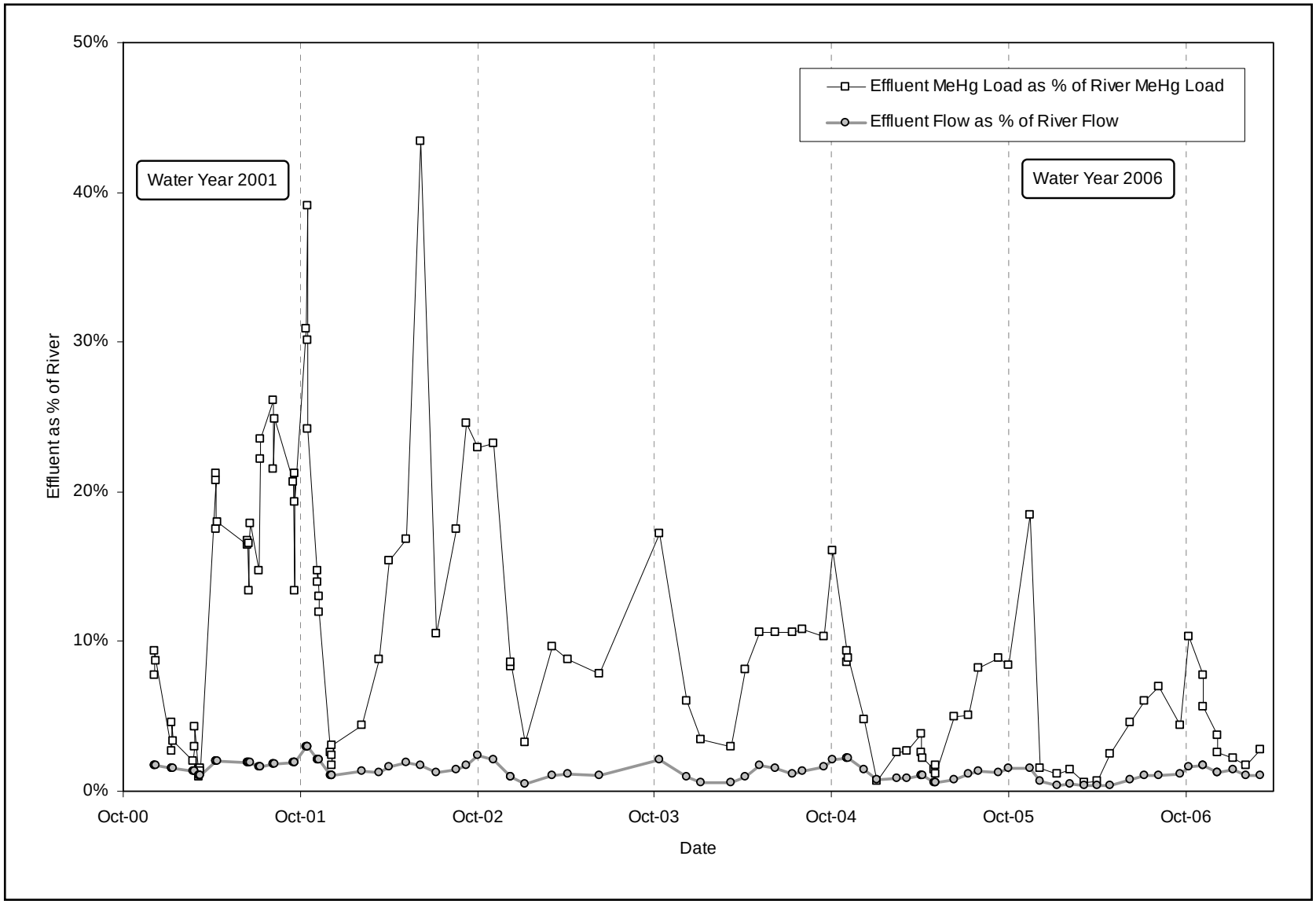

Figure 4: SRCSD Sacramento River WWTP Effluent Methylmercury Load and Flow as a Percent of Sacramento River Methylmercury Load and Flow for Water Years (WY) 2001-2007

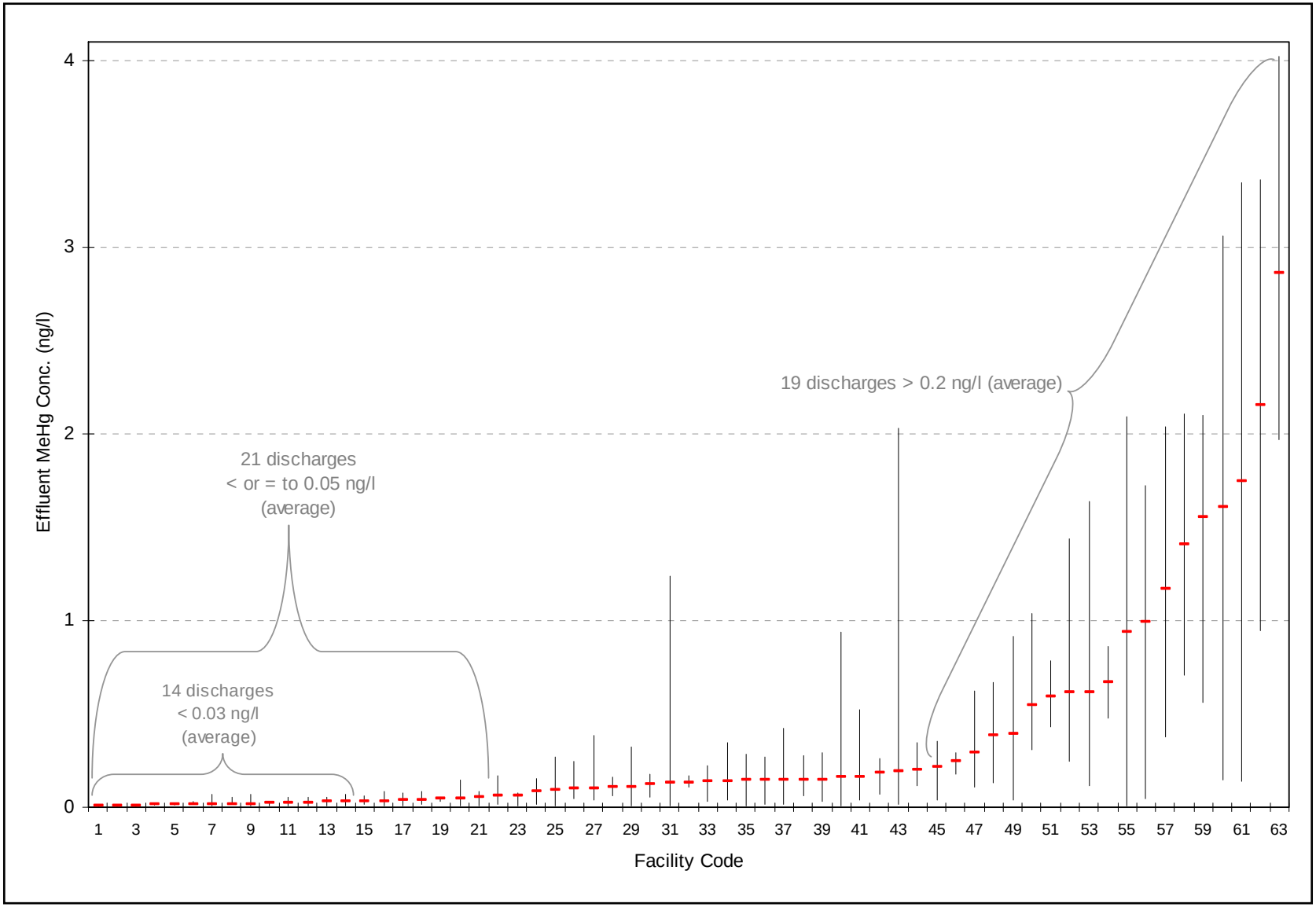

Figure 5: Average and Range of Effluent Methylmercury Concentrations for Each of the Municipal WWTP Discharges

Facility Codes Used in Figures 5 and 10 [(a)]

Facility Code	NPDES No.	Facility
1	CA0082660	Brentwood WWTP
2	CA0078093	Deuel Vocational Institute WWTP
3	CA0084697	United Auburn Indian Community Casino WWTP
4	CA0078671	El Dorado Hills WWTP (Discharge 2)
5	CA0082589	Redding Stillwater WWTP
6	CA0078662	Deer Creek WWTP
7	CA0084573	Roseville Pleasant Grove WWTP
8	CA0078671	El Dorado Hills WWTP (Discharge 1)
9	CA0084476	Lincoln WWTP
10	CA0079511	Shasta Lake WWTP
11	CA0079502	Roseville Dry Creek WWTP
12	CA0077691	Vacaville Easterly WWTP
13	CA0078891	Red Bluff WWTP
14	CA0077712	Auburn WWTP
15	CA0077950	Woodland WWTP
16	CA0079197	Atwater WWTP
17	CA0077895	UC Davis WWTP
18	CA0079731	Redding Clear Creek WWTP
19	CA0004995	Corning Industries/ Domestic WWTP
20	CA0079901	Nevada City WWTP
21	CA0079171	West Sacramento WWTP
22	CA0078956	Placerville Hangtown Creek WWTP
23	CA0078948	Turlock WWTP
24	CA0082848	San Joaquin Co DPW - Flag City WWTP
25	CA0077704	Anderson WWTP
26	CA0081507	Cottonwood WWTP
27	CA0079367	Placer Co. SMD #3 WWTP
28	CA0079391	Jackson WWTP
29	CA0077828	Nevada Co SD #1 Lake Wildwood WWTP
30	CA0079081	Chico Regional WWTP
31	CA0079243	Lodi White Slough WWTP
32	CA0079103	Modesto WWTP
33	CA0081434	Galt WWTP
34	CA0079316	Placer Co. SMD #1 WWTP
35	CA0083241	Nevada Co SD #1 Cascade Shores WWTP
36	CA0077836	Olivehurst PUD WWTP
37	CA0079154	Tracy WWTP
38	CA0079235	Oroville WWTP
39	CA0083682	Canada Cove LP French Camp Golf & RV Park WWTP
40	CA0079898	Grass Valley WWTP

Facility Codes Used in Figures 5 and 10 [(a)]

Facility Code	NPDES No.	Facility
41	CA0079588	Rio Vista Main WWTP
42	CA0084727	Tuolumne UD Sonora RWTP/ Jamestown SDWTP
43	CA0078590	Discovery Bay WWTP
44	CA0079529	Colfax WWTP
45	CA0081558	Manteca WWTP
46	CA0079464	San Andreas SD WWTP
47	CA0079260	Yuba City WWTP
48	CA0079219	Merced WWTP
49	CA0079430	Mariposa PUD WWTP
50	CA0079049	Davis WWTP (Discharge 1)
51	CA0079022	Live Oak WWTP
52	CA0079049	Davis WWTP (Discharge 2)
53	CA0077682	SRCSD Sacramento River WWTP
54	CA0079341	Placer Co. SA #28 Zone #6 WWTP
55	CA0079138	Stockton WWTP
56	CA0079987	Maxwell PUD WWTP
57	CA0078950	Planada Comm. Service Dist. WWTP
58	CA0081612	Nevada Co SD #2 Lake of the Pines WWTP
59	CA0077933	Williams WWTP
60	CA0078930	Biggs WWTP
61	CA0077852	Rio Alto WD- Lake CA WWTP
62	CA0078794	SRCSD Walnut Grove WWTP (CSD1)
63	CA0078999	Colusa WWTP

[(a)] Facilities are sorted by lowest to highest average effluent methylmercury concentration. Some facilities have multiple discharge locations, effluent from which may undergo different treatments.

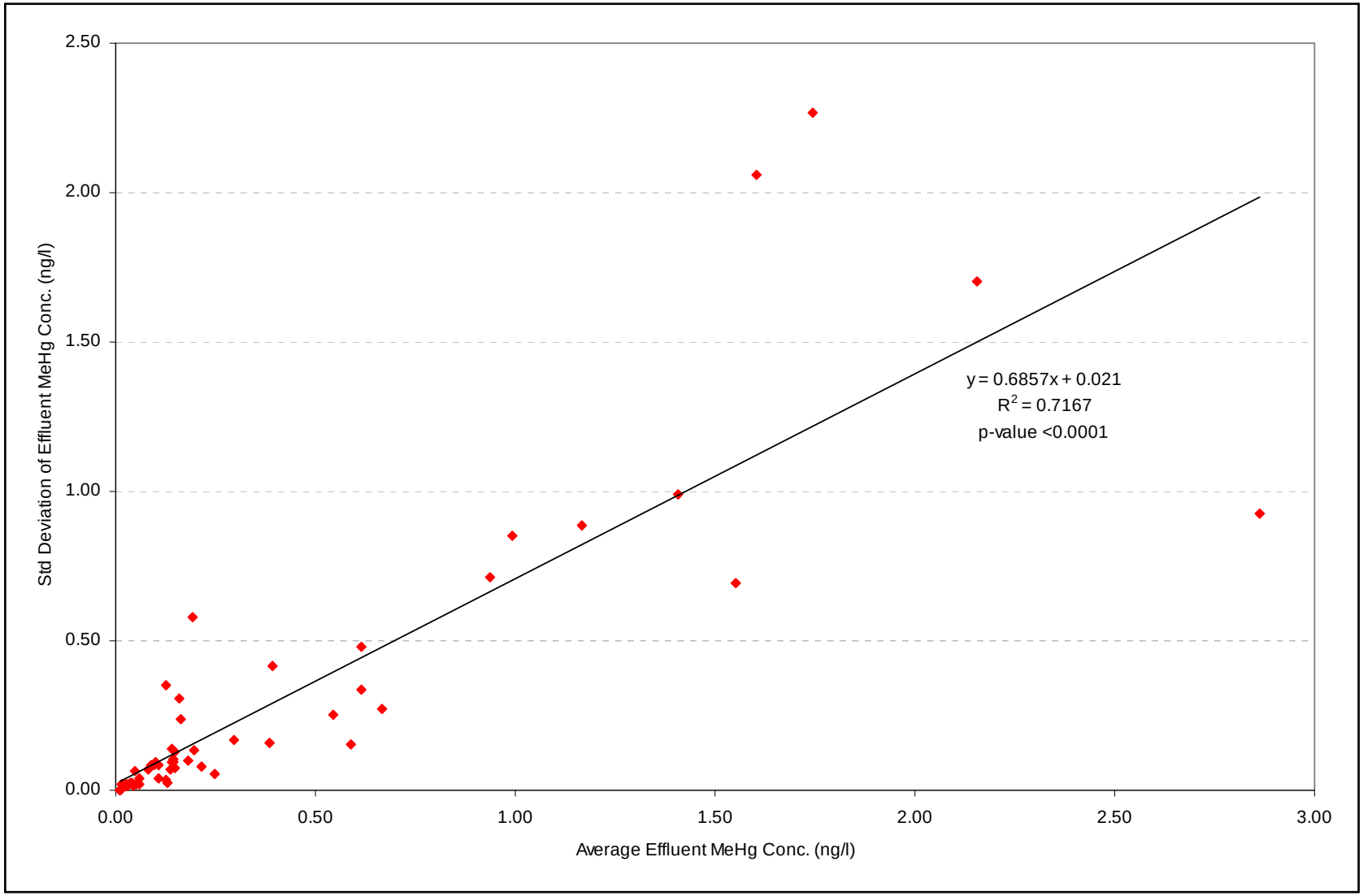

Figure 6: Average Effluent Methylmercury Concentration Versus the Corresponding Standard Deviation of Each Municipal WWTP

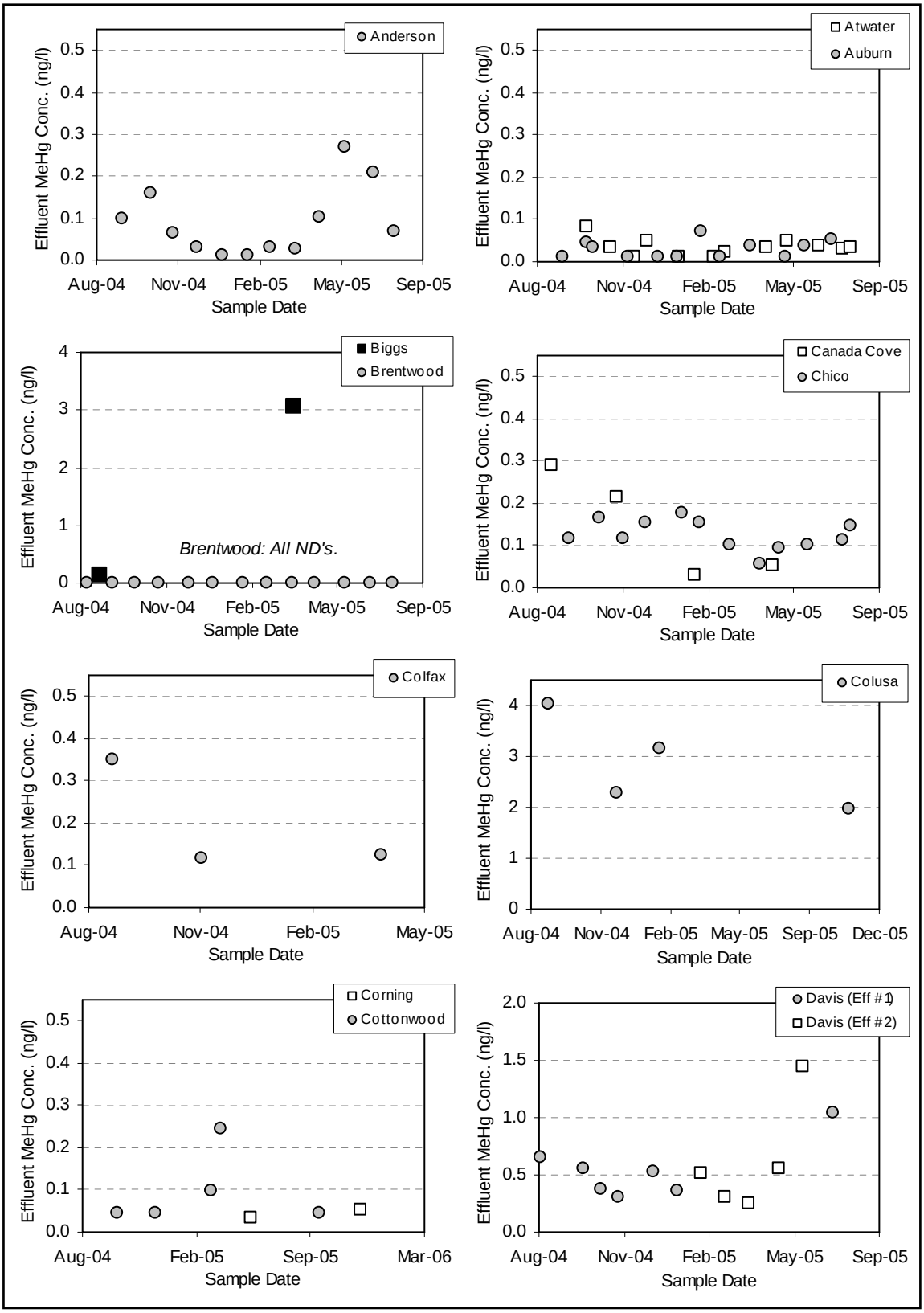

Figure 7a: Time-series Graphs of Municipal WWTP Effluent Methylmercury Concentrations

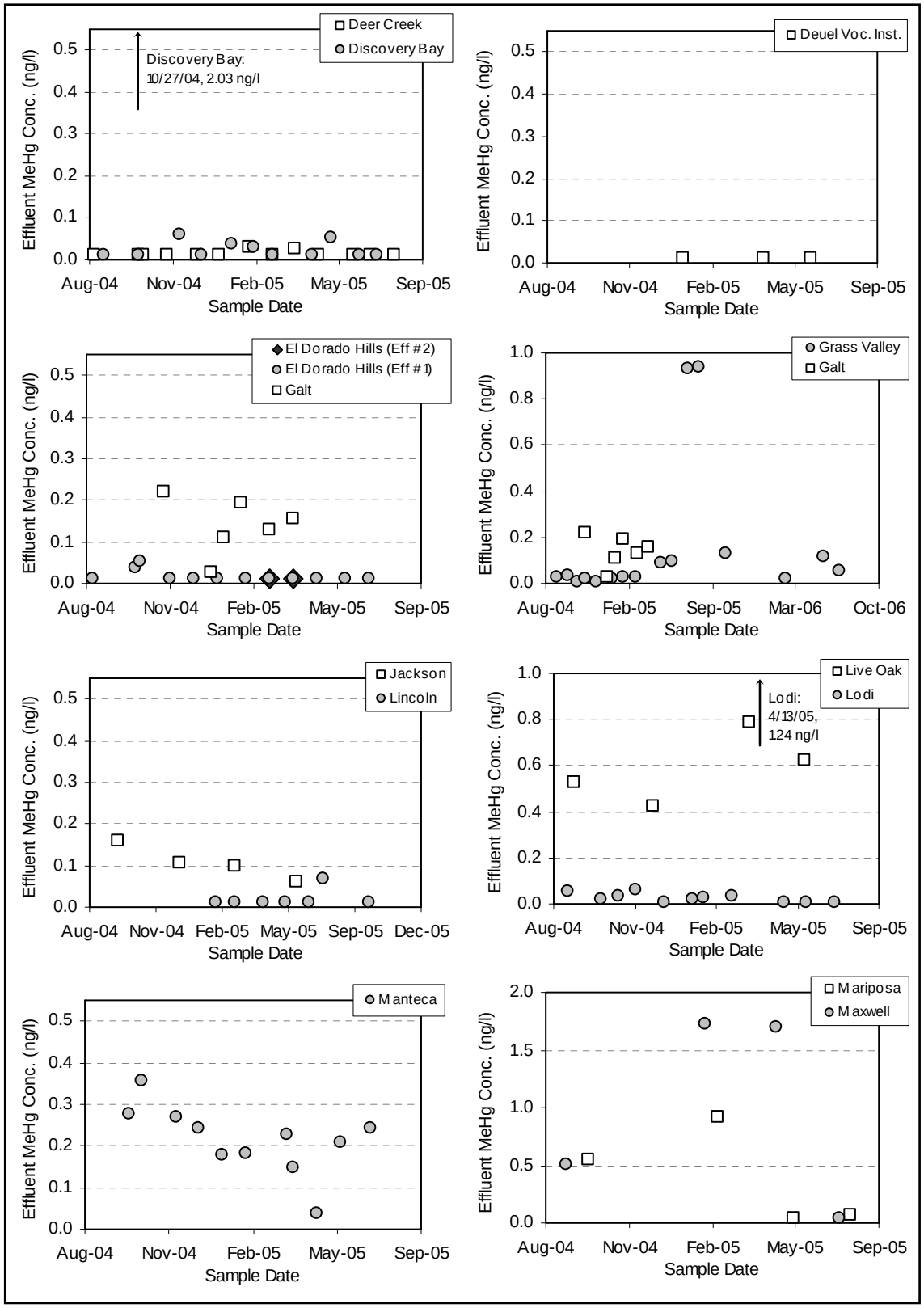

Figure 7b: Time-series Graphs of Municipal WWTP Effluent Methylmercury Concentrations

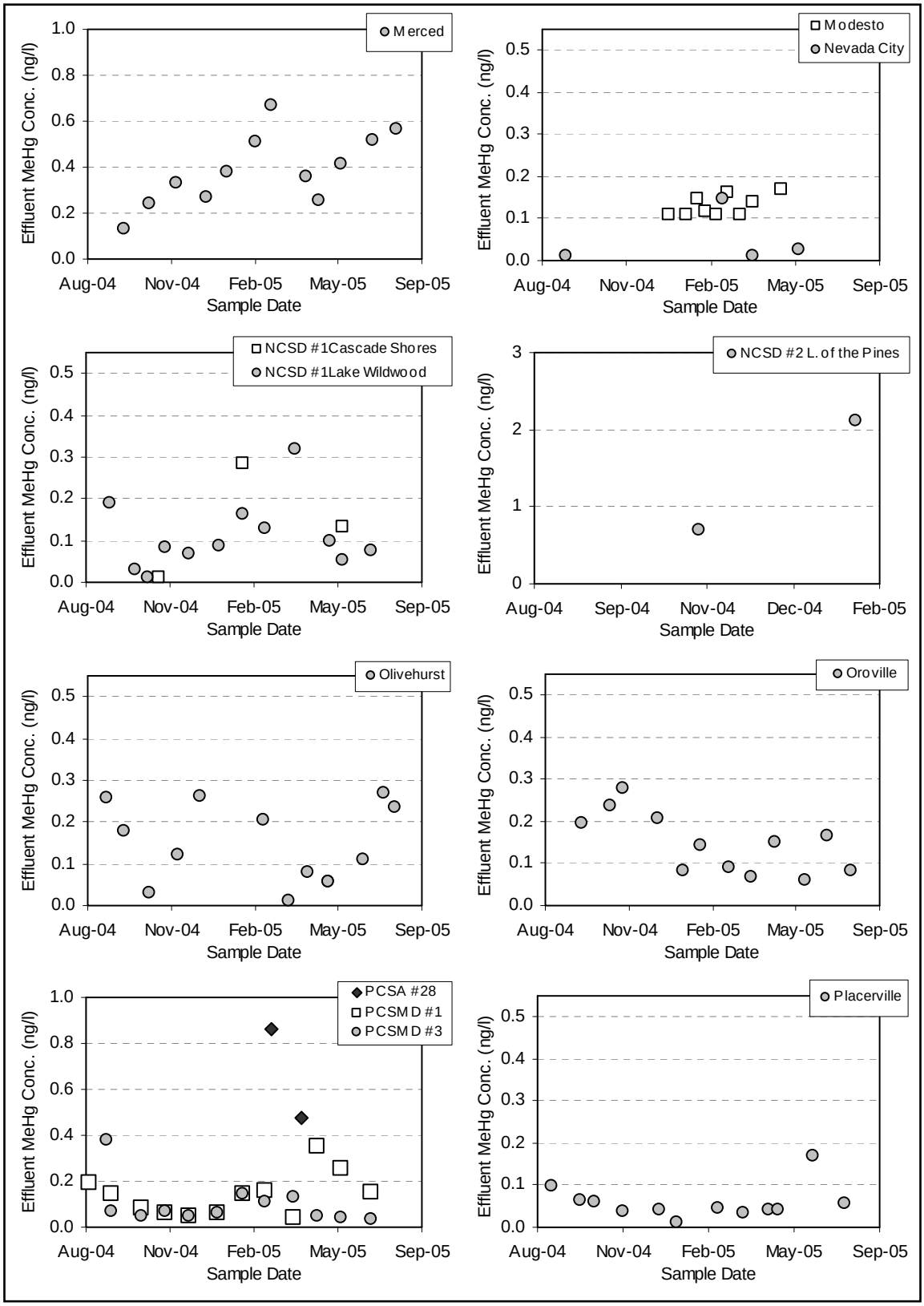

Figure 7c: Time-series Graphs of Municipal WWTP Effluent Methylmercury Concentrations

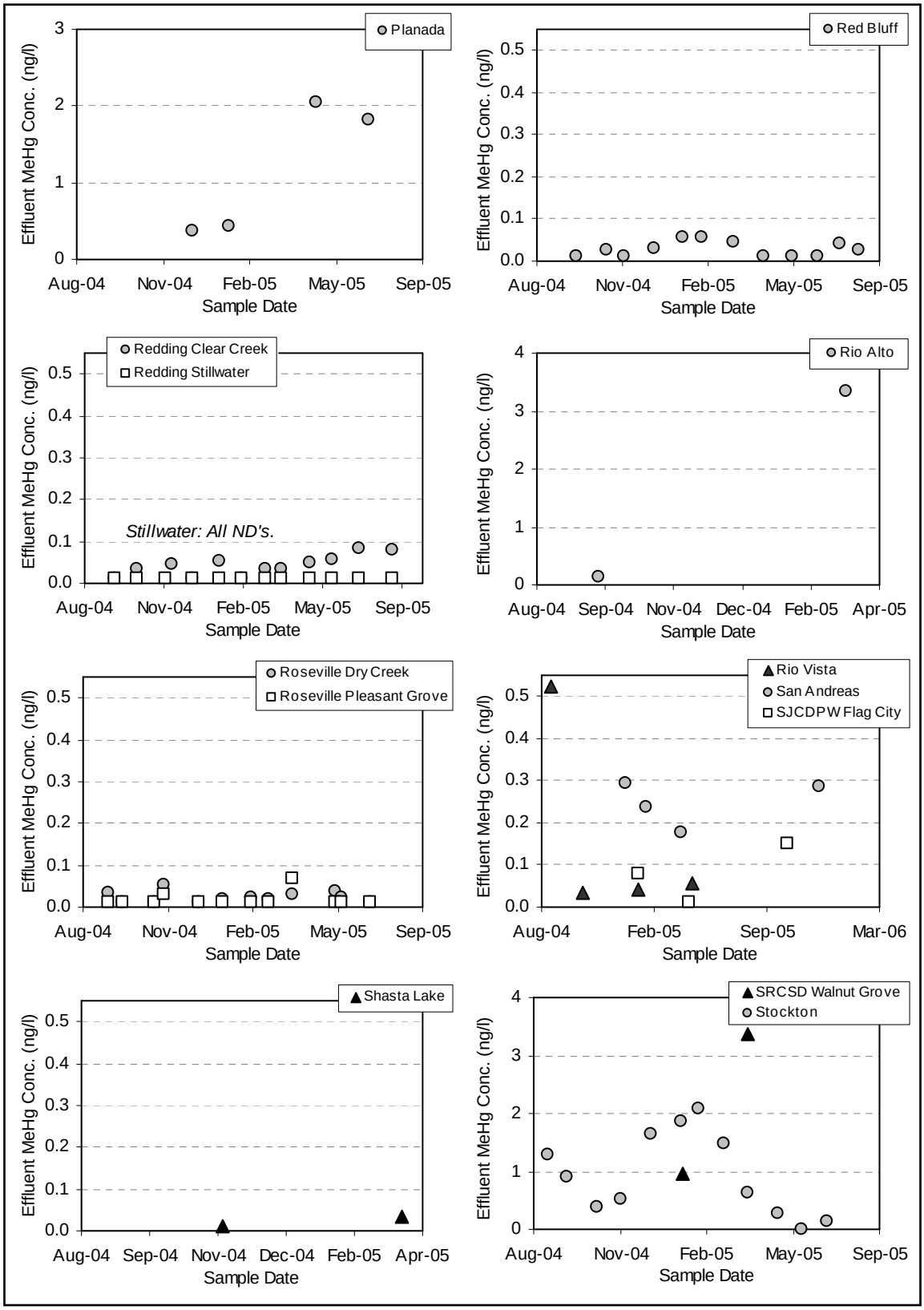

Figure 7d: Time-series Graphs of Municipal WWTP Effluent Methylmercury Concentrations

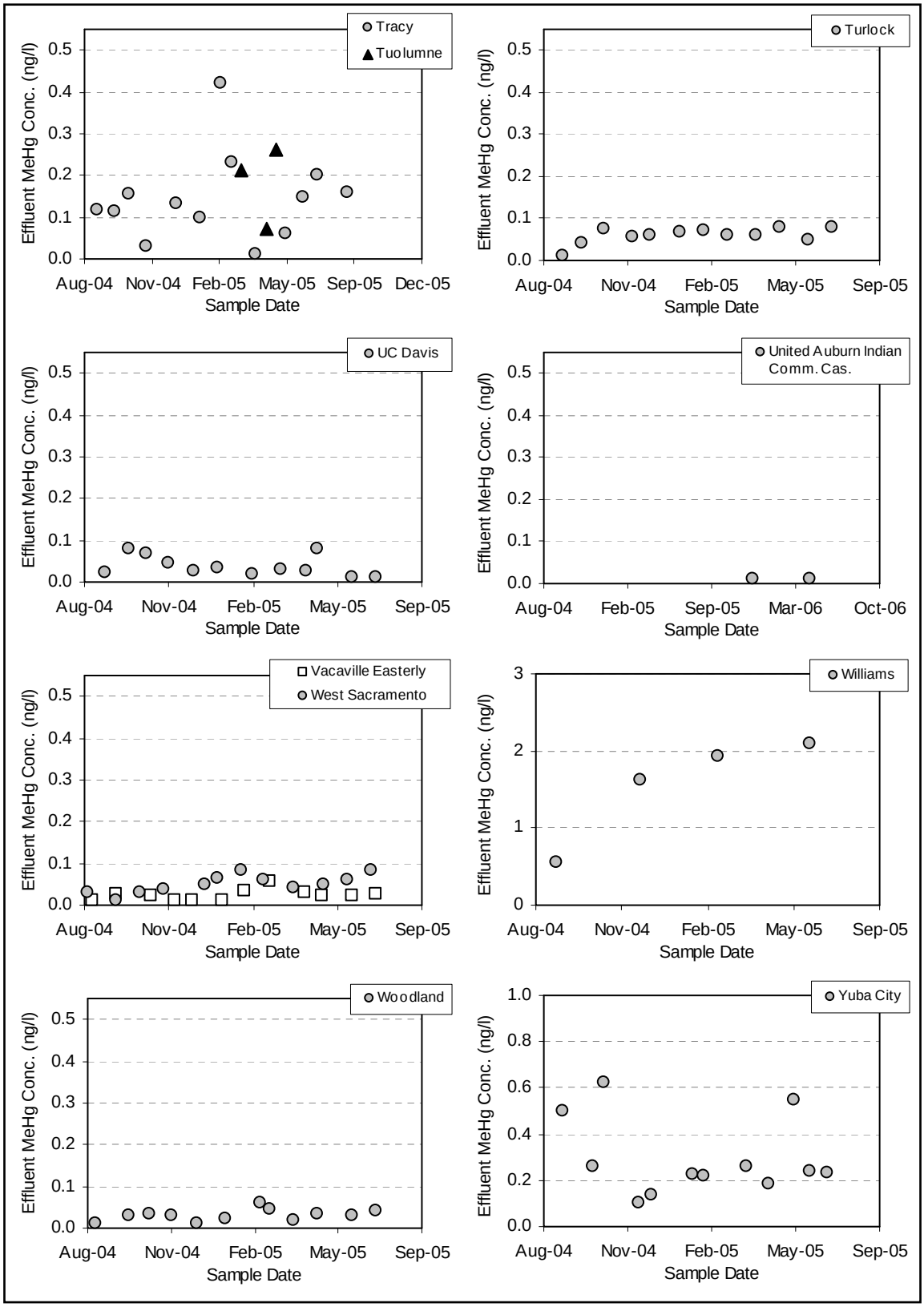

Figure 7e: Time-series Graphs of Municipal WWTP Effluent Methylmercury Concentrations

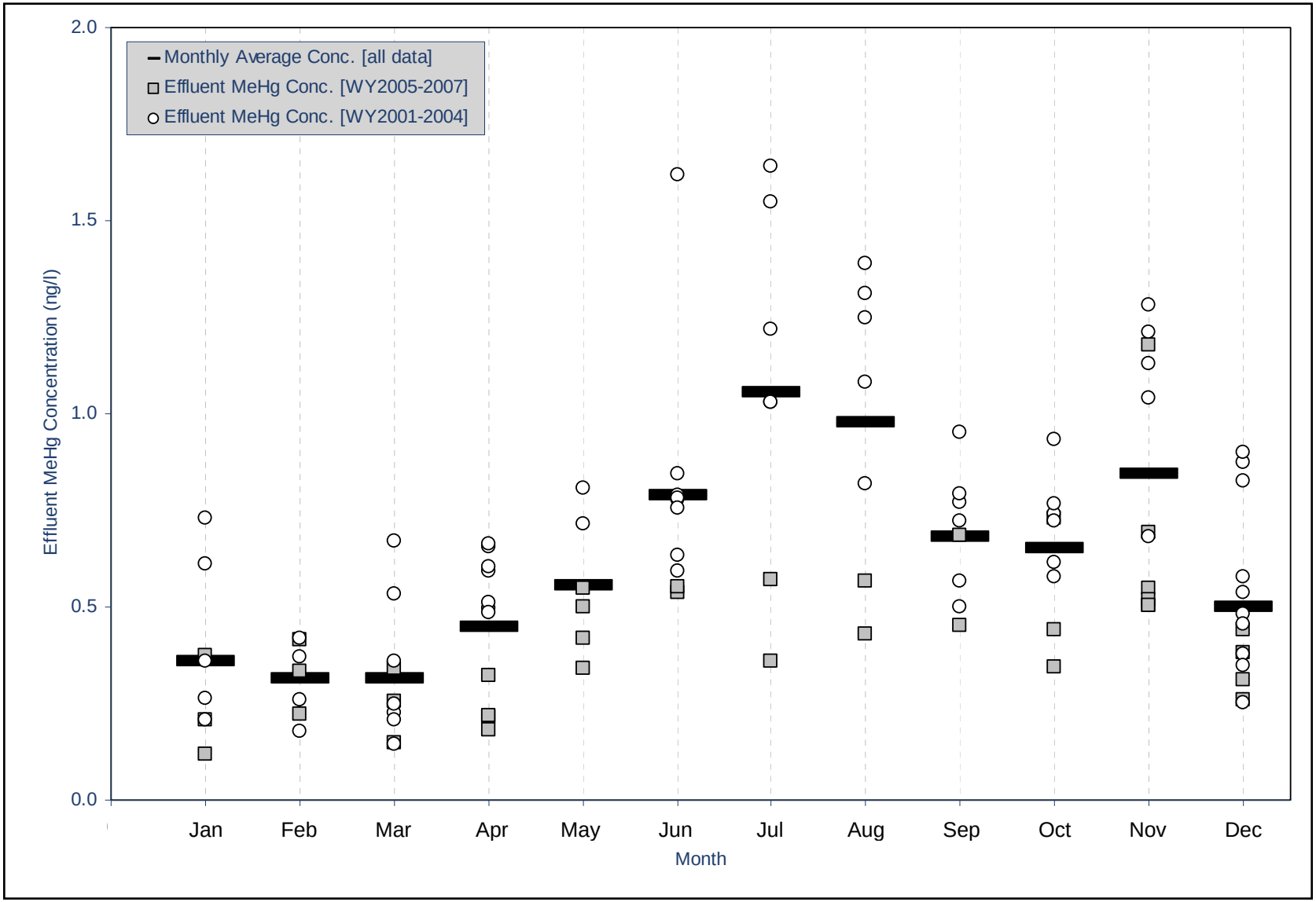

Figure 8: Monthly Effluent Methylmercury Concentrations for the SRCSD Sacramento River WWTP for WY2001-2007

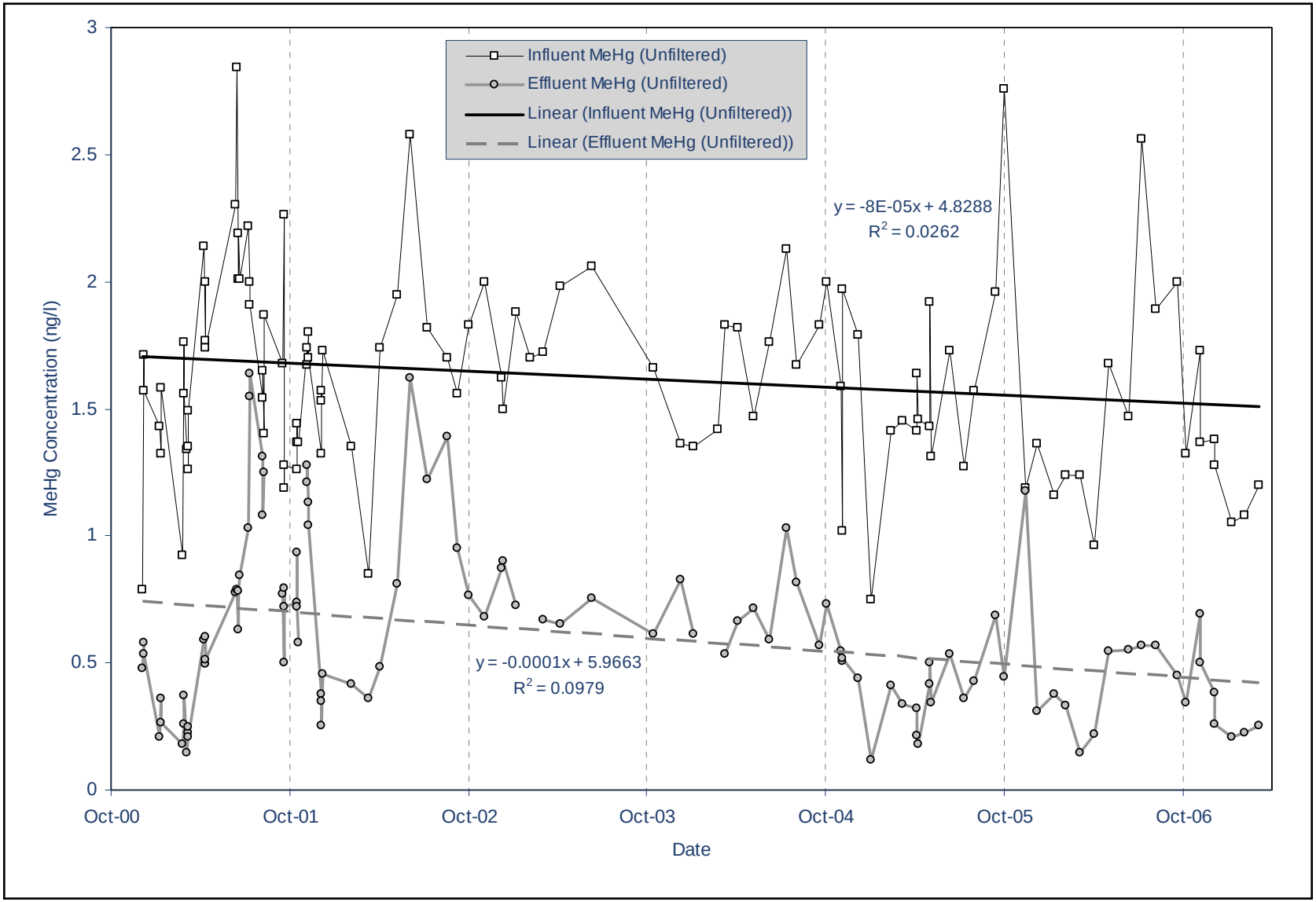

Figure 9: Time-series Graph for SRCSD Sacramento River WWTP Influent and Effluent Methylmercury Concentrations

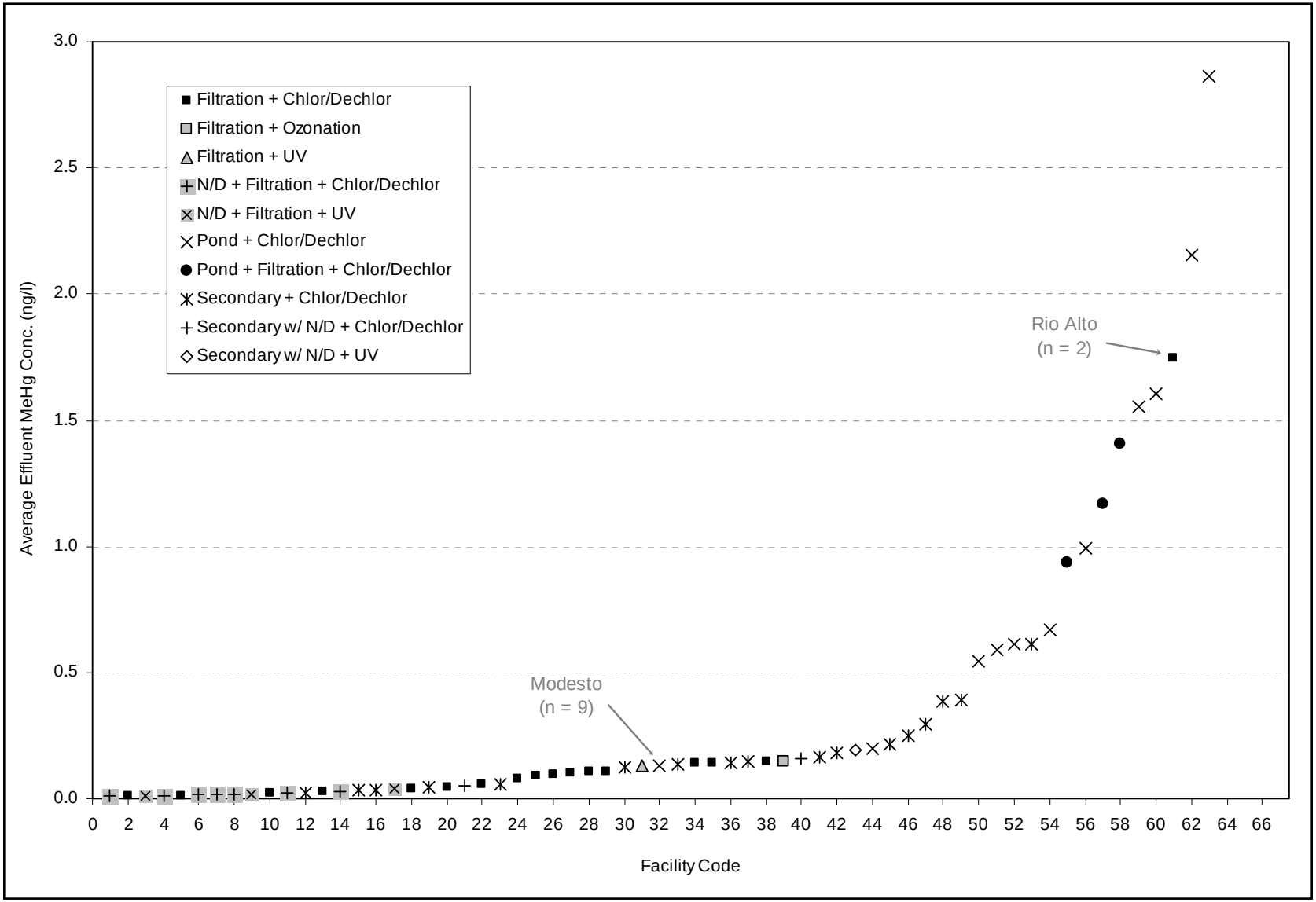

Figure 10: Average Effluent Methylmercury Concentrations for Each Municipal WWTP with the Maximum Treatment Category Defined
[WWTPs with relatively high or low effluent methylmercury concentrations compared to other WWTPs within the same maximum treatment category are labeled.]

