Water Quality Progress Report

Sacramento-San Joaquin Delta Estuary – Mercury and Methylmercury

(*Approved 2011*)

WATER QUALITY STATUS

- ○ TMDL targets achieved
- ○ Conditions improving
- ● Improvement needed
- ○ Data inconclusive

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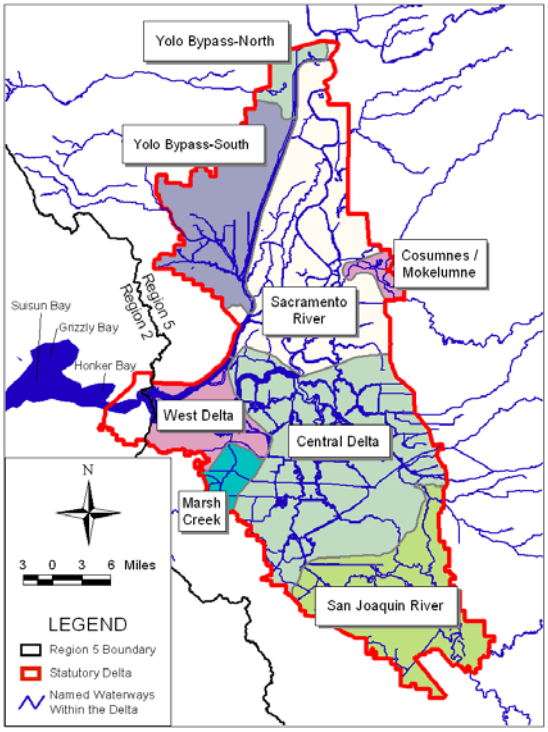
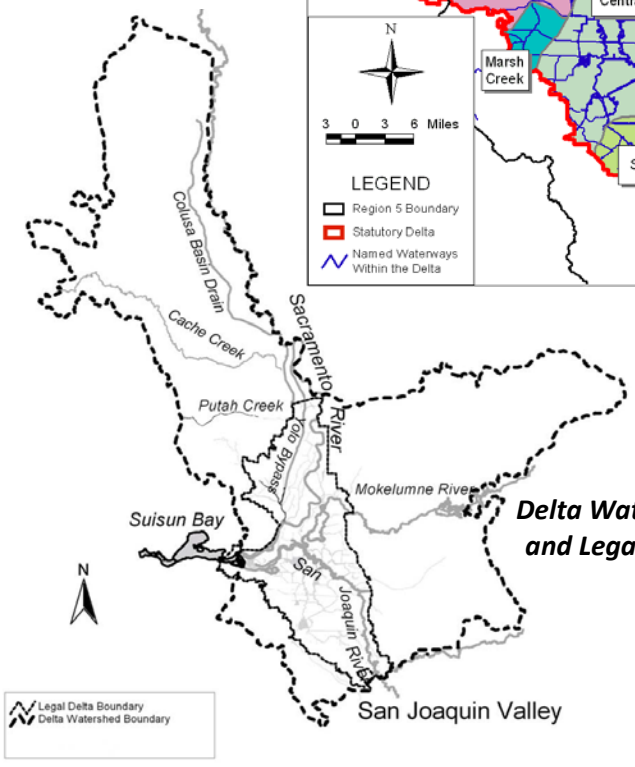
Total Maximum Daily Load (TMDL) Summary

Waterbody – The Sacramento-San Joaquin Delta Estuary (Delta) is made up of numerous river channels and islands hydrologically-connected through surface waters totaling approximately 738,000 acres in six central California counties. Sources of mercury come from both the legal Delta as well as the larger Delta watershed. For this TMDL, the Delta was divided into eight subareas based on hydrology (see map below): Yolo Bypass-North, Yolo Bypass-South, Cosumnes/Mokelumne, Sacramento River, West Delta, Central Delta, Marsh Creek, San Joaquin River.