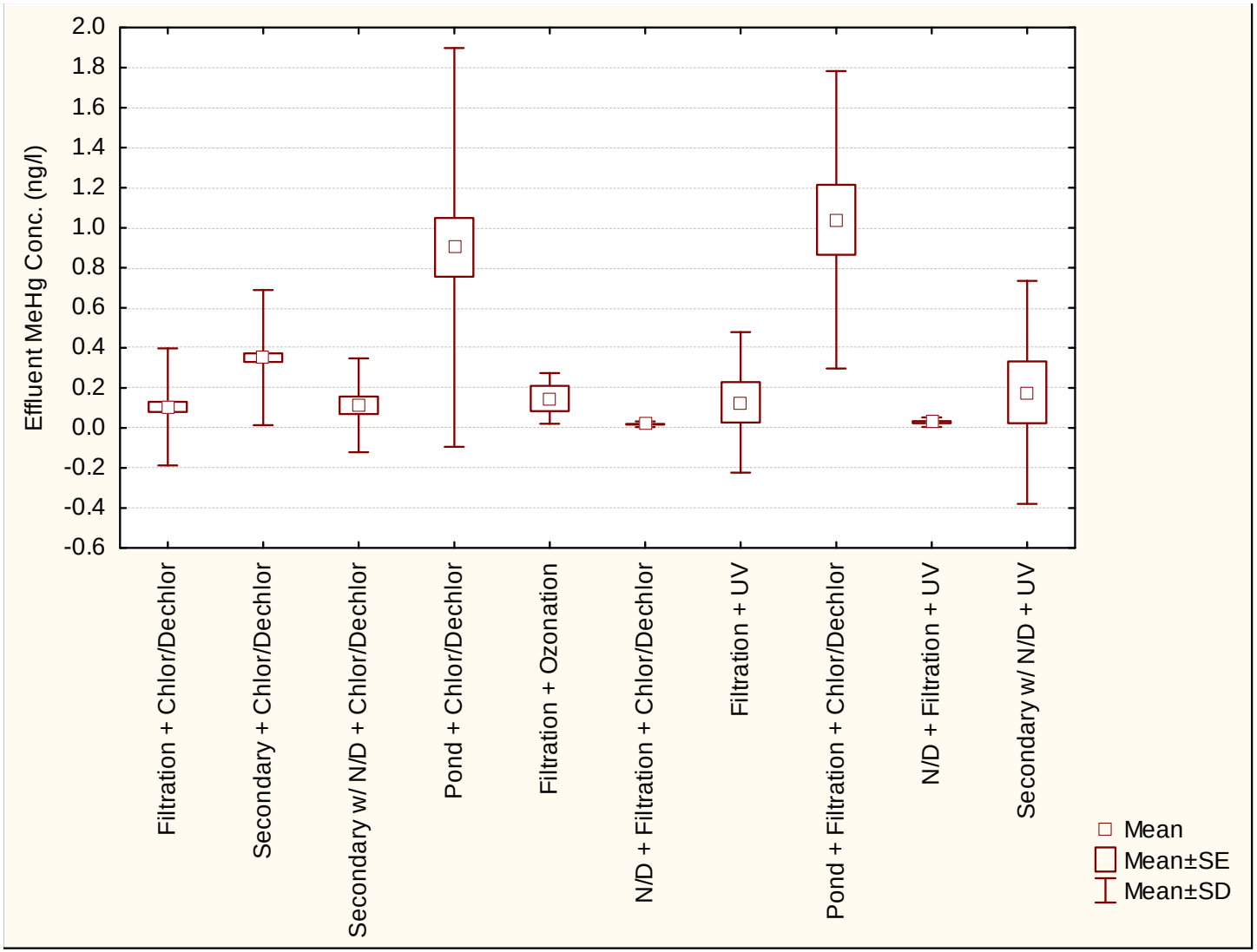

Figure 11: Box and Whisker Plot of Effluent Methylmercury Concentrations for the Municipal WWTP Maximum Treatment Categories

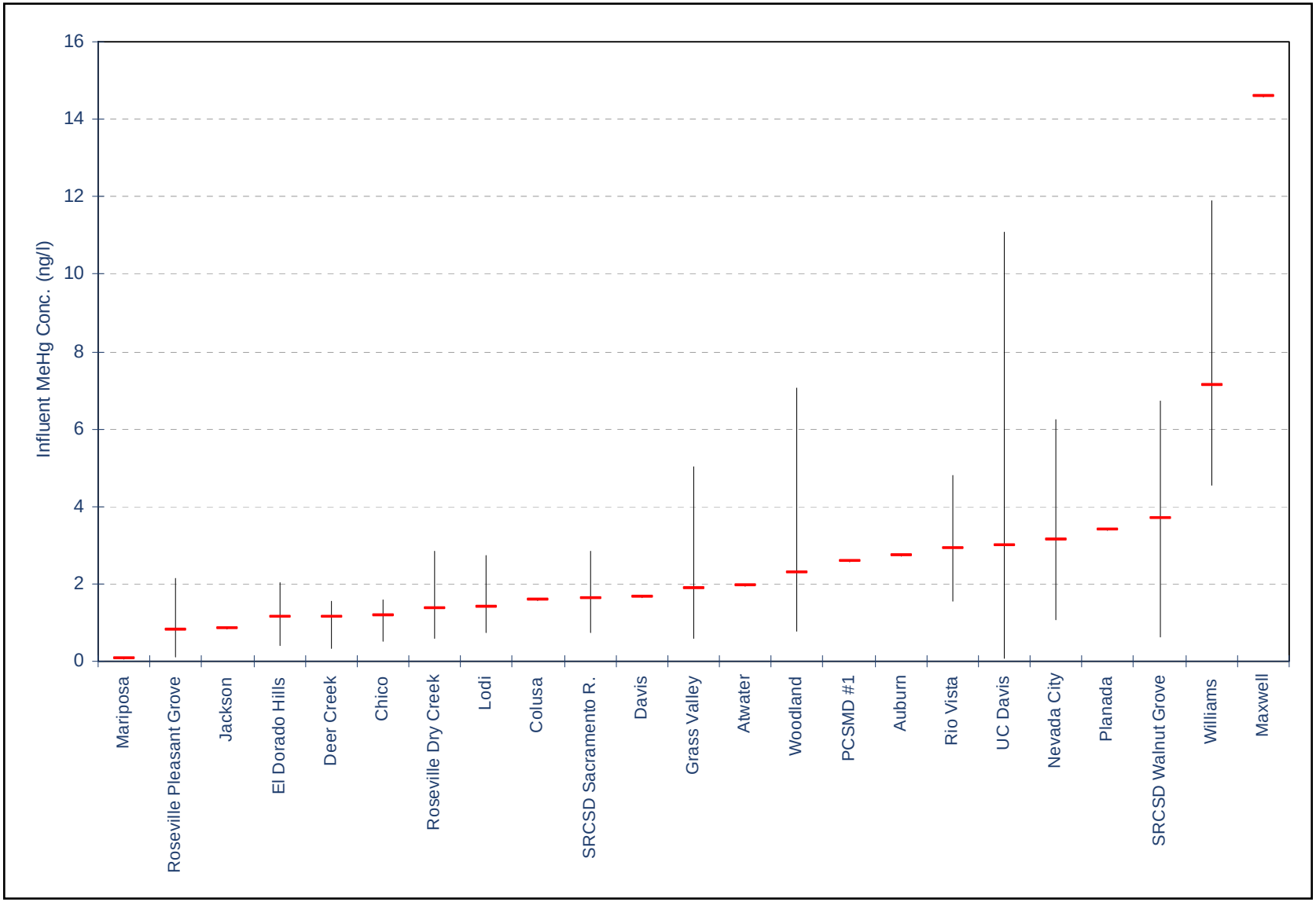

Figure 12: Average and Range of Influent Methylmercury Concentrations for Each Municipal WWTP

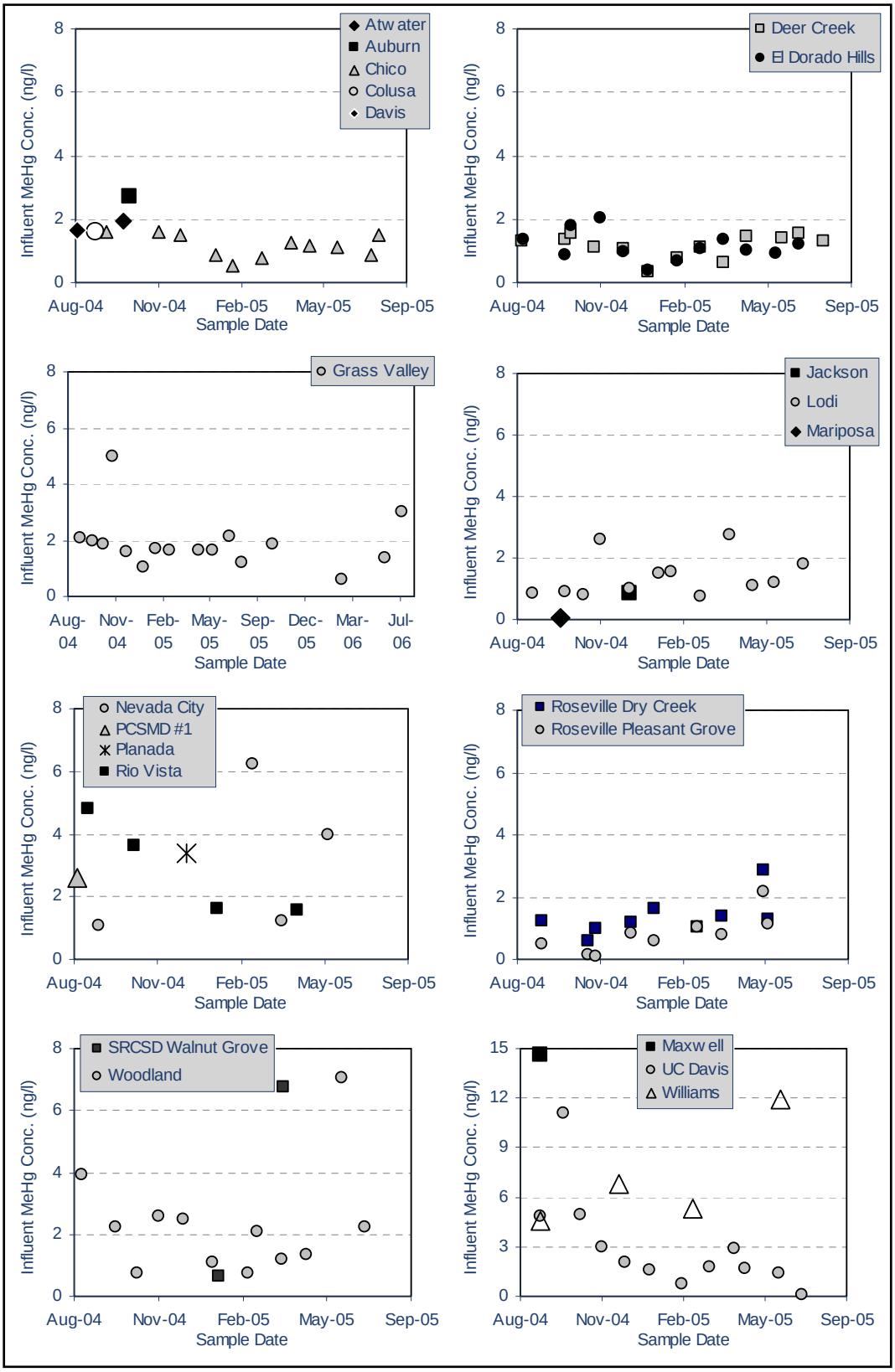

Figure 13: Time-series Graphs of Municipal WWTP Influent Methylmercury Concentrations

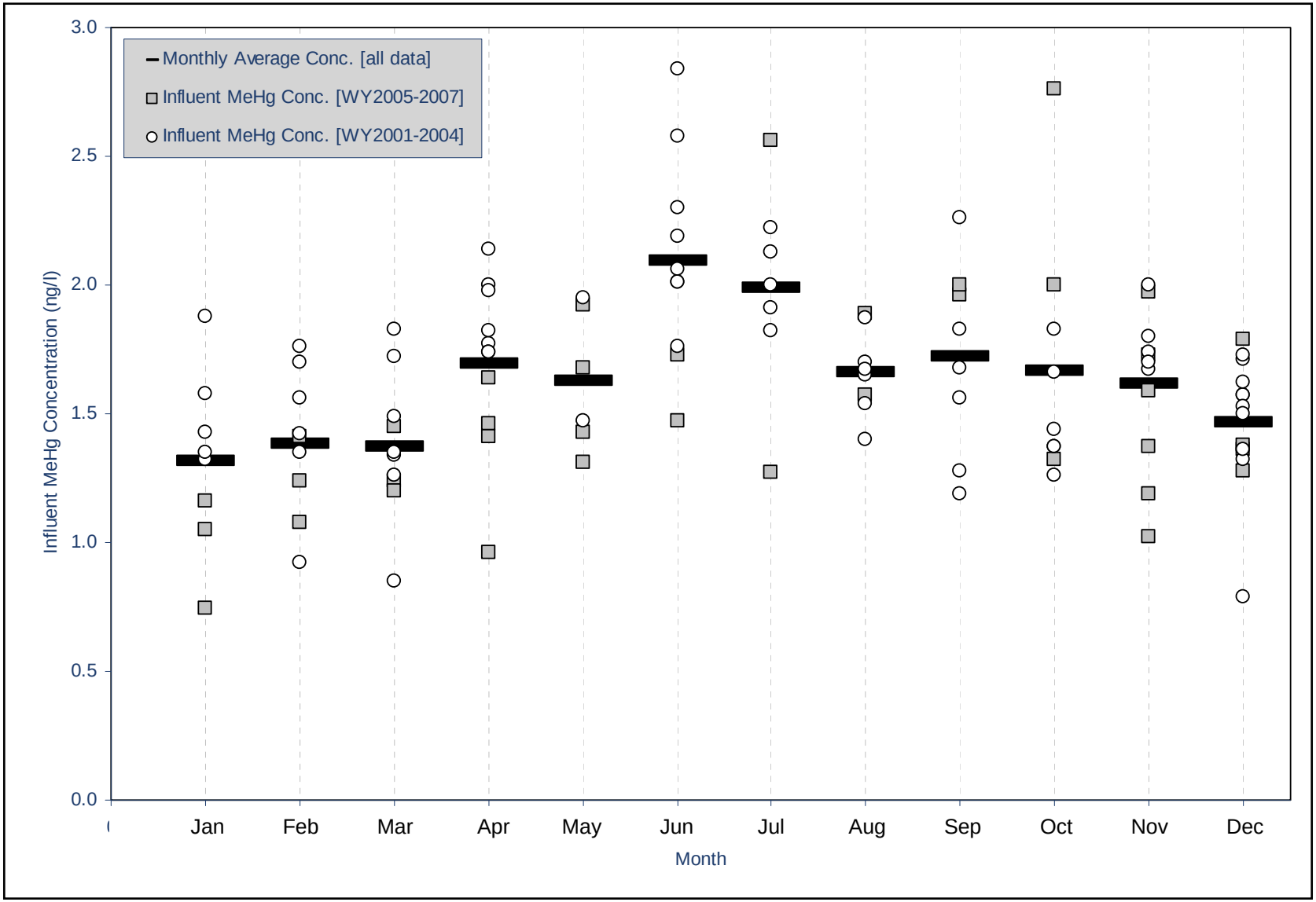

Figure 14: Monthly Influent Methylmercury Concentrations for the SRCSD Sacramento River WWTP from WY2001-2007

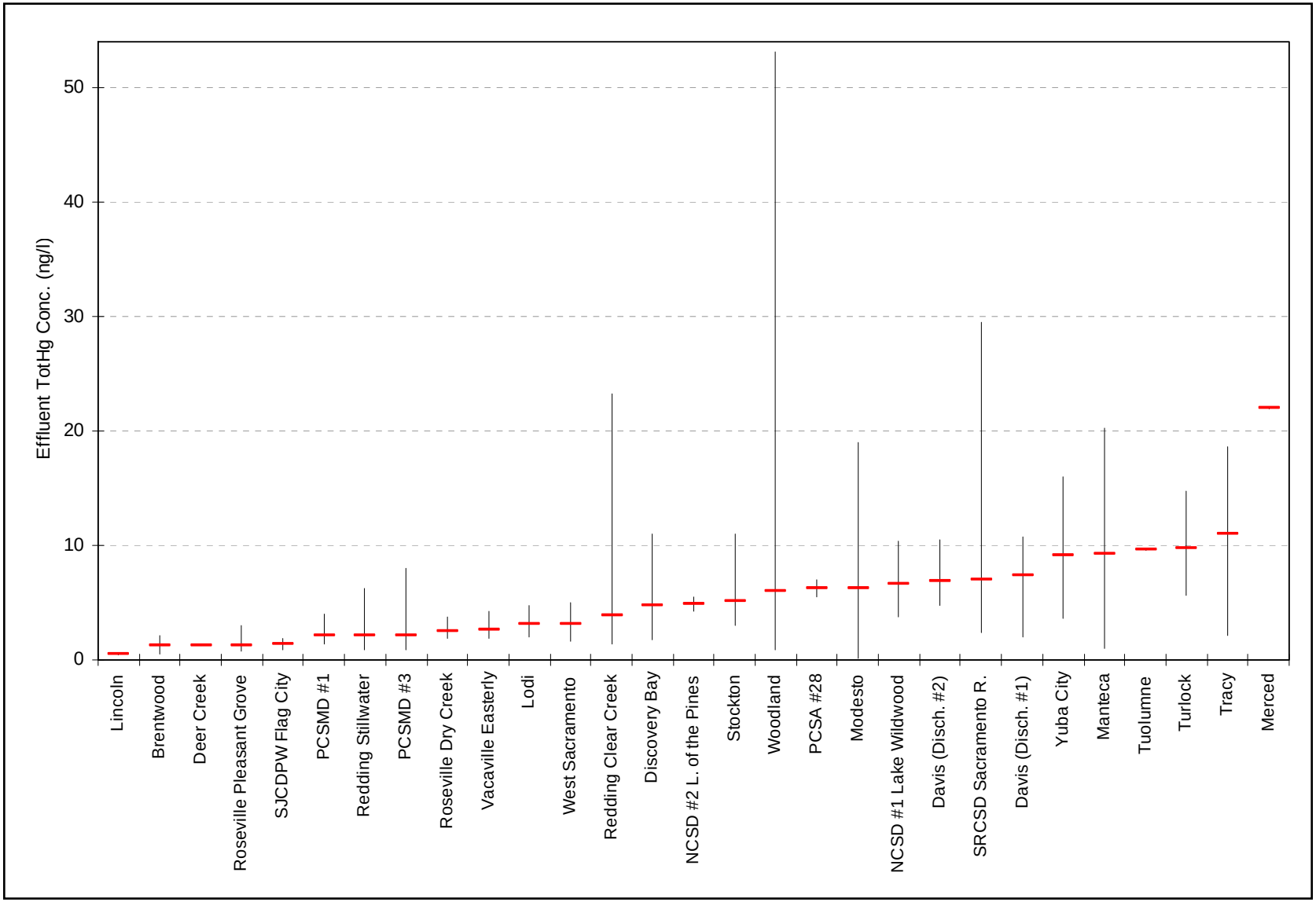

Figure 15: Average and Range of Effluent Inorganic Mercury Concentrations for Each Municipal WWTP

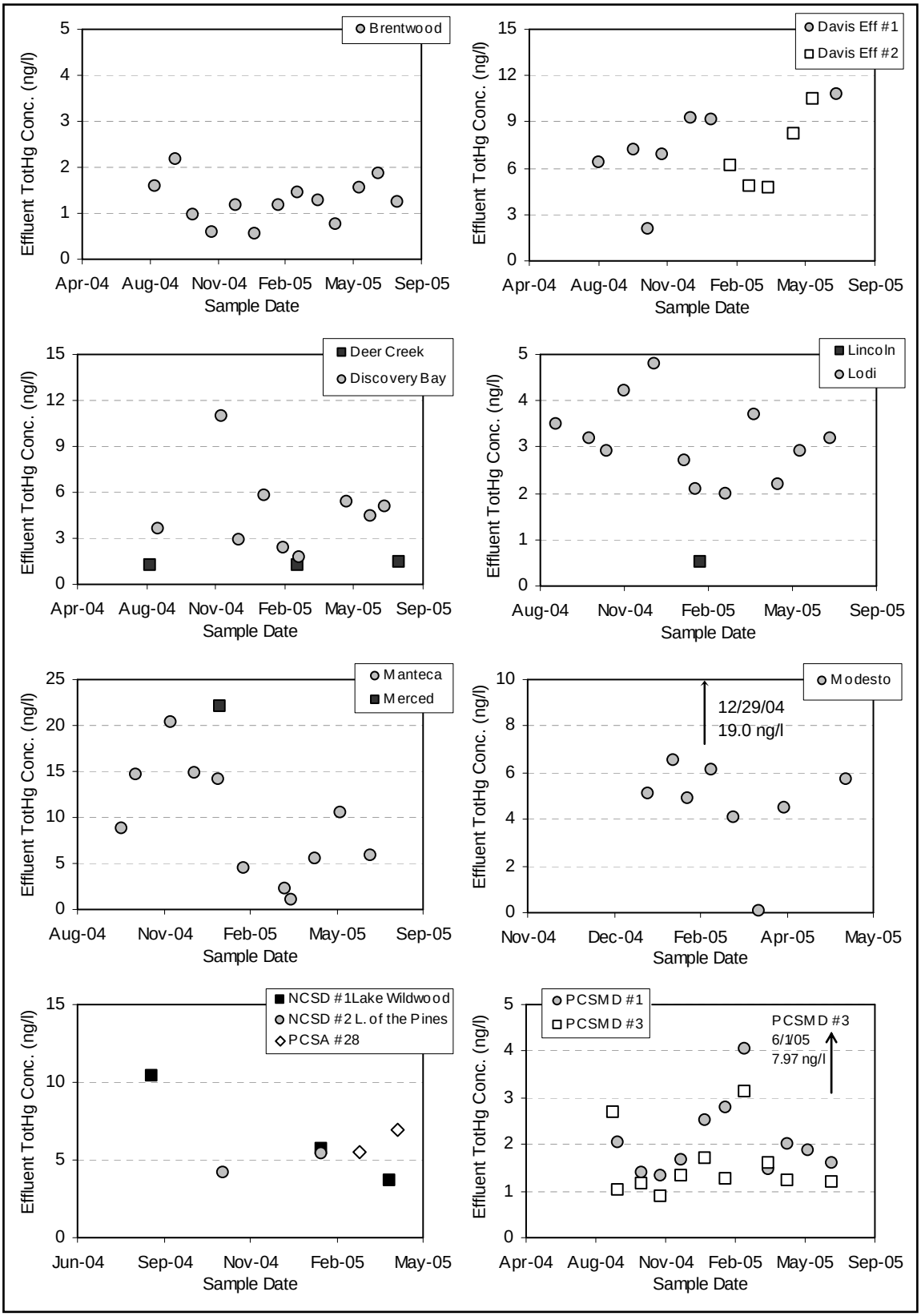

Figure 16a: Time-series Graphs of Municipal WWTP Effluent Inorganic Mercury Concentrations

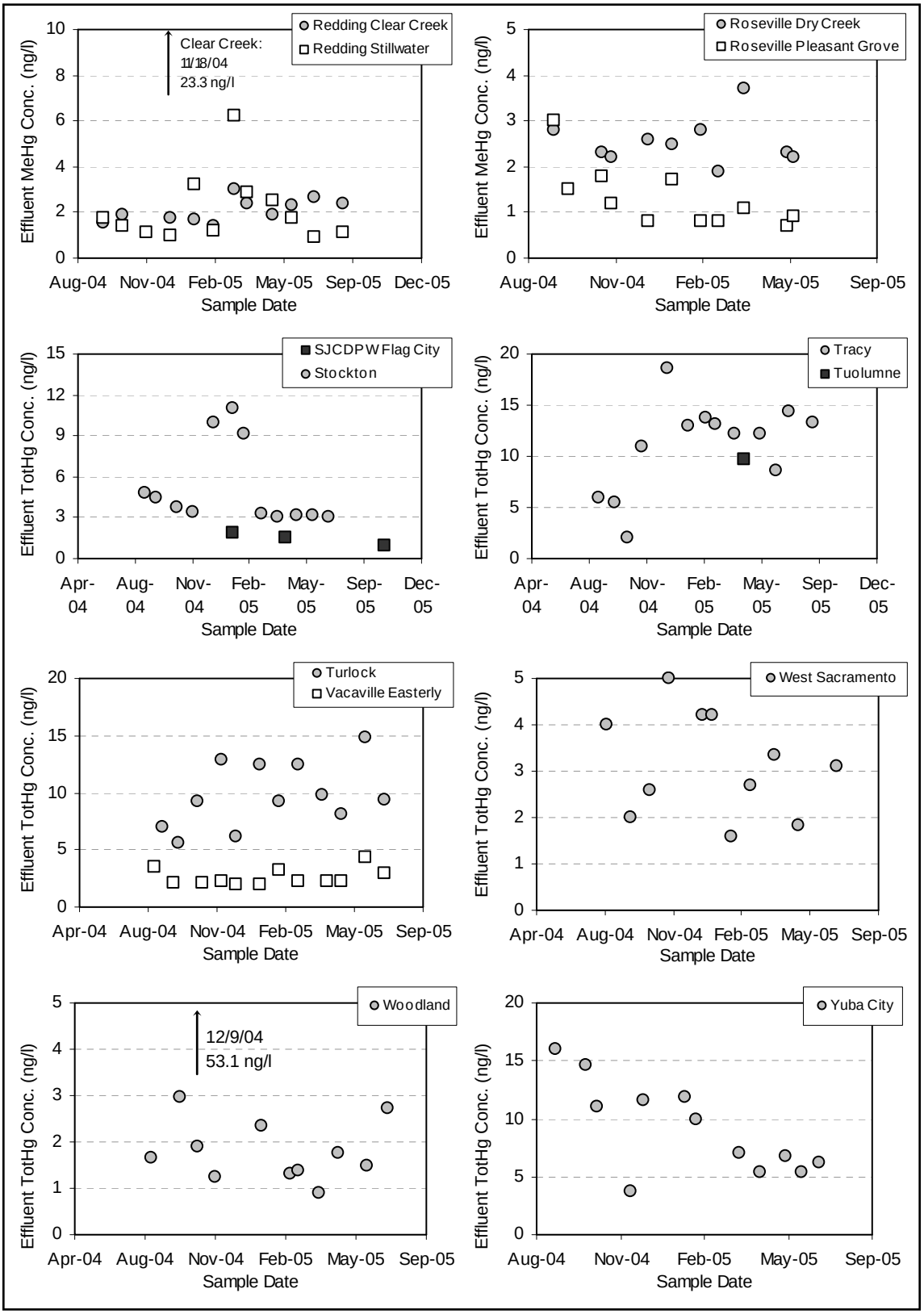

Figure 16b: Time-series Graphs of Municipal WWTP Effluent Inorganic Mercury Concentrations

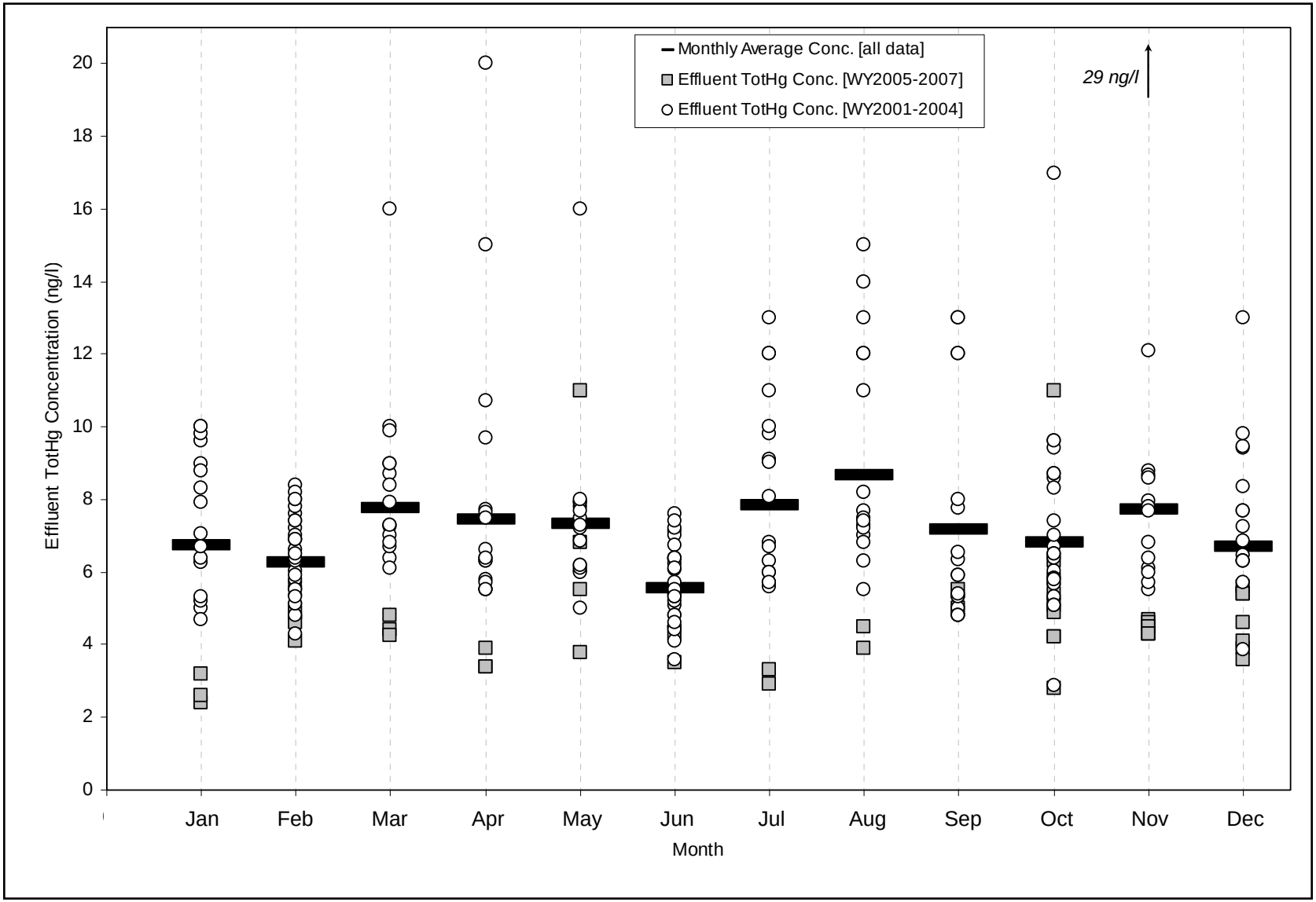

Figure 17: Monthly Effluent Inorganic Mercury Concentrations for the SRCSD Sacramento River WWTP from WY2001-2007

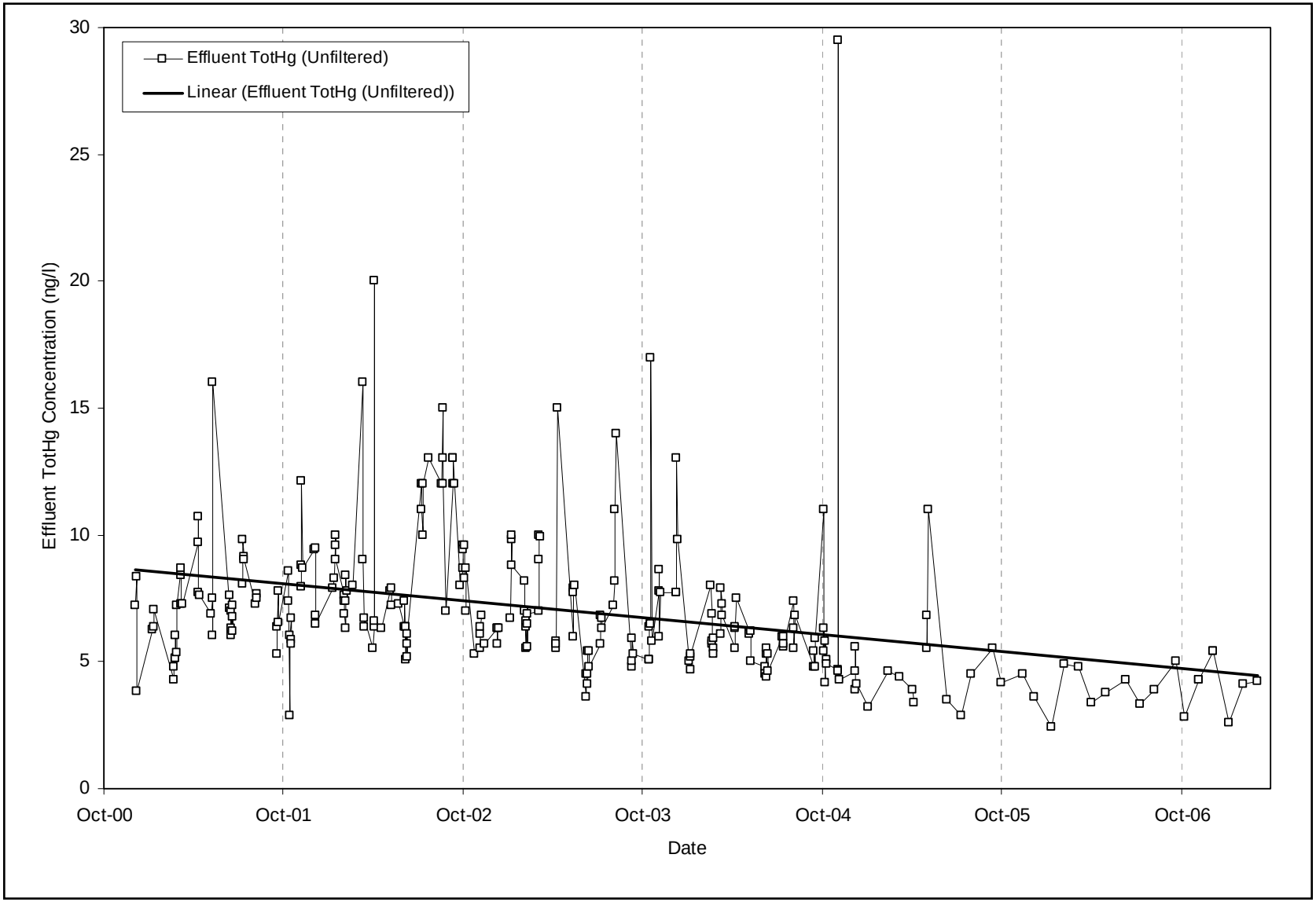

Figure 18: Time-series Graph of SRCSD Sacramento River WWTP Effluent Inorganic Mercury Concentrations

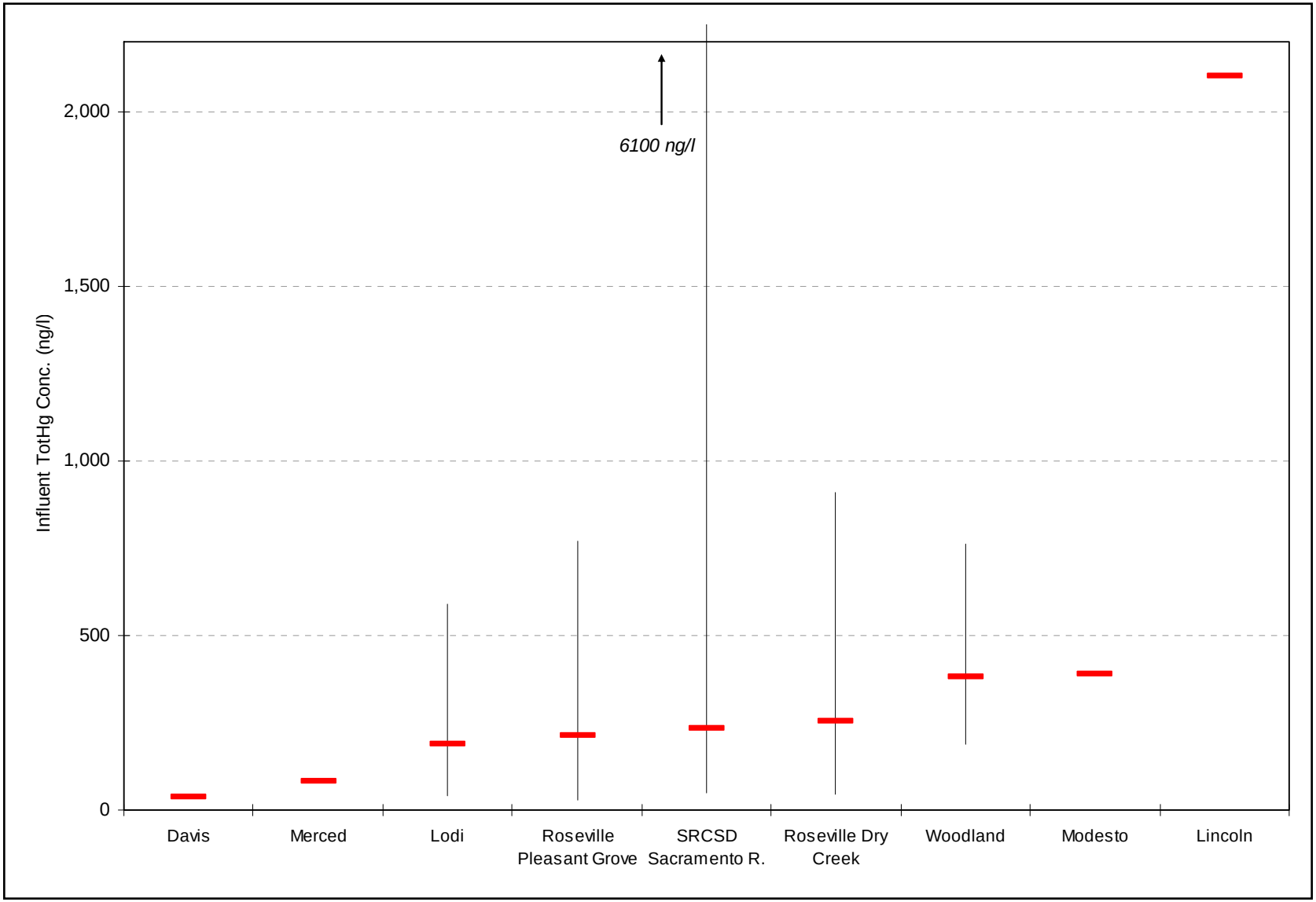

Figure 19: Average and Range of Influent Inorganic Mercury Concentrations for Each Municipal WWTP

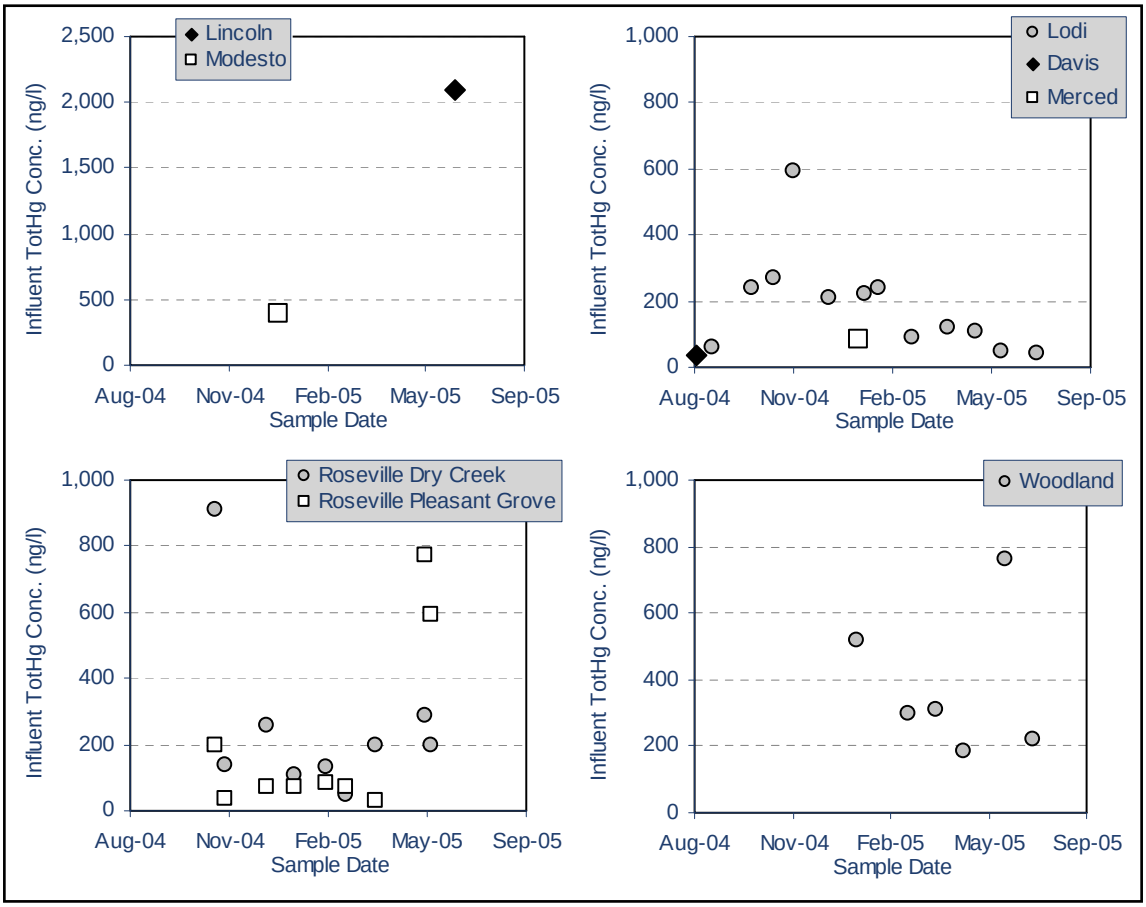

Figure 20: Time-series Graphs of Municipal WWTP Influent Inorganic Mercury Concentrations

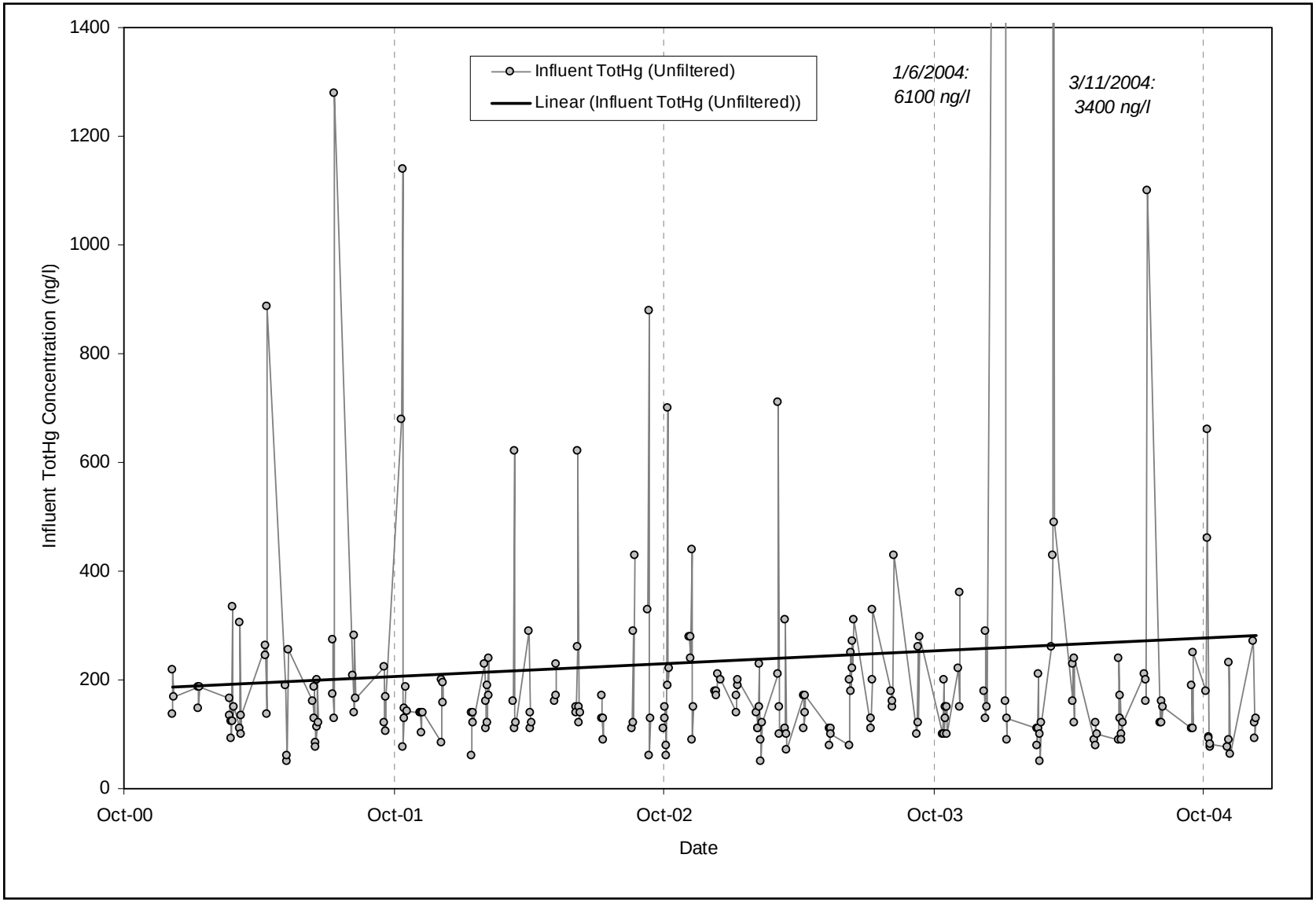

Figure 21: Time-series Graph of SRCSD Sacramento River WWTP Influent Inorganic Mercury Concentrations

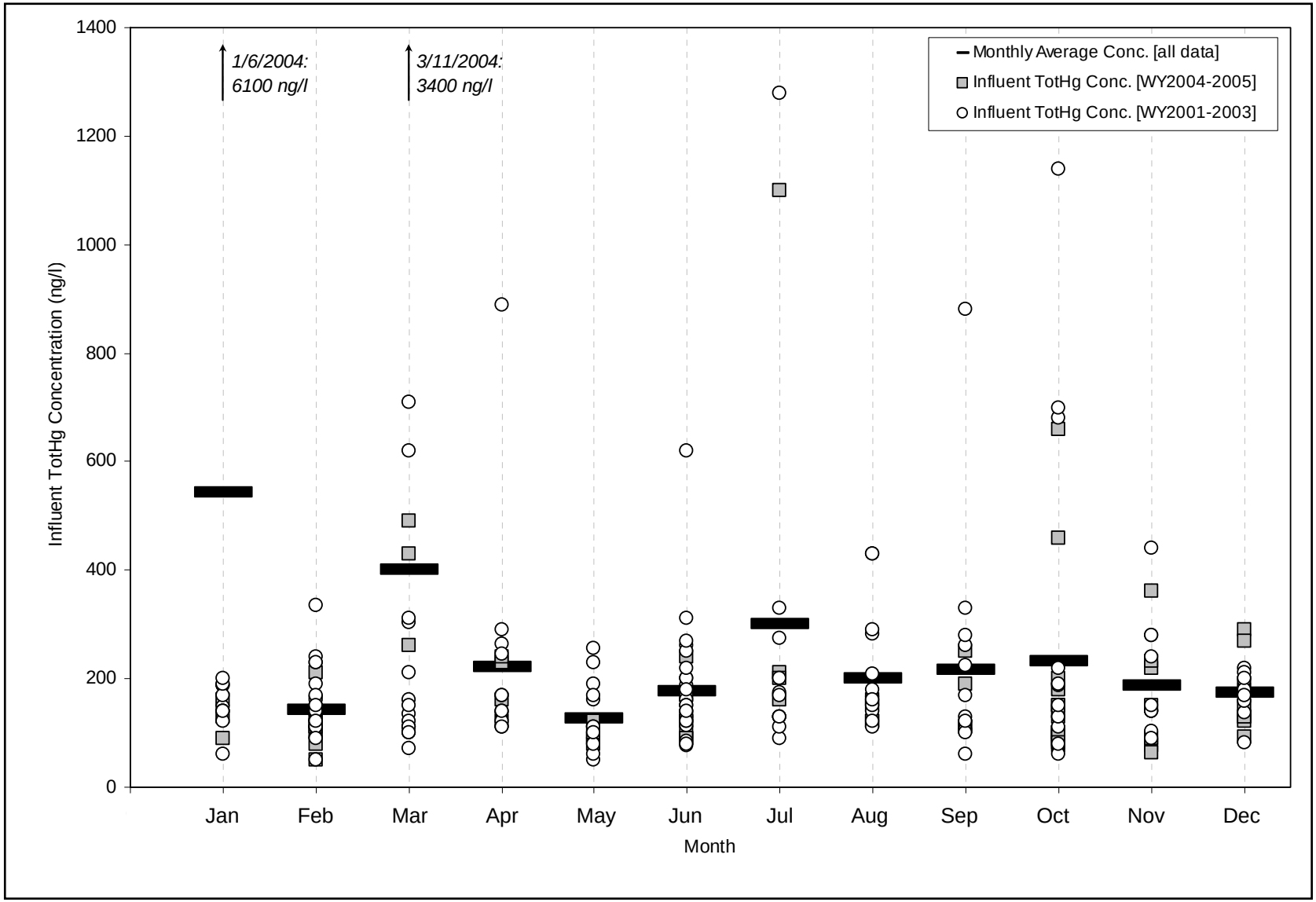

Figure 22: Monthly Influent Inorganic Mercury Concentrations for the SRCSD Sacramento River WWTP from December 2000 – December 2004

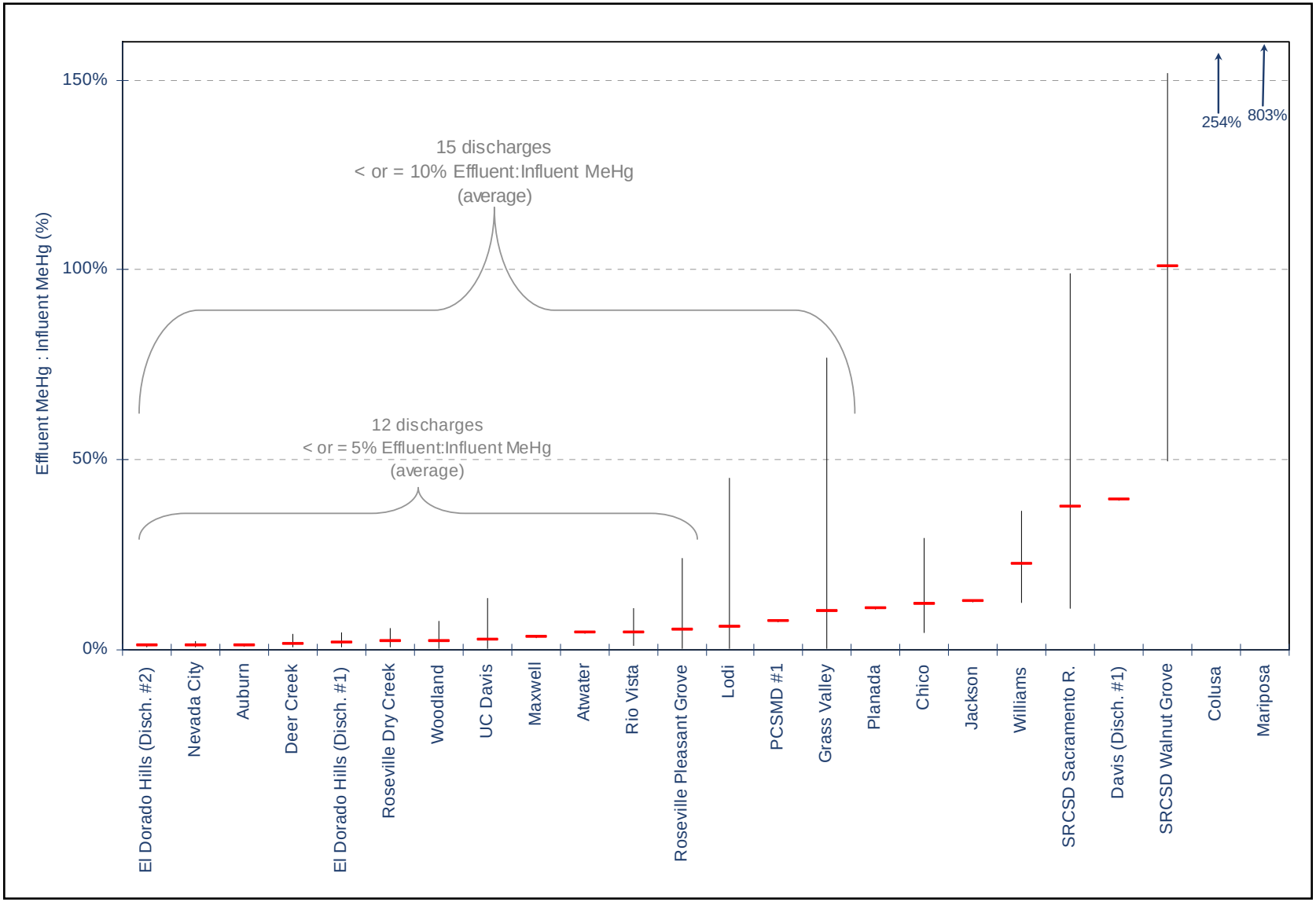

Figure 23: Average and Range of Effluent:Influent Methylmercury Concentration Ratios for Each Municipal WWTP

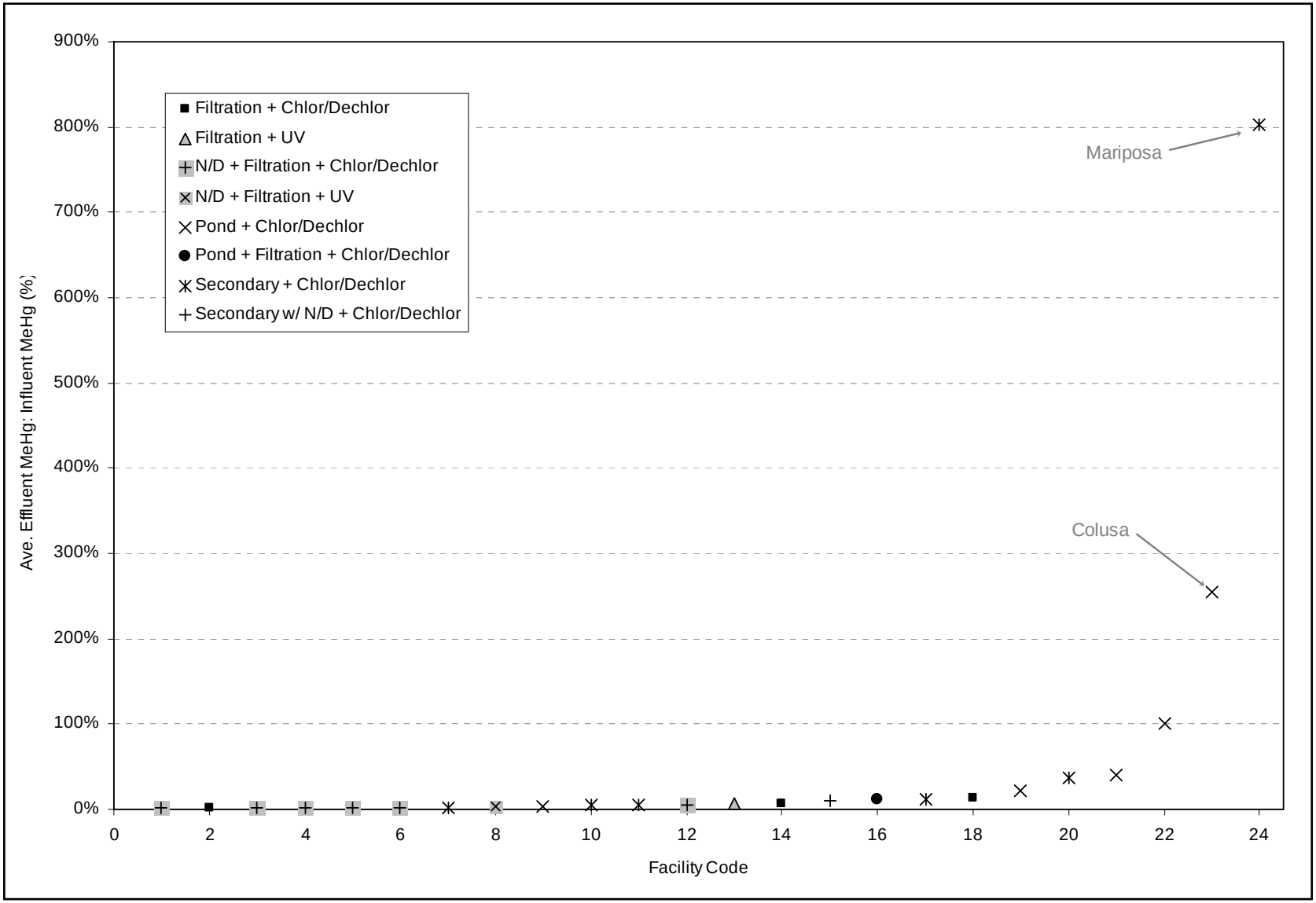

Figure 24: Average of Effluent:Influent Methylmercury Concentration Ratios with the Secondary Treatment Category Defined for Each Municipal WWTP

Facility Codes Used in Figure 24

Facility Code	NPDES No.	Facility
1	CA0078671	El Dorado Hills WWTP (Discharge 2)
2	CA0079901	Nevada City WWTP
3	CA0077712	Auburn WWTP
4	CA0078662	Deer Creek WWTP
5	CA0078671	El Dorado Hills WWTP (Discharge 1)
6	CA0079502	Roseville Dry Creek WWTP
7	CA0077950	Woodland WWTP
8	CA0077895	UC Davis WWTP
9	CA0079987	Maxwell PUD WWTP
10	CA0079197	Atwater WWTP
11	CA0079588	Rio Vista Main WWTP
12	CA0084573	Roseville Pleasant Grove WWTP
13	CA0079243	Lodi White Slough WWTP
14	CA0079316	Placer Co. SMD #1 WWTP
15	CA0079898	Grass Valley WWTP
16	CA0078950	Planada Comm. Service Dist. WWTP
17	CA0079081	Chico Regional WWTP
18	CA0079391	Jackson WWTP
19	CA0077933	Williams WWTP
20	CA0077682	SRCSD Sacramento River WWTP
21	CA0079049	Davis WWTP (Discharge 1)
22	CA0078794	SRCSD Walnut Grove WWTP (CSD1)
23	CA0078999	Colusa WWTP
24	CA0079430	Mariposa PUD WWTP

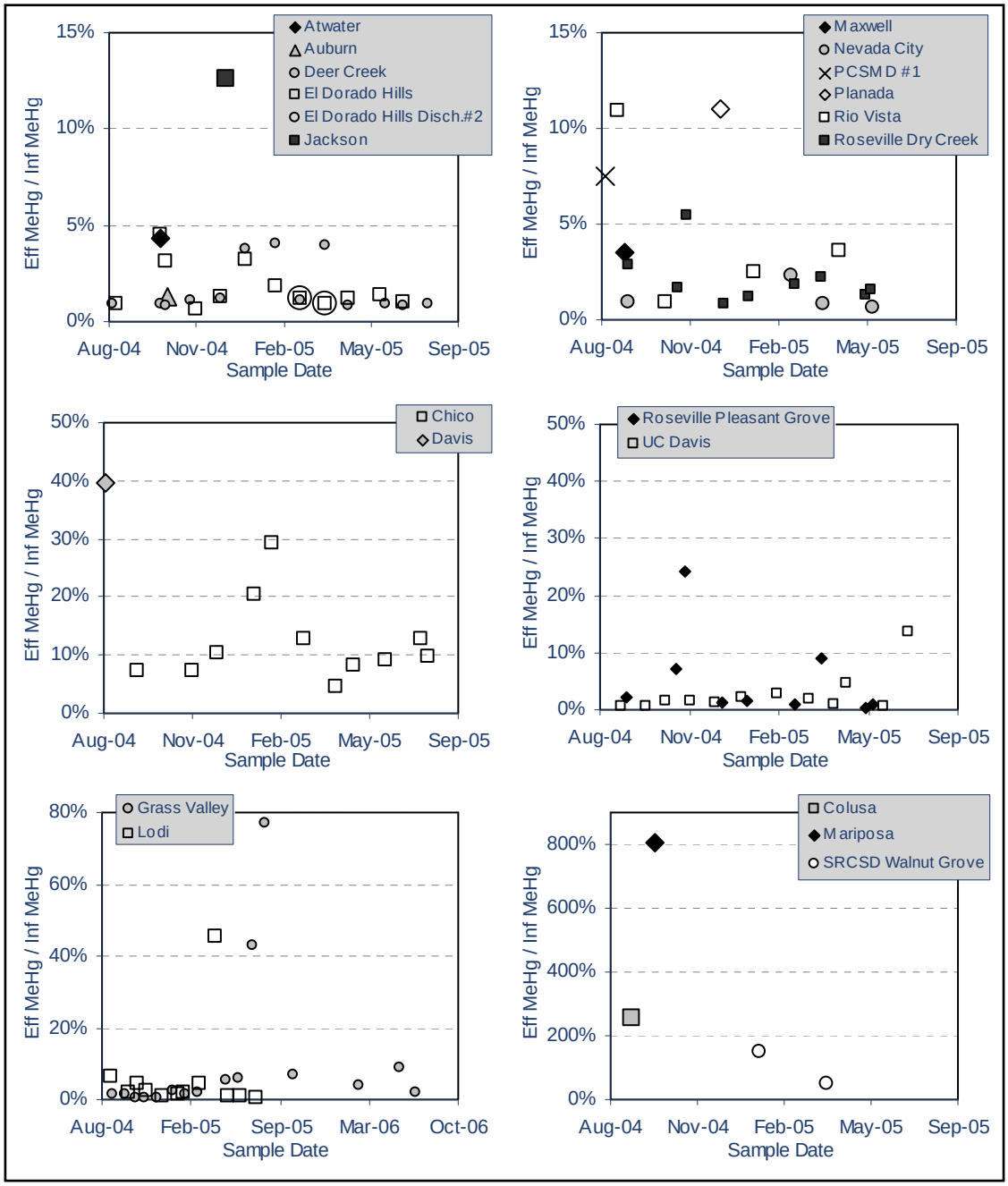

Figure 25: Time-series Graphs of Municipal WWTP Effluent:Influent Methylmercury Concentration Ratios

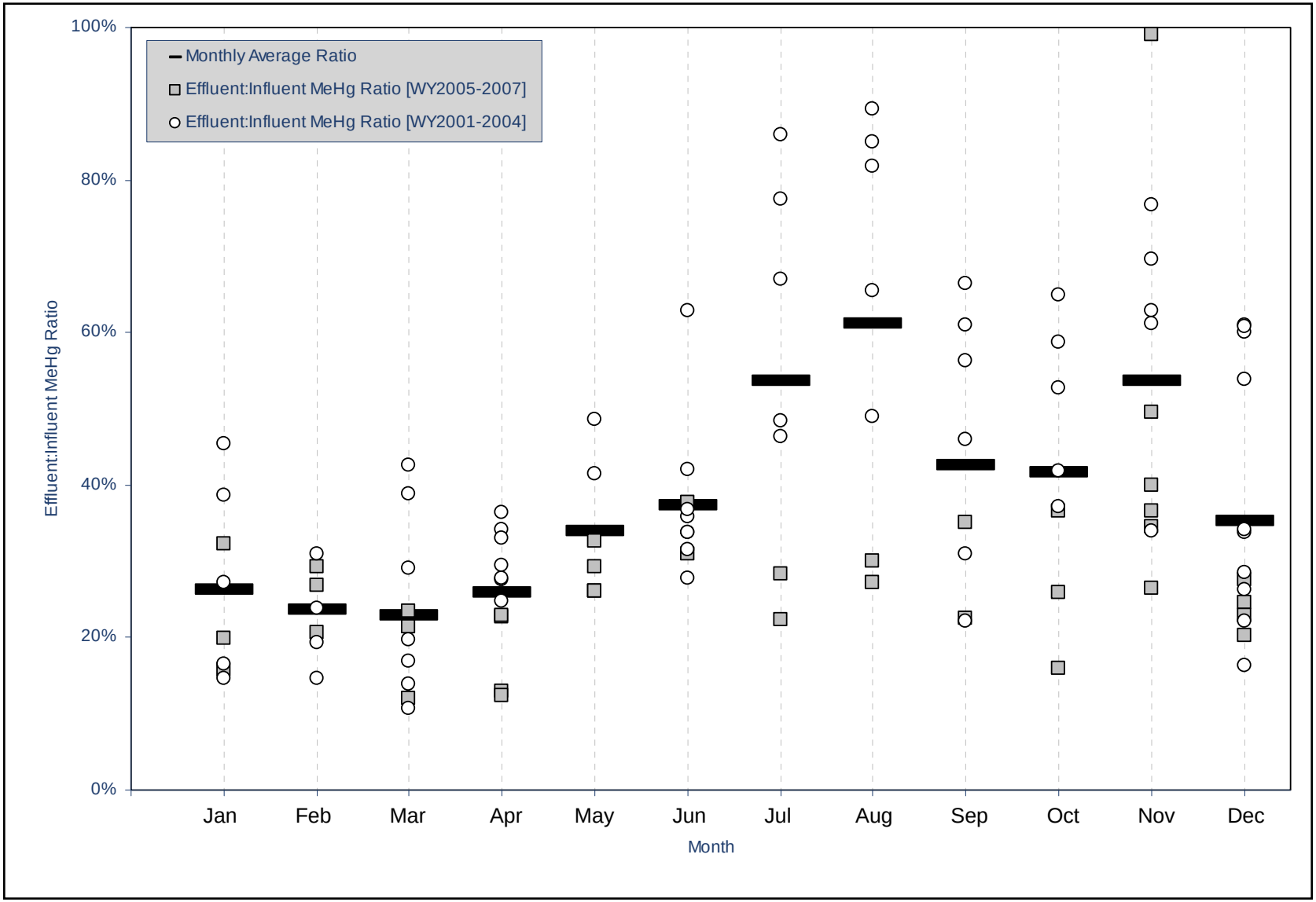

Figure 26: Monthly Effluent:Influent Methylmercury Concentration Ratios for the SRCSD Sacramento River WWTP from WY2001-2007

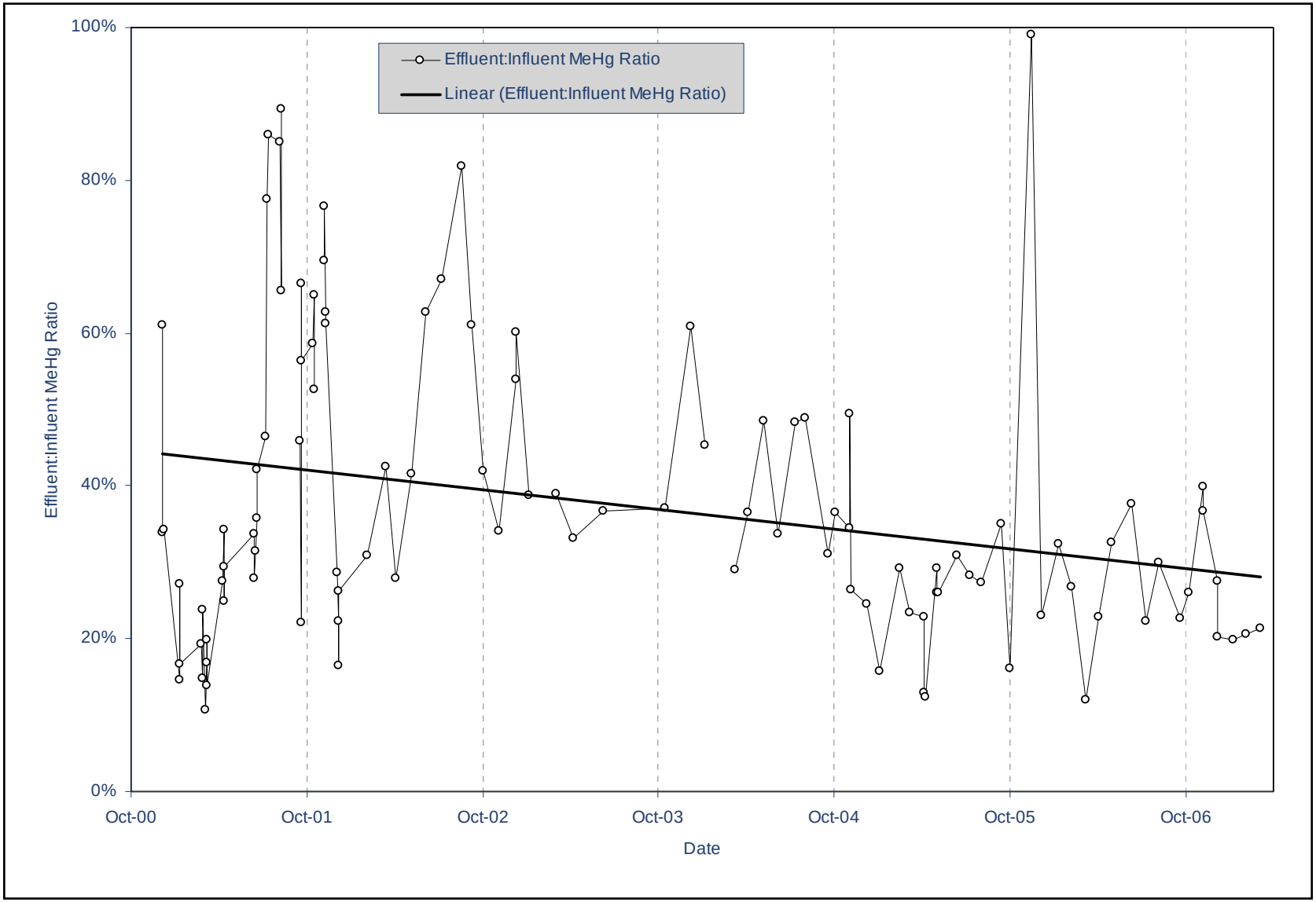

Figure 27: Time-series Graph of SRCSD Sacramento River WWTP Effluent:Influent Methylmercury Concentration Ratios

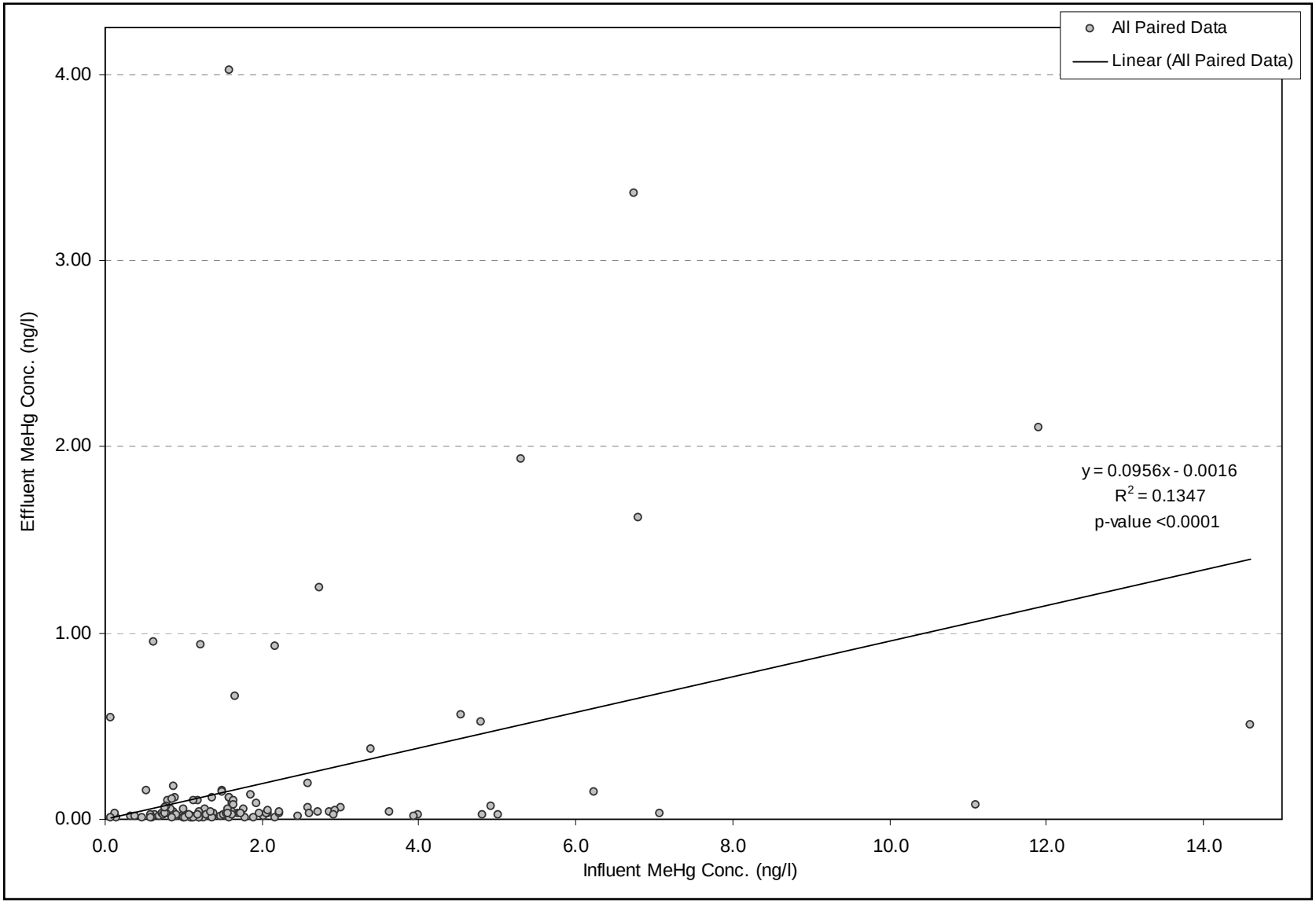

Figure 28a: Scatter-plot of Municipal WWTP Influent versus Effluent Methylmercury Concentrations for All Paired Data [excluding SRCSD Sacramento River WWTP data]

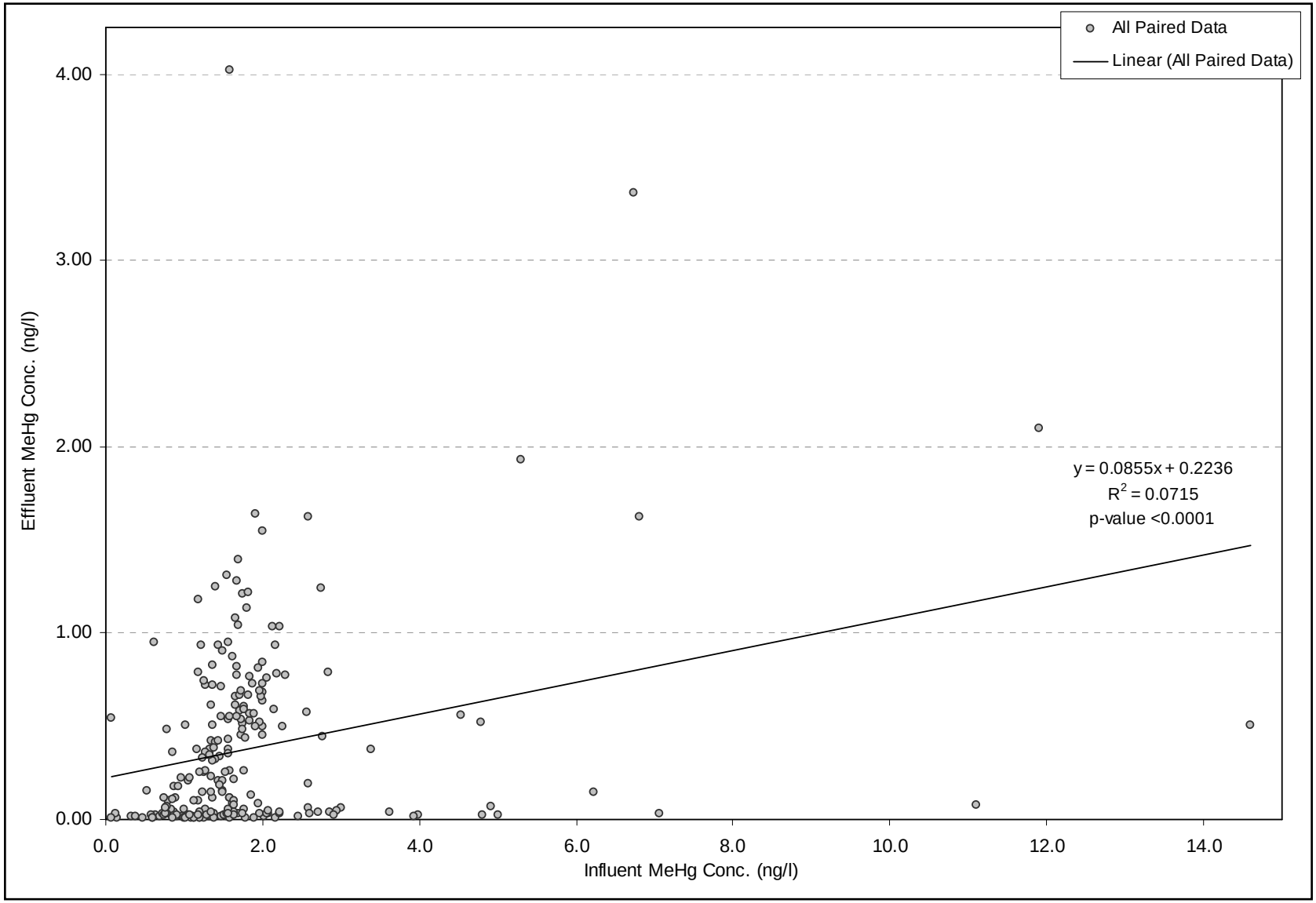

Figure 28b: Scatter-plot of Municipal WWTP Influent versus Effluent Methylmercury Concentrations for All Paired Data [including SRCSD Sacramento River WWTP data]

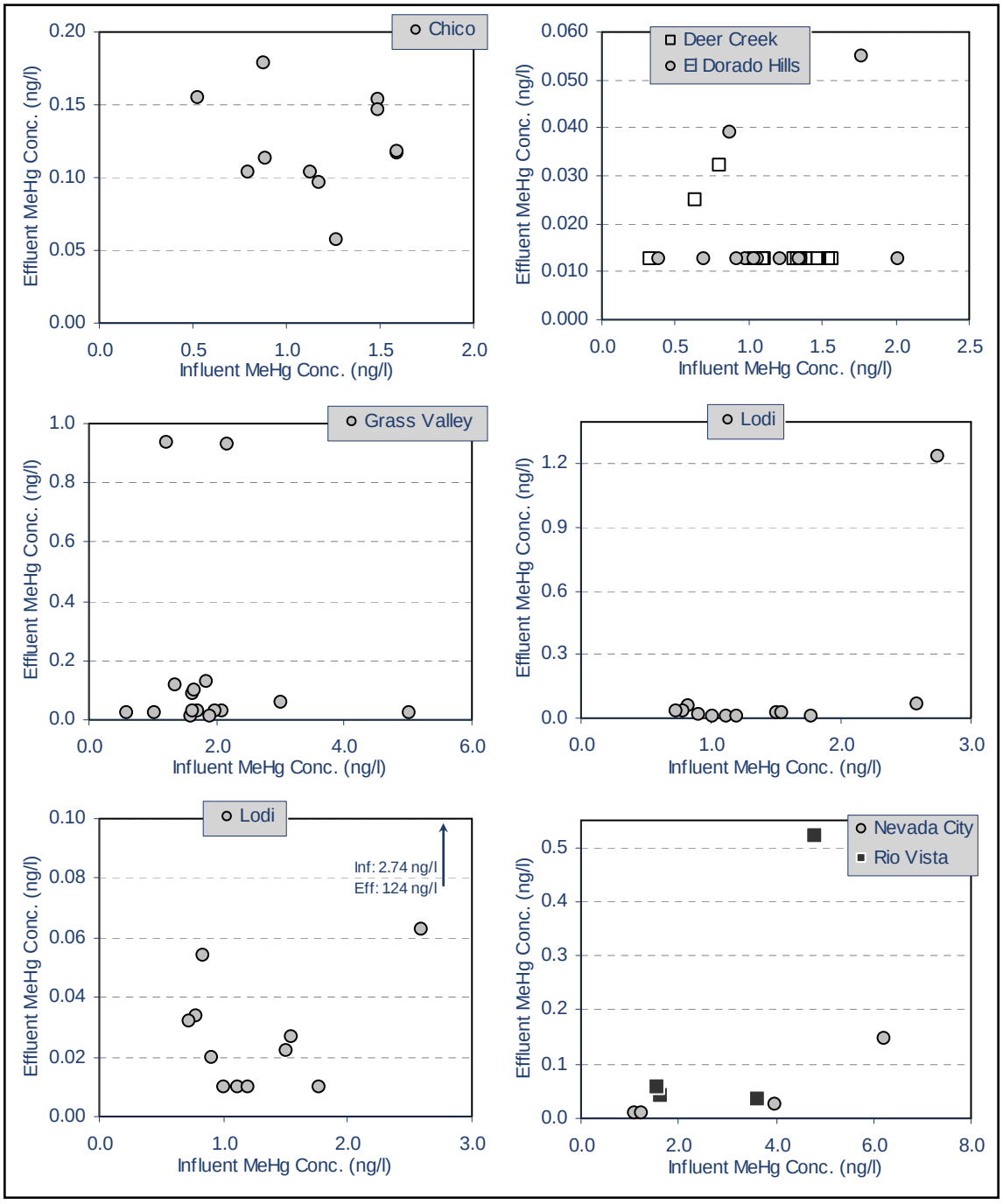

Figure 29a: Scatter-plots of Influent versus Effluent Methylmercury Concentrations for Each Municipal WWTP

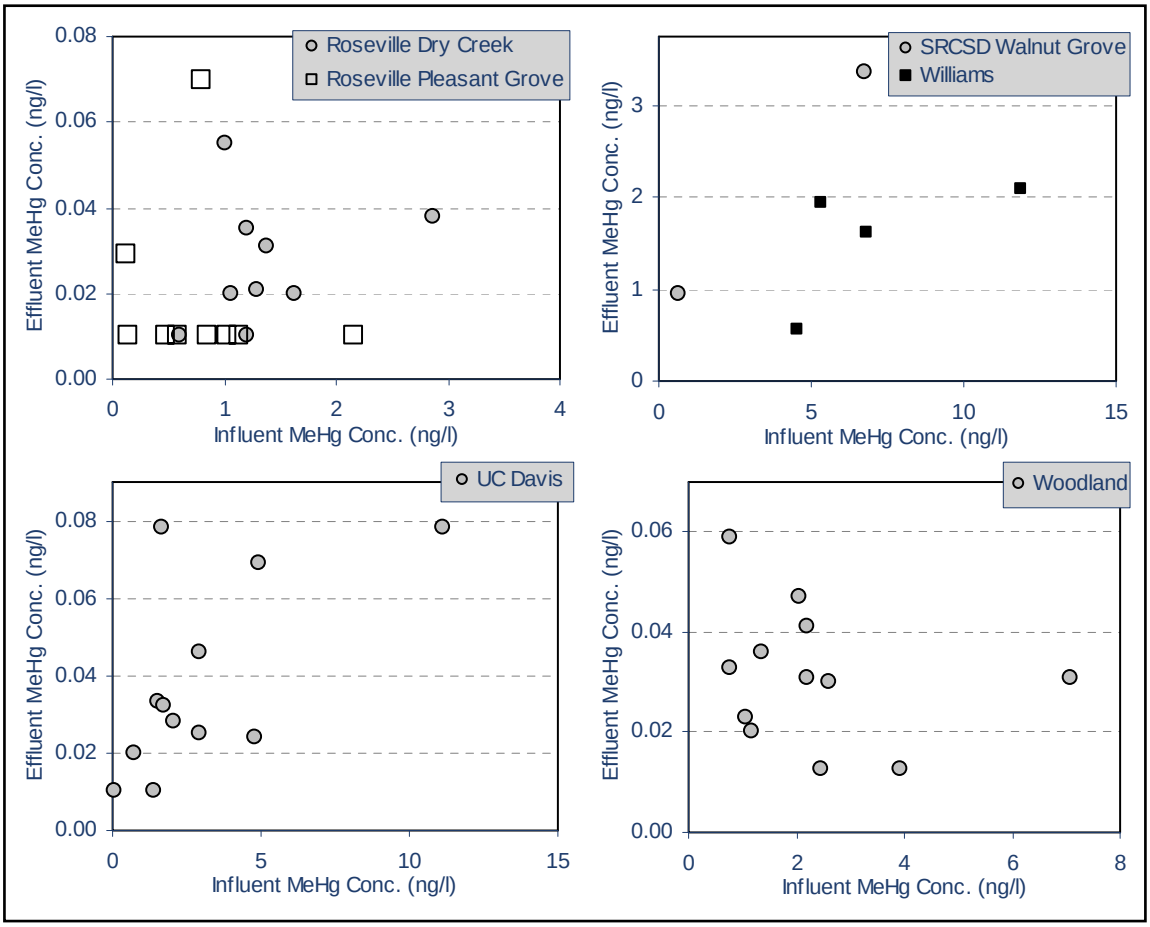

Figure 29b: Scatter-plots of Influent versus Effluent Methylmercury Concentrations for Each Municipal WWTP

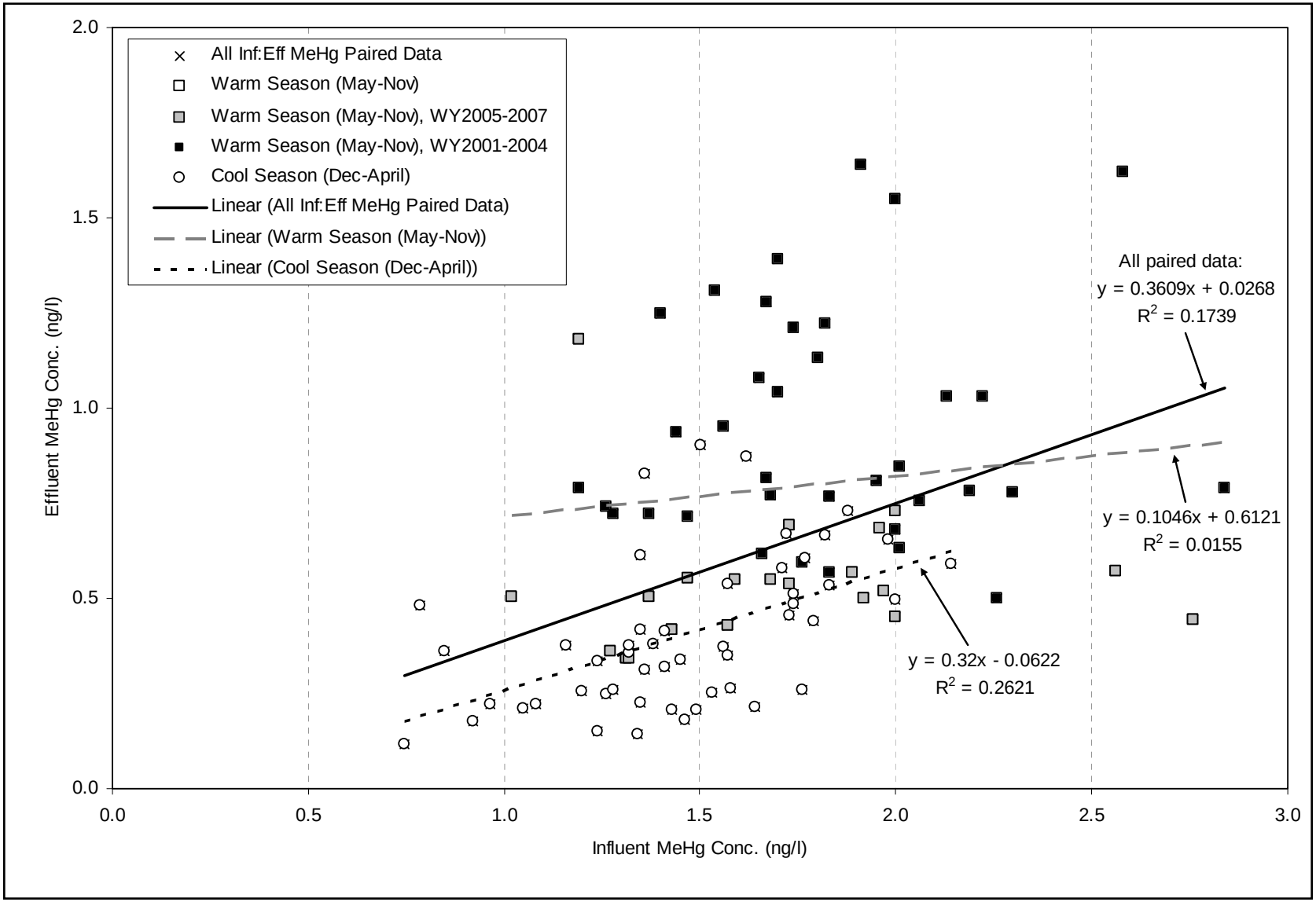

Figure 30: Scatter-plot of Influent versus Effluent Methylmercury Concentrations for the SRCSD Sacramento River WWTP

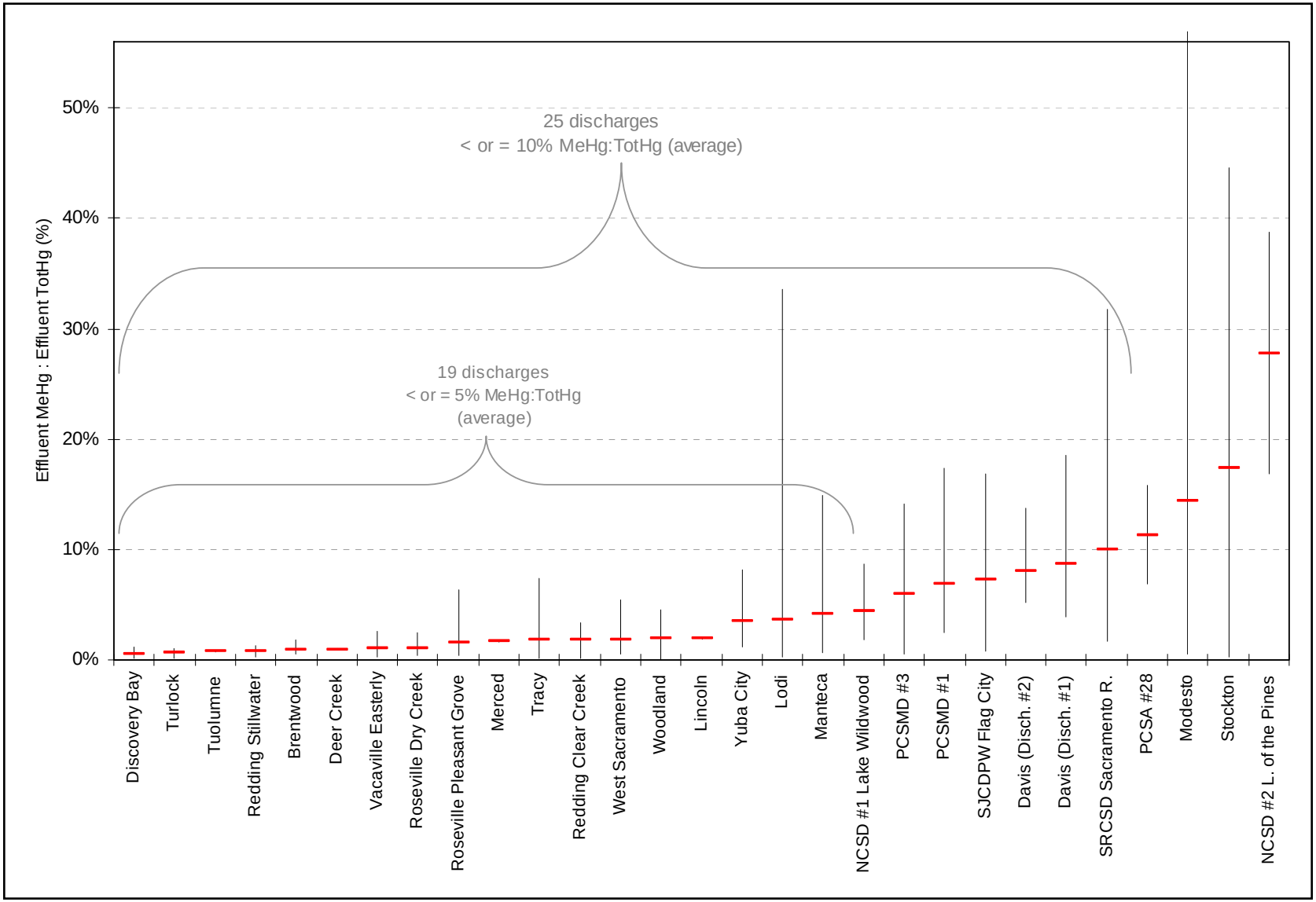

Figure 31: Average and Range of Effluent MeHg:TotHg Concentration Ratios for Each Municipal WWTP

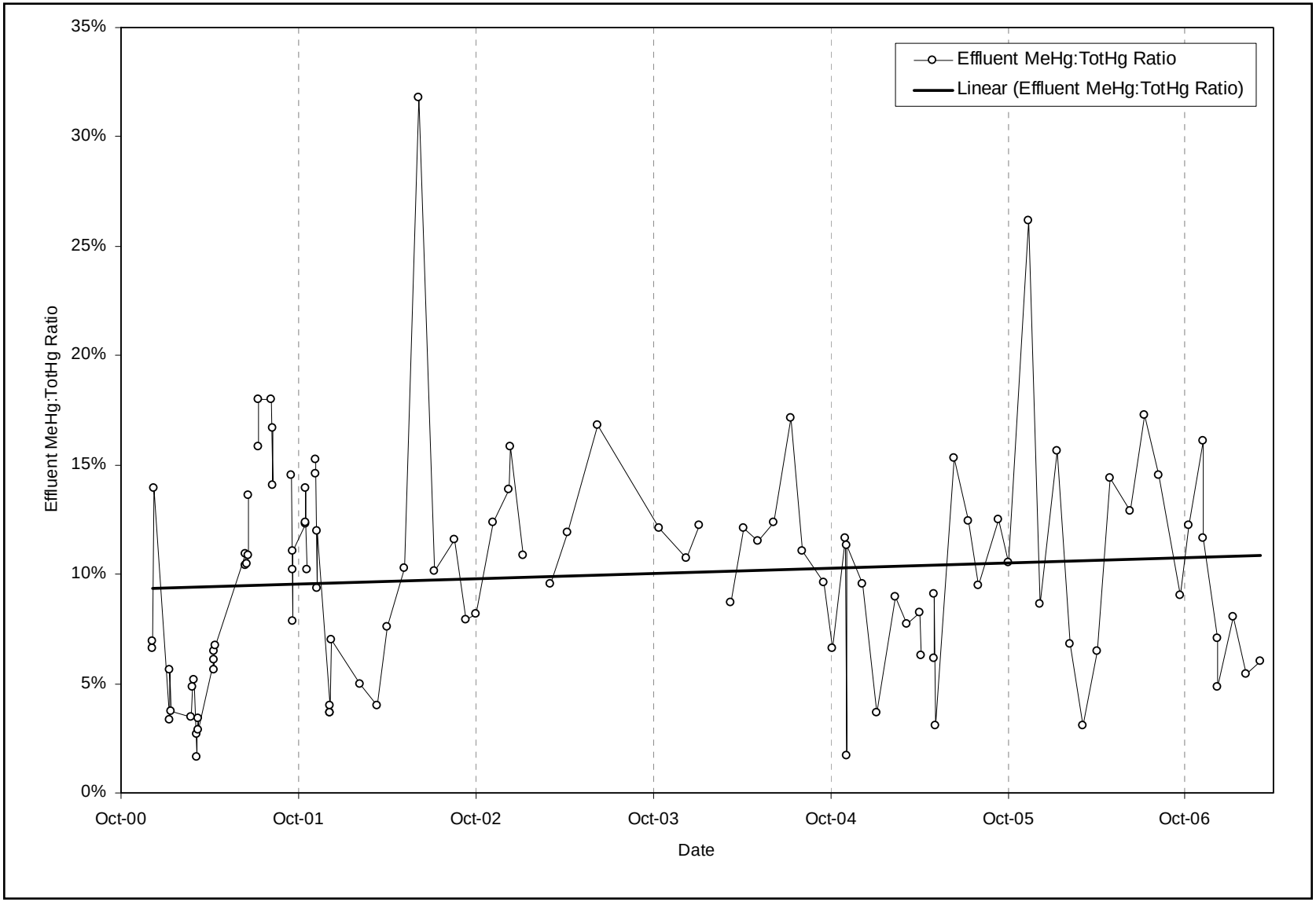

Figure 32: Time-series Graph of SRCSD Sacramento River WWTP Effluent MeHg:TotHg Concentration Ratios