The Legal Delta and eight hydrologic subareas





Delta Watershed (outer boundary) and Legal Delta (inner boundary)

Water Quality Goals

Mercury water quality objectives were identified for different size fish (by trophic level[1] [TL] and size measured in millimeters [mm]). These objectives protect both wildlife and human health.

The average methylmercury concentrations shall not exceed 0.08 and 0.24 mg methylmercury/kg (mg/kg) wet weight of tissue in trophic level 3 and 4 fish, respectively (150-500 mm total length).

The average methylmercury concentrations shall not exceed 0.03 mg methylmercury/kg wet weight in whole fish less than 50 mm in length.

Representative trophic level 3 fish include American shad, black bullhead, bluegill, carp, Chinook salmon, redear sunfish, Sacramento blackfish, Sacramento sucker, and white sturgeon. Trophic level 4 fish are represented by largemouth bass, striped bass, channel and white catfish, crappie, and Sacramento pikeminnow.

In addition, there is an implementation goal for unfiltered ambient water of 0.06 nanograms per liter (ng/L) methylmercury. This value is not a water quality objective, but is used in the TMDL to determine how much methylmercury in ambient Delta waters needs to be reduced to achieve the proposed fish targets. The TMDL also assigns load-based methylmercury allocations by Delta subarea for each source category and point source.

Targeted Attainment Date – Methylmercury load and waste load allocations for dischargers in the Delta and Yolo Bypass shall be met no later than 2030.

Water Quality Impairment – Mercury in the Delta comes from historic mining activity, natural springs and enriched soils, point sources, and deposition from air due to local and global emissions. Mercury is a naturally occurring element that has been mined because it is used for electrical applications, manufacture of chemicals, and certain lighting (among other devices), although its use is decreasing. Mining of mercury occurred in California for both direct use of the mercury as well as to extract gold during California's Gold Rush. It is also released from combustion (burning coal, natural gas, or petroleum). Mercury can be found in numerous chemical forms. One organic form, methylmercury, is the most hazardous form of mercury in the environment and can cause both chronic and acute toxicity to mammals (including humans), birds, and aquatic animals. In humans, methylmercury exposure can cause neurological symptoms as well as developmental concerns for children exposed in-utero. In addition, methylmercury exposure causes reduced reproductive success in wildlife. Within an organism, rates of intake of methylmercury tend to be greater than rates of elimination, such that it accumulates within tissues as an organism ages. Methylmercury also bioaccumulates, becoming increasingly concentrated in higher trophic levels of the food chain. The primary route of exposure for humans and wildlife to methylmercury is through consumption of contaminated fish and other aquatic organisms.

In 1971, a human health advisory was issued for the Delta advising pregnant women and children to not eat striped bass. Based on this advisory, the Delta was added to the California List of Impaired Waterbodies in 1990 because it is not meeting its beneficial uses due to mercury pollution. The advisory was most recently updated in November 2013. The California Office of Environmental Health Hazard Assessment issued separate advisories for the South and Central Delta and the North Delta. For these waterbodies, the advisories recommend that women ages 18 to 45 and children do not consume striped bass and white sturgeon due to elevated levels of methylmercury, among other pollutants. Consumption of pikeminnow and bass from the North Delta should also be avoided in this sensitive population. Subsequently, additional data collection indicates that several more fish species have high concentrations of methylmercury in their tissue, including some commonly-caught local sport fish. High methylmercury levels in fish pose risks for people and wildlife that eat Delta fish.

[1] Trophic levels identify the position of an organism in the food chain, ranging from level one to level five where higher values are associated with carnivores and predators.

Pollutant Sources – Sources of inorganic mercury in the Delta include tributary inflows from upstream watersheds, atmospheric deposition, urban runoff, dredging activities, and municipal and industrial wastewater. The tributary watersheds upstream of the Delta contain gold and mercury mine sites and legacy mercury in the stream channel sediments, geothermal springs, as well as other sources that wash downstream into the Delta. More than 97 percent of the identified total mercury that enters the Delta comes from these upstream watersheds.

There are also within-Delta sources of methylmercury. These more localized sources include the conversion of mercury to methylmercury by bacteria in wetlands and open water habitat as well as municipal and industrial wastewater, agricultural drainage, and urban runoff. Methylmercury is produced in surface sediments by bacteria. The chemicals cycle and they also flux between the water column and deposition to the sediment. The methylated mercury is bioavailable to organisms in the food chain, so the active sediment layer is an important source in the Delta. Overall, tributary inputs account for 58 percent of the methylmercury to the Delta (as opposed to the 97 percent of total mercury), while wetlands and open-water sediment contribute 36 percent (other smaller sources, such as wastewater, agricultural lands, urban runoff, and atmospheric deposition, make up the remaining 6 percent). These ratios represent the average inputs; specific loads vary by hydrologic subarea.

Loading Capacity and Allocations – The loading capacity is the maximum amount of a contaminant or stressor that can be assimilated by the waterbody without exceeding TMDL numeric targets (equal to the water quality objectives for this TMDL). The mercury loading capacity and source allocations in this TMDL are associated with the total allowable amount of methylmercury in water in the different Delta subareas and are presented in grams per year (g/yr). Reductions in existing sediment and water loads to the Delta are needed to reduce levels of methylmercury in fish, as the levels are strongly correlated.

Reductions were determined by comparing the existing average methylmercury concentrations in water for each subarea to the proposed methylmercury implementation goal for ambient water (0.06 ng/l). The reduction needed in each subarea is a percentage of the ambient concentration. Percent reductions required range from 0 percent in the Central Delta subarea to about 80 percent in the Yolo Bypass subarea. These subarea-specific percent reductions were applied to the existing methylmercury load to determine the loading capacity in g/yr (see table below).

The loading capacity was then separated by source, resulting in waste load allocations for point sources and load allocations for nonpoint sources (note: these are too numerous to list in the table below; detail is provided in the TMDL report). Waste load allocations are assigned to discharges from existing and future National Pollutant Discharge Elimination System (NPDES)-permitted wastewater treatment plants and municipal separate storm sewer systems within the Delta and Yolo Bypass. Load allocations apply to methylmercury flux from existing and future wetland and open-water sediments and agricultural lands and atmospheric deposition within the Delta and Yolo Bypass, as well as to tributary inputs to these areas.

	Delta Subarea						
	Central Delta	**Marsh Creek**	**Mokelumne River**	**Sacramento River**	**San Joaquin River**	**West Delta**	**Yolo Bypass**
Existing Annual Methylmercury Load (g/yr)	668	6.14	146	2,475	528	330	1,068
Loading Capacity (g/yr)	668	1.66	52.6	1,385	195	330	235
Percent Reduction Needed	0%	73%	64%	44%	63%	0%	78%

Note: No percent reductions are proposed for the Central and West Delta subareas because their fish tissue and aqueous methylmercury levels either currently achieve or are expected to achieve safe levels when actions are implemented to reduce upstream aqueous methylmercury levels.