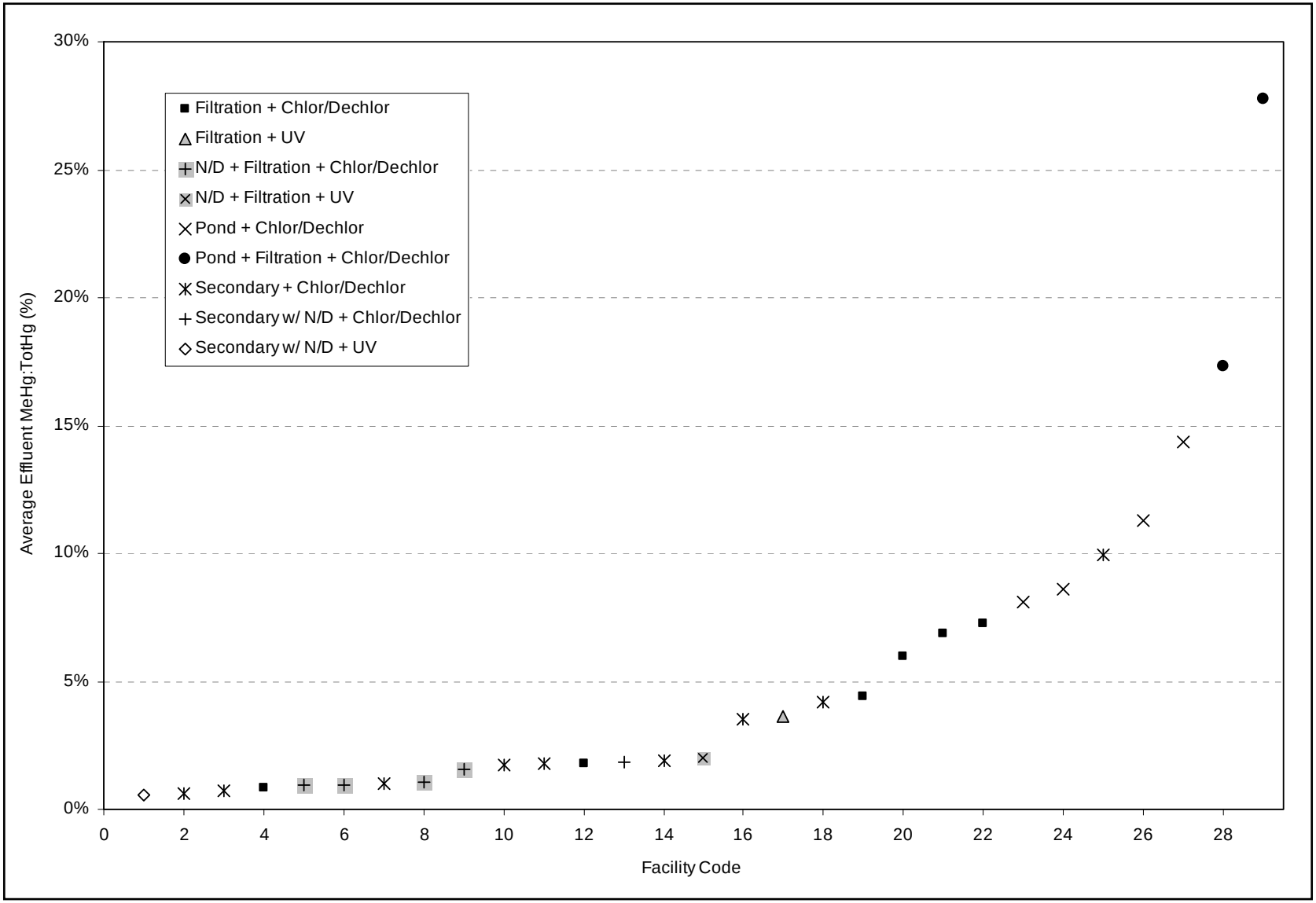

Figure 33: Average of Effluent MeHg:TotHg Concentration Ratios with the Secondary Treatment Category Defined for Each Municipal WWTP

Facility Codes Used in Figure 33

Facility Code	NPDES No.	Facility
1	CA0078590	Discovery Bay WWTP
2	CA0078948	Turlock WWTP
3	CA0084727	Tuolumne UD Sonora RWTP/ Jamestown SDWTP
4	CA0082589	Redding Stillwater WWTP
5	CA0082660	Brentwood WWTP
6	CA0078662	Deer Creek WWTP
7	CA0077691	Vacaville Easterly WWTP
8	CA0079502	Roseville Dry Creek WWTP
9	CA0084573	Roseville Pleasant Grove WWTP
10	CA0079219	Merced WWTP
11	CA0079154	Tracy WWTP
12	CA0079731	Redding Clear Creek WWTP
13	CA0079171	West Sacramento WWTP
14	CA0077950	Woodland WWTP
15	CA0084476	Lincoln WWTP
16	CA0079260	Yuba City WWTP
17	CA0079243	Lodi White Slough WWTP
18	CA0081558	Manteca WWTP
19	CA0077828	Nevada Co SD #1 Lake Wildwood WWTP
20	CA0079367	Placer Co. SMD #3 WWTP
21	CA0079316	Placer Co. SMD #1 WWTP
22	CA0082848	San Joaquin Co DPW - Flag City WWTP
23	CA0079049	Davis WWTP (Discharge 2)
24	CA0079049	Davis WWTP (Discharge 1)
25	CA0077682	SRCSD Sacramento River WWTP
26	CA0079341	Placer Co. SA #28 Zone #6 WWTP
27	CA0079103	Modesto WWTP
28	CA0079138	Stockton WWTP
29	CA0081612	Nevada Co SD #2 Lake of the Pines WWTP

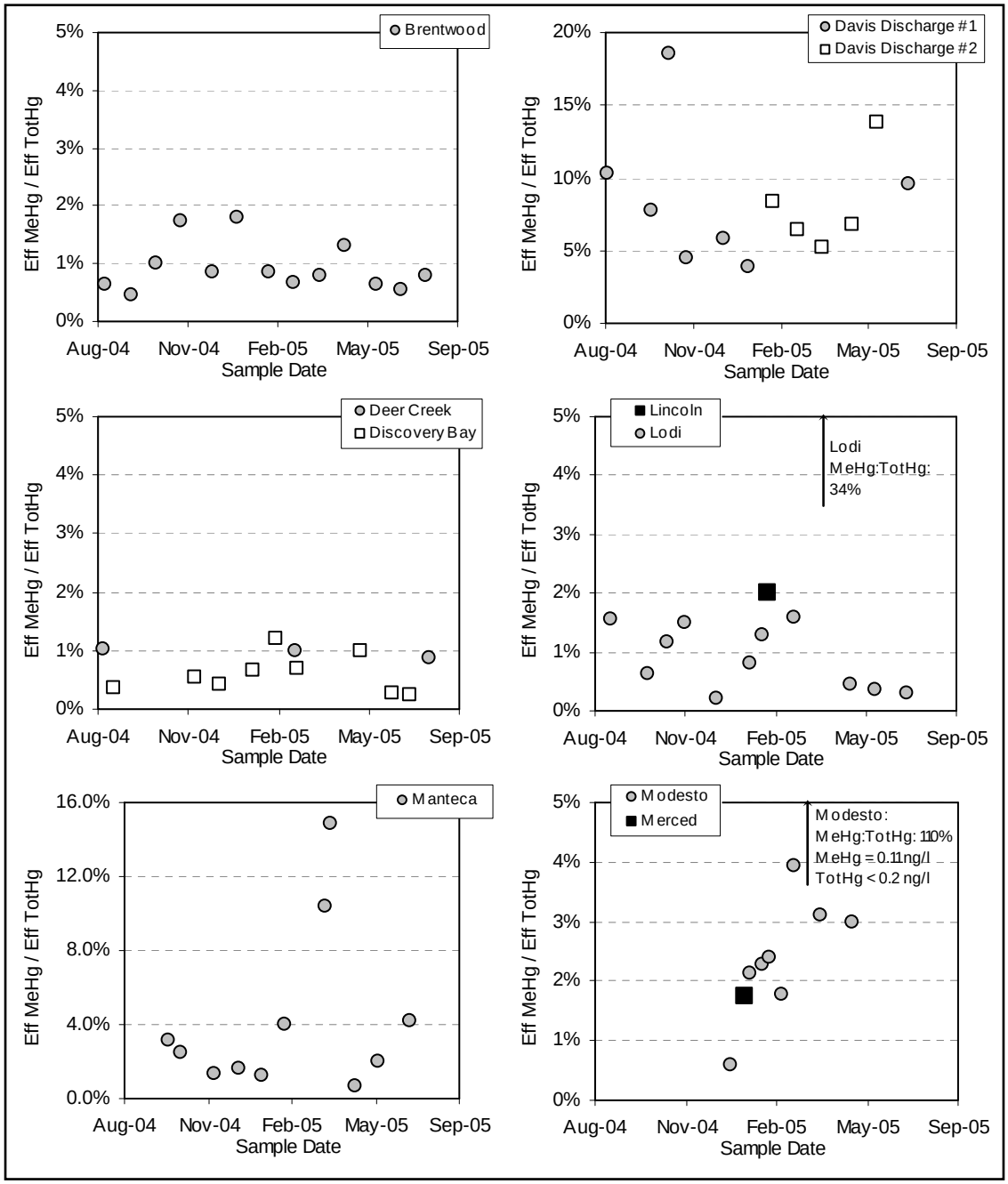

Figure 34a: Time-series Graphs of Municipal WWTP Effluent MeHg:TotHg Concentration Ratios

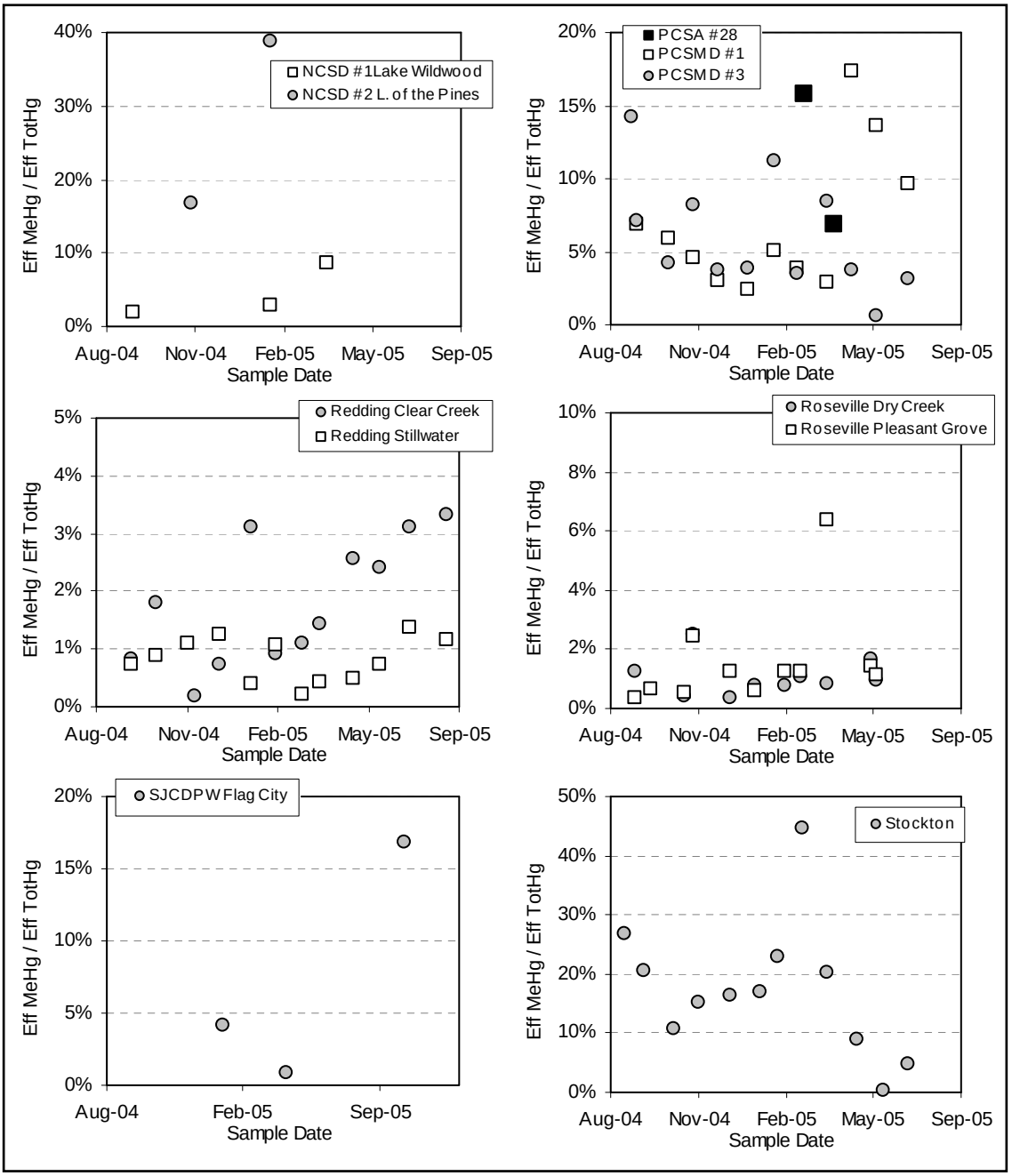

Figure 34b: Time-series Graphs of Municipal WWTP Effluent MeHg:TotHg Concentration Ratios

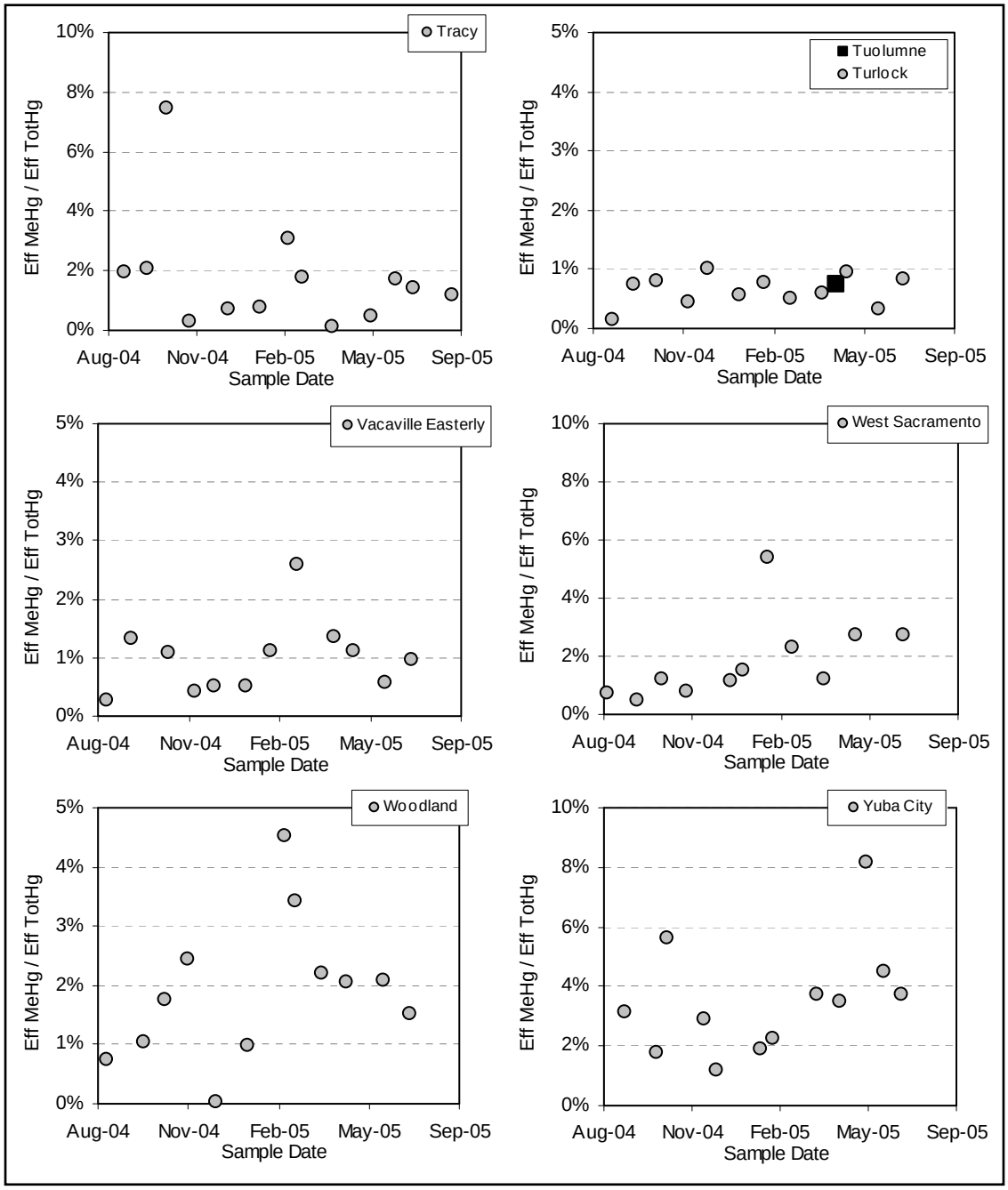

Figure 34c: Time-series Graphs of Municipal WWTP Effluent MeHg:TotHg Concentration Ratios

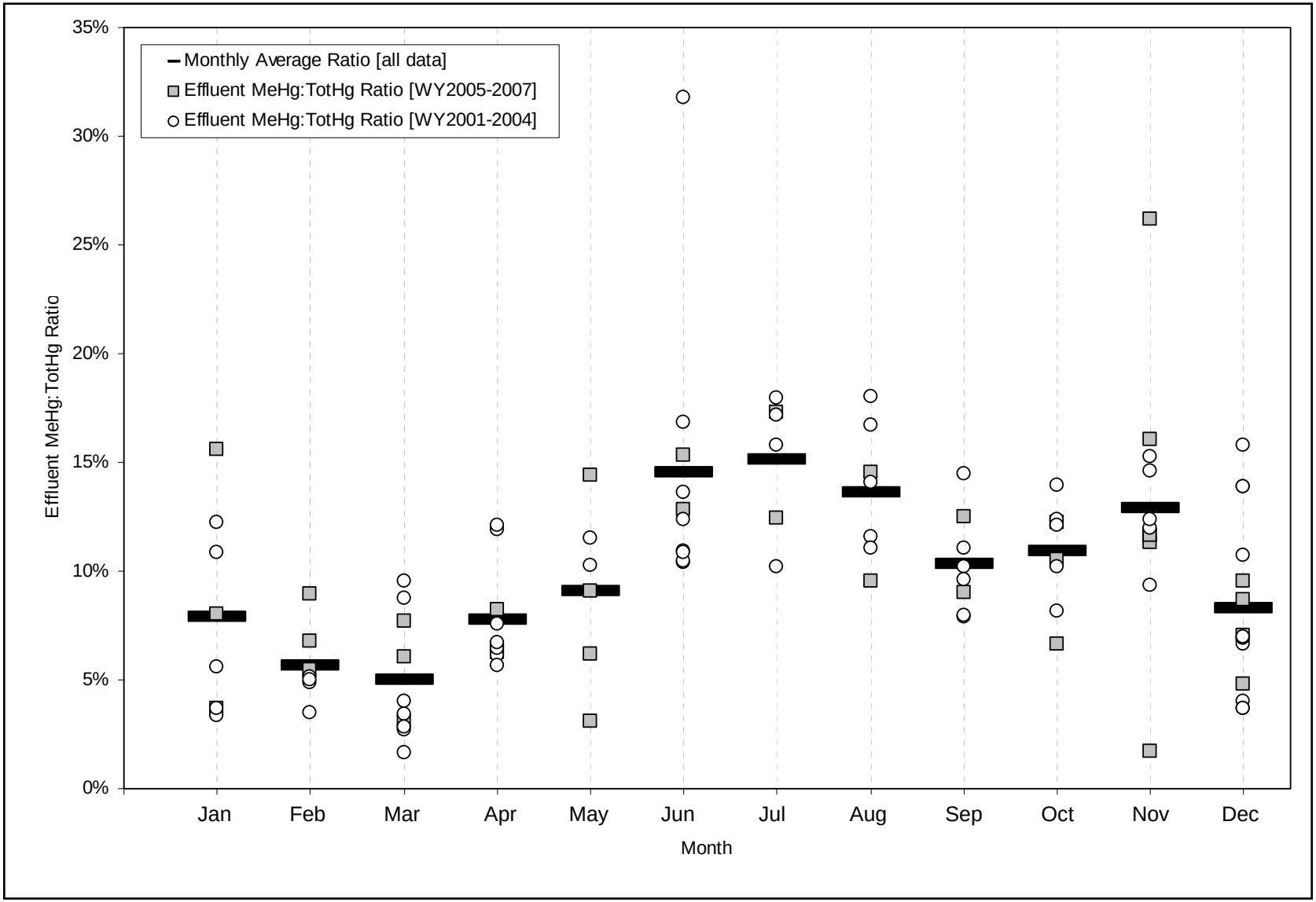

Figure 35: Monthly Effluent MeHg:TotHg Concentration Ratios for the SRCSD Sacramento River WWTP from WY2001-2007

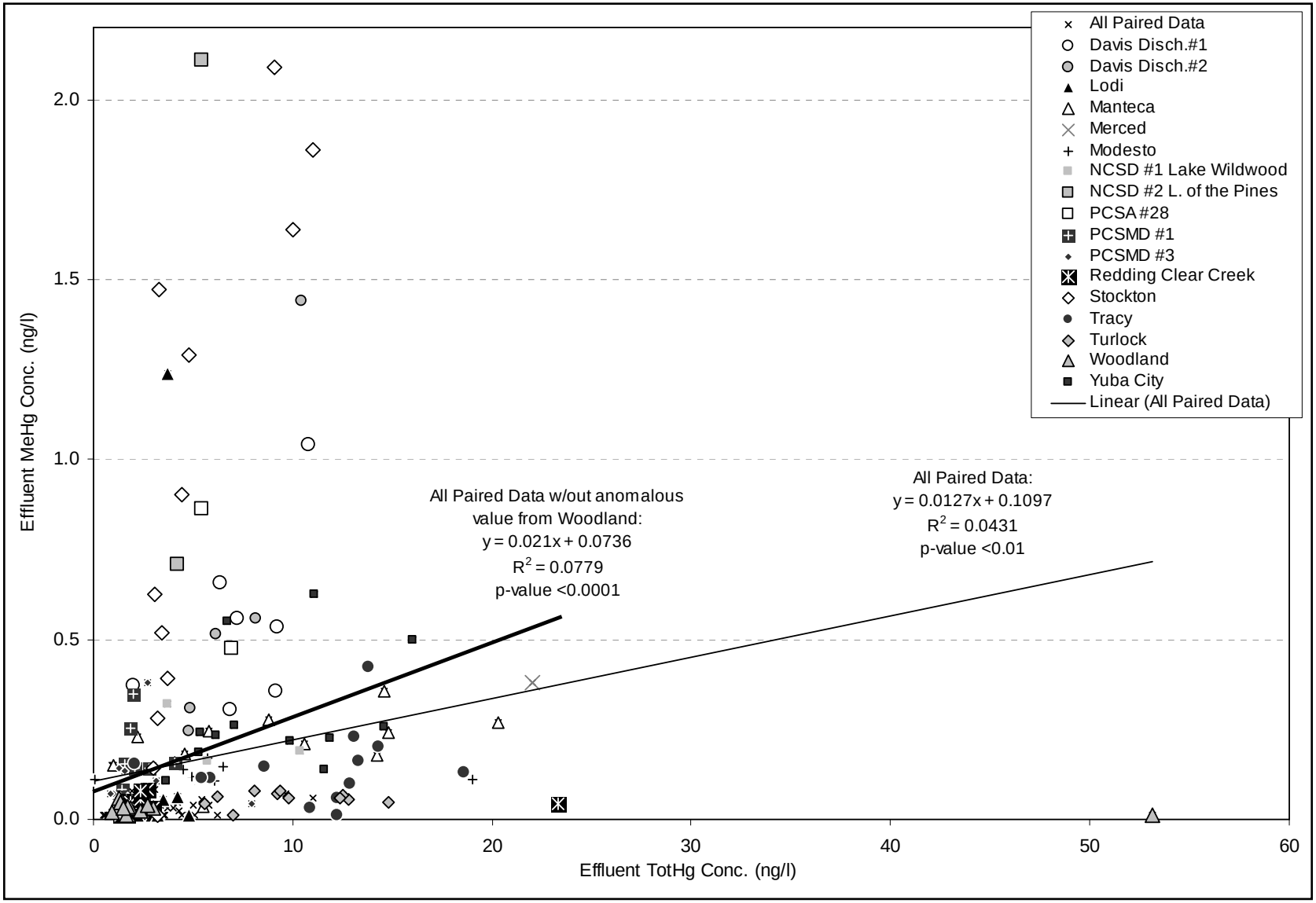

Figure 36a: Scatter-plot of Municipal WWTP Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for All Paired Data [excluding SRCSD Sacramento River WWTP data]

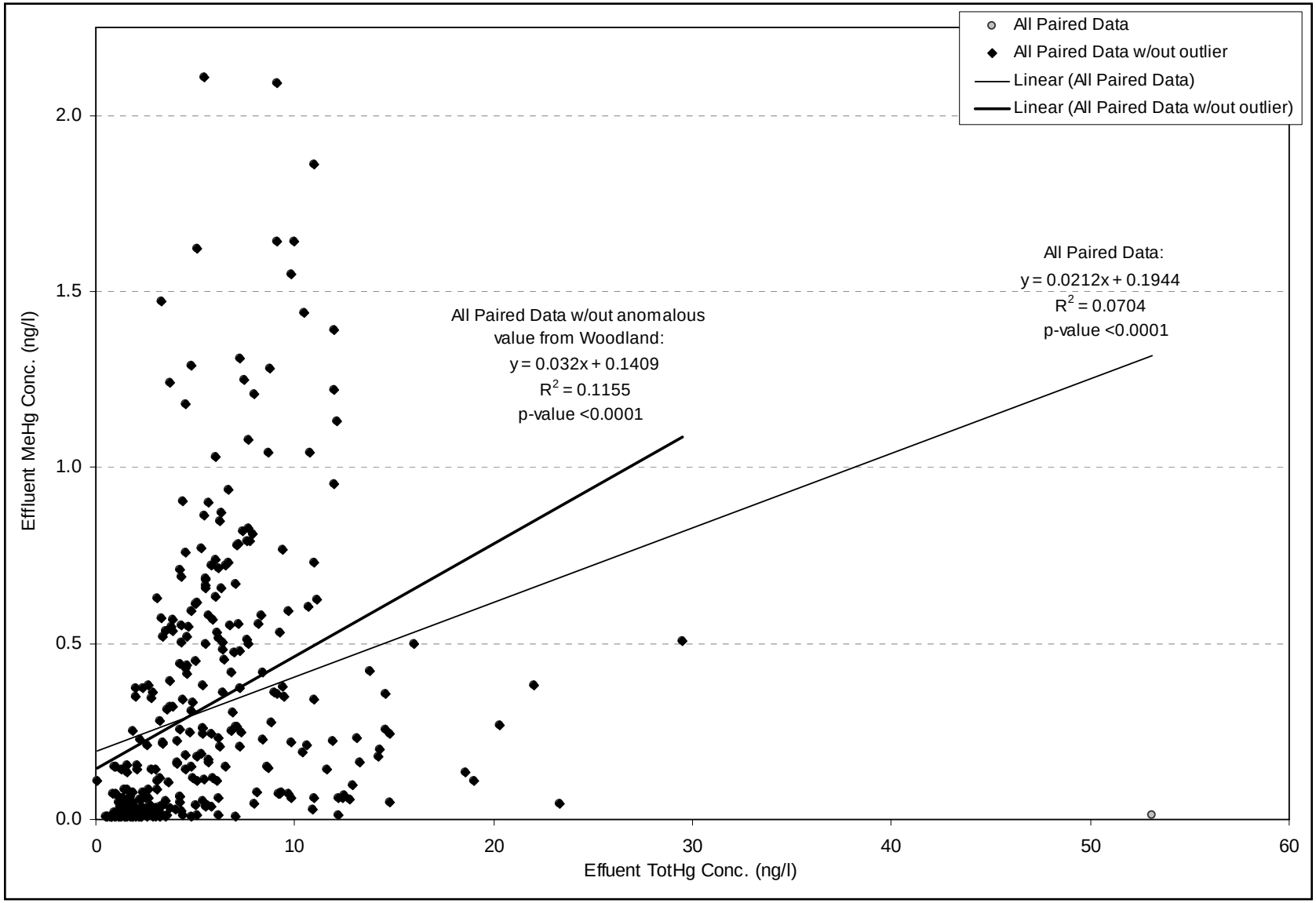

Figure 36b: Scatter-plot of Municipal WWTP Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for All Paired Data [including SRCSD Sacramento River WWTP data]

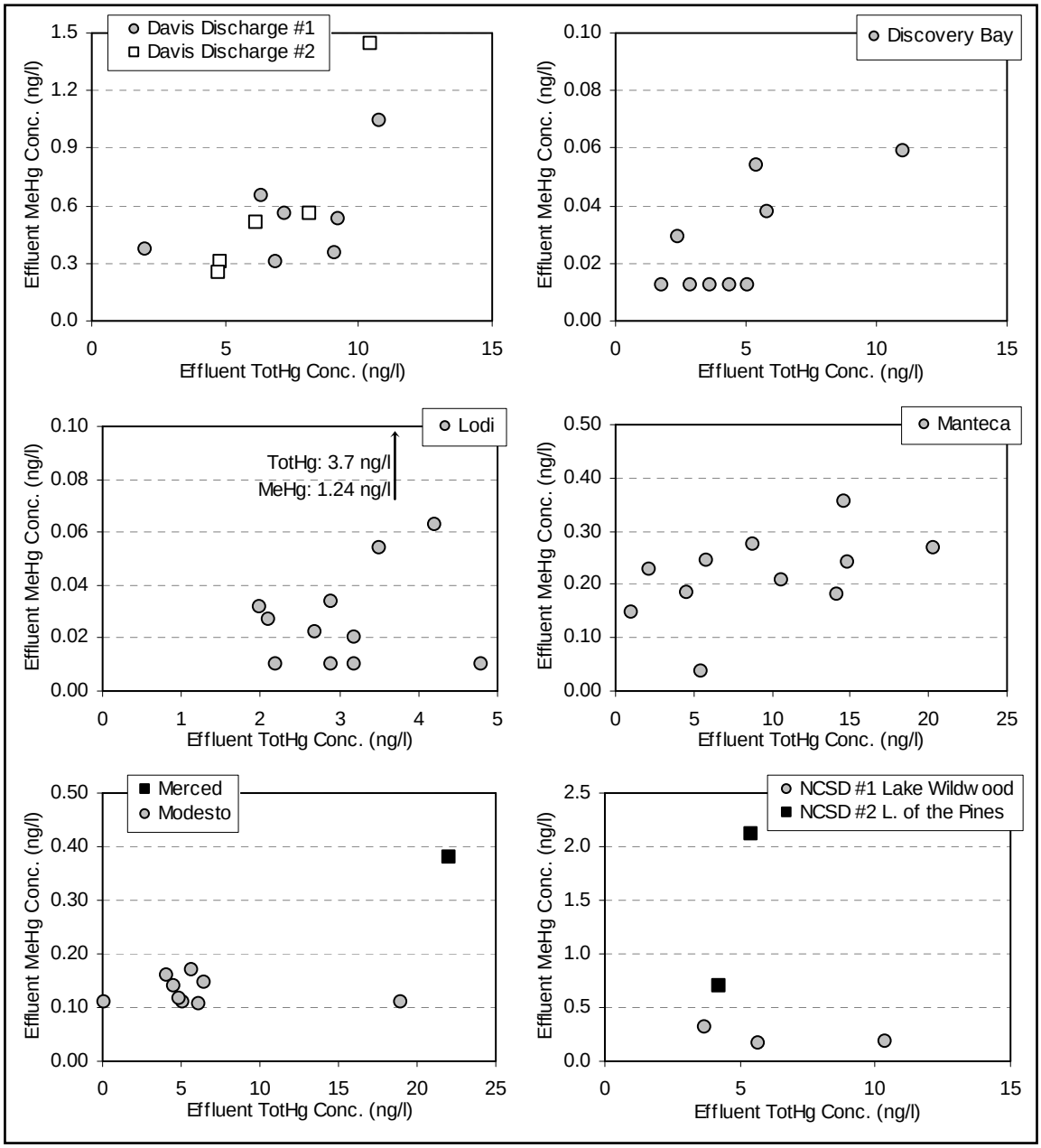

Figure 37a: Scatter-plots of Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for Each Municipal WWTP

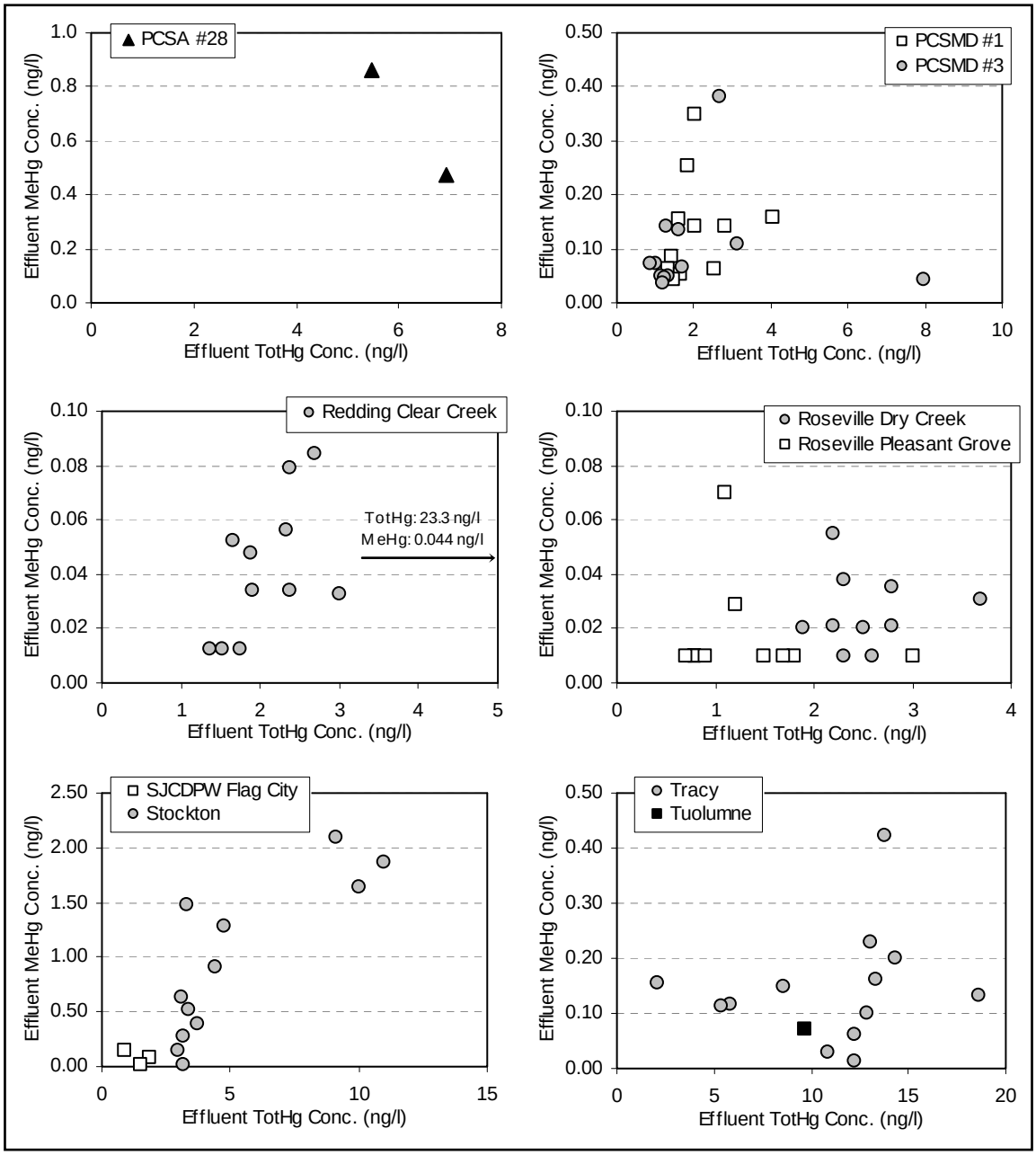

Figure 37b: Scatter-plots of Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for Each Municipal WWTP

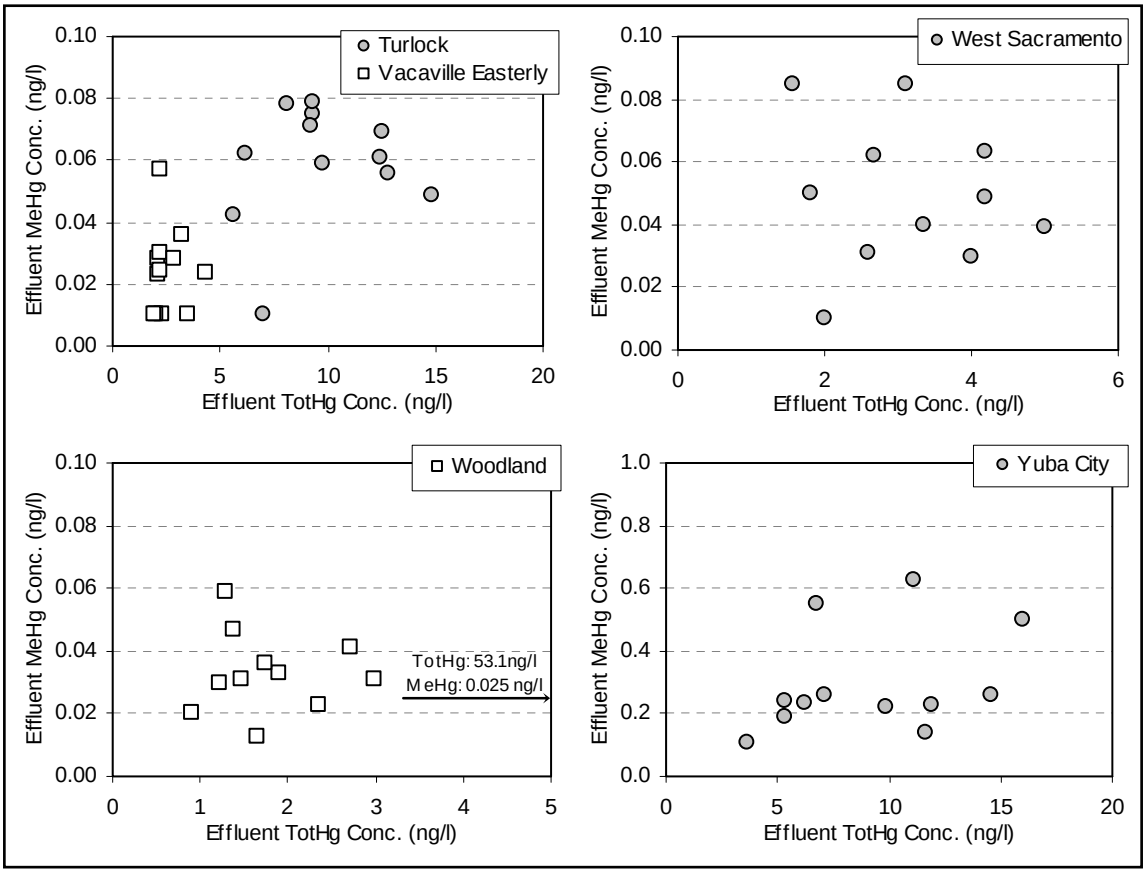

Figure 37c: Scatter-plots of Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for Each Municipal WWTP

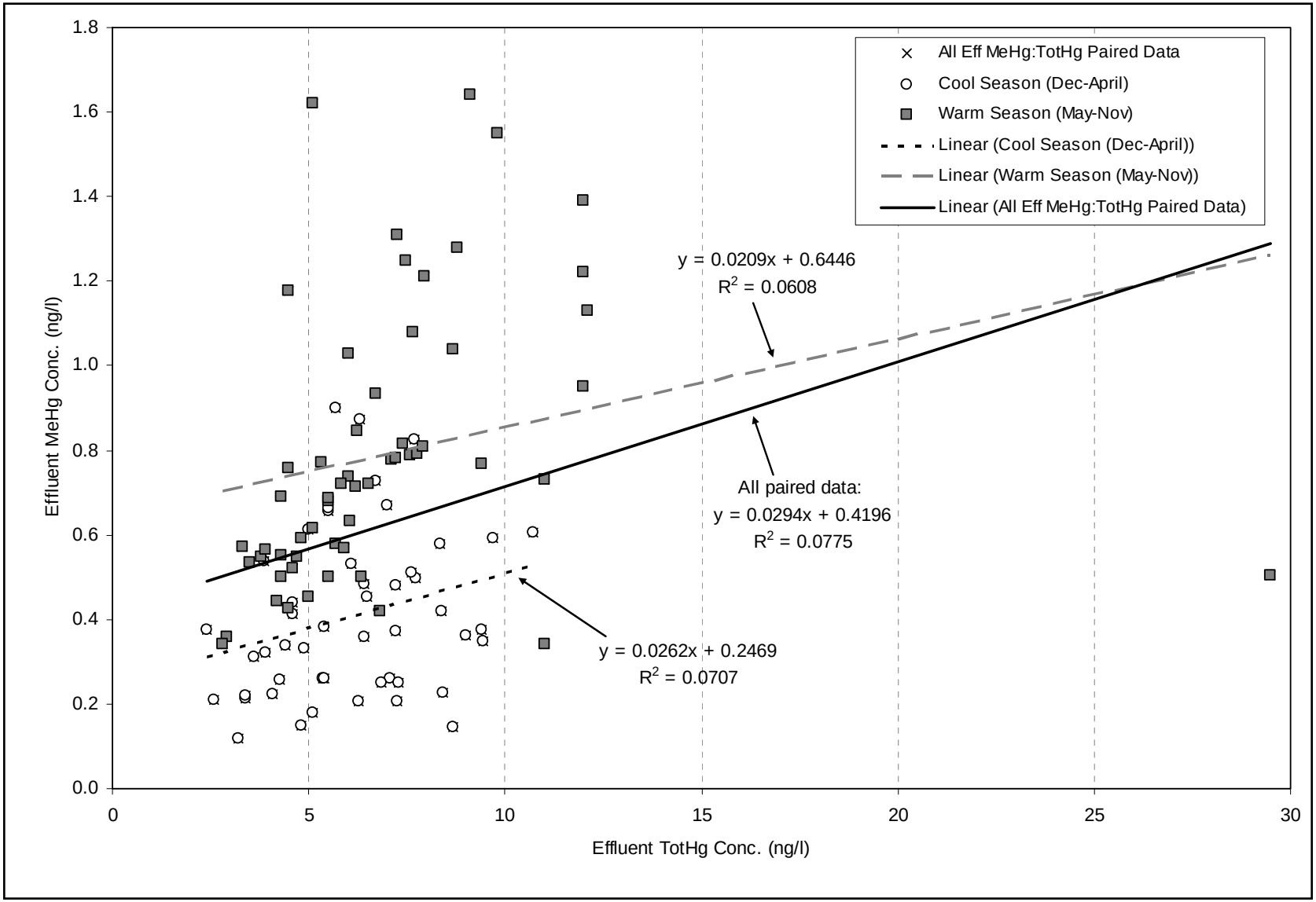

Figure 38: Scatter-plot of Effluent Inorganic Mercury versus Effluent Methylmercury Concentrations for the SRCSD Sacramento River WWTP

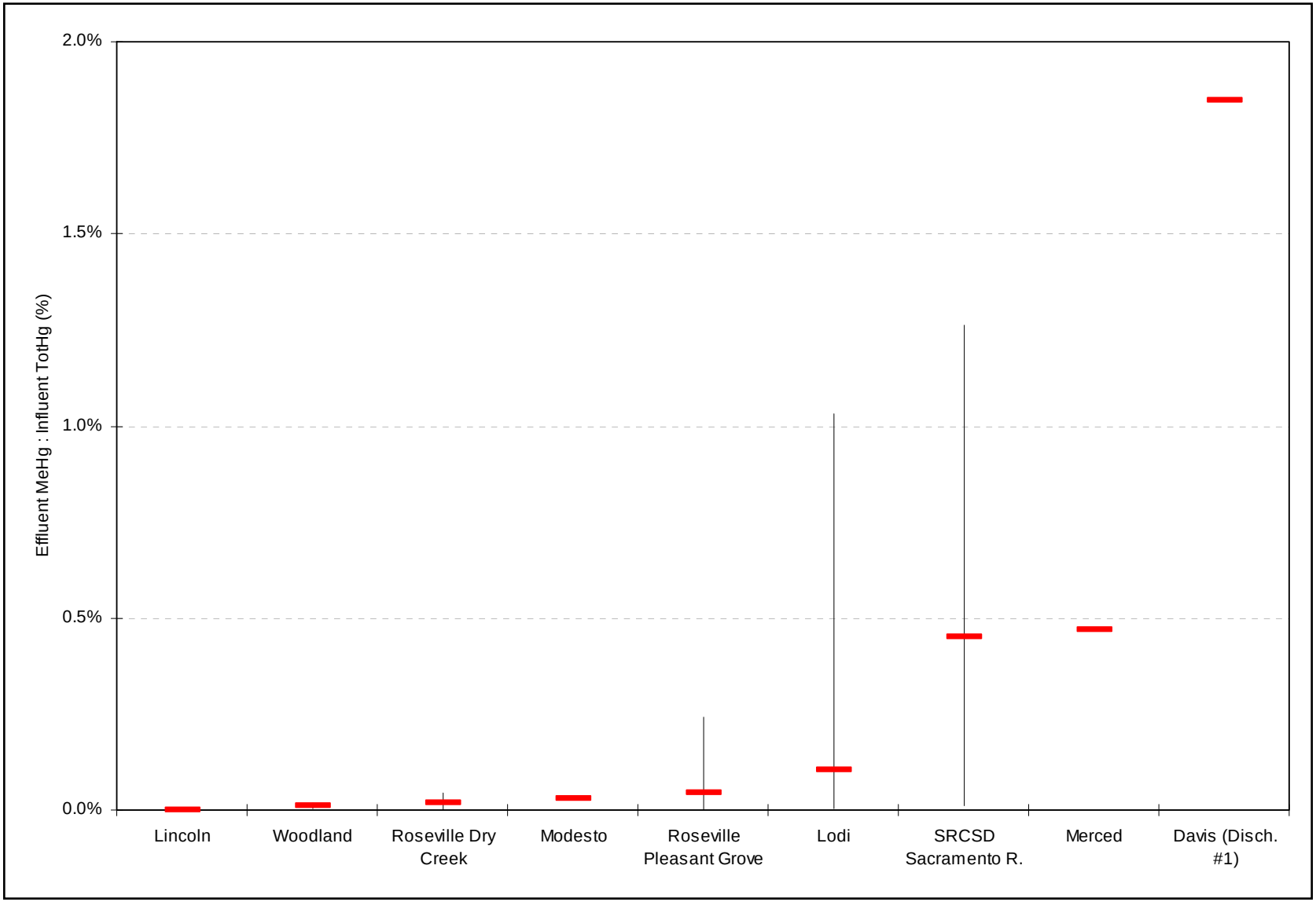

Figure 39: Average and Range of Effluent MeHg:Influent TotHg Concentration Ratios for Each Municipal WWTP