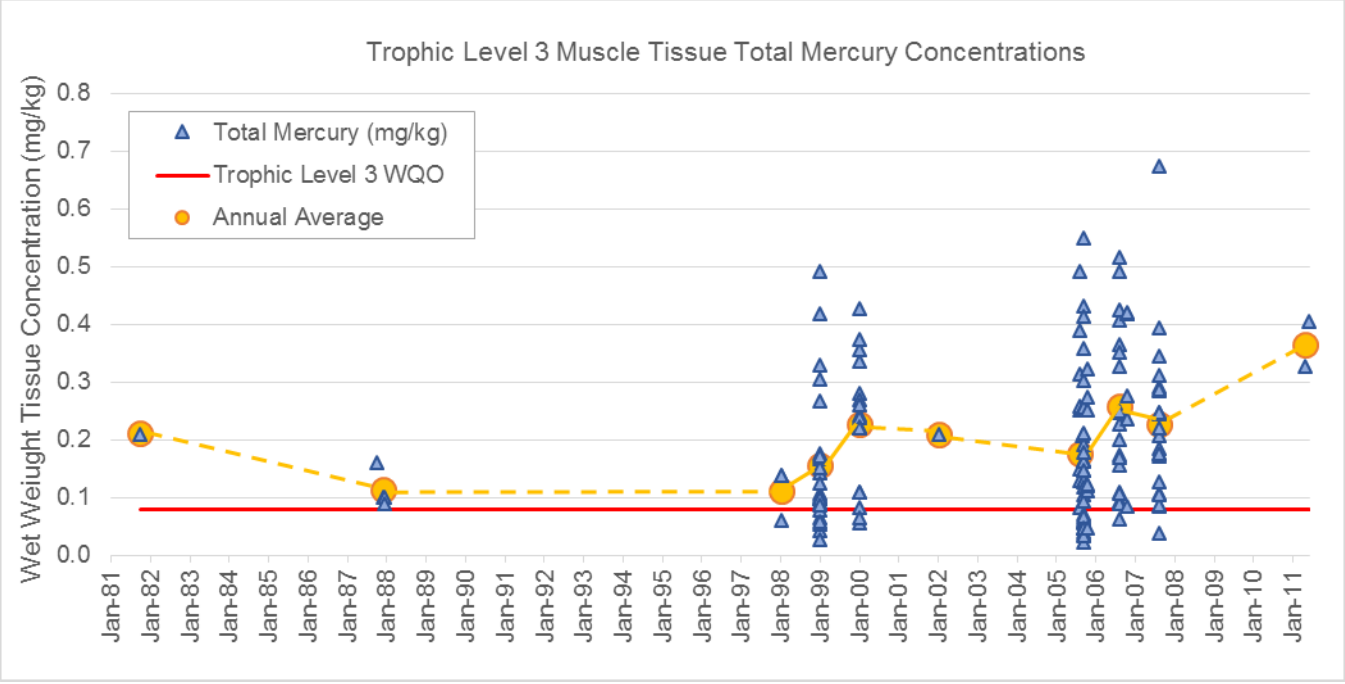
Is Water Quality Improving?