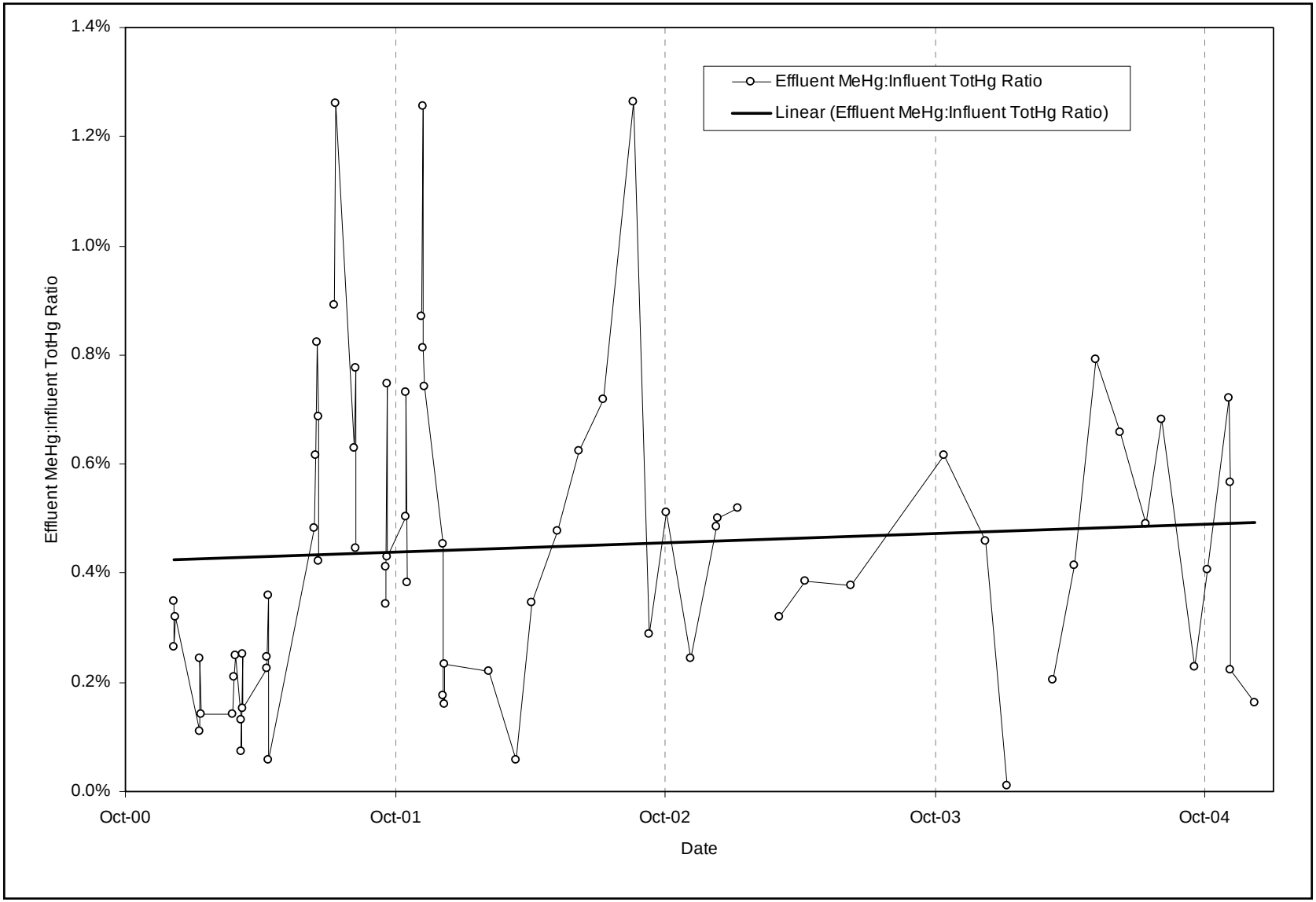

Figure 40: Time-series Graph of SRCSD Sacramento River WWTP Effluent MeHg:Influent TotHg Concentration Ratios

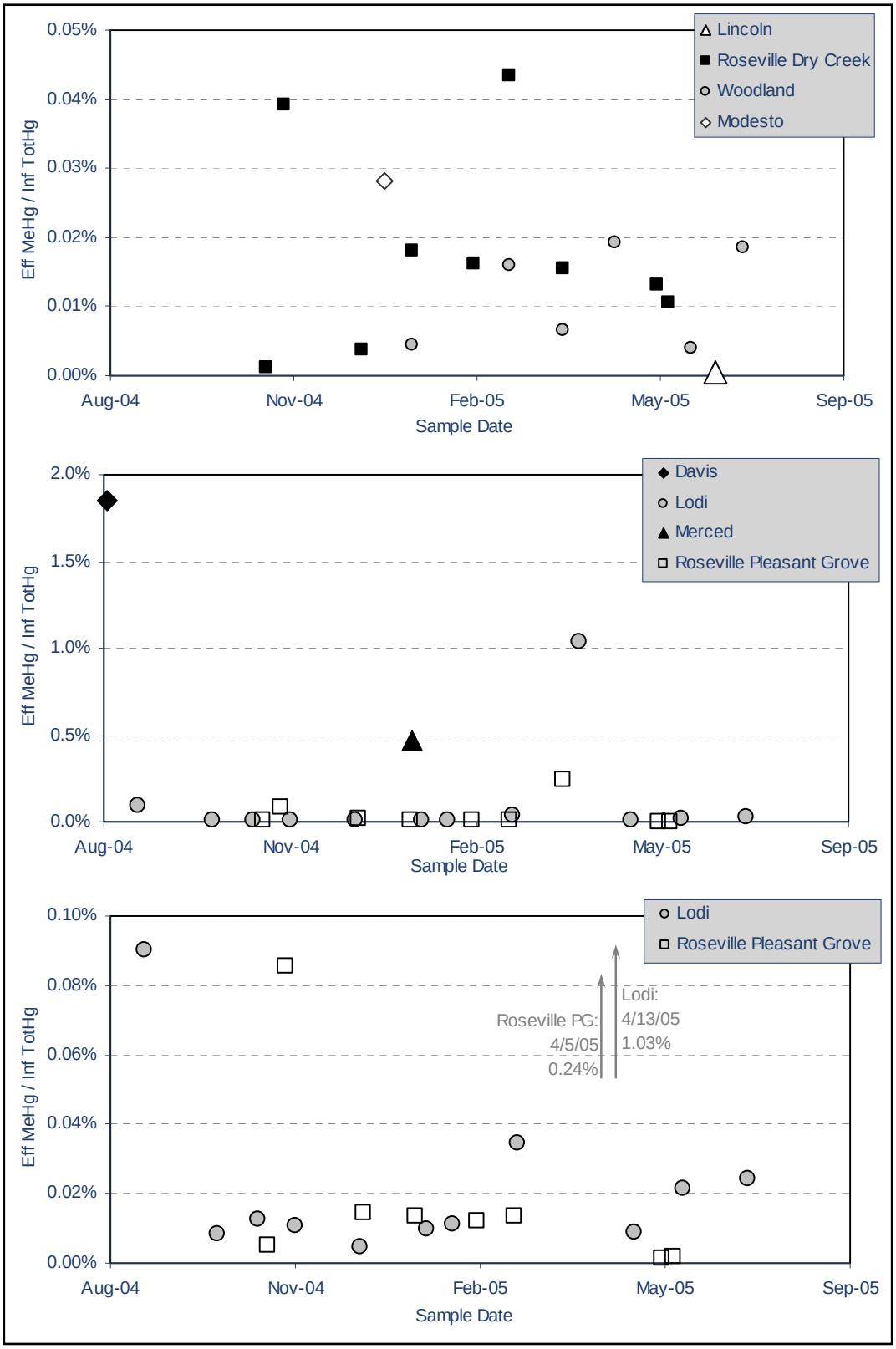

Figure 41: Time-series Graphs of Municipal WWTP Effluent MeHg:Influent TotHg Concentration Ratios

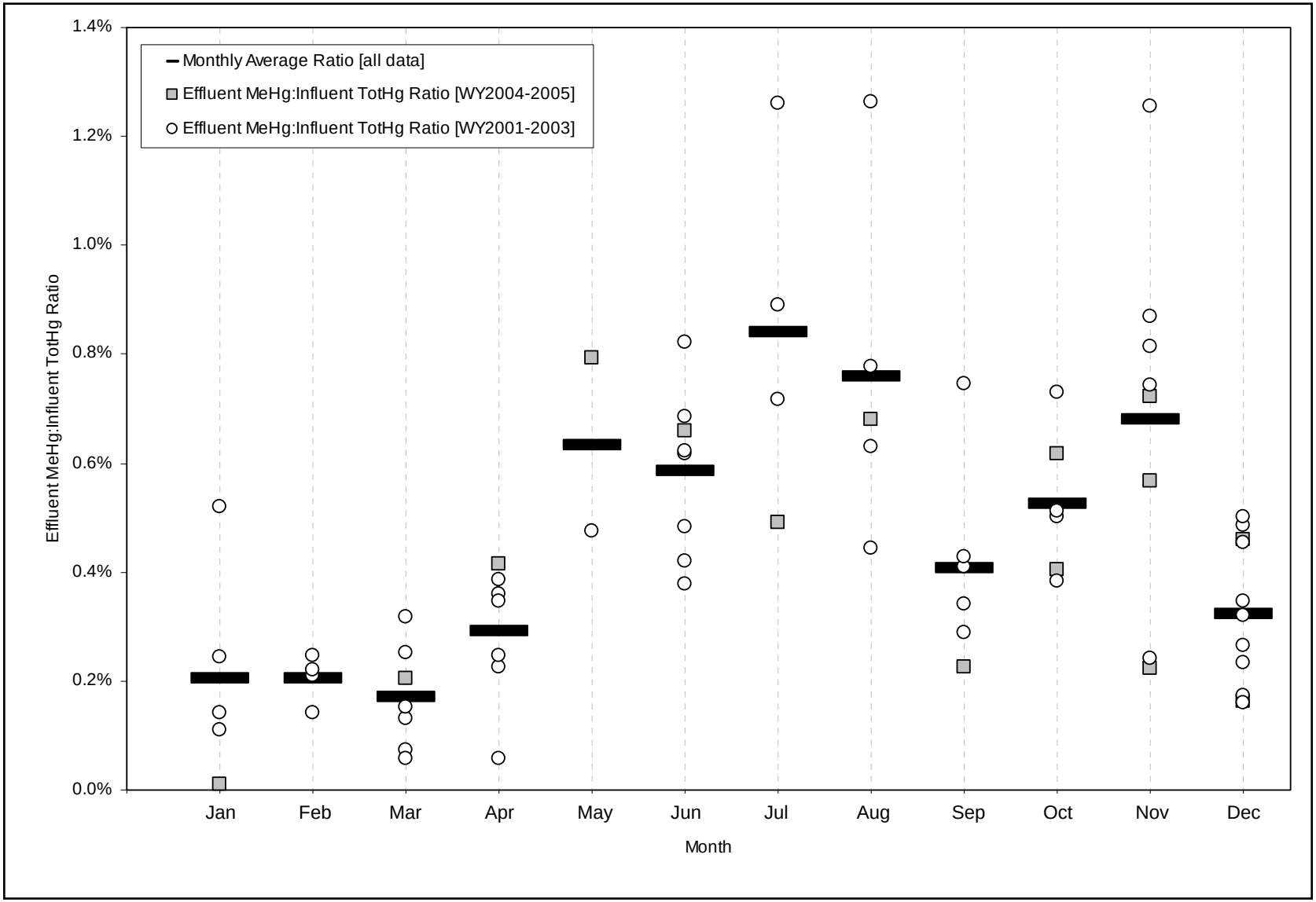

Figure 42: Monthly Effluent MeHg:Influent TotHg Concentration Ratios for the SRCSD Sacramento River WWTP from Dec. 2000 – Dec. 2004

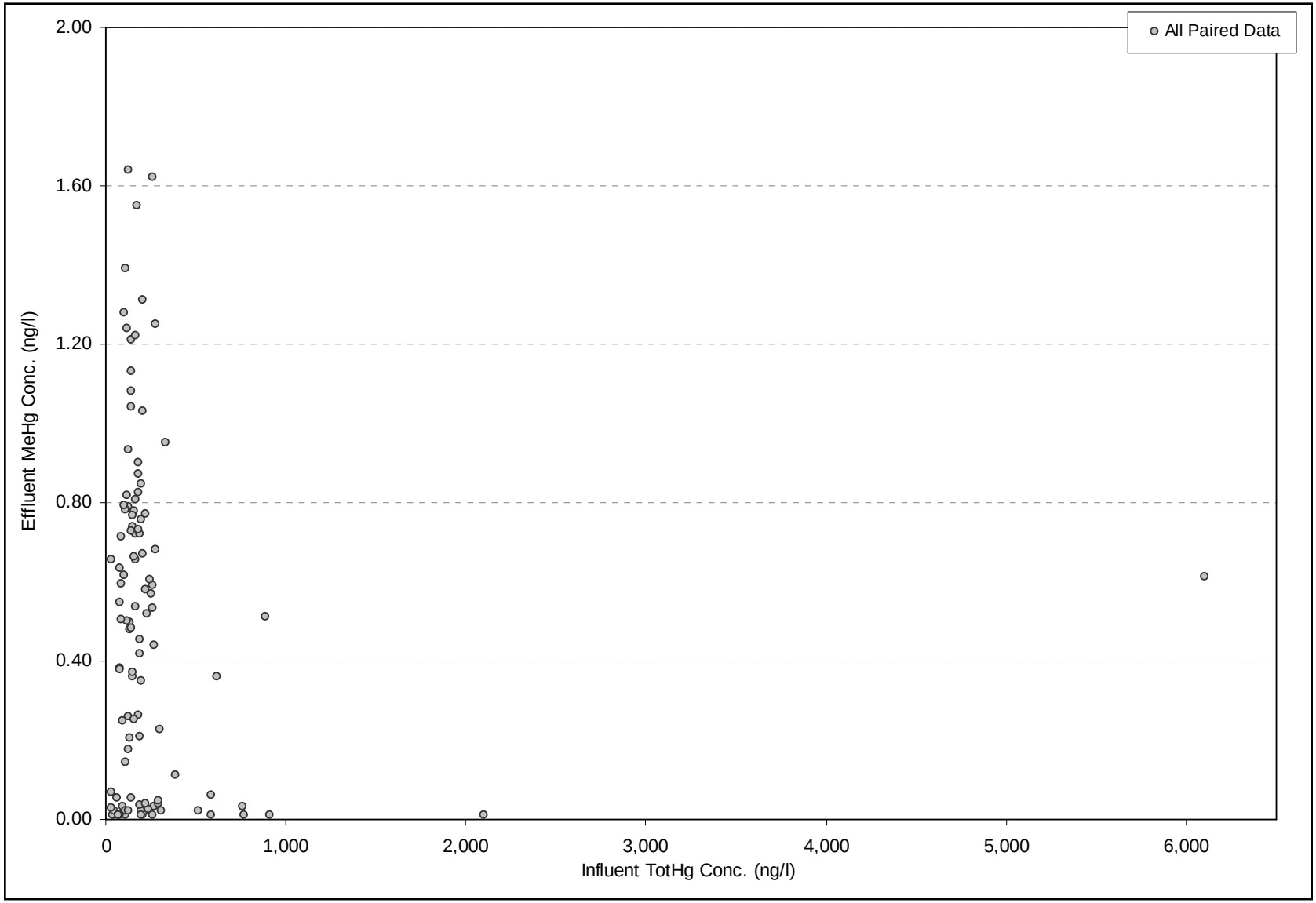

Figure 43a: Scatter-plot of Municipal WWTP Influent Inorganic Mercury versus Effluent Methylmercury Concentrations: All Paired Data [including SRCSD Sacramento WWTP data]

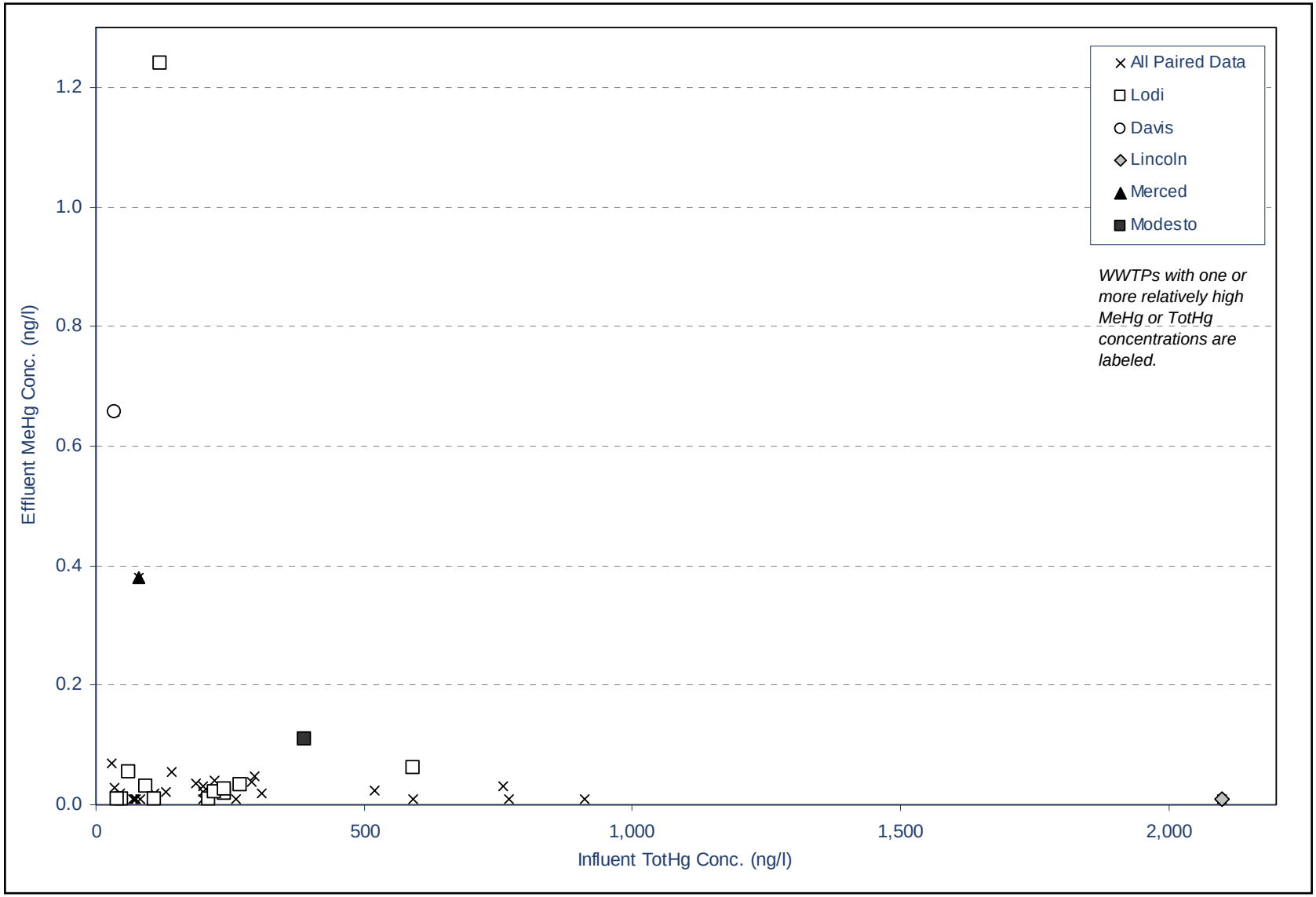

Figure 43b: Scatter-plot of Municipal WWTP Influent Inorganic Mercury versus Effluent Methylmercury Concentrations: All Paired Data [excluding SRCSD Sacramento WWTP data]

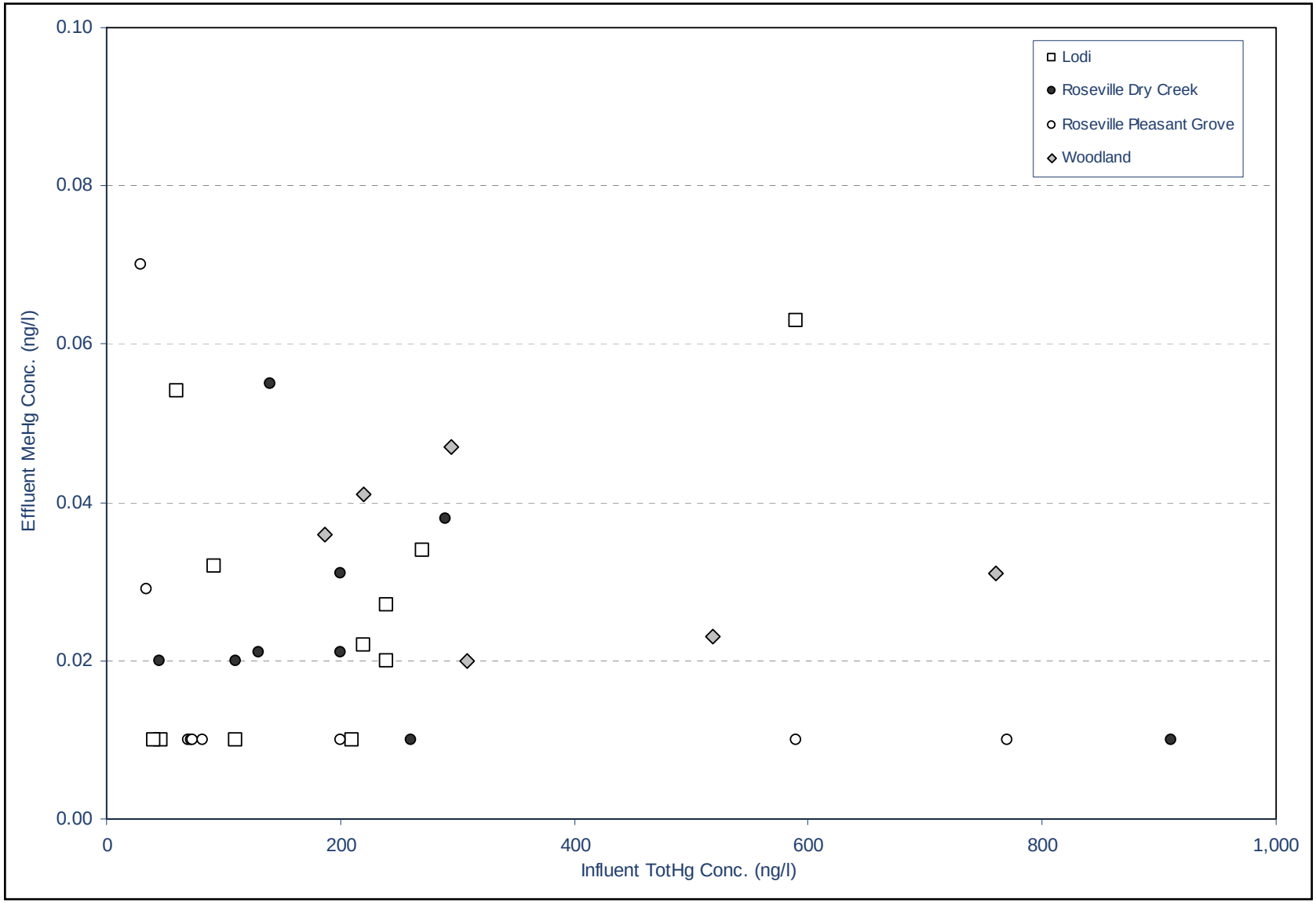

Figure 44: Scatter Plot of Municipal WWTP Influent Inorganic Mercury versus Effluent Methylmercury Concentrations: Zoomed to Show Typical Values

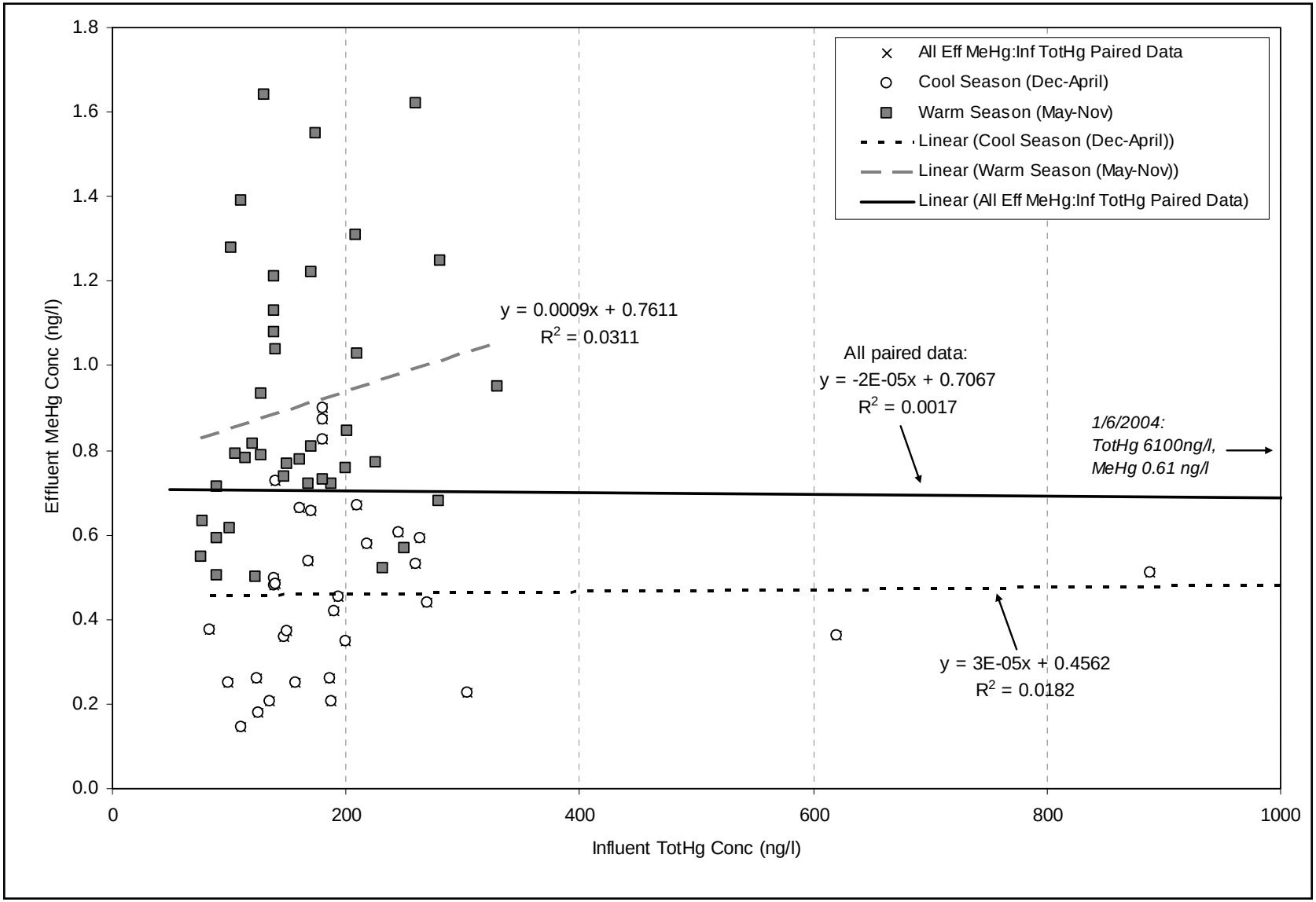

Figure 45a: Scatter-plot of Influent Inorganic Mercury versus Effluent Methylmercury Concentrations for the SRCSD Sacramento River WWTP

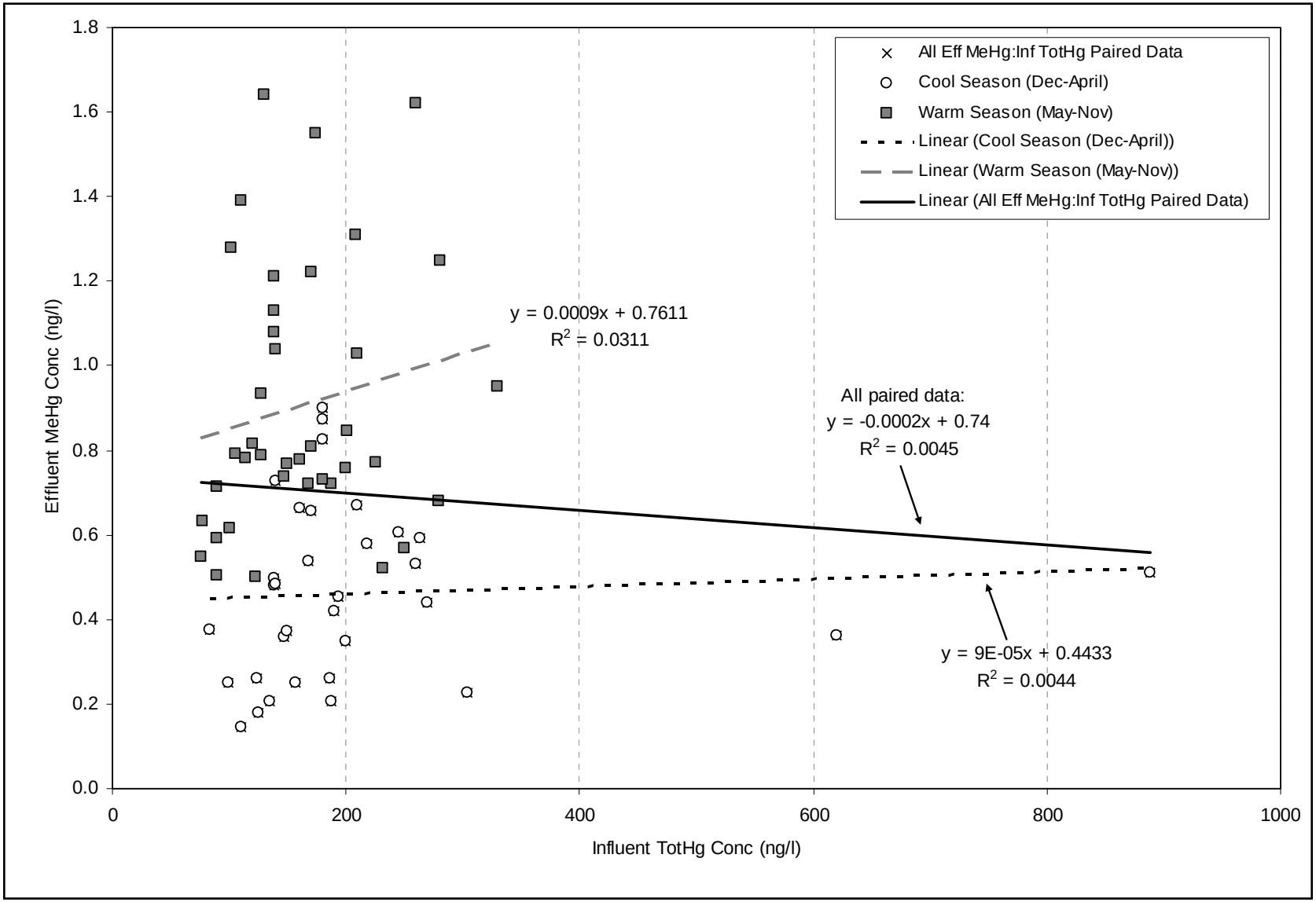

Figure 45b: Scatter-plot of Influent Inorganic Mercury versus Effluent Methylmercury Concentrations for the SRCSD Sacramento River WWTP (with the paired data that includes the anomalous value collected on 6 January 2004 removed)

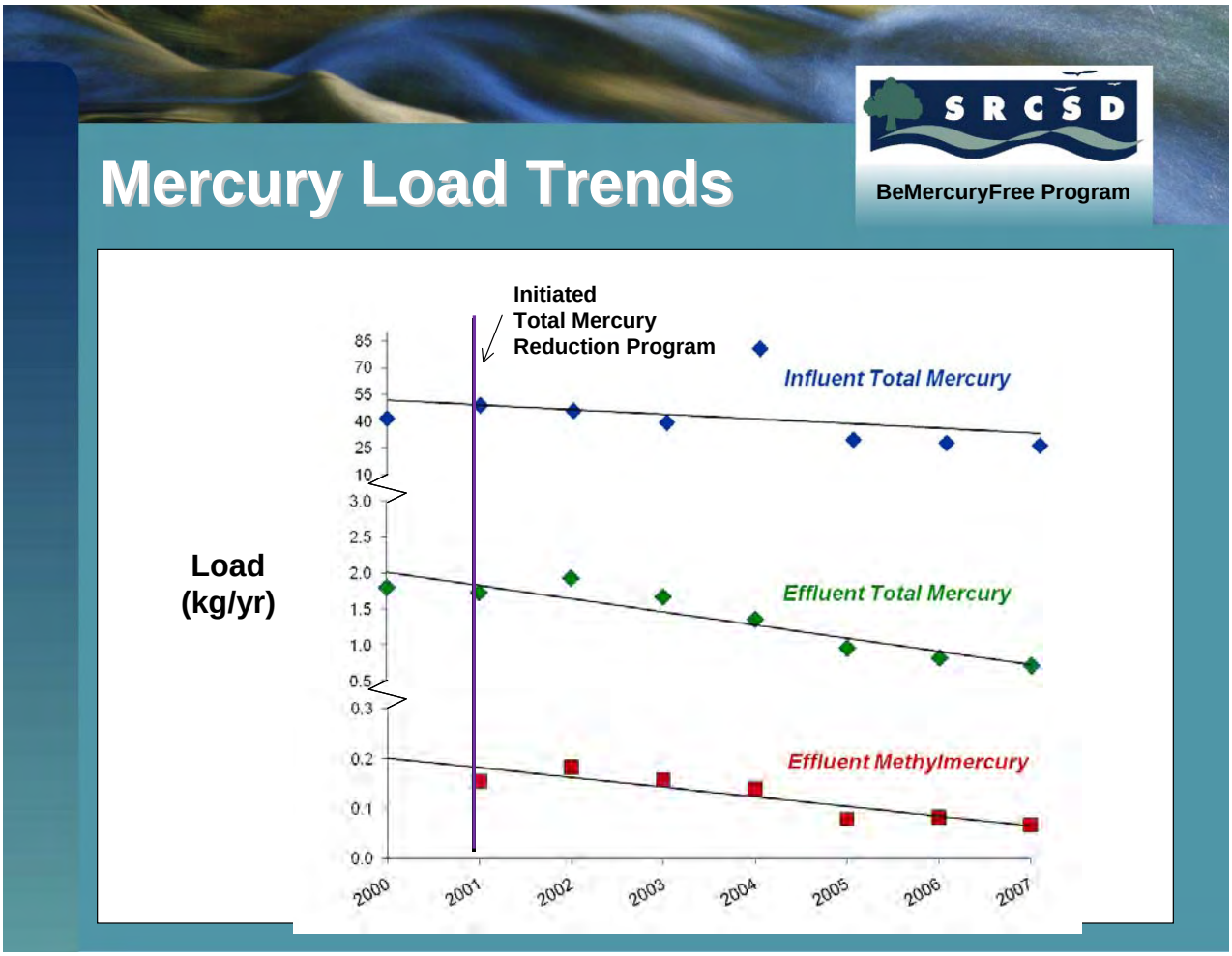

Figure 46: SRCSD Sacramento River WWTP Influent Inorganic Mercury and Effluent Inorganic Mercury and Methylmercury Loads

[Chart presented by the SRCSD District Engineer during testimony for the April 2008 Central Valley Water Board hearing for the Delta mercury control program.]

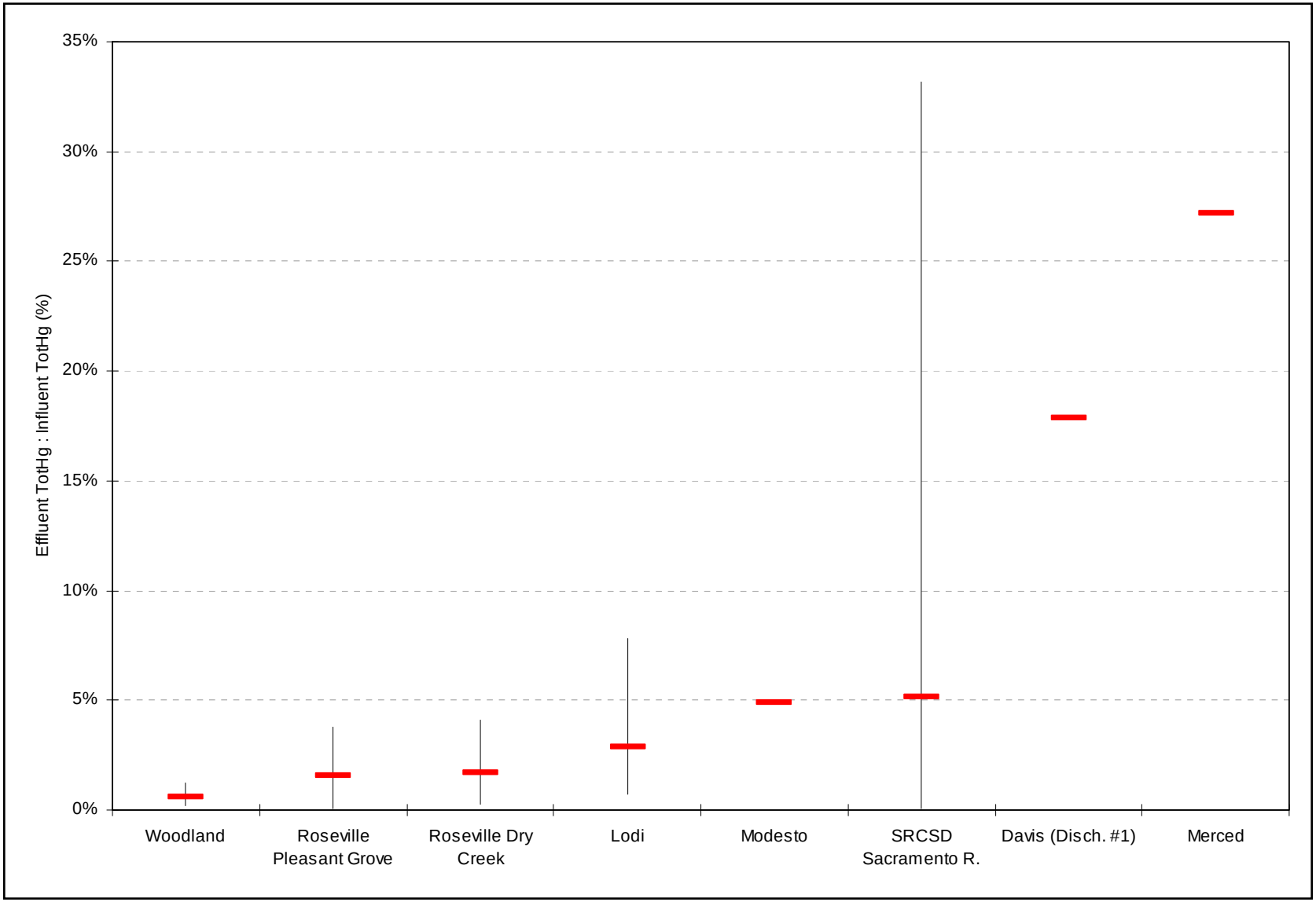

Figure 47: Average and Range of Effluent:Influent Inorganic Mercury Concentration Ratios for Each Municipal WWTP

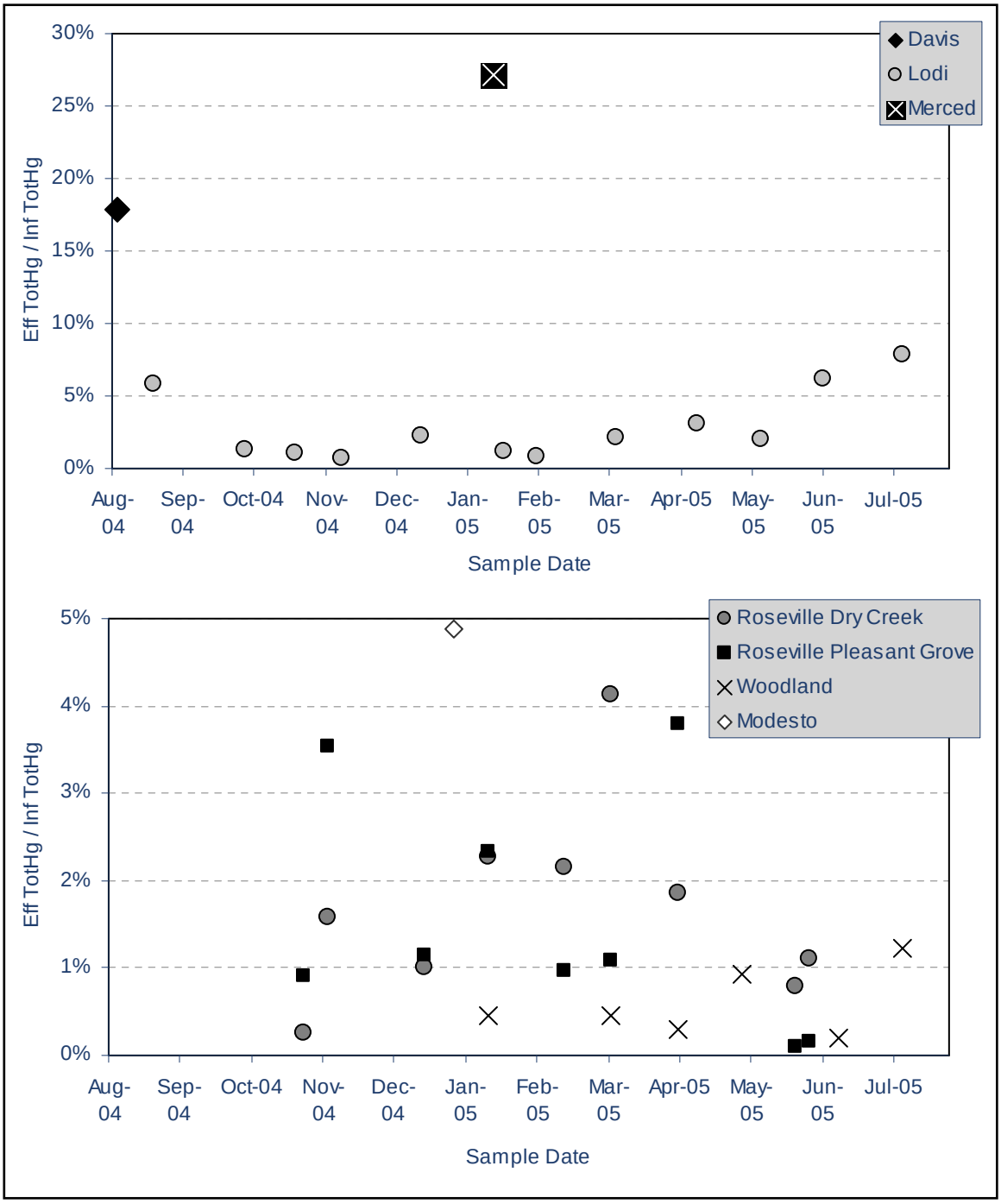

Figure 48: Time-series Graphs of Municipal WWTP Effluent:Influent Inorganic Mercury Concentration Ratios

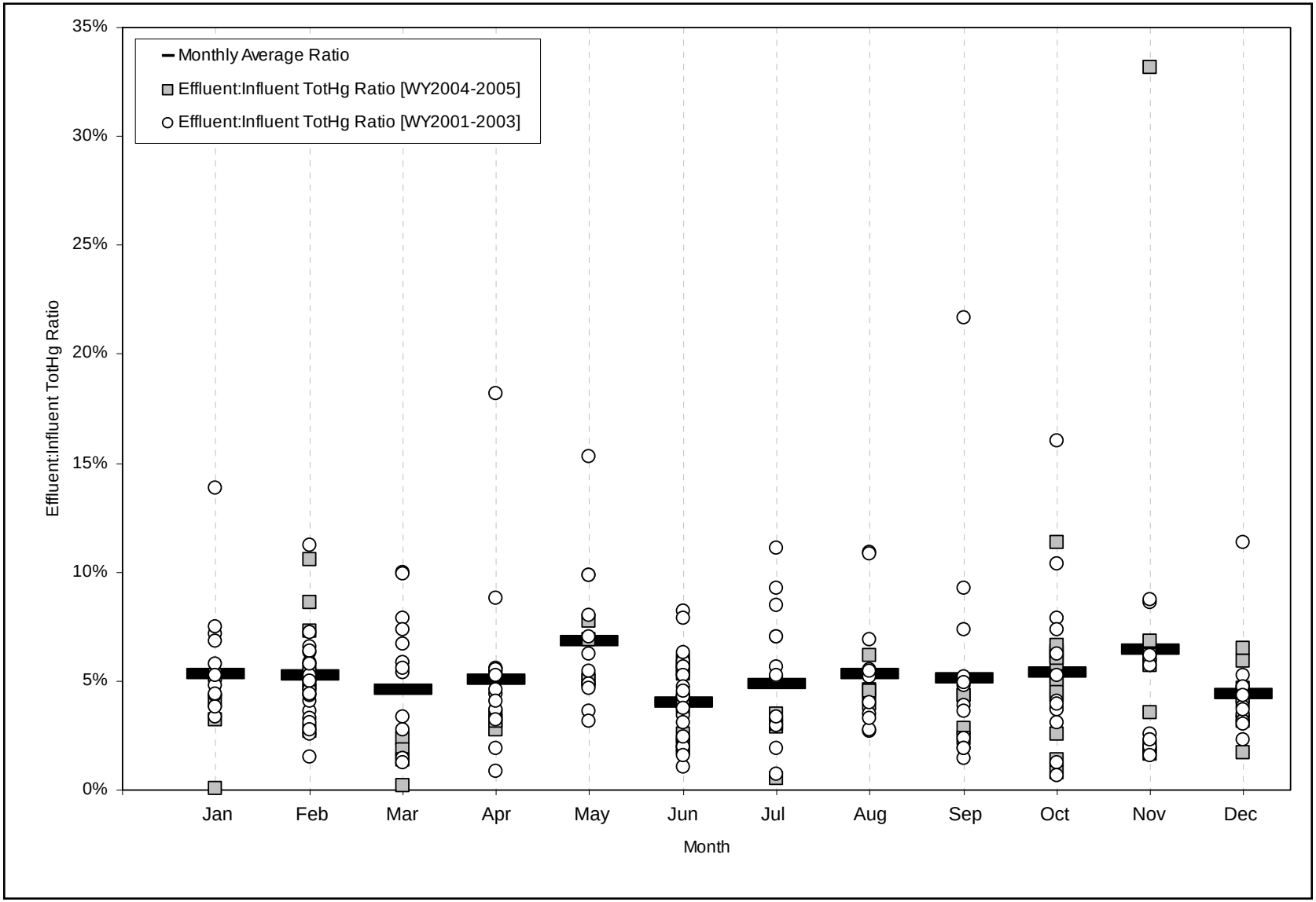

Figure 49: Monthly Effluent:Influent TotHg Concentration Ratios for the SRCSD Sacramento River WWTP from December 2000 – December 2004