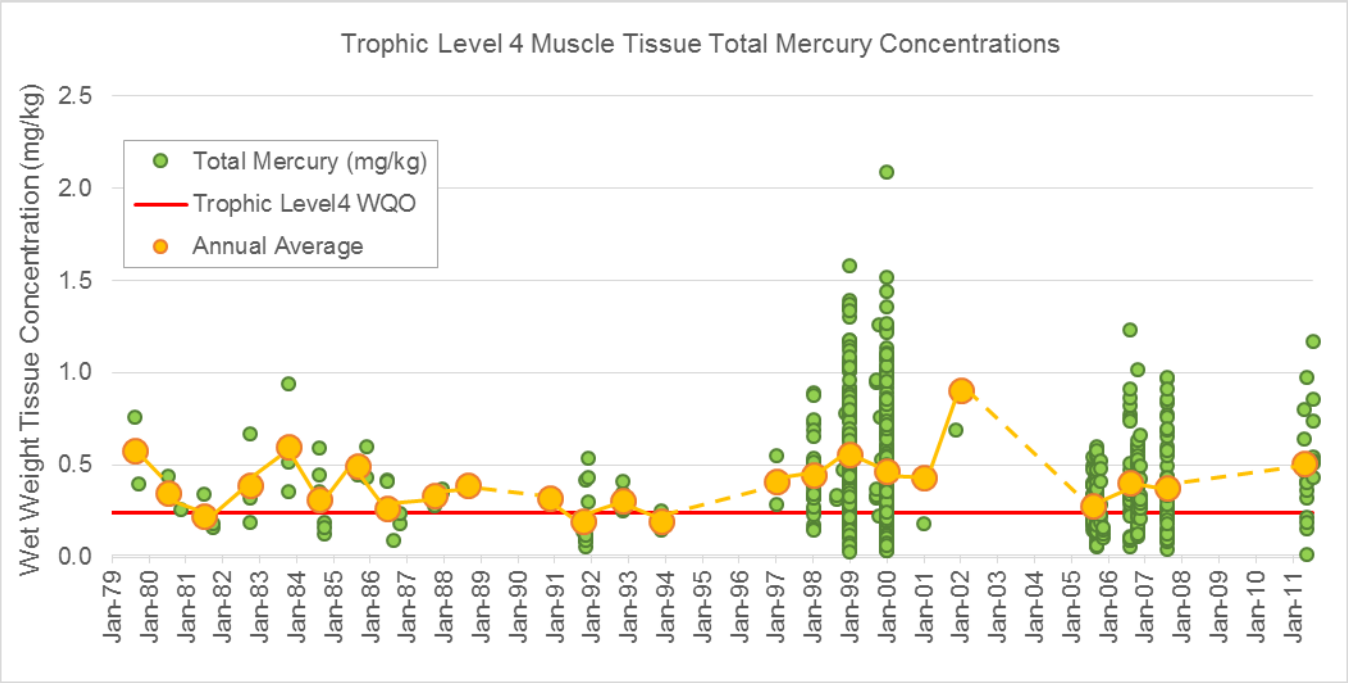
Fish tissue data are available for muscle tissue in trophic levels 3 and 4 in the Delta waterways. Raw data were assigned a trophic level based on the fish species and total length, consistent with the representative fish described above in the water quality objectives section. The data are graphed by date and compared to their applicable water quality objectives to investigate changes in concentration over time. The measurements generally fall between 0.1 and 1 mg/kg.

The first graph below shows the trophic level 3 fish tissue concentrations compared to the water quality objective, while the lower graph illustrates the trophic level 4 information. The majority of samples have concentrations well above water quality objectives for both trophic levels 3 and 4 (note: water quality objectives are based on methylmercury, while the data are total mercury values, providing a small margin of safety). In addition, the annual average concentration is shown on the plots (large circles connected by lines, where solid lines represent continuous years and dashed lines represent gaps between the years). Overall, these data confirm the lack of a temporal trend for the available data.

For trophic level 3 fish (American shad, black bullhead, bluegill, carp, Chinook salmon, redear sunfish, Sacramento blackfish, Sacramento sucker, and white sturgeon that are 150-500 mm in length), the earlier data are sparse, so it is impossible to tell whether concentrations have increased since the 1980s or if the lower concentrations are associated with a smaller sample size. Overall, these concentrations are within the same range as the more recent data. Nearly all of the trophic level 3 data collected since 2007 were all above the water quality objective.

There were more trophic level 4 samples than trophic level 3 collected throughout the 1980s and 1990s. These data are within the same range as the more recent data, although the more recent data have higher maximums and lower minimums, likely due to the increased sample sizes. When comparing the trophic level 4 data (largemouth bass, striped bass, channel and white catfish, crappie, and Sacramento pikeminnow that are 150-500 mm in length), the maximum concentrations were higher in 2000, although the recent decade of data are generally in the same range so it is not possible to identify trends.





These datasets indicate that concentrations have not decreased over time. The first ten years of TMDL implementation are referred to as Phase 1. During this phase, mercury reduction efforts will focus on reasonable, feasible implementation; however, most of effort in Phase 1 will include studies and planning for Phase 2. Phase 2 will involve implementation of the planned management measures. This phase will also include the initial fish tissue monitoring. The data presented above provide a useful baseline to compare the data collected as part of Phase 2 of TMDL implementation. Through continued implementation of management measures associated with the mercury sources described above, the water column and sediment concentrations are expected to decrease. The fish tissue concentrations will subsequently decline in response to the lower loadings; however, it is expected to take decades for the tissue data to show this response.