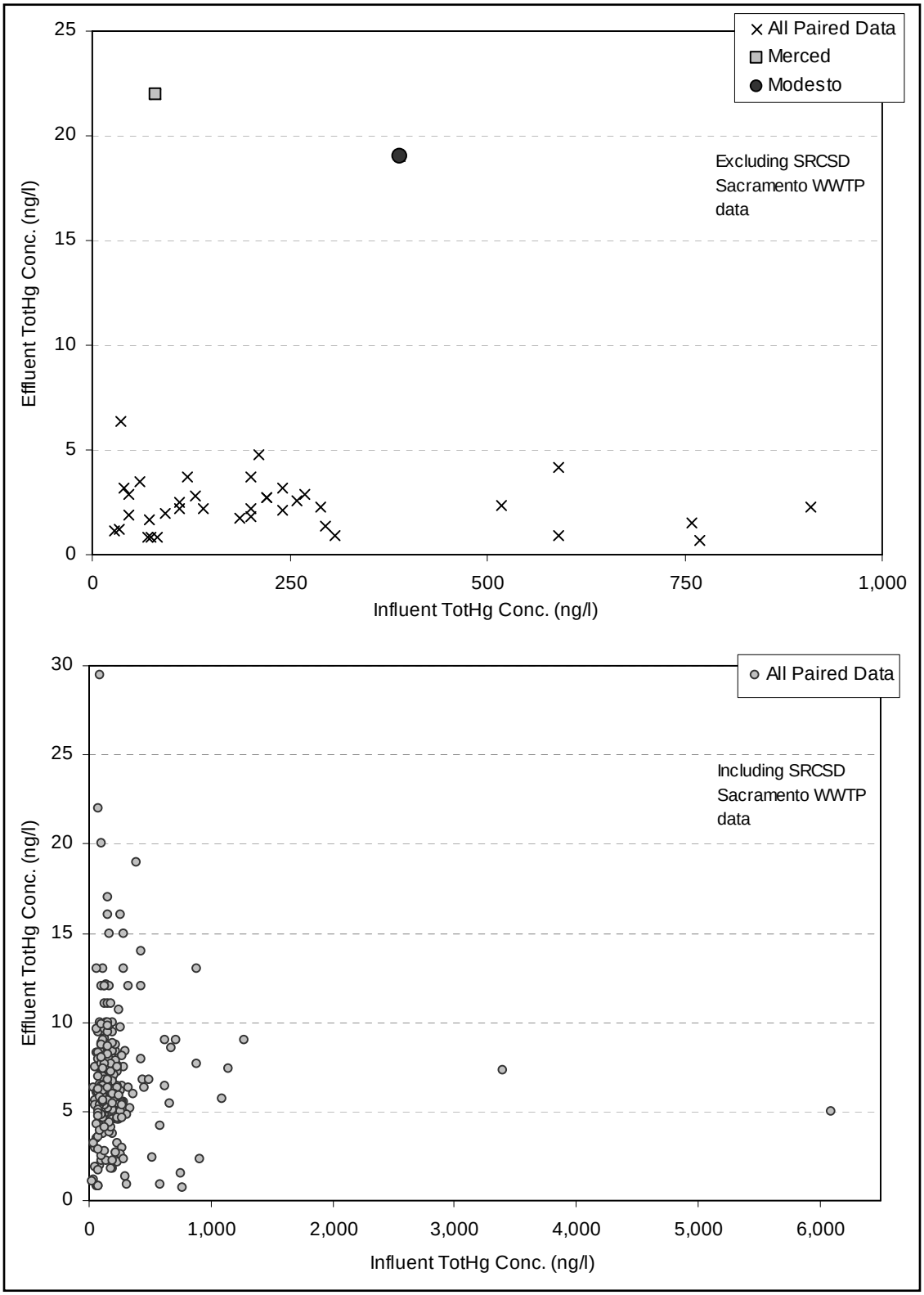

Figure 50: Scatter-plots of Municipal WWTP Influent Inorganic Mercury versus Effluent Inorganic Mercury Concentrations: All Paired Data

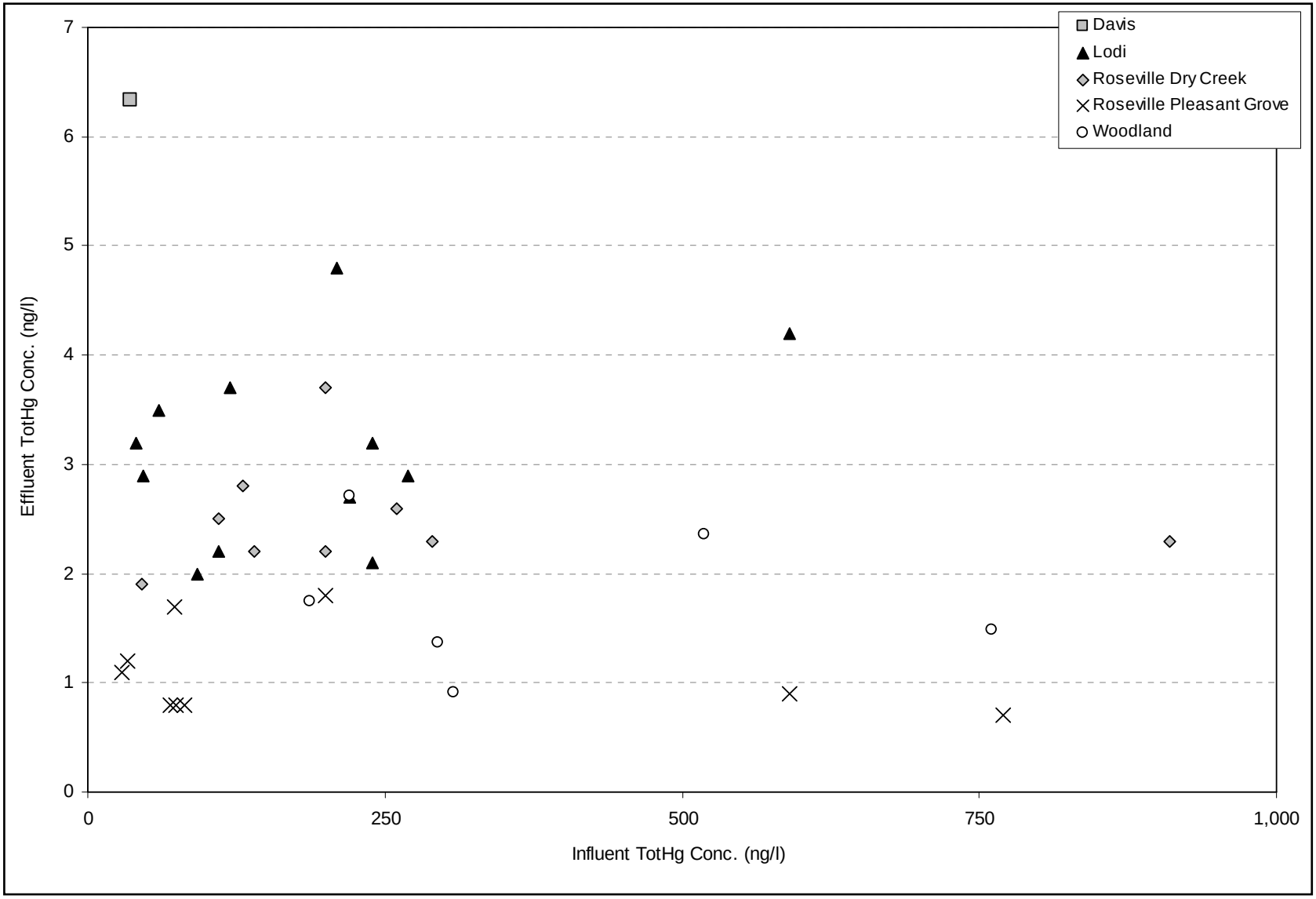

Figure 51: Scatter-plot of Municipal WWTP Influent Inorganic Mercury versus Effluent Inorganic Mercury Concentrations

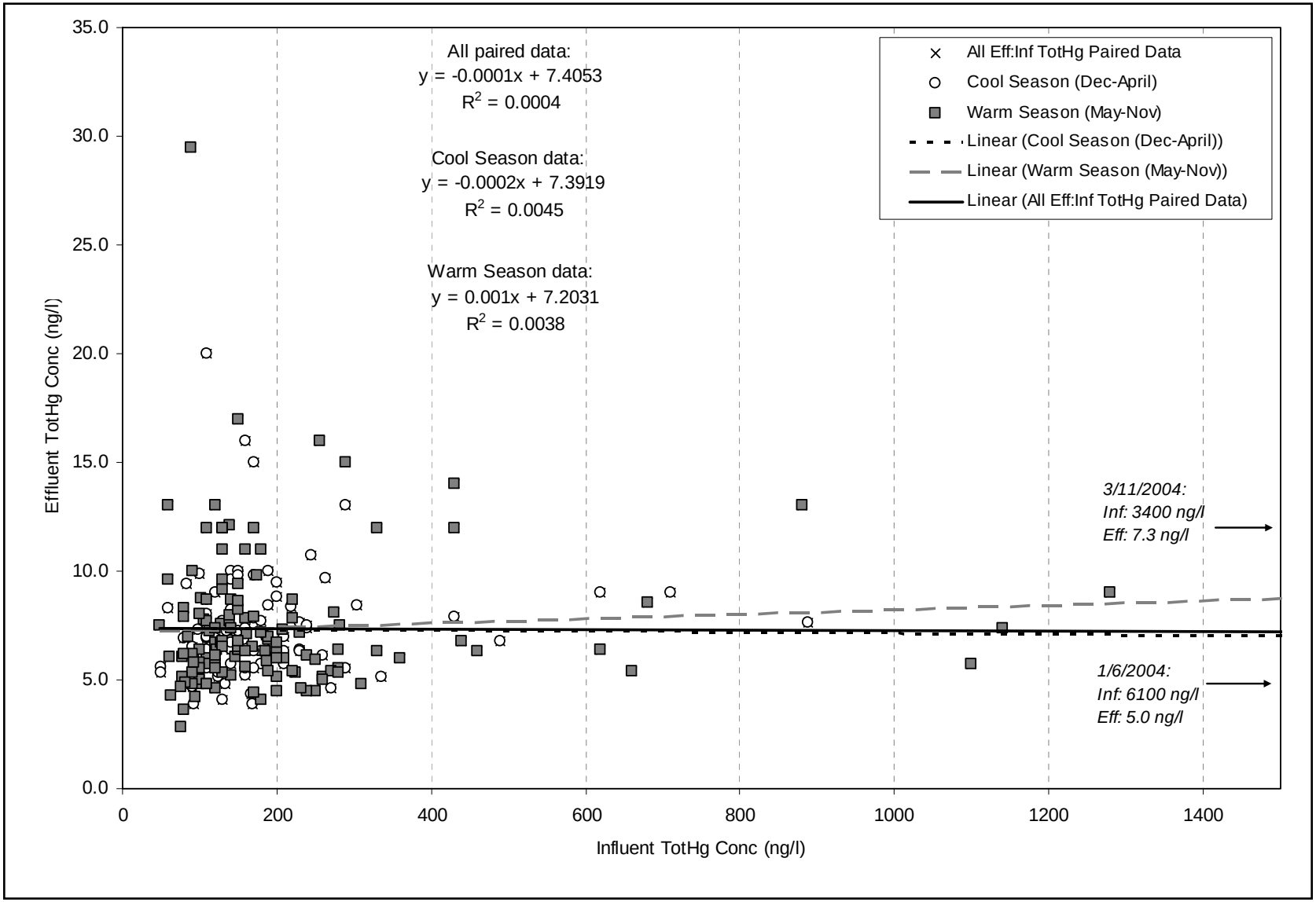

Figure 52: Scatter-plot of Influent Inorganic Mercury versus Effluent Inorganic Mercury Concentrations for the SRCSD Sacramento River WWTP

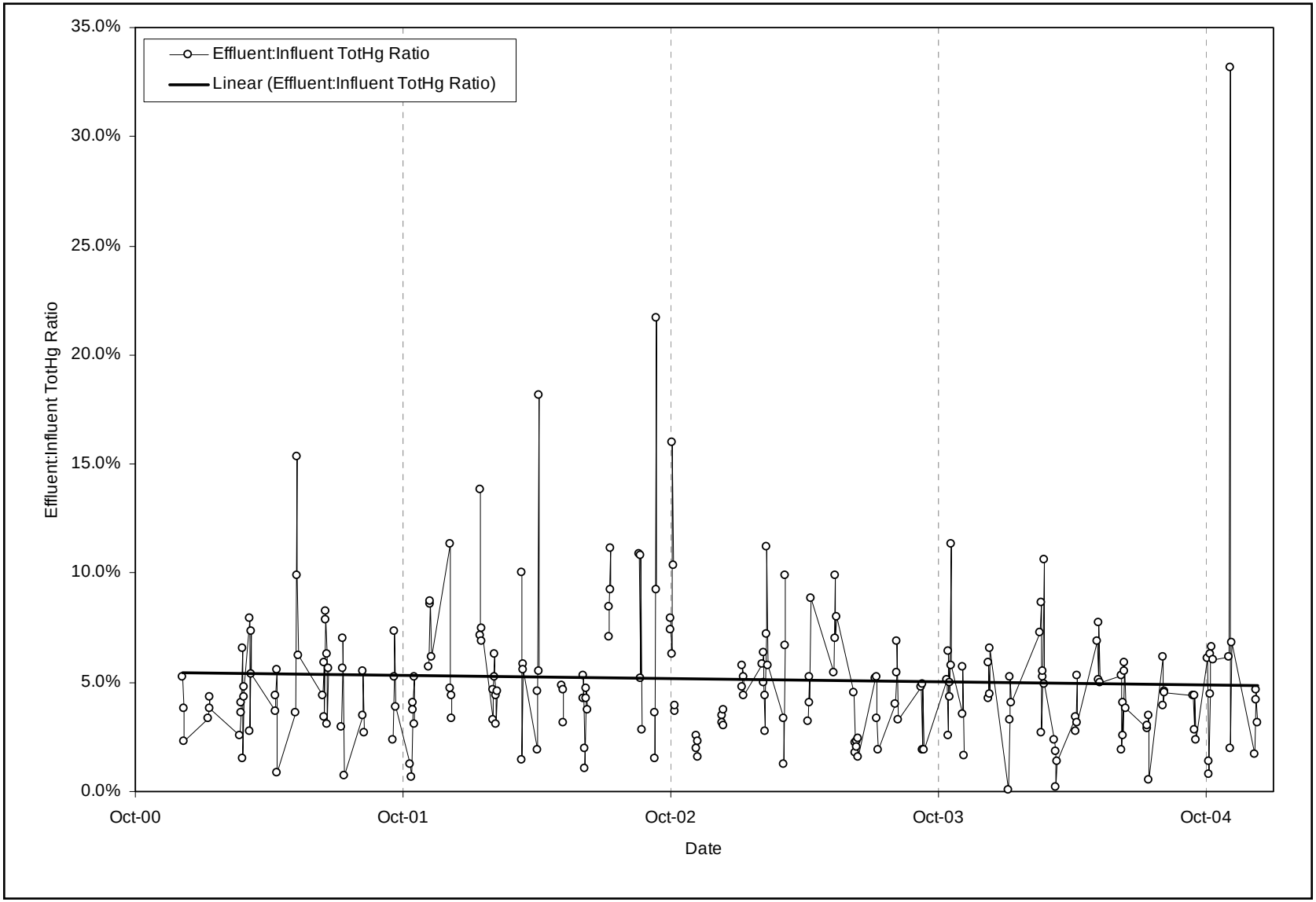

Figure 53: Time-series Graph of SRCSD Sacramento River WWTP Effluent:Influent Inorganic Mercury Concentration Ratios

APPENDIX A
EXAMPLE OF CALIFORNIA WATER CODE SECTION 13267 ORDER LETTER FOR EFFLUENT METHYLMERCURY MONITORING (4 PAGES) & DISCHARGERS TO WHICH A LETTER WAS SENT

California Regional Water Quality Control Board

Central Valley Region

Robert Schneider, Chair

Terry Tamminen
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

Sacramento Main Office
Internet Address: http://www.swrcb.ca.gov/rwqcb5
11020 Sun Center Drive #200 Rancho Cordova, CA 95670-6114
Phone (916) 464-3291

16 June 2004

CERTIFIED MAIL
«Certified_Mail» «Cert_2»

«MAIL_CONTACT»
«MAIL_NAME»
«MAIL_STREET»
«MAIL_CITY», «MAIL_STATE» «MAIL_ZIP»

ORDER FOR UNFILTERED METHYLMERCURY WASTE DISCHARGE DATA PURSUANT TO CALIFORNIA WATER CODE SECTION 13267 (*MONTHLY* SAMPLING) NPDES NO. «NPDES_NO»

Section 303(d) of the federal Clean Water Act requires States to list water bodies that do not meet water quality objectives to protect their beneficial uses and to develop and implement Total Maximum Daily Load (TMDL) control programs to eliminate the impairment of beneficial uses.

The Sacramento and San Joaquin Rivers and associated Delta Estuary were placed on the 303(d) list because of elevated methylmercury concentrations in fish. Recent data demonstrate a statistically significant correlation between methylmercury concentrations in water and fish, i.e., as concentrations of methylmercury increase in the water column, concentrations of methylmercury also increase in fish resident in that water column. The data thus suggest that the annual median methylmercury concentration of a water body is a major factor determining resident fish tissue methylmercury levels. The proposed TMDL goal to protect Delta beneficial uses is 0.05 nanograms per liter (ng/l) methylmercury in water.

Limited methylmercury effluent data are available for local NPDES facilities. A recent survey by the Regional Board found considerable variability between facilities and demonstrated that some plants were discharging methylmercury above the proposed TMDL goal. Table 1 summarizes data collected by the Regional Board in February and March of 2004 as well as data collected by the Sacramento Regional County Sanitation District from a year-long study in 2001.

Section 13267 of the California Water Code states in part that a regional board may investigate the quality of waters within its region, and in doing so may require dischargers to furnish technical or monitoring reports which the regional board requires. The burden, including costs, of these reports must bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports.

The monitoring reports required by this letter are necessary to determine the extent to which NPDES facilities are contributing methylmercury in concentrations that impair beneficial uses of receiving waters. Preliminary load calculations using the information shown in Table 1 estimate that POTWs discharge significant portions of the total methylmercury loading to the Delta. Accurate discharge information will be required from treatment facilities to complete the TMDL.

Table 1. Summary of unfiltered methylmercury concentrations in effluent from POTW's located in the Central Valley of California.

Facility	# of Sampling Events	Mean Concentration (ng/l)	Range (ng/l)
Sacramento Regional County Sanitation District	45	0.73	0.14-2.93
Stockton STP	2	0.34	0.13-0.59
Vacaville Easterly STP	2	0.10	0.09-0.11
West Sacramento STP	2	0.04	0.03-0.05
City of Roseville	2	0.01	0.01-0.01

Therefore pursuant to Section 13267 of the California Water Code, you are required to submit effluent methylmercury monitoring data for your facility. In most cases, this monitoring will be in addition to monitoring required in your NPDES Permit.

Instantaneous grab samples shall be collected monthly for one year (August 2004-July 2005) from the facility's effluent. Intermittent or seasonal dischargers shall collect monthly samples during those months for which a discharge occurs. The samples must be collected downstream from the last connection through which wastes can be admitted into the outfall, and shall be representative of the quality of the discharge from the treatment plant. Unfiltered methylmercury samples shall be taken using clean hands/dirty hands procedures[1] and shall be analyzed by U.S. EPA method 1630/1631 (Revision E) with a method detection limit of 0.02 ng/l. A matrix spike/matrix spike duplicate shall also be analyzed with either the first or second set of samples to insure an acceptable methylmercury recovery rate in your effluent. A travel-blank must also be collected and analyzed with every other set of samples. Any other methylmercury monitoring data collected by your plant during the above period shall also be reported to the Regional Board. If your facility is currently collecting total mercury data, methylmercury samples should be collected concurrently. A partial list of laboratories performing U.S. EPA method 1630/1631 is attached as Table 2.

While not required by this letter, we are also recommending that instantaneous grab samples be collected from the facility's upstream receiving water and the main influent to determine the methylmercury treatment efficiency of your facility.

Please submit quarterly reports summarizing the monitoring results to the Regional Board. The reports are due by 31 October 2004, 31 January 2005, 30 April 2005, and 31 July 2005. Your cooperation with this special discharge monitoring requirement is sincerely appreciated. However, we must advise that failure or refusal to comply with this request as required by Section 13267 of the California Water Code or falsifying any information provided may be subject to an administrative civil liability of up to $1,000 per day of violation in accordance with Section 13268.

[1] Described in U.S. EPA method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels for collection of equipment blanks (section 9.4.4.2)

Please contact your regular Regional Board staff representative if you have any questions regarding this order.

THOMAS R. PINKOS
Executive Officer

Attachment

Table 2. List of Analytical Laboratories Measuring Methylmercury by U.S. EPA Method 1630/1631

Presence on the list does not constitute endorsement by the Regional Board.

Facility	Contact	Phone
Battelle Marine Science Laboratory 1529 West Sequim Bay Road Sequim, WA 98382	Brenda Lasorsa	360-681-3650
Frontier GeoSciences 414 Pontius Ave N Seattle WA 98109 http://www.frontiergeosciences.com	Michelle Gauthier	206-622-6960
Brook-Rand Trace Metal Analysis and Products 3958 6th Ave N.W. Seattle WA 98107 http://www.brooksrand.com	Colin Davis	206-632-6206

Table A.1: NPDES-Permitted Facilities Required to Conduct Effluent Methylmercury Monitoring under California Water Code Section 13267.

AGENCY NAME	FACILITY NAME	NPDES NO	MONITORING FREQUENCY [a]
AEROJET GENERAL CORPORATION	INTERIM GROUNDWATER WTP	CA0083861	B
AEROJET GENERAL CORPORATION	SACRAMENTO FACILITY	CA0004111	B
AFB CONVERSION AGENCY	A C & W - GROUNDWATER TREATMENT	CA0083992	Q
ANDERSON, CITY OF	ANDERSON WWTP	CA0077704	M
ATWATER, CITY OF	ATWATER WWTP	CA0079197	M
AUBURN, CITY OF	AUBURN WWTP	CA0077712	M
BELL CARTER OLIVE COMPANY INC	BELL CARTER INDUSTRIAL WWTP	CA0083721	Q
BELL CARTER OLIVE COMPANY INC	PLANT 1	CA0081639	B
BELLA VISTA WD	BELLA VISTA WTP	CA0080799	B
BIGGS, CITY OF	BIGGS WWTP	CA0078930	Q
BRENTWOOD, CITY OF	BRENTWOOD WWTP	CA0082660	M
BROWN SAND, INC.	MANTECA AGGREGATE SAND PLANT [b]	CA0082783	Q
CA DEPT OF FISH & GAME	DARRAH SPRINGS HATCHERY	CA0004561	Q
CA DEPT OF FISH & GAME	FEATHER RIVER HATCHERY	CA0004570	Q
CA DEPT OF FISH & GAME	MERCED RIVER FISH HATCHERY	CA0080055	Q
CA DEPT OF FISH & GAME	MOCCASIN FISH HATCHERY	CA0004804	Q
CA DEPT OF FISH & GAME	MOKELUMNE RIVER FISH HATCHERY	CA0004791	Q
CA DEPT OF FISH & GAME	NIMBUS HATCHERY	CA0004774	Q
CA DEPT OF FISH & GAME	SAN JOAQUIN FISH HATCHERY	CA0004812	Q
CA DEPT OF FISH & GAME	THERMALITO ANNEX HATCHERY	CA0082350	Q
CA DEPT OF GENERAL SERVICES	STATE PRINTING & WAREHOUSES	CA0078875	Q
CA (STATE OF) CENTRAL PLANT	CENTRAL HEATING/COOLING FAC	CA0078581	Q
CALAVERAS TROUT FARM, INC	TROUT REARING FACILITY	CA0081752	Q
CALIF AMMONIA COMPANY	CALAMCO - STOCKTON TERMINAL	CA0083968	Q
CALIFORNIA DAIRIES, INC	LOS BANOS FOODS, INC	CA0082082	Q
CALPINE CORPORATION	GREENLEAF UNIT ONE COGEN PLANT	CA0081566	Q
CANADA COVE L.P.	FRENCH CAMP GOLF & RV PARK WWTP	CA0083682	Q
CHICO, CITY OF	CHICO REGIONAL WWTP	CA0079081	M
CLEAR CREEK CSD	CLEAR CREEK WTP	CA0083828	B
COLFAX, CITY OF	COLFAX WWTP	CA0079529	Q
COLUSA, CITY OF	COLUSA WWTP	CA0078999	Q
CORNING, CITY OF	CORNING INDUST/DOMESTIC WWTP	CA0004995	Q
CRYSTAL CREEK AGGREGATE INC	CRYSTAL CREEK AGGREGATE	CA0082767	B
DAVIS, CITY OF	CITY OF DAVIS WWTP	CA0079049	M
DEFENSE LOGISTICS AGENCY, ASCW	DDJC, SHARPE - GW CLEANUP	CA0081931	Q
DEUEL VOCATIONAL INSTITUTE	DEUEL VOCATNL INST. WWTP	CA0078093	Q
DISCOVERY BAY CSD	DISCOVERY BAY WWTP	CA0078590	M
DONNER SUMMIT PUBLIC UTILITY	DONNER SUMMIT WWTP	CA0081621	Q
EAST BAY MUD	CAMANCHE DAM POWER HOUSE	CA0082040	Q

Table A.1: NPDES-Permitted Facilities Required to Conduct Effluent Methylmercury Monitoring under California Water Code Section 13267.

AGENCY NAME	FACILITY NAME	NPDES NO	MONITORING FREQUENCY [(a)]
EL DORADO ID	DEER CREEK WWTP	CA0078662	M
EL DORADO ID	EL DORADO HILLS WWTP	CA0078671	M
FORMICA CORPORATION	SIERRA PLANT	CA0004057	Q
GALT, CITY OF	GALT SD WWTP	CA0081434	M
GAYLORD CONTAINER CORPORATION	ANTIOCH PULP & PAPER MILL	CA0004847	M
GENERAL ELECTRIC CO	GWCS	CA0081833	Q
GRASS VALLEY, CITY OF	GRASS VALLEY WWTP	CA0079898	M
GWF POWER SYSTEMS, INC.	GWF POWER SYSTEMS, SITE IV	CA0082309	Q
HERSHEY FOODS CORP	HERSHEY CHOCOLATE USA, OAKDALE	CA0004146	Q
JACKSON, CITY OF	CITY OF JACKSON WWTP	CA0079391	Q
LEHIGH SOUTHWEST CEMENT CO	LEHIGH SOUTHWEST CEMENT CO	CA0081191	B
LINCOLN, CITY OF	CITY OF LINCOLN WWTP	CA0084476	M
LINDA CO WATER DISTRICT	LINDA CO WTR DIST WWTP	CA0079651	Q
LIVE OAK, CITY OF	CITY OF LIVE OAK WWTP	CA0079022	Q
LODI, CITY OF	WHITE SLOUGH WWTP	CA0079243	M
MANTECA, CITY OF	MANTECA WWTP	CA0081558	M
MARIPOSA PUD	MARIPOSA WWTP	CA0079430	Q
MAXWELL P.U.D.	MAXWELL PUD WWTP	CA0079987	Q
MERCED, CITY OF	MERCED WWTP	CA0079219	M
MIRANT DELTA LLC	CONTRA COSTA POWER PLT ANTIOCH	CA0004863	M
MODESTO ID	MODESTO ID REGIONAL WTP	CA0083801	Q
MODESTO, CITY OF	GRAYSON PARK WELL NO.295	CA0083054	Q
MODESTO, CITY OF	MODESTO WWTP	CA0079103	M
MOUNTAIN HOUSE CSD	MOUNTAIN HOUSE WWTP	CA0084271	M
MT LASSEN TROUT FARMS INC	MEADOWBROOK FACILITY	CA0080373	Q
NEVADA CITY, CITY OF	NEVADA CITY WWTP	CA0079901	Q
NEVADA CO SD #1	CASCADE SHORES WWTP	CA0083241	Q
NEVADA CO SD #1	LAKE OF THE PINES WWTP	CA0081612	Q
NEVADA CO SD #1	LAKE WILDWOOD WWTP	CA0077828	M
OLIVEHURST PUD	OLIVEHURST WWTP	CA0077836	M
ORIGINAL SIXTEEN TO ONE MINE	SIXTEEN TO ONE MINE	CA0081809	Q
OROVILLE WYANDOTTE ID	MINERS RANCH WTP	CA0083143	B
PACIFIC COAST SPROUT FARMS	SACRAMENTO FACILITY	CA0082961	Q
PACTIV CORP	PACTIV MOLDED PULP MILL	CA0004821	M
PARADISE ID	PARADISE WTP	CA0083488	B
PLACER CO FACILITY SERVICES 1	PLACER CO SMD NO 1	CA0079316	M
PLACER CO FACILITY SERVICES 1	PLACER CO SMD NO 3	CA0079367	Q
PLACER CO FACILITY SERVICES 1	SA NO 28, ZONE NO.6	CA0079341	Q
PLACERVILLE, CITY OF	HANGTOWN CREEK WWTP	CA0078956	M

Table A.1: NPDES-Permitted Facilities Required to Conduct Effluent Methylmercury Monitoring under California Water Code Section 13267.

AGENCY NAME	FACILITY NAME	NPDES NO	MONITORING FREQUENCY [(a)]
PLANADA CSD	WWTP	CA0078950	Q
PROCTER AND GAMBLE COMPANY	PROCTER & GAMBLE CO WWTP	CA0004316	Q
RED BLUFF, CITY OF	RED BLUFF WWTP	CA0078891	M
REDDING, CITY OF	CLEAR CREEK WWTP	CA0079731	M
REDDING, CITY OF	STILLWATER WWTP	CA0082589	M
RIO ALTO WD	LAKE CALIFORNIA WWTP	CA0077852	B
RIO VISTA, CITY OF	RIO VISTA WWTP	CA0079588	Q
RIO VISTA, CITY OF	TRILOGY WWTP	CA0083771	Q
RIVER HIGHLANDS CSD	HAMMONTON GOLD VILLAGE WWTP	CA0081574	Q
RIVIERA WEST MUTUAL WATER CO	RIVIERA WEST WATER SUPPLY TP	CA0083925	Q
ROSEVILLE, CITY OF	DRY CREEK WWTP	CA0079502	M
ROSEVILLE, CITY OF	PLEASANT GROVE WWTP	CA0084573	M
S.M.U.D.	RANCHO SECO NUCLEAR GEN STA 1	CA0004758	M
SACRAMENTO CO AIRPORT SYSTEM	SACRAMENTO INTERNATIONAL AIRPT	CA0034841	Q
SACRAMENTO COGENERATION AUTH.	PROCTOR & GAMBLE COGEN. PLANT	CA0083569	Q
SACRAMENTO MUNICIPAL UTILITY D	SMUD COGENERATION PLANT	CA0083658	Q
SACRAMENTO REGIONAL CSD-ELK GV	WALNUT GROVE WWTP	CA0078794	Q
SACRAMENTO, CITY OF	COMBINED WW COLLECTION/TRT SYS	CA0079111	M
SAN ANDREAS SANITARY DIST.	SAN ANDREAS WWTP	CA0079464	Q
SAN JOAQUIN CO DPW	CSA 31 - FLAG CITY WWTP	CA0082848	Q
SEWER COMM - OROVILLE REGION	OROVILLE WWTP	CA0079235	M
SHASTA CSA #17	COTTONWOOD WWTP	CA0081507	Q
SHASTA LAKE, CITY OF	SHASTA LAKE WTP	CA0004693	B
SHASTA LAKE, CITY OF	SHASTA LAKE WWTP	CA0079511	Q
SHEA, J F COMPANY INC	FAWNDALE ROCK & ASPHALT	CA0083097	B
SIERRA PACIFIC INDUSTRIES	CAMINO SAWMILL	CA0078841	Q
SIERRA PACIFIC INDUSTRIES	MARTELL COMPLEX/SIERRA PINE	CA0004219	Q
SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC, ANDERSON DIV	CA0082066	Q
SIERRA PACIFIC INDUSTRIES	SIERRA PACIFIC, SHASTA LAKE DV	CA0081400	Q
STIMPEL-WIEBELHAUS ASSOCIATES	SWA AT MOUNTAIN GATE	CA0084140	B
STOCKTON COGENERATION COMPANY	STOCKTON COGENERATION FACILITY	CA0081965	Q
STOCKTON, CITY OF	STOCKTON WWTP	CA0079138	M
THE BOEING COMPANY	INTERIM GW TREATMENT SYSTEM	CA0084891	B
TRACY, CITY OF	TRACY WWTP	CA0079154	M
TUOLUMNE UD/JAMESTOWN SD	SONORA WWTP/JAMESTOWN WWTP	CA0084727	M
TURLOCK, CITY OF	TURLOCK WWTP	CA0078948	M
U.A. LOCAL 38 TRUST FUND	KONOCTI HARBOR INN	CA0083551	Q
U.S. BUREAU OF RECLAMATION	SLIGER MINE	CA0084905	Q
UNIVERSITY OF CALIFORNIA, DAVIS	AQUATIC CENTER/ANIMAL SCIENCE	CA0083348	Q

Table A.1: NPDES-Permitted Facilities Required to Conduct Effluent Methylmercury Monitoring under California Water Code Section 13267.

AGENCY NAME	FACILITY NAME	NPDES NO	MONITORING FREQUENCY [a]
UNIVERSITY OF CALIFORNIA, DAVIS	HYDRAULICS LABORATORY	CA0084182	Q
UNIVERSITY OF CALIFORNIA, DAVIS	UC DAVIS WWTP	CA0077895	M
UNITED AUBURN INDIAN COMMUNITY	AUBURN RANCHERIA CASINO WWTP	CA0084697	Q
US AIR FORCE - BEALE AFB	BEALE AFB WWTP	CA0110299	B
US AIR FORCE - MCCLELLAN AFB	GW EXTR & TRMT SYSTEM	CA0081850	B
US DEPT OF AGRICULTURE	UCD AQUATIC WEED LABORATORY	CA0083364	Q
USDI BUREAU OF RECLAMATION	WINTER RUN REARING FACILITY	CA0084298	Q
USDI FISH & WILDLIFE SERVICE	COLEMAN FISH HATCHERY	CA0004201	Q
VACAVILLE, CITY OF	EASTERLY WWTP	CA0077691	M
WASTE MANAGEMENT OF ALAMEDA CO	ALTAMONT LANDFILL & RESOURCE	CA0083763	Q
WEST SACRAMENTO, CITY OF	WEST SACRAMENTO WWTP	CA0079171	M
WHEELABRATOR SHASTA ENERGY CO	WHEELABRATOR SHASTA ENERGY CO	CA0081957	Q
WILLIAMS, CITY OF	WILLIAMS WWTP	CA0077933	Q
WILLOWS, CITY OF	WILLOWS WWTP	CA0078034	M
WOODLAND, CITY OF - DOMESTIC	WOODLAND WWTP	CA0077950	M
YUBA CITY	YUBA CITY WWTP	CA0079260	M
YUBA CWD	FORBESTOWN WTP	CA0084824	B

[a] Key: Biannual (B); Monthly (M); and Quarterly (Q).
[b] The Manteca Aggregate Sand Plant is now known as Oakwood Lake Subdivision Mining Reclamation.

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APPENDIX B
SUMMARY OF NPDES FACILITY EFFLUENT AND INFLUENT METHYLMERCURY AND TOTAL MERCURY CONCENTRATIONS

Many facilities have multiple discharge locations and influent sources (intakes). Therefore, there are separate tables that summarize the methylmercury concentrations for each discharge and intake:

- Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations
- Table B.2: Summary of Effluent 3 and Effluent 4 Methylmercury Concentrations
- Table B.3: Summary of Influent/Intakes 1 and 2 Methylmercury Concentrations
- Table B.4: Summary of Influent/Intakes 3 and 4 Methylmercury Concentrations

Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

Facility	Footnotes	# of EFF 1 MeHg Samples	# of EFF 1 Nondetect Samples	Ave. EFF 1 MeHg Conc. (ng/l) (p)	Min. EFF 1 MeHg Conc (ng/l)	Max. EFF 1 MeHg Conc (ng/l)	# of EFF 2 MeHg Samples	# of EFF 2 Nondetect Samples	Ave. EFF 2 MeHg Conc. (ng/l) (p)	Min. EFF 2 MeHg Conc (ng/l)	Max. EFF 2 MeHg Conc (ng/l)
Aggregate											
Crystal Creek Aggregate	a	1	1	0.010	0.010	0.010					
J.F. Shea CO Fawndale Rock and Asphalt	a	1	1	0.010	0.010	0.010	1	1	0.010	0.010	0.010
Lehigh Southwest Cement Co.	a, b	1	1	0.010	0.010	0.010	1	1	0.010	0.010	0.010
Oakwood Lake Subdivision Mining Reclamation	a	2	1	0.027	0.010	0.043					
Stimpel Wiebelhaus Assoc. SWA at Mountain Gate		1		0.081	0.081	0.081					
Aquaculture											
Calaveras Trout Farm (Rearing Facility)		2		0.060	0.027	0.092					
DFG Darrah Springs Fish Hatchery	a, c	4	1	0.024	0.010	0.031	4	1	0.028	0.010	0.043
DFG Merced River Fish Hatchery		1		0.037	0.037	0.037					
DFG Moccasin Creek Fish Hatchery	a	1	1	0.010	0.010	0.010					
DFG Mokelumne River Fish Hatchery	a	4	1	0.041	0.010	0.059					
DFG Nimbus Fish Hatchery		3		0.065	0.053	0.085	1		0.129	0.129	0.129
DFG San Joaquin Fish Hatchery		2		0.060	0.047	0.073					
Pacific Coast Sprout Farms (Sacramento Facility)	a	1	1	0.010	0.010	0.010					
UC Davis Center for Aquatic Biology & Aquaculture	a, d	4	2	0.030	0.010	0.067	4	1	0.082	0.010	0.243
USDI BR Winter Run Rearing Facility	a	4	4	0.010	0.010	0.010					
USDI FWS Coleman Fish Hatchery		3		0.030	0.023	0.043					
Drinking Water Treatment											
Bella Vista Water District		1		0.027	0.027	0.027					
Clear Creek CSD WTP		2		0.036	0.028	0.043	1		0.041	0.041	0.041
Modesto ID Regional WTP	k	3 [2]		0.056	0.045	0.066					
Paradise Irrigation District	a	1	1	0.013	0.013	0.013					
Shasta Lake WTP	a	2	1	0.025	0.010	0.040					
South Feather Water & Power Agency Miners Ranch WTP	a, k	2 [1]	2 [1]	0.013	0.013	0.013					

Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

Facility	Footnotes	# of EFF 1 MeHg Samples	# of EFF 1 Nondetect Samples	Ave. EFF 1 MeHg Conc. (ng/l) (p)	Min. EFF 1 MeHg Conc (ng/l)	Max. EFF 1 MeHg Conc (ng/l)	# of EFF 2 MeHg Samples	# of EFF 2 Nondetect Samples	Ave. EFF 2 MeHg Conc. (ng/l) (p)	Min. EFF 2 MeHg Conc (ng/l)	Max. EFF 2 MeHg Conc (ng/l)
Food Processing											
Bell Carter Olive Company Inc.	a	4	2	0.017	0.010	0.027					
CA Dairies, Inc. Los Banos Foods	a	4	3	0.016	0.013	0.026					
Hershey Chocolate USA, Oakdale	a	4	4	0.010	0.010	0.010					
Groundwater Remediation											
Aerojet Interim GW WTP	a, k	2 [1]	2 [1]	0.013	0.013	0.013	1	1	0.013	0.013	0.013
Boeing Company Interim Treat. System	a	1	1	0.010	0.010	0.010					
Defense Logistics Agency Sharpe GW Cleanup	a, i	3	2	0.018	0.010	0.033	1	1	0.010	0.010	0.010
General Electric Co. GWCS	a, j, m	3	3	0.010	0.010	0.010	3	3	0.010	0.010	0.010
Heating/Cooling											
Aerojet Sacramento Facility	f, k	1 [0]		(k)	(k)	(k)					
CA (State of) Central Heating/Cooling Facility	a	4	3	0.015	0.010	0.029					
CALAMCO - Stockton Terminal		4		0.293	0.030	0.919					
Gaylord Container Corp. Antioch Pulp and Paper Mill		3		0.055	0.048	0.061					
Sacramento International Airport		2		0.035	0.023	0.046					
UA Local 38 Trust Fund Konocti Harbor Resort		1		0.079	0.079	0.079					
Manufacturing											
Formica Corporation Sierra Plant		1		0.050	0.050	0.050					
Proctor & Gamble Co. WWTP	a, e	3	3	0.010	0.010	0.010	1		0.033	0.033	0.033
Mines											
Sliger Mine	a	4	1	0.064	0.025	0.091					
Miscellaneous											
DGS Office of State Publishing	a, k	4 [3]	4 [3]	0.010	0.010	0.010					
UC Davis Hydraulics Laboratory		3		0.057	0.038	0.082					
Municipal WWTPs											
Anderson WWTP	a	12	2	0.090	0.010	0.271					

Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

Facility	Footnotes	# of EFF 1 MeHg Samples	# of EFF 1 Nondetect Samples	Ave. EFF 1 MeHg Conc. (ng/l) (p)	Min. EFF 1 MeHg Conc (ng/l)	Max. EFF 1 MeHg Conc (ng/l)	# of EFF 2 MeHg Samples	# of EFF 2 Nondetect Samples	Ave. EFF 2 MeHg Conc. (ng/l) (p)	Min. EFF 2 MeHg Conc (ng/l)	Max. EFF 2 MeHg Conc (ng/l)
Atwater WWTP	a	12	3	0.034	0.010	0.084					
Auburn WWTP	a	12	6	0.028	0.010	0.072					
Biggs WWTP		2		1.605	0.150	3.060					
Brentwood WWTP	a	13	13	0.010	0.010	0.010					
Canada Cove LP French Camp Golf & RV Park WWTP		4		0.147	0.029	0.291					
Chico Regional WWTP		12		0.126	0.057	0.178					
Colfax WWTP		3		0.197	0.115	0.350					
Colusa WWTP		4		2.863	1.970	4.020					
Corning Industries/ Domestic WWTP	k	3 [2]		0.044	0.034	0.053					
Cottonwood WWTP		5		0.096	0.045	0.245					
Davis WWTP	o	7		0.546	0.305	1.040	5		0.613	0.247	1.440
Deer Creek WWTP	a	13	11	0.015	0.013	0.032					
Deuel Vocational Institute WWTP	a, k	4 [3]	4 [3]	0.010	0.010	0.010					
Discovery Bay WWTP	a	12	7	0.191	0.013	2.030					
El Dorado Hills WWTP	a, k, l	13 [12]	10	0.018	0.013	0.055	2	2	0.013	0.013	0.013
Galt WWTP		6		0.139	0.027	0.220					
Grass Valley WWTP	a	16	2	0.160	0.010	0.938					
Jackson WWTP		4		0.108	0.061	0.161					
Lincoln WWTP	a, k	8 [7]	6	0.018	0.010	0.068					
Live Oak WWTP		4		0.591	0.427	0.785					
Lodi White Slough WWTP	a, n	12	4	0.128	0.010	1.240					
Manteca WWTP		11		0.216	0.037	0.356					
Mariposa PUD WWTP		4		0.393	0.040	0.912					
Maxwell PUD WWTP		4		0.993	0.044	1.720					
Merced WWTP		12		0.386	0.130	0.672					
Modesto WWTP		9		0.130	0.108	0.170					

Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

Facility	Footnotes	# of EFF 1 MeHg Samples	# of EFF 1 Nondetect Samples	Ave. EFF 1 MeHg Conc. (ng/l) (p)	Min. EFF 1 MeHg Conc (ng/l)	Max. EFF 1 MeHg Conc (ng/l)	# of EFF 2 MeHg Samples	# of EFF 2 Nondetect Samples	Ave. EFF 2 MeHg Conc. (ng/l) (p)	Min. EFF 2 MeHg Conc (ng/l)	Max. EFF 2 MeHg Conc (ng/l)
Nevada City WWTP	a	4	2	0.048	0.010	0.146					
Nevada Co SD #1 Cascade Shores WWTP	a	3	1	0.142	0.010	0.286					
Nevada Co SD #1 Lake Wildwood WWTP	a	12	1	0.109	0.010	0.320					
Nevada Co SD #2 Lake of the Pines WWTP		2		1.409	0.708	2.110					
Olivehurst PUD WWTP	a	13	1	0.144	0.013	0.268					
Oroville WWTP		12		0.147	0.061	0.280					
Placer Co. SA #28 Zone #6 WWTP		2		0.668	0.474	0.862					
Placer Co. SMD #1 WWTP		12		0.141	0.042	0.350					
Placer Co. SMD #3 WWTP		12		0.100	0.037	0.381					
Placerville Hangtown Creek WWTP	a	12	1	0.058	0.013	0.170					
Planada Comm. Service Dist. WWTP		4		1.168	0.374	2.040					
Red Bluff WWTP	a	12	6	0.027	0.010	0.057					
Redding Clear Creek WWTP	a	12	3	0.042	0.013	0.084					
Redding Stillwater WWTP	a	12	12	0.013	0.013	0.013					
Rio Alto WD- Lake CA WWTP		2		1.746	0.141	3.350					
Rio Vista Main WWTP		4		0.164	0.035	0.522					
Roseville Dry Creek WWTP	a	12	4	0.023	0.010	0.055					
Roseville Pleasant Grove WWTP	a	12	10	0.017	0.010	0.070					
San Andreas SD WWTP		4		0.249	0.178	0.293					
San Joaquin Co DPW - Flag City WWTP	a	3	1	0.081	0.013	0.152					
Shasta Lake WWTP	a	2	1	0.022	0.010	0.034					
SRCSD Sacramento River WWTP		108		0.613	0.118	1.640					
SRCSD Walnut Grove WWTP (CSD1)	k	3 [2]		2.155	0.949	3.360					
Stockton WWTP	a	12	1	0.935	0.010	2.090					
Tracy WWTP	a	13	1	0.145	0.013	0.422					
Tuolumne UD Sonora WWTP/ Jamestown WWTP		3		0.182	0.071	0.262					

Table B.1: Summary of Effluent 1 and Effluent 2 Methylmercury Concentrations

Facility	Footnotes	# of EFF 1 MeHg Samples	# of EFF 1 Nondetect Samples	Ave. EFF 1 MeHg Conc. (ng/l) (p)	Min. EFF 1 MeHg Conc (ng/l)	Max. EFF 1 MeHg Conc (ng/l)	# of EFF 2 MeHg Samples	# of EFF 2 Nondetect Samples	Ave. EFF 2 MeHg Conc. (ng/l) (p)	Min. EFF 2 MeHg Conc (ng/l)	Max. EFF 2 MeHg Conc (ng/l)
Turlock WWTP	a, g	12	1	0.059	0.010	0.079					
UC Davis WWTP	a	12	3	0.038	0.010	0.078					
United Auburn Indian Community Casino WWTP	a	2	2	0.010	0.010	0.010					
Vacaville Easterly WWTP	a	12	4	0.024	0.010	0.057					
West Sacramento WWTP	a	12	1	0.050	0.010	0.085					
Williams WWTP		4		1.553	0.560	2.100					
Woodland WWTP	a	12	2	0.031	0.013	0.059					
Yuba City WWTP		12		0.295	0.106	0.625					
Paper & Saw Mills											
Pactiv Molded Pulp Mill	a	12	5	0.039	0.010	0.085					
SPI Anderson Division		4		0.106	0.036	0.140	3		0.120	0.052	0.177
SPI Shasta Lake							2		0.607	0.023	1.190
Power Generation											
Calpine Corp. Greenleaf Unit One Cogen Plant		4		0.064	0.020	0.117					
Camanche Dam Powerhouse	a	4	3	0.020	0.010	0.039					
GWF Power Systems	a	4	4	0.013	0.013	0.013					
Mirant Delta CCPP	h	12		0.075	0.020	0.121	10		0.086	0.042	0.150
Sacramento Cogen Authority Procter & Gamble Plant	a	4	1	0.052	0.013	0.070					
Stockton Congeneration Co.	a	4	3	0.017	0.013	0.029					
Wheelabrator Shasta Energy Co.		4		0.104	0.055	0.178					
Power Generation/ Domestic WWTP											
SMUD Rancho Seco Nuclear Generating Station	a	12	4	0.040	0.013	0.104					

Table B.1 Footnotes:

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.

b. Lehigh Southwest Cement Co. EFF 1: Outfall #1, Shale Quarry Tunnel Road. Effluent 2: Lehigh Southwest Cement Co., 002B: Shale Quarry

c. Darrah Springs Fish Hatchery EFF 1: Upper Springs. EFF 2: Darrah Springs Fish Hatchery - Lower Springs

d. UCD Center for Aquatic Biology & Aquaculture, EFF 1: CABA Aquatic Center. EFF 2: CABA Putah Creek Facility

e. Proctor & Gamble, Pond EFF 2: Effluent PTI-660

f. Aerojet Sacramento Facility, EFF 1 Sample collected from West Detention Pond because there was no discharge to the American River during the rainy season.

g. City of Turlock WWTP, EFF 1: R5

h. Mirant Delta CCPP EFF 1:Outfall 001, EFF 2: Outfall 002

i. Defense Logistics Agency, Sharp Groundwater Cleanup; EFF 1: CBCGWTPEFF = Central Area B/C Aquifer Zone, EFF 2: NBGWTPEFF = North GWTP effluent

j. General Electric Co., GWCS: EFF 1: Air Stripper Effluent, EFF 2: 100-foot Zone Effluent

k. Results for the following facilities and sample dates were not incorporated in the calculations due to sample preservation hold times exceeding EPA recommendations: Aerojet Interim GW WTP (18 November 2005, EFF 1 and EFF 2 were both <MDL); Aerojet Sacramento Facility (18 March 2005, 0.057 ng/l); Corning Industries/ Domestic WWTP (22 September 2004, 0.041 ng/l); Deuel Vocational Institute WWTP (26 October 2004, <MDL); DGS Office of State Publishing (8 July 2005, <MDL); El Dorado Hills WWTP (9 August 2005, 0.057 ng/l); Lincoln WWTP (25 August 2005, 0.034 ng/l); Modesto ID Regional WWTP (8 October 2004, 0.038 ng/l); South Feather Water & Power Agency Miners Ranch WTP (9 September 2004, <MDL); and SRCSD Walnut Grove WWTP (CSD1) (29 December 2004, 0.759 ng/l).

l. El Dorado Hills WWTP sampled effluent when discharging to land and to surface water. Only samples collected when the plant discharged to surface water (December 2004 through April 2005) were used in the February 2008 Delta TMDL Report (Wood *et al.*, 2008b). However, this summary includes samples that were collected when the plant discharged to land and to surface water.

m. General Electric Co. GWCS conducted four sampling events. However, results for samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations.

n. Lodi White Slough WWTP sampled effluent when discharging to land and to surface water. Only samples collected when the plant discharged to surface water (September 2004 through June 2005) were used in the TMDL Report. However, this summary includes samples that were collected when the plant discharged to land and to surface water.

o. Davis WWTP: EFF 1: Willow Slough, EFF 2: Conaway Ranch Toe Drain in the Yolo Bypass

p. Tables 6.5 and 8.4 in the main text of the February 2008 TMDL Report and Tables B and C in the draft Basin Plan amendment provide average concentration values rounded to two decimal places based on un-rounded calculations. For example, the Tracy WWTP had an average methylmercury concentration of 0.014465 ng/l, which rounds to 0.0145 ng/l in this table, and 0.14 ng/l in Table 6.5.

Table B.2: Summary of Effluent 3 and Effluent 4 Methylmercury Concentrations

Facility	Footnotes	# of EFF 3 MeHg Samples	# of EFF 3 Nondetect Samples	Ave. EFF 3 MeHg Conc. (ng/l)	Min. EFF 3 MeHg Conc. (ng/l)	Max. EFF 3 MeHg Conc. (ng/l)	# of EFF 4 MeHg Samples	# of EFF 4 Nondetect Samples	Ave. EFF 4 MeHg Conc. (ng/l)	Min. EFF 4 MeHg Conc. (ng/l)	Max. EFF 4 MeHg Conc. (ng/l)
Aggregate											
Lehigh Southwest Cement Co.	a, b	1	1	0.010	0.010	0.010	1		0.062	0.062	0.062
Groundwater Remediation											
Aerojet Interim GW WTP	a, e	2 [1]	2 [1]	0.013	0.013	0.013	2 [1]	2 [1]	0.013	0.013	0.013
Defense Logistics Agency Sharpe GW Cleanup	a, c	2	2	0.010	0.010	0.010					
General Electric Co. GWCS	a, d, f	3	3	0.010	0.010	0.010					

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.
b. Lehigh Southwest Cement Co., EFF 3: 001A: Limestone Quarry, EFF 4: 00X: Cement Plant
c. Defense Logistics Agency, Sharp Groundwater Cleanup, EFF 3: SBGWTPEFF= South GWTP effluent, EFF 4: SSJCUPST = South San Joaquin Irrigation District Canal (upstream sample).
d. General Electric Co. EFF 3: GWCS: Multizone Effluent
e. Aerojet Interim Groundwater WTP results for samples collected on 18 November 2005 (both <MDL) were not incorporated in the calculations due to sample preservation hold time exceeding EPA recommendations.
f. General Electric Co. GWCS conducted four sampling events. However, results for General Electric Co. GWCS samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations.

Table B.3: Summary of Influent/Intakes 1 and 2 Methylmercury Concentrations

Facility	Footnotes	# of INF 1 MeHg Samples	# of INF 1 Nondetect Samples	Ave. INF 1 MeHg Conc. (ng/l)	Min. INF 1 MeHg Conc. (ng/l)	Max. INF 1 MeHg Conc. (ng/l)	# of INF 2 MeHg Samples	# of INF 2 Nondetect Samples	Ave. INF 2 MeHg Conc. (ng/l)	Min. INF 2 MeHg Conc. (ng/l)	Max. INF 2 MeHg Conc. (ng/l)
Aquaculture											
Calaveras Trout Farm (Rearing Facility)		1		0.067	0.067	0.067					
DFG Darrah Springs Fish Hatchery	a, b	1	1	0.010	0.010	0.010	1	1	0.010	0.010	0.010
DFG Mokelumne River Fish Hatchery	a	1	1	0.010	0.010	0.010					
DFG Nimbus Fish Hatchery		2		0.052	0.051	0.052	1		0.031	0.031	0.031
DFG San Joaquin Fish Hatchery		1		0.021	0.021	0.021					
Drinking Water Treatment											
Bella Vista Water District		1		0.084	0.084	0.084					
Modesto ID Regional WTP	a, h	3 [2]	2 [1]	0.022	0.010	0.033					
Groundwater Remediation											
General Electric Co. GWCS	a, g	3	3	0.010	0.010	0.010	3	3	0.010	0.010	0.010
Heating/Cooling											
CALAMCO - Stockton Terminal		1		0.026	0.026	0.026					
Manufacturing											
Proctor & Gamble Co. WWTP	a, c	3	3	0.010	0.010	0.010	3	2	0.015	0.010	0.026
Municipal WWTPs											
Atwater WWTP		1		1.940	1.940	1.940					
Auburn WWTP		1		2.720	2.720	2.720					
Chico Regional WWTP		11		1.167	0.527	1.590					
Colusa WWTP		1		1.580	1.580	1.580					
Davis WWTP	d	1		1.660	1.660	1.660					
Deer Creek WWTP		13		1.154	0.335	1.570					
El Dorado Hills WWTP	h	13 [12]		1.139	0.388	2.020					
Grass Valley WWTP		16		1.897	0.588	5.010					
Jackson WWTP		1		0.854	0.854	0.854					
Lodi White Slough WWTP		12		1.396	0.730	2.740					

Table B.3: Summary of Influent/Intakes 1 and 2 Methylmercury Concentrations

Facility	Footnotes	# of INF 1 MeHg Samples	# of INF 1 Nondetect Samples	Ave. INF 1 MeHg Conc. (ng/l)	Min. INF 1 MeHg Conc. (ng/l)	Max. INF 1 MeHg Conc. (ng/l)	# of INF 2 MeHg Samples	# of INF 2 Nondetect Samples	Ave. INF 2 MeHg Conc. (ng/l)	Min. INF 2 MeHg Conc. (ng/l)	Max. INF 2 MeHg Conc. (ng/l)
Mariposa PUD WWTP		1		0.068	0.068	0.068					
Maxwell PUD WWTP		1		14.600	14.600	14.600					
Nevada City WWTP		4		3.140	1.090	6.230					
Placer Co. SMD #1 WWTP		1		2.590	2.590	2.590					
Planada Comm. Service Dist. WWTP		1		3.390	3.390	3.390					
Rio Vista Main WWTP		4		2.903	1.570	4.790					
Roseville Dry Creek WWTP		9		1.360	0.600	2.860					
Roseville Pleasant Grove WWTP		9		0.808	0.120	2.160					
SRCSD Sacramento River WWTP		111		1.624	0.746	2.840					
SRCSD Walnut Grove WWTP (CSD1)	h	3 [2]		3.683	0.626	6.740					
UC Davis WWTP		12		2.991	0.074	11.100					
Williams WWTP		4		7.133	4.530	11.900					
Woodland WWTP		12		2.309	0.767	7.070					
Power Generation											
Camanche Dam Powerhouse	e	1		0.095	0.095	0.095					
GWF Power Systems	a	4	3	0.075	0.013	0.263					
Mirant Delta CCPP	a, f	12	1	0.096	0.010	0.296					
Sacramento Cogen Authority Procter & Gamble Plant	a	4	3	0.029	0.010	0.080					

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.
b. Darrah Springs Fish Hatchery, INF 1 & 2 Upper Springs
c. Proctor & Gamble, INF 2: Well #2 BR-226
d. City of Davis Plant, INF 1 -Head: Influent coming to the plant, collected at head-gate
e. Camache Dam Powerhouse, INF 1: receiving water received 200 feet upstream of discharge
f. Mirant Delta CCPP, INF 1: Intake 002
g. General Electric Co., INF 1: GWCS: Air Stripper Influent, INF 2: 100-foot Zone Influent. General Electric Co. GWCS conducted four sampling events. However, results for General Electric Co. GWCS samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations.
h. Results for the following facilities and sample dates were not incorporated in the calculations due to sample preservation hold times exceeding EPA recommendations: El Dorado Hills WWTP (9 August 2005, 1.41 ng/l); Modesto ID Regional WWTP (8 October 2004, <MDL); and SRCSD Walnut Grove WWTP (CSD1) (29 December 2004, 1.15 ng/l).

Table B.4: Summary of Influent/Intakes 3 and 4 Methylmercury Concentrations

Facility	Footnotes	# of INF 3 MeHg Samples	# of INF 3 Nondetect Samples	Ave. INF 3 MeHg Conc. (ng/l)	Min. INF 3 MeHg Conc. (ng/l)	Max. INF 3 MeHg Conc. (ng/l)	# of INF 4 MeHg Samples	# of INF 4 Nondetect Samples	Ave. INF 4 MeHg Conc. (ng/l)	Min. INF 4 MeHg Conc. (ng/l)	Max. INF 4 MeHg Conc. (ng/l)
Groundwater Remediation											
General Electric Co. GWCS	a, c	3	3	0.010	0.010	0.010					
Manufacturing											
Proctor & Gamble Co. WWTP	a, b	3	3	0.010	0.010	0.010	3	3	0.010	0.010	0.010

a. Sample MeHg concentration <MDL; half the detection limit was used for calculations.
b. Proctor & Gamble, INF 3: Well #3 BR-2025, INF 4:Well #4 BRL-341
c. General Electric Co., INF 3: Multizone Influent. General Electric Co. GWCS conducted four sampling events. However, results for General Electric Co. GWCS samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations.

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Aerojet Interim GW WTP	CA0083861	WTP (GW)	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	5.00	average			2.6*	18	0.013		0.090
Aerojet Sacramento Facility WWTP	CA0004111	Heating / Cooling	U/S of Delta / Yolo Bypass	Sacra-mento			X			0.024	WY2005					0.057		
AFB Conversion Agency A C & W GW Treatment	CA0083992	WTP (GW)	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.39	average			2.6*	1.4	0.013		0.0070
Agricultural Mgmt & Production Afterthought Mine	CA0084166	Mines	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.054	peak flow					0.064*	Mines	0.0048
Altamont Landfill and Resource	CA0083763	Landfill	U/S of Delta / Yolo Bypass	San Joaquin	X	Jun-07			X	0.15	(c)			23.1				
Anderson WWTP	CA0077704	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.4	dry weather average		Tertiary	4.1*	7.9	0.090		0.17
Atwater WWTP	CA0079197	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	3.4	dry weather average		Secondary	8.7*	41	0.034		0.16
Auburn WWTP	CA0077712	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.17	WY2005	Tertiary		1.5	2.4	0.028		0.045
Beale Air Force Base WWTP	CA0110299	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.7	baseline	Secondary		15.9	15	0.105*	Mun WWTP: Filtration + Chlor./ Dechlor.	0.10
Bell Carter Olive Company Inc.	CA0083721	Food	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.38	maximum flow allowed					0.017		0.0089
Bell Carter Olive Company Inc. Plant 1	CA0081639	Food	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.15	baseline					0.014*	Food	0.0029

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescission Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Bella Vista Water District	CA0080799	Water Filtration	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.5	baseline			4.6*	3.200	0.027		0.019
Biggs WWTP	CA0078930	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.38	average		Secondary	8.7*	4.6	1.605		0.84
Boeing Company, Interm. Treat. System	CA0084891	WTP (GW)	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.56	WY2005			2.6*	5.2	0.010		0.0077
Brentwood WWTP	CA0082660	Mun. WWTP	Delta/Yolo Bypass	Marsh Creek			X	X	X	3.09	WY2005	Tertiary		1.3	5.5	0.010		0.086
CA Dairies, Inc. Los Banos Foods	CA0082082	Food	U/S of Delta / Yolo Bypass	San Joaquin	X	Oct-07		X	X	0.5						0.016		0.011
CALAMCO - Stockton Terminal	CA0083968	Heating / Cooling	Delta/Yolo Bypass	Central	X	Oct-06				5.06	WY2005			6.6		0.293		
Calaveras Trout Farm (Rearing Facility)	CA0081752	Aqua-culture	U/S of Delta / Yolo Bypass	San Joaquin			X			19.4	average					0.060		
Calpine Corp. Greenleaf Unit One Cogen Plant	CA0081566	Power	U/S of Delta / Yolo Bypass	Sacra-mento	X	Apr-08				0.11	WY2005			2.3		0.064		
Camache Dam Powerhouse	CA0082040	Power	U/S of Delta / Yolo Bypass	Mokelumne	X	Oct-08				0.04	average			0.8		0.020		
Canada Cove LP French Camp Golf & RV Park WWTP	CA0083682	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	0.04	average		Tertiary	4.1*	0.23	0.147		0.0081
Chester WWTP	CA0077747	Mun. WWTP	U/S of Major Dam	Sacra-mento								Secondary		8.9				
Chico Regional WWTP	CA0079081	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	7.2	average		Secondary	8.7*	86	0.126		1.3
Clear Creek CSD WTP	CA0083828	Water Filtration	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.16	average			4.6*	1.000	0.036		0.0080
Colfax WWTP	CA0079529	Mun. WWTP	U/S of Major Dam	Sacra-mento						0.024	average seepage rate	Secondary		7.0		0.197		0.0065

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescission Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Collins and Aikman	CA0081531	WTP (GW)	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	0.022	average			2.6	0.079	0.013		0.00040
Collins Pine Company Chester Sawmill	CA0004391	Paper Mill / Saw Mills	U/S of Major Dam	Sacra-mento										5.9				
Colusa WWTP	CA0078999	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.66	WY2005		Secondary	8.7*	7.9	2.863		2.6
Corning Industries/ Domestic WWTP	CA0004995	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1	average		Secondary	8.7*	12	0.044		0.061
Cottonwood WWTP	CA0081507	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.29	2002 average		Tertiary	4.1*	1.6	0.096		0.038
Crystal Creek Aggregate	CA0082767	Aggregate	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.002	average			4.8	0.013	0.010		2.8×10^{-5}
Davis WWTP Discharge 001	CA0079049	Mun. WWTP	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	2.8	WY2005	Secondary		7.4	17	0.550		1.3
Davis WWTP Discharge 002	CA0079049	Mun. WWTP	Delta/Yolo Bypass	Yolo Bypass			X	X	X	2.4	WY2005	Secondary		6.9	23	0.610		0.78
Defense Logistics Agency Sharpe GW Cleanup	CA0081931	WTP (GW)	U/S of Delta / Yolo Bypass	San Joaquin	X	Apr-08		X	X	1.9				2.6*	6.8	0.018		0.047
Deuel Vocational Institute WWTP	CA0078093	Mun. WWTP	Delta/Yolo Bypass	San Joaquin			X	X	X	0.47	WY2005	Tertiary		3.3	2.1	0.010		0.013
DFG Darrah Springs Fish Hatchery	CA0004561	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			18.7	average					0.024		
DFG Feather River Fish Hatchery	CA0004570	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			25.8	baseline			1.4				
DFG Merced River Fish Hatchery	CA0080055	Aqua-culture	U/S of Delta / Yolo Bypass	San Joaquin			X			4.55	average					0.037		
DFG Moccasin Creek Fish Hatchery	CA0004804	Aqua-culture	U/S of Delta / Yolo Bypass	San Joaquin			X			19.62	WY2005					0.010		

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
DFG Mokelumne River Fish Hatchery	CA0004791	Aqua-culture	U/S of Delta / Yolo Bypass	Mokelumne			X			21	average					0.041		
DFG Nimbus Fish Hatchery	CA0004774	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			40	baseline			26.8		0.065		
DFG San Joaquin Fish Hatchery	CA0004812	Aqua-culture	U/S of Delta / Yolo Bypass	San Joaquin			X			22.6	average					0.060		
DFG Thermalito Annex Fish Hatchery	CA0082350	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			7.8	average			1.5				
DGS Office of State Publishing	CA0078875	Publishing	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.3	WY2005			1.5	0.62	0.010		0.0041
Discovery Bay WWTP	CA0078590	Mun. WWTP	Delta/Yolo Bypass	Central			X	X	X	1.5	WY2005	Secondary		5.0	10	0.178		0.37
Donner Summit WWTP	CA0081621	Mun. WWTP	U/S of Major Dam	Sacra-mento								Tertiary		7.8				
El Dorado ID Deer Creek WWTP	CA0078662	Mun. WWTP	U/S of Delta / Yolo Bypass	Mokelumne			X	X	X	2.52	WY2005	Tertiary		5.1	18	0.015		0.052
El Dorado ID El Dorado Hills WWTP Discharge 1	CA0078671	Mun. WWTP	U/S of Delta / Yolo Bypass	Mokelumne			X	X	X	1.08	WY2005	Tertiary		2.0	3.0	0.018		0.027
Formica Corporation Sierra Plant	CA0004057	Manufactu ring	U/S of Delta / Yolo Bypass	Sacra-mento	X	Apr-09		X	X	0.88	average			3.5	4.3	0.050		0.061
Galt WWTP	CA0081434	Mun. WWTP	U/S of Delta / Yolo Bypass	Mokelumne			X	X	X	1.92	WY2005	Secondary		3.7	9.8	0.139		0.37
Gaylord Container Corp. Antioch Pulp and Paper Mill	CA0004847	Heating / Cooling	Delta/Yolo Bypass	West	X	Jun-06								7.1		0.055		
General Electric Co. GWCS	CA0081833	WTP (GW)	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	1.6	average			2.6*	5.7	0.010		0.022

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Grass Valley WWTP	CA0079898	Mun. WWTP	U/S of Major Dam	Sacra-mento						2.1	WY2005	Secondary		5.0		0.160		0.46
Grizzly Lake Resort Dellecker WWTP	CA0081744	Mun. WWTP	U/S of Major Dam	Sacra-mento								Secondary		8.6				
GWF Power Systems	CA0082309	Power	Delta/Yolo Bypass	West			X	X	X	0.05	WY2005			4.3	0.27	0.020		0.0019
Hershey Chocolate USA, Oakdale	CA0004146	Food	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	1.03	WY2005					0.010		0.014
J.F. Enterprises Worm Farm	CA0081949	Aqua-culture	U/S of Delta / Yolo Bypass	San Joaquin			X			5.44	maximum flow							
J.F. Shea CO Fawndale Rock and Asphalt	CA0083097	Aggregate	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	3.87	average			4.8*	26	0.010		0.053
Jackson WWTP	CA0079391	Mun. WWTP	U/S of Major Dam	Mokelumne						0.56	WY2005	Tertiary		6.1		0.108		0.11
Kinder Morgan Elmira Remediation Project	CA0084719	WTP (GW)	U/S of Delta / Yolo Bypass	Yolo Bypass	X	Jun-08		X	X	0.07				2.6*	0.25	0.013		0.0013
Kinder Morgan Fox Rd Pipeline Release Site	CA0084760	WTP (GW)	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	0.072	average			2.6*	0.26	0.013		0.0013
Kinder Morgan Holt Ground Water Recovery	CA0084701	WTP (GW)	Delta/Yolo Bypass	Central	X	Jun-05		X	X	0.044	monthly average			2.5	0.15	0.013		0.00079
Land O'Lakes, Inc., Valley Gold LLC	CA0084808	Food	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	0.152	baseline					0.014*	Food	0.0029
Lehigh Southwest Cement Co.	CA0081191	Aggregate	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X		typically little discharge							

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Lincoln Center Groundwater Treatment Facility	CA0084255	WTP (GW)	Delta/Yolo Bypass	Central			X	X	X	0.25				0.6	0.21	0.03*	WTP (GW)	0.010
Lincoln WWTP	CA0084476	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.13	WY2005	Tertiary		1.4	2.2	0.018		0.028
Linda Co Water Dist WWTP	CA0079651	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.3	baseline	Secondary		20.7	37	0.018*	Mun WWTP: N/D + Filtration + Chlor./ Dechlor.	0.032
Live Oak WWTP	CA0079022	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.7	Nov04-Oct05		Secondary	8.7*	20	0.591		1.4
LLNL Site 300 GW Treatment	CA0082651	WTP (GW)	U/S of Delta / Yolo Bypass	San Joaquin	X	Aug-05			X	0.065	average			2.6*	0.23	0.013		
Lodi White Slough WWTP	CA0079243	Mun. WWTP	Delta/Yolo Bypass	Central			X	X	X	4.5	WY2005	Tertiary		3.3	21	0.128		0.93
Manteca WWTP	CA0081558	Mun. WWTP	Delta/Yolo Bypass	San Joaquin			X	X	X	4.63	WY2005	Secondary		10.6	68	0.216		1.4
Mariposa PUD WWTP	CA0079430	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	0.245	average		Secondary	8.7*	2.9	0.393		0.13
Maxwell PUD WWTP	CA0079987	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.14	average		Secondary	8.7*	1.7	0.993		0.19
Merced WWTP	CA0079219	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	8.5	baseline	Secondary		9.3	109	0.386		4.5
Metropolitan Stevedore	CA0084174	Port Terminal	Delta/Yolo Bypass	Central			X	X	X		(g)							
Mirant Delta LLC Contra Costa Power Plant, Outfall 1	CA0004863	Power	Delta/Yolo Bypass	West			X			2.9	WY2005			6.1		0.075		

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Mirant Delta LLC Contra Costa Power Plant, Outfall 2	CA0004863	Power	Delta/Yolo Bypass	West			X			121.0	WY2005			7.1		0.086		
Modesto ID Regional WTP	CA0083801	Water Filtration	U/S of Delta / Yolo Bypass	San Joaquin	X	Sep-07		X	X	0.04	WY2005			4.6*	0.25	0.056		0.0031
Modesto WWTP	CA0079103	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	11.8	WY2005	Secondary		5.7	93	0.130		2.1
Mountain House CSD WWTP	CA0084271	Mun. WWTP	Delta/Yolo Bypass	San Joaquin			X			0.45	(h)	Tertiary	Tertiary	0.8	0.50	0.050		0.031
Mt Lassen Trout Farms Dales Facility	CA0080381	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			2.4	average							
Mt Lassen Trout Farms Jeffcoat Facility	CA0082104	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			2	baseline							
Mt Lassen Trout Farms Jeffcoat West Facility	CA0082813	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			4.5	average							
Mt Lassen Trout Farms Meadowbrook Facility	CA0080373	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			2.76	average							
Mt Lassen Trout Farms Millseat Facility	CA0082279	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			14	average							
Mt Lassen Trout Farms Volta Facility	CA0083879	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			1.9	average							
Mt Lassen Trout Farms Willow Springs Facility	CA0082163	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			3	average							
Nevada City WWTP	CA0079901	Mun. WWTP	U/S of Major Dam	Sacra-mento						0.43	average			7.1		0.048		0.029

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Nevada Co SD #1 Cascade Shores WWTP	CA0083241	Mun. WWTP	U/S of Major Dam	Sacra-mento						0.026	average					0.142		0.0051
Nevada Co SD #1 Lake Wildwood WWTP	CA0077828	Mun. WWTP	U/S of Major Dam	Sacra-mento						0.5	1999-2002 annual average					0.109		0.075
Nevada Co SD #2 Lake of the Pines WWTP	CA0081612	Mun. WWTP	U/S of Major Dam	Sacra-mento						0.54	baseline					1.409		1.1
Oakwood Lake Subdivision Mining Reclamation	CA0082783	Lake Dewaterin g	Delta/Yolo Bypass	San Joaquin			X	X	X	9.15	WY2005			2.9	37	0.030		0.38
Olivehurst PUD WWTP	CA0077836	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.2	WY2005		Secondary	8.7*	22	0.144		0.24
Oroville WWTP	CA0079235	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	3	average	Tertiary		3.7	15	0.147		0.61
Pacific Coast Sprout Farms, Inc. (Sacramento Facility)	CA0082961	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			0.1	baseline			1.8		0.010		
Pactiv Molded Pulp Mill	CA0004821	Paper Mill / Saw Mills	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.9	average			2.0	5.3	0.039		0.10
Paradise Irrigation District	CA0083488	Water Filtration	U/S of Major Dam	Sacra-mento						1.5	design flow			4.7	9.7	0.013		
Placer Co. SA #28 Zone #6 WWTP	CA0079341	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.01	WY2005	Secondary		9.3	0.13	0.668		0.0092
Placer Co. SMD #1 WWTP	CA0079316	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.90	WY2005	Tertiary		2.1	5.7	0.141		0.37
Placer Co. SMD #3 WWTP	CA0079367	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.12	WY2005	Tertiary		2.1	0.35	0.100		0.017
Placerville Hangtown Creek WWTP	CA0078956	Mun. WWTP	U/S of Major Dam	Sacra-mento						1.3	average	Tertiary		11.6		0.058		0.10

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Planada Comm. Service Dist. WWTP	CA0078950	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	0.38	average		Tertiary	4.1*	2.2	1.168		0.61
Pliant Corp Vitafilm Plant	CA0080071	Heating / Cooling	U/S of Delta / Yolo Bypass	San Joaquin	X	Dec-06				0.338								
Portola WWTP	CA0077844	Mun. WWTP	U/S of Major Dam	Sacra-mento								Secondary		4.9				
Proctor & Gamble Co. WWTP	CA0004316	Manufactu ring	U/S of Delta / Yolo Bypass	Sacra-mento	X	Jun-06		X	X	5.5				1.9	14	0.010		0.076
Quincy WWTP	CA0078981	Mun. WWTP	U/S of Major Dam	Sacra-mento								Secondary		15.8				
Red Bluff WWTP	CA0078891	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.4	baseline		Tertiary	4.1*	7.9	0.027		0.052
Redding Clear Creek WWTP	CA0079731	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	7.5	baseline	Tertiary		3.7	38	0.042		0.44
Redding Stillwater WWTP	CA0082589	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	3.46	WY2000-02 average	Tertiary		2.1	10	0.013		0.062
Rio Alto WD- Lake CA WWTP	CA0077852	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.15	dry weather average		Tertiary	4.1*	0.85	1.746		0.36
Rio Vista Northwest WWTP	CA0083771	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X			1	(i)		Tertiary	4.1*	5.7	0.05*	Mun WWTP: N/D + Filtration + UV	0.069
Rio Vista Trilogy WWTP	CA0083771	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento	X	Replac ed by Rio Vista Northw est WWTP in 2007.		X	X	0.1	seasonal discharge (181 days)	Secondary		3.7	0.52	0.06*	Mun WWTP: Filtration + Chlor./ Dechlor. + Activated Sludge + Trickling Filter	0.0041

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Rio Vista WWTP	CA0079588	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X	X	X	0.47	WY2005	Secondary		9.5	6.2	0.164		0.10
River Highlands CSD Hammonton Gold Village WWTP	CA0081574	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.008	baseline	Secondary		6.9	0.076	0.902*	Mun WWTP: Pond + Chlor./ Dechlor.	0.010
Roseville Dry Creek WWTP	CA0079502	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	10.19	WY2005	Tertiary		10.9	196	0.023		0.41
Roseville Pleasant Grove WWTP	CA0084573	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X			5.90	WY2005 (j)	Tertiary		1.3	8.7	0.017		0.11
Sacramento Cogen Authority Procter & Gamble Plant	CA0083569	Power	U/S of Delta / Yolo Bypass	Sacra-mento	X	Sep-06				1.5				5.5		0.052		
Sacramento Combined WWTP (CWTP)	CA0079111	Combined Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X	X	X	0.59		Primary		66	54	0.536		0.44
Sacramento Combined WWTP (Pioneer)	CA0079111	Combined Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X	X	X	0.27				104	60	0.536		0.20
Sacramento Combined WWTP (Sump 2)	CA0079111	Combined Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X	X	X	0.42				101	38	0.536		0.31
Sacramento International Airport	CA0034841	Heating / Cooling	U/S of Delta / Yolo Bypass	Sacra-mento	X	Jun-06				1.5	design flow					0.035		
Sacramento Power Authority Campbells Cogen Plant	CA0083658	Power	U/S of Delta / Yolo Bypass	Sacra-mento	X	Mar-05								18.8				
San Andreas SD WWTP	CA0079464	Mun. WWTP	U/S of Major Dam	Central						0.3	baseline					0.249		0.10

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
San Joaquin Co DPW CSA 31 Flag City WWTP	CA0082848	Mun. WWTP	Delta/Yolo Bypass	Central	X	Jun-08		X	X	0.06	WY2005	Tertiary		9.1	0.27	0.081		0.0066
Shasta Lake WTP	CA0004693	Water Filtration	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.05	average			4.6*	0.32	0.025		0.0017
Shasta Lake WWTP	CA0079511	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.64	baseline		Tertiary	4.1*	3.6	0.022		0.019
Shasta Paper Co Shasta Mill	CA0004065	Paper Mill / Saw Mills	U/S of Delta / Yolo Bypass	Sacra-mento	X	Jan-05		X	X		(d)							
Sliger Mine	CA0084905	Mines	U/S of Major Dam	Sacra-mento						0.0646	average portal discharge					0.064		0.0057
SMUD Rancho Seco Nuclear Generating Station	CA0004758	Power/Domestic WWTP	U/S of Delta / Yolo Bypass	Mokelumne	X	Aug-09		X	X	0.09	average			0.8	0.10	0.040		0.0050
South Feather Water & Power Agency Miners Ranch WTP	CA0083143	Water Filtration	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.25	baseline			4.6	1.6	0.013		0.0045
SPI Anderson Division	CA0082066	Paper Mill / Saw Mills	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X		typically no discharge					0.106		
SPI Camino Sawmill	CA0078841	Paper Mill / Saw Mills	U/S of Major Dam	Sacra-mento										3.3				
SPI Martell Complex/Sierra Pine	CA0004219	Paper Mill / Saw Mills	U/S of Delta / Yolo Bypass	Mokelumne			X	X	X	0.57	baseline			11.7	9.2	0.117*	Paper Mill /Saw Mills	0.092
SPI Quincy Division	CA0080357	Paper Mill / Saw Mills	U/S of Major Dam	Sacra-mento										6.2				
SPI Shasta Lake	CA0081400	Paper Mill / Saw Mills	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.15	baseline			5.8*	1.4	0.117*	Paper Mill /Saw Mills	0.024
SRCSD Sacramento River WWTP	CA0077682	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento			X	X	X	162	WY2001-2003	Secondary		7.3	1,634	0.718		161

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
SRCSD Walnut Grove WWTP	CA0078794	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento	X	(e)		X	X	0.08		Secondary		21.5	2.4	2.155		0.24
State of California Central Heating/Cooling Plant	CA0078581	Heating / Cooling	Delta/Yolo Bypass	Sacra-mento			X			5.26	WY2005			2.8		0.015		
Stimpel Wiebelhaus Assoc. SWA at Mountain Gate Quarry	CA0084140	Aggregate	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.02	average			4.8*	0.13	0.081		0.0022
Stockton Congeneration Co.	CA0081965	Power	U/S of Delta / Yolo Bypass	San Joaquin	X	Oct-06				1.17				0.3		0.017		
Stockton WWTP	CA0079138	Mun. WWTP	Delta/Yolo Bypass	San Joaquin			X	X	X	28	WY2005	Tertiary		5.1	201	0.935		36
Tehama Co SD 1 Mineral WWTP	CA0084069	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.027	baseline		Tertiary	4.1*	0.15	1.04*	Mun WWTP: Pond + Filtration + Chlor./ Dechlor.	0.039
The Vendo Co GW Cleanup System	CA0083046	WTP (GW)	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	0.72	baseline			2.6*	2.6	0.013		0.013
Tracy WWTP	CA0079154	Mun. WWTP	Delta/Yolo Bypass	San Joaquin			X	X	X	9.49	WY2005	Secondary		11.0	145	0.145		1.8
Tuolumne UD Sonora WWTP/ Jamestown WWTP	CA0084727	Mun. WWTP	U/S of Major Dam	San Joaquin						0.16	WY2005					0.182		0.040
Turlock WWTP	CA0078948	Mun. WWTP	U/S of Delta / Yolo Bypass	San Joaquin			X	X	X	11.7	WY2005	Secondary		9.3	151	0.059		0.95
U.S. Army Corp of Engineers Titan 1-A Missile Facility	CA0084743	WTP (GW)	U/S of Delta / Yolo Bypass	Sacra-mento	X	Jun-07		X	X	0.0432				2.6*	0.16	0.013		0.00078

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [(a)]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [(b)] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [(b)] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
UC Davis Center for Aquatic Biology & Aquaculture Aquatic Center	CA0083348	Aqua-culture	U/S of Delta / Yolo Bypass	Yolo Bypass			X			0.67	WY2005					0.030		
UC Davis Center for Aquatic Biology & Aquaculture Putah Creek Facility	CA0083348	Aqua-culture	U/S of Delta / Yolo Bypass	Yolo Bypass			X			0.14	WY2005					0.082		
UC Davis Hydraulics Laboratory	CA0084182	Laboratory	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	0.01	average					0.057		0.00079
UC Davis WWTP	CA0077895	Mun. WWTP	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	1.93	WY2005		Tertiary	4.1*	11	0.038		0.10
United Auburn Indian Community Casino WWTP	CA0084697	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.15	WY2005		Tertiary	4.1*	0.85	0.010		0.0021
USAF McClellan AFB GW Ext & Trt Sys	CA0081850	WTP (GW)	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	2.12	average			2.6*	7.6	0.013		0.038
USDI BR Winter Run Rearing Facility	CA0084298	Aqua-culture	U/S of Major Dam	Sacra-mento												0.010		
USDI FWS Coleman Fish Hatchery	CA0004201	Aqua-culture	U/S of Delta / Yolo Bypass	Sacra-mento			X			40.08	average					0.030		
USDI UC Davis Aquatic Weed Laboratory	CA0083364	Laboratory	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	0.05	baseline					0.057*	Labor-atory	0.0039
Vacaville Easterly WWTP	CA0077691	Mun. WWTP	U/S of Delta / Yolo Bypass	Yolo Bypass			X	X	X	9.26	WY2005	Secondary		3.1	40	0.024		0.31
West Sacramento WWTP	CA0079171	Mun. WWTP	Delta/Yolo Bypass	Sacra-mento	X	Apr-08		X	X	5.6		Secondary		3.1	26	0.050		0.39

Table B.5: Summary of Facility Discharge Volumes and Effluent Total Mercury and Methylmercury Concentrations and Loads

Facility	NPDES No.	Facility Type	Proximity to Delta / Yolo Bypass [a]	Delta Subarea that Receives Discharge	NPDES Permit Rescinded During or After TMDL Study Period	NPDES Permit Rescinsion Date	Discharged in Sept. 2009 d/s Major Dams	Include in Sum of MeHg Source Loads d/s Major Dams for TMDL Period	Include in Sum of TotHg Source Loads d/s Major Dams for 20-yr Period	Annual Discharge (mgd)	Annual Discharge Type	Maximum Level of Mun. WWTP Treatment When EFF TotHg Data Were Collected	Treatment Category for Mun WWTPs d/s Major Dams w/o EFF TotHg Data	Ave. EFF TotHg Conc. [b] (ng/l)	EFF TotHg Load (g/yr)	Ave. EFF MeHg Conc. [b] (ng/l)	Treatment Category for EFF MeHg Conc. Estimate	EFF MeHg Load (g/yr)
Wheelabrator Shasta Energy Co.	CA0081957	Power	U/S of Delta / Yolo Bypass	Sacra-mento			X			0.02	average					0.104		
Williams WWTP	CA0077933	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.44	WY2005		Secondary	8.7*	3.6	1.553		0.94
Willows WWTP	CA0078034	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	1.22	average		Secondary	8.7*	15	0.105*	Mun WWTP: Filtration + Chlor./ Dechlor.	0.18
Woodland WWTP	CA0077950	Mun. WWTP	Delta/Yolo Bypass	Yolo Bypass			X	X	X	6.05	WY2005	Secondary		6.1	51	0.031		0.25
Yuba City WWTP	CA0079260	Mun. WWTP	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	5.5	(f)	Secondary		9.1	69	0.295		2.2
Yuba CWD Forbestown WTP	CA0084824	Water Filtration	U/S of Delta / Yolo Bypass	Sacra-mento			X	X	X	0.07	design flow			0.6	0.058	0.033*	Water Filtration	0.0032

Footnotes for Table B.5:

(a) U/S: Upstream.

(b) An asterisk (*) indicates that effluent total mercury and/or methylmercury concentration date were not available for these facilities. Average effluent concentrations observed at similar facilities were used to estimate their effluent loads. The average concentrations shown in this table for non-municipal WWTPs for which effluent total mercury and/or methylmercury concentration data were not available are based on the average of average effluent concentrations observed at facilities within their respective facility categories. Average total mercury concentrations for municipal WWTPs with tertiary and secondary treatment processes for which effluent data were not available are based on the average of the average total mercury concentrations observed at tertiary and secondary municipal WWTPs, 4.1 and 8.7 ng/l, respectively. Average methylmercury concentrations for municipal WWTPs for which effluent data were not available are based on the average concentrations observed at municipal treatment plants with a similar suite of treatment processes, as shown in Tables 17, 23 and 26.

(c) Altamont Landfill and Resource discharge: average wet weather/dry weather design prior to 1999; there has been no discharge since 1999.

(d) Shasta Paper Co Shasta Mill discharge: stormwater discharges only; there has been no discharge of treated process and domestic wastewater from the treatment plant to Sacramento River since 31 August 2001.

(e) SRCSD Walnut Grove WWTP discharge: The WWTP no longer discharges; as of March 2010, the NPDES permit has not yet been rescinded.

(f) Yuba City WWTP discharge: average daily flow for dates effluent was sampled for methylmercury.

(g) Metropolitan Stevedore discharge: the facility's discharge volume was not specified by its permit.

(h) Mountain House CSD WWTP discharge: Phase 1 dry weather design capacity; the WWTP began to discharge to surface water in 2007.

(i) Rio Vista Northwest WWTP discharge: start-up capacity; the WWTP began to discharge to surface water in 2007.

(j) Roseville Pleasant Grove WWTP discharge: the WWTPbegan to discharge to surface water in June 2004.

APPENDIX C
SUMMARY OF NPDES FACILITY EFFLUENT, INFLUENT, AND RECEIVING WATER MATRIX SPIKES AND MATRIX SPIKE DUPLICATES

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0083861	AEROJET INTERIM GROUND WTP	11/17/05	Effluent	99.1%	107.4%	8.0%
CA0083861	AEROJET INTERIM GROUND WTP	06/06/06	Effluent	90.3%	98.4%	8.6%
CA0004111	AEROJET SACRAMENTO FACILITY	03/18/05	Effluent	86.5%	97.6%	12.1%
CA0004847	ANTIOCH PULP & PAPER MILL	09/23/04	Effluent	106.8%	103.9%	2.8%
CA0004847	ANTIOCH PULP & PAPER MILL	10/14/04	Effluent	118.9%	114.9%	3.4%
CA0083721	BELL CARTER INDUSTRIAL WWTP	03/02/05	Effluent	119.4%	103.4%	14.4%
CA0083721	BELL CARTER INDUSTRIAL WWTP	12/15/04	Effluent	100.3%	92.1%	8.5%
CA0080799	BELLA VISTA WTP	09/21/04	Effluent	105.7%	107.6%	1.8%
CA0084891	BOEING COMPANY INTERIM GW TRT SYSTEM	08/17/04	Effluent	86.8%	85.6%	1.4%
CA0078581	CA CENTRAL HEATING/COOLING FAC	12/15/04	Effluent	103.0%	108.6%	5.3%
CA0078581	CA CENTRAL HEATING/COOLING FAC	03/07/05	Effluent	102.4%	95.3%	7.2%
CA0078581	CA CENTRAL HEATING/COOLING FAC	08/25/04	Effluent	114.4%	101.2%	12.2%
CA0078581	CA CENTRAL HEATING/COOLING FAC	06/06/05	Effluent	117.0%	103.0%	12.7%
CA0078875	CA STATE PRINTING & WAREHOUSES	08/30/04	Effluent	98.5%	86.5%	13.0%
CA0083968	CALAMCO - STOCKTON TERMINAL	07/11/05	Effluent	120.0%	117.9%	1.8%
CA0083968	CALAMCO - STOCKTON TERMINAL	08/04/05	Effluent	125.5%	119.6%	4.8%
CA0083968	CALAMCO - STOCKTON TERMINAL	08/26/04	Effluent	122.3%	107.4%	13.0%
CA0081752	CALAVERAS TROUT FARM, INC TROUT REARING FAC.	09/30/04	Effluent	103.0%	107.9%	4.6%
CA0083828	CLEAR CREEK WTP	12/09/04	Effluent	111.6%	105.3%	5.8%
CA0083828	CLEAR CREEK WTP	06/27/05	Effluent	91.0%	106.7%	15.9%
CA0082767	CRYSTAL CREEK AGGREGATE	01/04/05	Effluent	100.1%	112.5%	11.7%
CA0081931	DEFENSE LOGISTICS AGENCY GW CLEANUP	09/27/04	Effluent	115.6%	115.6%	0.0%
CA0004561	DFG DARRAH SPRINGS HATCHERY	09/15/04	Effluent	115.5%	105.6%	9.0%
CA0004561	DFG DARRAH SPRINGS HATCHERY	09/14/04	Effluent	96.2%	111.4%	14.6%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [a]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0080055	DFG MERCED RIVER FISH HATCHERY	05/26/05	Effluent	120.2%	117.3%	2.4%
CA0004804	DFG MOCCASIN FISH HATCHERY	08/24/04	Effluent	92.0%	86.5%	6.2%
CA0004812	DFG SAN JOAQUIN FISH HATCHERY	09/28/04	Effluent	109.7%	108.8%	0.8%
CA0083097	FAWNDALE ROCK & ASPHALT	10/20/04	Effluent	102.3%	100.9%	1.4%
CA0083097	FAWNDALE ROCK & ASPHALT	10/20/04	Effluent	99.6%	119.9%	18.5%
CA0081833	GENERAL ELECTRIC CO GWCS	01/24/05	Effluent	120.6%	119.1%	1.3%
CA0081833	GENERAL ELECTRIC CO GWCS	07/05/05	Effluent	111.8%	108.1%	3.4%
CA0081833	GENERAL ELECTRIC CO GWCS	10/08/04	Effluent	114.0%	122.4%	7.1%
CA0082309	GWF POWER SYSTEMS, SITE IV	02/03/05	Effluent	97.8%	96.4%	1.4%
CA0082309	GWF POWER SYSTEMS, SITE IV	08/11/04	Effluent	94.8%	92.5%	2.5%
CA0004146	HERSHEY CHOCOLATE USA, OAKDALE	10/12/04	Effluent	111.5%	109.2%	2.1%
CA0004146	HERSHEY CHOCOLATE USA, OAKDALE	02/07/05	Effluent	100.9%	91.9%	9.3%
CA0083551	KONOCTI HARBOR INN	10/13/04	Effluent	110.8%	100.1%	10.1%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	12/08/04	Effluent	111.3%	111.1%	0.2%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	10/19/04	Effluent	107.0%	116.5%	8.5%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	10/19/04	Effluent	116.7%	100.9%	14.5%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	12/08/04	Effluent	121.6%	97.9%	21.6%
CA0082082	LOS BANOS FOODS, INC	09/07/04	Effluent	103.7%	89.9%	14.3%
CA0082783	MANTECA AGGREGATE SAND PLANT [b]	08/26/04	Effluent	96.5%	92.0%	4.8%
CA0083143	MINERS RANCH WTP	09/09/04	Effluent	106.6%	97.7%	8.7%
CA0004863	MIRANT CCPP ANTIOCH	11/02/04	Effluent	115.3%	122.6%	6.1%
CA0004863	MIRANT CCPP ANTIOCH	11/02/04	Effluent	123.5%	106.3%	15.0%
CA0083801	MODESTO ID REGIONAL WTP	01/18/05	Effluent	113.6%	111.3%	2.0%
CA0083801	MODESTO ID REGIONAL WTP	10/08/04	Effluent	113.8%	108.1%	5.1%
CA0083801	MODESTO ID REGIONAL WTP	04/11/05	Effluent	104.2%	95.8%	8.4%
CA0004821	PACTIV MOLDED PULP MILL	04/06/05	Effluent	116.8%	117.1%	0.3%
CA0004821	PACTIV MOLDED PULP MILL	08/03/05	Effluent	88.8%	100.5%	12.4%
CA0004821	PACTIV MOLDED PULP MILL	09/16/04	Effluent	123.5%	86.6%	35.1%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0083488	PARADISE WTP	09/08/04	Effluent	96.1%	103.7%	7.6%
CA0004316	PROCTER & GAMBLE CO WWTP	08/30/04	Effluent	124.6%	108.9%	13.4%
CA0083569	PROCTOR & GAMBLE COGEN. PLANT	08/11/04	Effluent	94.4%	93.2%	1.3%
CA0083569	PROCTOR & GAMBLE COGEN. PLANT	08/11/04	Effluent	100.0%	97.5%	2.5%
CA0034841	SACRAMENTO INTERNATIONAL AIRPT	08/31/04	Effluent	116.3%	110.6%	5.0%
CA0034841	SACRAMENTO INTERNATIONAL AIRPT	05/20/05	Effluent	103.0%	118.1%	13.7%
CA0004693	SHASTA LAKE WTP	11/12/04	Effluent	107.8%	104.1%	3.5%
CA0004693	SHASTA LAKE WTP	08/23/04	Effluent	80.5%	103.0%	24.5%
CA0082066	SIERRA PACIFIC, ANDERSON DIV	01/26/05	Effluent	95.2%	91.7%	3.7%
CA0082066	SIERRA PACIFIC, ANDERSON DIV	12/26/04	Effluent	102.6%	107.0%	4.2%
CA0082066	SIERRA PACIFIC, ANDERSON DIV	12/26/04	Effluent	112.7%	117.7%	4.3%
CA0082066	SIERRA PACIFIC, ANDERSON DIV	01/26/05	Effluent	93.8%	86.7%	7.9%
CA0081400	SIERRA PACIFIC, SHASTA LAKE DV	03/23/05	Effluent	103.2%	100.1%	3.0%
CA0081400	SIERRA PACIFIC, SHASTA LAKE DV	12/30/04	Effluent	91.2%	86.1%	5.8%
CA0084905	SLIGER MINE	12/20/05	Effluent	92.4%	99.1%	7.0%
CA0081965	STOCKTON COGENERATION FACILITY	08/18/04	Effluent	104.3%	96.1%	8.2%
CA0084182	UC DAVIS HYDRAULICS LABORATORY	09/22/04	Effluent	113.4%	110.3%	2.8%
CA0083348	UCDAVIS AQUATIC CENTER/ANIMAL SCIENCE	11/05/04	Effluent	103.7%	100.0%	3.6%
CA0083348	UCDAVIS AQUATIC CENTER/ANIMAL SCIENCE	09/22/04	Effluent	118.8%	124.6%	4.8%
CA0083348	UCDAVIS AQUATIC CENTER/ANIMAL SCIENCE	09/22/04	Effluent	116.7%	126.3%	7.9%
CA0004201	USDI FWS COLEMAN FISH HATCHERY	11/24/04	Effluent	112.8%	108.4%	4.0%
CA0084298	USDI FWS WINTER RUN REARING FACILITY	10/28/04	Effluent	118.1%	116.7%	1.2%
CA0081957	WHEELABRATOR SHASTA ENERGY CO	10/07/04	Effluent	91.0%	91.0%	0.0%
CA0077704	ANDERSON WWTP	10/06/04	Effluent (Mun-WW)	120.2%	128.4%	6.6%
CA0079197	ATWATER WWTP	09/28/04	Effluent (Mun-WW)	102.70%	107.70%	4.8%
CA0079219	ATWATER WWTP	09/14/04	Effluent (Mun-WW)	106.80%	106.60%	0.2%
CA0077712	AUBURN WWTP	10/06/04	Effluent (Mun-WW)	115.4%	115.9%	0.4%
CA0077712	AUBURN WWTP	08/31/04	Effluent (Mun-WW)	120.7%	115.1%	4.7%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0077712	AUBURN WWTP	07/12/05	Effluent (Mun-WW)	96.2%	117.8%	20.2%
CA0078930	BIGGS WWTP	08/23/04	Effluent (Mun-WW)	55.5%	56.0%	0.9%
CA0082660	BRENTWOOD WWTP	12/06/04	Effluent (Mun-WW)	107.6%	107.2%	0.4%
CA0082660	BRENTWOOD WWTP	11/01/04	Effluent (Mun-WW)	117.9%	119.3%	1.2%
CA0082660	BRENTWOOD WWTP	03/07/05	Effluent (Mun-WW)	115.9%	118.1%	1.9%
CA0082660	BRENTWOOD WWTP	10/04/04	Effluent (Mun-WW)	108.8%	110.9%	1.9%
CA0082660	BRENTWOOD WWTP	09/08/04	Effluent (Mun-WW)	109.5%	116.7%	6.4%
CA0082660	BRENTWOOD WWTP	01/03/05	Effluent (Mun-WW)	107.4%	99.7%	7.4%
CA0082660	BRENTWOOD WWTP	08/09/04	Effluent (Mun-WW)	99.4%	73.5%	30.0%
CA0079081	CHICO REGIONAL WWTP	05/10/05	Effluent (Mun-WW)	107.60%	107.60%	0.0%
CA0079081	CHICO REGIONAL WWTP	09/07/04	Effluent (Mun-WW)	106.10%	107.50%	1.3%
CA0079081	CHICO REGIONAL WWTP	06/14/05	Effluent (Mun-WW)	89.40%	91.70%	2.5%
CA0079731	CLEAR CREEK WWTP	06/09/05	Effluent (Mun-WW)	95.5%	95.5%	0.0%
CA0079731	CLEAR CREEK WWTP	09/08/04	Effluent (Mun-WW)	108.5%	105.5%	2.8%
CA0079529	COLFAX WWTP	11/10/04	Effluent (Mun-WW)	122.1%	117.0%	4.3%
CA0078999	COLUSA WWTP	08/26/04	Effluent (Mun-WW)	133.2%	91.9%	13.3%
CA0078999	COLUSA WWTP	12/02/04	Effluent (Mun-WW)	89.5%	90.7%	0.3%
CA0004995	CORNING INDUST/DOMESTIC WWTP	09/22/04	Effluent (Mun-WW)	122.3%	107.4%	13.0%
CA0081507	COTTONWOOD WWTP	09/30/04	Effluent (Mun-WW)	101.0%	106.8%	5.6%
CA0081507	COTTONWOOD WWTP	04/01/05	Effluent (Mun-WW)	98.7%	84.6%	15.4%
CA0079049	DAVIS WWTP	09/22/04	Effluent (Mun-WW)	102%	96%	6.1%
CA0078662	DEER CREEK WWTP	12/07/04	Effluent (Mun-WW)	92.5%	91.1%	1.5%
CA0078662	DEER CREEK WWTP	02/08/05	Effluent (Mun-WW)	105.5%	103.8%	1.6%
CA0078093	DEUEL VOCATNL INST. WWTP	04/20/05	Effluent (Mun-WW)	91.3%	92.5%	1.3%
CA0078093	DEUEL VOCATNL INST. WWTP	01/12/05	Effluent (Mun-WW)	99.5%	101.2%	1.7%
CA0078093	DEUEL VOCATNL INST. WWTP	10/26/04	Effluent (Mun-WW)	97.4%	93.8%	3.8%
CA0078590	DISCOVERY BAY WWTP	04/25/05	Effluent (Mun-WW)	87.9%	86.7%	1.4%
CA0078590	DISCOVERY BAY WWTP	08/18/04	Effluent (Mun-WW)	96.1%	92.0%	4.4%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0077691	EASTERLY WWTP	01/11/05	Effluent (Mun-WW)	87.1%	92.9%	6.4%
CA0078671	EL DORADO HILLS WWTP	06/07/05	Effluent (Mun-WW)	90.0%	90.0%	0.0%
CA0078671	EL DORADO HILLS WWTP	05/03/05	Effluent (Mun-WW)	95.3%	100.7%	5.5%
CA0078671	EL DORADO HILLS WWTP	01/04/05	Effluent (Mun-WW)	87.1%	92.3%	5.8%
CA0083682	FRENCH CAMP GOLF & RV PARK WWTP	08/17/04	Effluent (Mun-WW)	96.7%	98.0%	1.3%
CA0081434	GALT WWTP	11/02/04	Effluent (Mun-WW)	99.8%	117.0%	15.9%
CA0079898	GRASS VALLEY WWTP	06/02/05	Effluent (Mun-WW)	107.8%	105.6%	2.1%
CA0079898	GRASS VALLEY WWTP	08/26/04	Effluent (Mun-WW)	118.4%	109.3%	8.0%
CA0078956	HANGTOWN CREEK WWTP	07/27/05	Effluent (Mun-WW)	91.9%	93.8%	2.0%
CA0078956	HANGTOWN CREEK WWTP	08/18/04	Effluent (Mun-WW)	92.6%	107.7%	15.1%
CA0079391	JACKSON WWTP	09/14/04	Effluent (Mun-WW)	111.5%	112.3%	0.7%
CA0077852	LAKE CALIFORNIA WWTP	03/15/05	Effluent (Mun-WW)	102.1%	110.8%	8.2%
CA0081612	LAKE OF THE PINES WWTP	11/04/04	Effluent (Mun-WW)	97.4%	93.8%	3.8%
CA0077828	LAKE WILDWOOD WWTP	08/30/04	Effluent (Mun-WW)	106.0%	106.0%	0.0%
CA0077828	LAKE WILDWOOD WWTP	05/18/05	Effluent (Mun-WW)	100.0%	97.6%	2.4%
CA0084476	LINCOLN WWTP	10/20/05	Effluent (Mun-WW)	106.4%	106.5%	0.1%
CA0084476	LINCOLN WWTP	02/08/05	Effluent (Mun-WW)	103.8%	107.0%	3.0%
CA0079430	MARIPOSA WWTP	09/22/04	Effluent (Mun-WW)	106.0%	108.3%	2.4%
CA0079987	MAXWELL PUD WWTP	08/26/04	Effluent (Mun-WW)	79.8%	69.2%	14.2%
CA0079901	NEVADA CITY WWTP	08/30/04	Effluent (Mun-WW)	91.5%	104.0%	12.8%
CA0077836	OLIVEHURST WWTP	12/13/04	Effluent (Mun-WW)	80.7%	92.2%	13.3%
CA0077836	OLIVEHURST WWTP	08/23/04	Effluent (Mun-WW)	103.8%	89.3%	15.0%
CA0079235	OROVILLE WWTP	09/13/04	Effluent (Mun-WW)	97.70%	102.60%	4.9%
CA0079235	OROVILLE WWTP	10/18/04	Effluent (Mun-WW)	91.90%	99.70%	8.1%
CA0079316	PLACER CO SMD NO 1	09/01/04	Effluent (Mun-WW)	108.0%	103.7%	4.1%
CA0079316	PLACER CO SMD NO 1	10/06/04	Effluent (Mun-WW)	103.3%	96.5%	6.8%
CA0079367	PLACER CO SMD NO 3	08/25/04	Effluent (Mun-WW)	90.5%	87.8%	3.0%
CA0079367	PLACER CO SMD NO 3	09/01/04	Effluent (Mun-WW)	101.9%	108.9%	6.6%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0078950	PLANANDA CSD WWTP	12/13/04	Effluent (Mun-WW)	99.0%	107.0%	7.8%
CA0078891	RED BLUFF WWTP	02/09/05	Effluent (Mun-WW)	97.6%	97.9%	0.3%
CA0078891	RED BLUFF WWTP	09/16/04	Effluent (Mun-WW)	116.2%	113.1%	2.7%
CA0079588	RIO VISTA WWTP	04/25/05	Effluent (Mun-WW)	87.9%	86.7%	1.4%
CA0079588	RIO VISTA WWTP	08/18/04	Effluent (Mun-WW)	136.6%	109.1%	22.4%
CA0079464	SAN ANDREAS WWTP	12/29/04	Effluent (Mun-WW)	103.5%	101.9%	1.6%
CA0082848	SAN JOAQUIN CO DPW - FLAG CITY WWTP	04/21/05	Effluent (Mun-WW)	87.9%	86.7%	1.4%
CA0079511	SHASTA LAKE WWTP	11/12/04	Effluent (Mun-WW)	119.1%	111.3%	6.8%
CA0004758	SMUD RANCHO SECO NUCLEAR GEN STA 1	08/04/04	Effluent (Mun-WW)	93.6%	89.9%	4.0%
CA0082589	STILLWATER WWTP	06/09/05	Effluent (Mun-WW)	95.5%	95.5%	0.0%
CA0082589	STILLWATER WWTP	09/08/04	Effluent (Mun-WW)	129.8%	117.7%	9.8%
CA0079138	STOCKTON WWTP	11/10/04	Effluent (Mun-WW)	120.50%	120.10%	0.3%
CA0079138	STOCKTON WWTP	08/18/04	Effluent (Mun-WW)	99.70%	95.10%	4.7%
CA0079154	TRACY WWTP	10/06/04	Effluent (Mun-WW)	108.30%	106.90%	1.3%
CA0079154	TRACY WWTP	08/19/04	Effluent (Mun-WW)	48.30%	49.60%	2.7%
CA0079154	TRACY WWTP	06/22/05	Effluent (Mun-WW)	109.90%	115.40%	4.9%
CA0079154	TRACY WWTP	07/13/05	Effluent (Mun-WW)	90.70%	75.20%	18.7%
CA0078948	TURLOCK WWTP	08/23/04	Effluent (Mun-WW)	74.5%	75.5%	1.3%
CA0078794	WALNUT GROVE WWTP	04/06/05	Effluent (Mun-WW)	102.5%	110.0%	7.1%
CA0077933	WILLIAMS WWTP	08/25/04	Effluent (Mun-WW)	82.0%	122.0%	39.2%
CA0077950	WOODLAND WWTP	03/07/05	Effluent (Mun-WW)	104.1%	98.7%	5.3%
CA0077950	WOODLAND WWTP	08/11/04	Effluent (Mun-WW)	86.8%	100.5%	14.6%
CA0079260	YUBA CITY WWTP	08/24/04	Effluent (Mun-WW)	101.8%	111.7%	7.5%
CA0079260	YUBA CITY WWTP	11/22/04	Effluent (Mun-WW)	98.70%	97.40%	1.3%
CA0079260	YUBA CITY WWTP	05/26/05	Effluent (Mun-WW)	106.50%	93.90%	12.6%
CA0083968	CALAMCO - STOCKTON TERMINAL	08/26/04	Influent	102.6%	104.0%	1.4%
CA0081752	CALAVERAS TROUT FARM, INC TROUT REARING FAC.	09/30/04	Influent	113.6%	106.3%	6.6%
CA0004561	DFG DARRAH SPRINGS HATCHERY	09/15/04	Influent	100.5%	102.9%	2.4%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0004561	DFG DARRAH SPRINGS HATCHERY	09/14/04	Influent	111.9%	114.9%	2.6%
CA0004812	DFG SAN JOAQUIN FISH HATCHERY	09/28/04	Influent	108.8%	111.9%	2.8%
CA0082309	GWF POWER SYSTEMS, SITE IV	05/05/05	Influent	99.6%	93.4%	6.4%
CA0004316	PROCTER & GAMBLE CO WWTP	11/01/04	Influent	108.6%	106.6%	1.9%
CA0004316	PROCTER & GAMBLE CO WWTP	02/16/05	Influent	94.2%	99.3%	5.3%
CA0079197	ATWATER WWTP	09/28/04	Influent (Mun-WW)	37.90%	53.10%	33.4%
CA0079081	CHICO REGIONAL WWTP	09/07/04	Influent (Mun-WW)	113.80%	106.10%	7.0%
CA0078999	COLUSA WWTP	08/26/04	Influent (Mun-WW)	39.8%	33.6%	5.3%
CA0078662	DEER CREEK WWTP	08/02/05	Influent (Mun-WW)	125.0%	118.6%	5.3%
CA0079898	GRASS VALLEY WWTP	05/05/05	Influent (Mun-WW)	108.8%	115.0%	5.5%
CA0079898	GRASS VALLEY WWTP	12/02/04	Influent (Mun-WW)	129.5%	101.3%	24.4%
CA0079898	GRASS VALLEY WWTP	08/26/04	Influent (Mun-WW)	63.5%	44.9%	34.3%
CA0079430	MARIPOSA WWTP	09/22/04	Influent (Mun-WW)	104.2%	104.8%	0.0%
CA0079987	MAXWELL PUD WWTP	08/26/04	Influent (Mun-WW)	87.0%	98.5%	12.4%
CA0079901	NEVADA CITY WWTP	08/30/04	Influent (Mun-WW)	44.6%	31.7%	33.8%
CA0079901	NEVADA CITY WWTP	06/02/05	Influent (Mun-WW)	113.2%	79.6%	34.9%
CA0079588	RIO VISTA WWTP	08/18/04	Influent (Mun-WW)	94.5%	90.7%	4.1%
CA0077933	WILLIAMS WWTP	08/25/04	Influent (Mun-WW)	33.4%	23.2%	36.0%
CA0077933	WILLIAMS WWTP	03/01/05	Influent (Mun-WW)	132.9%	84.2%	44.9%
CA0077950	WOODLAND WWTP	02/09/05	Influent (Mun-WW)	98.2%	95.7%	2.6%
CA0077950	WOODLAND WWTP	09/20/04	Influent (Mun-WW)	83.4%	85.7%	2.7%
CA0077950	WOODLAND WWTP	10/14/04	Influent (Mun-WW)	92.0%	99.8%	8.1%
CA0079197	ATWATER WWTP	09/28/04	Receiving Water	109.70%	107.10%	2.4%
CA0083721	BELL CARTER INDUSTRIAL WWTP	12/15/04	Receiving Water	116.4%	116.3%	0.1%
CA0083721	BELL CARTER INDUSTRIAL WWTP	03/02/05	Receiving Water	129.1%	133.3%	3.2%
CA0079081	CHICO REGIONAL WWTP	09/07/04	Receiving Water	95.60%	102.50%	7.0%
CA0079081	CHICO REGIONAL WWTP	01/18/05	Receiving Water	89.70%	98.20%	9.0%
CA0077691	EASTERLY WWTP	05/10/05	Receiving Water	109.0%	107.0%	1.9%

Table C.1: Summary of Matrix Spike and Matrix Spike Duplicate Recoveries and Relative Percent Differences

NPDES NUMBER	FACILITY	DATE	MATRIX [(a)]	MS % RECOVERY	MSD % RECOVERY	RPD
CA0077691	EASTERLY WWTP	12/09/04	Receiving Water	105.0%	109.0%	3.7%
CA0077691	EASTERLY WWTP	01/11/05	Receiving Water	94.9%	88.5%	7.0%
CA0077691	EASTERLY WWTP	12/07/04	Receiving Water	97.2%	108.5%	11.0%
CA0004146	HERSHEY CHOCOLATE USA, OAKDALE	10/12/04	Receiving Water	105.5%	111.9%	5.9%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	12/08/04	Receiving Water	114.0%	116.3%	2.0%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	10/19/04	Receiving Water	105.5%	111.9%	5.9%
CA0081191	LEHIGH SOUTHWEST CEMENT CO	10/19/04	Receiving Water	117.5%	103.8%	12.4%
CA0079430	MARIPOSA WWTP	09/22/04	Receiving Water	110.3%	114.3%	3.4%
CA0079901	NEVADA CITY WWTP	08/30/04	Receiving Water	85.5%	83.5%	2.4%
CA0004821	PACTIV MOLDED PULP MILL	05/04/05	Receiving Water	118.0%	116.8%	1.0%
CA0004821	PACTIV MOLDED PULP MILL	09/16/04	Receiving Water	110.6%	116.8%	5.5%
CA0079316	PLACER CO SMD NO 1	08/05/04	Receiving Water	97.8%	106.1%	8.1%
CA0083569	PROCTOR & GAMBLE COGEN. PLANT	08/11/04	Receiving Water	98.8%	95.1%	3.8%
CA0081400	SIERRA PACIFIC, SHASTA LAKE DV	03/23/05	Receiving Water	100.0%	99.6%	0.4%
CA0081400	SIERRA PACIFIC, SHASTA LAKE DV	03/23/05	Receiving Water	88.9%	103.8%	15.5%
CA0081400	SIERRA PACIFIC, SHASTA LAKE DV	12/30/04	Receiving Water	110.6%	94.1%	16.1%
CA0084140	SWA AT MOUNTAIN GATE	10/19/04	Receiving Water	116.9%	115.6%	1.1%
CA0079154	TRACY WWTP	04/11/05	Receiving Water	104.20%	100.70%	3.4%
CA0079154	TRACY WWTP	08/25/05	Receiving Water	97.10%	93.50%	3.8%
CA0078948	TURLOCK WWTP	08/23/04	Receiving Water	13.3%	12.3%	7.8%
CA0078948	TURLOCK WWTP	08/23/04	Receiving Water	103.0%	83.5%	20.9%
CA0084182	UC DAVIS HYDRAULICS LABORATORY	09/22/04	Receiving Water	116.5%	127.4%	8.9%
CA0083348	UCDAVIS AQUATIC CENTER/ANIMAL SCIENCE	09/22/04	Receiving Water	116.5%	127.4%	8.9%
CA0077933	WILLIAMS WWTP	08/25/04	Receiving Water	90.5%	86.5%	4.5%
CA0077950	WOODLAND WWTP	11/09/04	Receiving Water	93.3%	93.6%	0.3%
CA0079260	YUBA CITY WWTP	10/12/04	Receiving Water	86%	99.40%	14.5%

[(a)] Effluent and influent data for municipal WWTPs is annotated with “(Mun-WW)”.
[(b)] The Manteca Aggregate Sand Plant is now known as Oakwood Lake Subdivision Mining Reclamation.

APPENDIX D
COMMENTS AND RESPONSES SUBMITTED DURING THE ADMINISTRATIVE DRAFT REVIEW AND PUBLIC DRAFT REVIEW

Following are comments submitted during the Administrative Draft Report and Public Draft Report reviews and staff responses. Comments are in **bold** and staff responses are in plain text.

1. Mike Paulucci (Laboratory Manager), City of Yuba City Utilities Department, Yuba City WWTP (CA0079260) – E-mail dated December 15, 2008

2. William T. Aravanis PE REA (Senior Engineer) and Paul C. Deutsch (Principal Scientist), General Electric Company, Former Kendall Site, Merced, California (CA0081833) – Letter dated December 22, 2008

3. Art O' Brien PE (Wastewater Utility Manager), City of Roseville, Roseville Pleasant Grove and Dry Creek WWTPs (CA0084573 and CA0079502) – Letter dated January 14, 2009

4. Linda Dorn (Business Citizen's Assistant), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) – Letter dated January 15, 2009

5. Lysa Voight PE (Senior Civil Engineer), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) – Letter dated March 18, 2009

6. Airy Krich-Brinton, Larry Walker Associates – Email dated June 11, 2009

7. Lysa Voight PE (Senior Civil Engineer), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) – Letter dated 15 June 2009

1. Mike Paulucci (Laboratory Manager), City of Yuba City Utilities Department, Yuba City WWTP (CA0079260) – Letter dated December 15, 2008

Table 11 on page 52 is missing the Field Duplicate data from our August 2004 sample event. I have attached a copy of the laboratory report. The table should include for the City's August 24, 2004 sample event a duplicate 1 value of 0.036 ng/L and duplicate 2 value of 0.038 ng/L (RPD 5.4%). Yuba City did not conduct field duplicates for September 2004 as properly noted in Table 11.

Table 11 on page 52 also lists both values for the July 5, 2005 sample event as 0.025 ng/L; however, the values should indicate that both sample were not detected at a reporting limit (RL) of 0.025 ng/L or"<0.025 ng/L".

Table 15 on page 62 lists Yuba City's discharge flow as 5.50 MGD. The flow for the sample dates is 5.22 MGD.

Table 19 on page 70 lists Yuba City's discharge flow as 5.50 MGD. The flow for the sample dates is 5.22 MGD.

Table C.1 on page 183 indicates Yuba City collected an influent sample on July 5, 2005. The City did not collect any influent methylmercury samples for this study as influent samples were voluntary as listed in the 13267 Order. The data listed in Table C.1 is from a sample location not related to the methylmercury study and should be removed.

R-1: Staff incorporated all of the corrections into the report.

2. William T. Aravanis PE REA (Senior Engineer) and Paul C. Deutsch (Principal Scientist), General Electric Company, Former Kendall Site, Merced, California (CA0081833) – Letter dated December 22, 2008

Table A.1 includes data for the National Pollutant Discharge Elimination System (NPDES) number CA0083739. That NPDES number was discontinued when NPDES number CA0081833 was issued in July 2004 with provisions to include discharges originally permitted under NPDES number CA0083739. The first round of methylmercury samples were collected in October 2004. Consequently, samples included in the December 2008 letter were not collected subject to NPDES number CA0083739 and reference to this NPDES number should be removed from Table A.1.

R-2: Staff removed the record of the NPDES # CA0083739 from Table A.1, since at the time the 13267 letter was sent, discharges originally covered under permit CA0083739 were included under the permit CA0081833.

Tables B.1 through B.4 contain footnotes (footnotes m, f, g, and c of tables B.1, B.2, B.3, and B.4, respectively)describing reasons that results of samples collected from the site on October 8, 2004, were not included in the tables. These footnotes indicate the samples were contaminated at the laboratory and that hold times were exceeded. However, the footnotes do not clearly indicate that the location where the hold time was exceeded was at the laboratory. For example, footnote m of table B.1 says "However, results for samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times exceeding EPA recommendations." GE requests that the RWQCB revise

the footnote to read "However, results for samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations for reanalyzing the samples." This change in wording would remove any ambiguity concerning where the samples were located when hold times were exceeded.

R-3: After looking at the Semiannual Monitoring Report sent on 21 February 2005, it does not appear that Brooks Rand was able to reanalyze the contaminated samples after the GE request because the remaining sample was contaminated as well. Therefore, staff revised the footnotes in Tables B.1 through B.4 to state: "However, results for samples collected on 8 October 2004 were not incorporated in the calculations due to sample contamination with mercury in the laboratory and preservation hold times at the laboratory exceeding EPA recommendations."

3. Art O' Brien PE (Wastewater Utility Manager), City of Roseville, Roseville Pleasant Grove and Dry Creek WWTPs (CA0084573 and CA0079502) – Letter dated January 14, 2009

Thank you for the opportunity to comment on the subject report. The comments are outlined below:

1. Page 26, 2nd full paragraph: "The denitrification process involves anaerobic bacteria converting nitrate to nitrogen gas with the help of methanol (Metcalf and Eddy, Inc., 1972)." This is likely an incorrect reference quote. First, at our WWTPs, the anoxic bacteria convert the nitrate to nitrogen gas. Second, not all WWTPs use methanol as the carbon source for the denitrification process. We do not add methanol as a carbon source. Third, a carbon source is only needed when the denitrification process follows the nitrification process. This sentence should be changed to: "The denitrification process involves anoxic bacteria converting nitrate to nitrogen gas with the help of a carbon source such as methanol (Metcalf and Eddy, Inc., 1972)."

R-4: Staff agrees with the suggested sentence change and modified the sentence in the report accordingly.

2. Table 19 (page 69): PGWWTP should have box 15 and 19 marked off
DCWWTP should have box 15 marked off

R-5: Staff made the suggested changes in Table 19. The Roseville Pleasant Grove WWTP was already placed in the "N/D + Filtration + Chlor./ Dechlor." treatment category, so the effluent methylmercury analysis for the various categories did not need to be redone.

3. Some of the data and statistical analyses do not support the conclusions:

- **Section 4.2.5, pg 30, 2nd full paragraph: the authors conclude there is a "significant positive relationship (R^2=0.1347, Figure 28a and R^2=0.0715, Figure 28b)" between influent methylmercury and effluent methylmercury. The authors go on to state: "These significant relationships indicate that reductions in methylmercury in the effluent were in part due to lower influent concentrations." This conclusion is not supported by the statistical analysis. The extremely low R^2 value would draw the exact opposite conclusion. R^2 is the square of the correlation coefficient or coefficient of determination. This statistical method is a good way of evaluating the strength of the relationship**

between 2 variables and is measure between 0 and 1. When R^2=1, there is a very strong relationship, conversely when R^2=0, a weak relationship exists. Therefore, it appears that these data demonstrates a very weak relationship at best.

R-6: Staff agrees that there is a weak relationship between influent methylmercury and effluent methylmercury indicated by the low R^2 values (square of the correlation coefficient). R^2 is the proportion of the variance of "variable y" that can be explained by the "variable x". Staff discussed this in the last sentence of the 2nd full paragraph on page 30: "…7-13% of the variability in effluent methylmercury concentrations was explained by influent concentrations, indicating that effluent concentrations were affected by other factors as well." Even though both of the relationships shown in Figures 28a and 28b have low R^2 values, they are statistically significant with p-values (two-sided levels of significance) less than 0.0001 using the one-sample t-test for the correlation coefficient (R). Typically, p-values less than 0.05 are considered statistically significant. The reason that the relationships have low R^2 values and are still significant is in part due to the large number of paired data points in each relationship. Figure 28a, which is the scatter plot of all paired data from all WWTPs excluding SRCSD Sacramento River WWTP, has 131 paired data points. Figure 28b, which includes the SRCSD Sacramento River WWTP paired data, has 238.

- **Section 4.2.6, pages 31 and 32: the authors draw the same "significant positive relationship" conclusion as was done in section 4.2.5. These data, again, resulted in extremely low R^2 values indicating that there is very low correlation between effluent methylmercury and effluent total mercury.**

R-7: Staff agrees that the relationships referred to in this comment are weakly correlated. However, all of these relationships have p-values less than 0.01 using the one-sample t-test for the correlation coefficient (R), which indicates statistical significance. See comment R-6 for further explanation.

- **Section 4.2.7, 3rd paragraph, page 32 and Section 4.2.8, 3rd paragraph, page 33: the authors conclude that there is no relationship between effluent methylmercury and influent total mercury. However, no statistical analysis (i.e. R^2 values) is presented that support these conclusions.**

R-8: Staff added the R^2 values and p-values to the text in the report referring to these relationships. All of the effluent methylmercury vs. influent inorganic Mercury and effluent vs. influent inorganic Mercury relationships had p-values greater than 0.05, indicating no statistical significance.

4. General observations:

- **The authors appear to work very hard at trying to draw statistically "significant" conclusions from this data using statistical modeling. This leaves the impression they are trying to make the data support a preconceived conclusion. Based on the data and the statistical analysis performed, the only conclusions that can be drawn are:**

  1. **Low levels of methylmercury exist in some WWTP's influent and effluent; however, a relationship can not be drawn.**

  2. **Low levels of total methylmercury exist in some WWTP's influent and effluent. Removal efficiencies can be determined.**

3. **The type of WWTP treatment process may influence the removal efficiency.**

4. **Seasonality may or may not play a role in methylmercury concentrations.**

R-9: One of the questions the Central Valley Water Board (Board) staff posed and analyzed in this report was: "Does a relationship exist between WWTP treatment processes and effluent methylmercury concentrations? Do WWTPs with a particular treatment process have higher effluent concentrations than WWTPs with other treatment processes?" In order to answer these questions, staff developed 10 mutually exclusive treatment categories based on secondary, tertiary and disinfectant treatment types. Pond and nitrification/denitrification treatments were considered separately from other types of secondary treatment types because they are significantly different from other treatments and could have an effect on effluent methylmercury concentrations. The categories were internally reviewed and verified by multiple Board engineers in the NPDES permitting unit who are very knowledgeable about WWTP treatment processes. Each WWTP that submitted effluent methylmercury data was assigned to one of these 10 categories and the data for all of the WWTPs in each category were grouped together for the analysis. Differences between the treatment categories were analyzed using a nonparametric multiple comparison procedure and the results were presented in the report. Staff allowed for the robust statistical test used to conclude the differences between the treatment categories and did not bias the test and results in any way. A similar procedure was used to compare effluent:influent methylmercury ratios, effluent inorganic Mercury:methylmercury ratios and the 3 secondary subcategories within the "Secondary + C/D" and "Filtration + C/D" categories.

- **The last paragraph of the report is of great concern (pg 38, 39): "additional monitoring studies and pilot projects". To require municipalities, under the auspices of AB13267, to provide personnel and funding to support this massive data acquisition could be problematic. Due to the limited resources and reduced budgets we are operating under, it would present real challenges to support this project both financially and from a personnel standpoint. Sampling for these constituents and performing the associated analyses is very expensive.**

R-10: The full paragraph (pg 38, 39) is: "Several Central Valley WWTP staff and consultants have noted that it would be very helpful to establish a working group that coordinates efforts between CVCWA, San Francisco Bay area facilities, and other regional efforts to develop more detailed analyses of the existing information, further evaluate treatment processes, and design additional monitoring studies and pilot projects. Board staff is supportive of this concept and will work with dischargers and working groups to design and review studies." Board staff appreciates the financial and personnel challenges of conducting additional studies and pilot projects. It is possible that this report's results may be used to support additional studies during the implementation phase of the Delta mercury control program and other upstream mercury control programs. As noted in the February 2008 draft Basin Plan amendment staff report[1] and in later responses to public comments,[2] Board staff recommends that, during the implementation phase of the Delta mercury control program, entities responsible for point and nonpoint sources conduct collaborative and coordinated control studies. During the time of this report, Board staff has been working with stakeholders to develop an efficient and cost effective mercury control program.

[1] Available at: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/staff_report_feb08/index.shtml

[2] Available at: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/stakeholder_meetings/25nov08_hearing_rtc.pdf

- **Our overarching concern is that further study and/or further regulation of WWTPs regarding methylmercury will not reduce the concentrations of mercury in fish tissue. It is important to provide a clear conclusion on this point in this report. As research has shown, and the authors actually cite in the second sentence of the Executive Summary, methylmercury only accounts for 1% of all mercury discharged to the Delta. Therefore removing 100% of the 1% isn't even statistically significant and wouldn't begin to address the problem. Also it should be noted, that all the WWTPs that discharge to the Delta account for less than 2% of the total mercury in the Delta. Again if 100% of the 2% were removed, no significant impact in reducing the mercury in the Delta would be realized.**

R-11: Of the approximately 400 kg inorganic Mercury that enters the Delta each year, about 2.2 kg is methylmercury. Although methylmercury is less than 1% of all mercury discharged to the Delta, methylmercury is the form that accumulates in the food web. If there were no methylmercury in Delta waters (i.e., if the 1% of all mercury discharged to the Delta that is in the form of methylmercury were demethylated), there would be no fish impairment.

The best available science indicates that reducing methylmercury in ambient water is the most direct way to reduce methylmercury in biota. Methylmercury is produced by many modern-day activities that humans may be able to modify so that less methylmercury is discharged. The Delta control program could focus on reducing methylmercury sources by reducing the inorganic mercury that supplies the methylation sites (i.e., reduce the inorganic mercury levels in Delta sediments by reducing discharges from mine sites and other legacy and modern sources) and by managing the methylation sources themselves to reduce methylmercury discharges. As part of their recommendations for a Delta mercury control program, Board staff recommended that WWTPs, MS4s, wetlands, irrigated agriculture, and new water management activities evaluate and develop management practices to reduce their methylmercury loads, such that each takes responsibility for its contribution to the impairment. As noted earlier, staff does not recommend that every individual NPDES, MS4, and agricultural and wetland landowner individually conduct a study, but instead recommends coordinated studies.

The stakeholder process for the Delta mercury control program will be developing an adaptive management approach to address the methylmercury impairment. Without the completion of point and nonpoint methylmercury control studies, it is not yet possible to define which sources are "important" or "insignificant" or which are feasible or make sense to control. When discussing the importance of different sources, many stakeholders have focused on the amount of loading by source category and by individual discharge. However, there are additional factors that should be considered. Given the number of individual discharges there are in each source category in the Delta, almost all of the individual discharges are small. Although the tributary inputs are substantial, available information indicates that they also contain a similar distribution of individual discharges. As determined as early as 1997 in the Sacramento River Mercury Control Planning Project report prepared for SRCSD by Larry Walker Associates, "… mercury sources in the study area appear to be diffusely distributed without any significant "hotspots" …" (LWA, 1997, page 31). Examples of small discharges include most wastewater treatment plants (which comprise about 4% of methylmercury inputs to the Delta), individual farm fields, and wetlands where water flow is managed in discrete units. It is the sum of all of the individual discharges (point and non-point) in the Delta and its tributary watersheds that impairs the Delta. The "importance" or "insignificance" of different methylmercury and inorganic Mercury sources could be defined by: (a) their load, (b) their distance from an impaired area, (c) how big of a reduction is needed to achieve safe fish mercury levels in a given impaired area, (d) whether they can be controlled, (e) whether they can be controlled without impacting habitat or operational function, (f) the cost to control them, and (g) the resources available to the

responsible parties to implement controls. It is conceivable that the control program for the Delta will need to focus on just a few large projects in some watersheds, but many small projects in other watersheds, to reduce methylmercury levels throughout the Delta.

Please refer to the February 2008 draft Basin Plan amendment and Delta TMDL staff reports[3] and the follow-up document, "Staff's Initial Responses to Board and Stakeholder Questions and Comments at the April 2008 Hearing"[4], for additional discussion on this topic.

4. Linda Dorn (Business Citizen's Assistant), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) – Letter dated January 15, 2009

SRCSD submitted two letters (attached), which included three lab reports, to the RWQCB within the required monitoring period. The three sampling dates are: 12/29/2004, 1/20/2005, and 4/6/2005. The data presented in the report only includes two sampling results rather than the three submitted. The sample result for 12/29/04 is missing. Including this result will decrease the average effluent methylmercury concentration from 2.16 ng/L to 1.69 ng/L. The average methylmercury concentration in discharge is presented in Tables 18 and 19 of the administrative draft of the staff report.

R-12: The sample collected on 29 December 2004 was excluded from calculations made in the report because the hold time between collection and preservation exceeded 60 hours. This is consistent with all other samples that exceeded 60 hours hold times. The effluent sample collected on 29 December 2004 arrived at Frontier Geosciences on 3 January 2005 and was preserved with acid upon receipt. This is approximately 120 hours between collection and preservation. USEPA Method 1630 (methylmercury analysis in water) requires samples to be preserved with acid within 48 hours to a pH of less than two. Acid preservation stops the bacterial activity in the water that produces methylmercury from inorganic mercury. Samples without preservation may not be representative of the conditions at the time of sampling if bacterial activity continues after sampling. Therefore, staff excluded data for all samples whose hold times exceeded 60 hours.

5. Lysa Voight PE (Senior Civil Engineer), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) - Letter dated March 18, 2009

Page 116, Figure 25 and Page 122 Figure 29B: SRCSD requests that a note be added to the figures indicating that three points of data were provided, but only two were used in this report for the SRCSD Walnut Grove WWTP. This might also be explained in section 3.6 anomalous values. A suggested wording for the footnote is: "Three data points were provided, but only two data points were used. The third data point was not considered in this report due to receipt of the

[3] Available at: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/staff_report_feb08/index.shtml

[4] Available at: http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/stakeholder_meetings/25nov08_hearing_rtc.pdf

sample beyond the 48 hour holding period at an elevated temperature as noted on the lab's transmittal memo."

R-13: Staff added a new table (Table 11) to the report to provide the methylmercury data that were excluded from the report's calculations due to quality control concerns (e.g., hold time exceedances greater than 60 hours and laboratory contamination). This table includes the effluent sample collected at SRCSD Walnut Grove WWTP on 29 December 2004. Section 3.2 (page 13) in the revised report refers to Table 11. Samples that do not meet quality control requirements may not be representative of the conditions at the time of sampling. Therefore, including excluded data in calculations could be misleading.

P.22: The statement "Municipal WWTPs may contribute significant methylmercury loads to receiving water" perpetuates the misperception that WWTPs are major sources of the total methylmercury to the river. This report and its analysis are focused on NPDES permit holders which are a small portion of the total and methylmercury loading. All loads to receiving water are not compared in this report so care should be used when referencing whether or not WWTP loading is significant. A more appropriate statement that SRCSD suggests is: "Municipal WWTPs appear to contribute a greater methylmercury load to receiving water when compared to the other permitted sources investigated in this report but are a small fraction of the total and methylmercury load in the Sacramento River and the Delta."

R-14: Staff edited the beginning of Section 4.2.

P.29-30: The paired influent-effluent samples should be qualified more by mention of the following note that SRCSD recommends adding to the second paragraph of page 30: "The paired samples do not necessarily represent the same parcels of water due to in-plant residence time."

R-15: Staff added the suggested text to the report.

P.38: An additional question that might be addressed by future analysis is suggested as follows: "Do other factors impact reported concentrations, such as sampling protocols including location, time of day, holding time, composite vs. grab samples?"

R-16: Staff added the suggested text to the report.

Executive Summary: SRCSD suggests that the following comment be added to the executive summary so that readers understand the relationship between discharge and receiving waters: "The concentration of mercury and methylmercury in waters is dynamic. Mercury methylates and demethylates as a function of several factors including the characteristics of the effluent stream and the characteristics of the receiving waters. The mercury/methylmercury inter-relationships are currently being studied by various stakeholders but are not fully understood at the time of the completion of this report."

R-17: Staff edited the Executive Summary.

6. Airy Krich-Brinton, Larry Walker Associates – Email dated June 11, 2009 sent to Michelle Wood (Environmental Scientist, Central Valley Water Board)

I have been using the data file you sent and checking the statistical calculations shown in the methyl mercury report, and I have a question. In Table 24 (and similar tables), the title indicates that a Kruskal-Wallis Multiple Comparison was performed on median values. However, that test only produces a single p-value, and the table is populated with multiple p-values, one for each

treatment category pair. Can you explain further how those p-values were calculated? The footnote states that they are two-sided significance levels multiplied by 36, but it does not tell how the significance levels are determined (what test was used). Can you help me find out which test was used to calculate the p-values in tables like Table 24?

R-18: Table 24 and similar tables report the p-values for the Kruskal-Wallis Multiple Comparison test run in the Statistica software. Basically, you run a Kruskal Wallis test and if you find that there are significant differences between medians then you have to run a multiple comparison test to identify which medians are responsible for the statistical difference. The documentation from Statistica (see attached) is the best way to determine the type of multiple comparison test used. Most likely it is a Dunn's comparison procedure. With Statistica you can set the test for a default p value. We used a traditional value of $p < 0.05$ as the cut off. However, the program will give you actual p-values, which is what we reported. Also, Table 24 and similar tables report two p-values for each pair comparison, which are actually identical when looking closely. We set the table up this way to make it easier to identify the p-values for a particular pair of treatment categories. [Response provided in a 12 June 2009 email.]

7. Lysa Voight PE (Senior Civil Engineer), Sacramento Regional County Sanitation District, Sacramento River and Walnut Grove WWTPs (CA0077682 and CA0078794) – Letter dated June 15, 2009

Thank you for the opportunity to review the final version of the subject document and for taking into account our comments from the previous draft version of the document. The following comments are being provided by SRCSD to help put the report's findings in a context that is useful for policy and regulatory efforts such as the Delta Mercury TMDL.

In the Executive Summary and in the Introduction, the low aggregate contribution of methylmercury to the Delta by NPDES permitted facilities should be clearly stated. The report refers to the relative contributions from different NPDES permitted sources, but does not provide important information regarding the numerical or quantitative significance of the sum of the point sources in the Delta relative to the entire methylmercury impairment.

R-19: The Administrative and Public Review drafts of this report focused on a review of effluent methylmercury concentrations and did not attempt to calculate effluent methylmercury loads for the more than 100 facilities in the Central Valley. However, staff agrees that having load estimates will be useful for the Delta and upstream TMDL development efforts. To address SRCSD's comment, staff added a new chapter to the report (Chapter 5) that includes a method for calculating methylmercury loads discharged by NPDES facilities within the Delta and its upstream watersheds, and compares the sum of those loads to overall methylmercury loading to the Delta by watershed.

Page 22, Section 4.2: The report cites older data for the SRWTP and states that methylmercury loads as a percentage of receiving water loads "was as high as 30 to 43% during the warm seasons of 2001 and 2002". Page 91 of the report shows a graphical representation of the percentage of methylmercury in SRWTP discharge compared to the Sacramento River. The two points selected for discussion are not typical values for the stated time period. Many of the points reported for years 2000-2006 indicate the SRWTP contribution to methylmercury is under 10%.

R-20: The entire sentence in the report is, "For example, a six-year comparison of the SRCSD Sacramento River WWTP effluent methylmercury loads as a percentage of its receiving

water loads was as high as 30 to 43% during the warm seasons of 2001 and 2002 and less than 1% during the wet seasons of 2005 and 2006 (Figure 4; Bosworth, 2008), ranging from 4.2% to 17% on an annual basis." The purpose of the text is to highlight the range of conditions as well as typical conditions. Also, although the three high points mentioned in the text (30%, 31%, and 43%) are not typical values, they are not anomalously high, given that there were 14 other points that fell between 20% and 30%. No changes were made to the text.

In the absence of an actual conclusive analysis, a general statement regarding the ability to reduce methylmercury levels in water through point source controls is questionable.

R-21: Staff assumes that SRCSD is referring to the sentence that follows the above mentioned percent range, at the end of the last paragraph on Page 22 of the draft report: "For some receiving waters, reducing municipal WWTP methylmercury discharges, along with other point and nonpoint sources, may be an important component in reducing methylmercury levels in water." Staff was careful to include both point and nonpoint sources in this general sentence. Until the proposed Phase 1 control studies are conducted, we cannot know for certain which point and nonpoint sources can be feasibly and reasonably reduced. However, it seems reasonable to note that reducing municipal WWTP methylmercury discharges may be an important component, especially for individual water bodies that are dominated by effluent from municipal WWTPs or for which municipal WWTP discharges comprise a substantial source. For example, the Sacramento River is the largest river in California and drains a 27,000 square-mile area – almost one fifth of the State of California and about one half of the Central Valley – that contains numerous reservoirs and a myriad of point and nonpoint sources downstream of the reservoirs. As noted as early as 1997 in the Sacramento River Mercury Control Planning Project report prepared for SRCSD by Larry Walker Associates, "… mercury sources in the study area appear to be diffusely distributed without any significant "hotspots" …" (LWA, 1997, page 31). As a result, any individual discharge from a point or nonpoint source that provides a notable percentage (e.g., more than 1%) of methylmercury loading to the Sacramento River warrants evaluation.

It should be noted in the report that methylmercury is not strictly bioavailable mercury nor is it conservative.

R-22: Staff edited the Introduction to reflect that methylmercury is the most bioaccumulated form of mercury, rather than most bioavailable. In addition, staff added text to further describe degradation processes, as well as how in some waterways processes of methylmercury production and transport downstream in the water column are dominant and in others, processes that remove methylmercury from the water column such as photodegradation and sedimentation are dominant, and included the results of SRCSD's 2008 Localized Mercury Bioaccumulation Study.

The Water Environment Research Foundation (WERF) recently completed a study of mercury bioavailability discharged from conventional municipal wastewater treatment plants. The WERF research is part of the difficult process of understanding the relationship between total mercury methylmercury and bioavailable mercury, all of which should be considered when evaluating the TMDL.

R-23: Staff agrees and, in response to this comment, staff added the following text to Chapter 6: "… at the time this report was receiving final review, reports for Phases 1 and 2 of the WERF-funded project, "Estimation of Mercury Bioaccumulation Potential from Wastewater

Treatment Plants in Receiving Waters", were released (Dean and Mason, 2009a and 2009b). This project assessed changes in mercury bioavailability in wastewater effluents and receiving waters and developed a guidance document for wastewater treatment professionals who want to assess the bioavailability of mercury in their wastewater, compare it to other point and nonpoint sources, and assess changes in bioavailability in their effluent when it is mixed in a receiving water body. The Phase 1 and 2 reports should be considered by future wastewater analyses and control studies, as well as when the Delta mercury TMDL control program goes through future reviews."

SRCSD previously commented with an objection to the use of the term "significant positive relationship" between paired influent and effluent data with low R^2 values (low model reliability). The Regional Board responded by stating that the low p-values associated with the results allow this term. While it is correct to say that a low p-value indicates statistical significance, the low R-values indicate that the fit of the model cannot be trusted more than "R-value" percent of the time. Thus, the model is not a good predictor on an individual basis.

R-24: Staff assumes that SRCSD is referring to the comment made by Art O' Brien (Wastewater Utility Manager, City of Roseville), and staff's response regarding how paired influent/effluent data with low R^2 values can have low p-values, indicating statistical significance (staff response R-6, page 192 in this appendix). As noted in staff's response, staff agrees that there is a weak relationship between influent methylmercury and effluent methylmercury indicated by the low R^2 values, and further that influent methylmercury concentration alone is not a good predictor of effluent methylmercury on an individual basis. This is why staff had included the following text in earlier drafts, "…7-13% of the variability in effluent methylmercury concentrations was explained by influent concentrations, indicating that effluent concentrations were affected by other factors as well." Staff added the word "substantially" ("were substantially affected") in attempt to more clearly indicate that staff is not stating that influent methylmercury alone is a good predictor, and carefully included similar text wherever low R^2 values were associated with paired data that also had low p values.