TMDL Progress – Implementation activities and milestones

Implementation Activity	Target Date	Status	Progress Details
Submittal of **individual pollutant minimization program workplans** to the Central Valley Regional Water Quality Control Board (Water Board) by all NPDES permitted facilities.	04/20/2012	Complete	• Pollutant minimization programs conducted by individual permittees and submitted as part of permit conditions.
Implementation of best management practices (BMPs) by all Municipal Separate Storm Sewer System (MS4) dischargers to control erosion and sediment discharges as well as implementation of **pollution prevention measures and BMPs to minimize total mercury discharges**.	None specified	In progress	• Ongoing activities are being implemented as part of permit requirements.

Implementation Activity	Target Date	Status	Progress Details
Annual progress report from NPDES Permitted Facilities and MS4 dischargers on implementation activities, evaluation of their effectiveness, and summary of monitoring results	Annually	In Progress	• All permittees submit reports as part of their permit requirements. • As an example: Sacramento Stormwater Quality Partnership submits and posts their Annual Reports (link)
Nonpoint sources in the Delta and Yolo Bypass shall **implement reasonable, feasible actions to reduce sediment in runoff** with the goal of reducing inorganic mercury loading to the Yolo Bypass and Delta, in compliance with existing Basin Plan objectives and requirements, and Irrigated Lands Regulatory Program requirements.	None specified	In Progress	• Nonpoint source programs, including the irrigated lands program, are conducting studies to characterize existing conditions, which will guide subsequent management actions. • Pilot tests of management measures in managed wetlands, effects of aquatic vegetation removal, and low intensity dosing with coagulants are underway.
Conduct Phase 1 Control Studies – report on how groups or individual dischargers will develop Control Study Workplans	04/20/2012	Complete	• Reported to the Board during annual update.
Conduct Phase 1 Control Studies –Control **Study Workplans due** to Central Valley Water Board (Executive Officer will approve within four months)	07/20/2012	Complete	• Including both individual and group efforts, thirteen methylmercury control work plans have been or will be finalized. Control Study Workplans largely cover the breadth of methylmercury source types in the Delta (urban runoff, wastewater treatment facilities, managed wetlands, irrigated agriculture, and tidal wetlands). • For open water, a methylmercury study is being conducted by several government agencies whose water management activities may effect methylmercury in Delta channels and the Bypass. • Methylmercury Control Study Workplans were approved by the Executive Officer and are being implemented.

Implementation Activity	Target Date	Status	Progress Details
Phase 1 Control Studies – Report **documenting progress** towards Control Study Workplans due to Central Valley Water Board.	10/20/2015	In Progress	Pending effort.
Phase 1 Control Studies – **Final Reports** for Phase 1 Control Studies due to Central Valley Water Board.	10/20/2018	In Progress	Pending effort.
Comprehensive Report on Phase 1 progress by the Executive Officer.	10/20/2015	In Progress	Pending effort.
Phase 1 Delta Mercury Control Program Review: Central Valley Water Board Staff reports to the Board the methylmercury control study results, pilot offset project results, and Technical Advisory Committee and staff proposals for updated TMDL allocations, and revisions for the Delta mercury control program and offset program.	10/20/2020	In Progress	Pending effort.
Water Board staff shall work with stakeholders to complete an **Exposure Reduction Strategy**.	10/20/2012	Complete	• Mercury Exposure Reduction Program Strategy, final report dated November 15, 2012 (link)
Dischargers to submit an **exposure reduction workplan** to Central Valley Water Board for approval	10/20/2013	Complete	• Delta Mercury Exposure Reduction Program Workplan submitted to the Water Board in October 2013 (link)
Dischargers to submit a **progress report** on the implementation of the exposure reduction workplan	Every three years after workplan approved	In Progress	• Ongoing effort, initial progress report due in 2016.
Study workplan for monitoring and studies to evaluate management practices to minimize methylmercury discharges from dredge return flows and dredge material reuse sites.	10/20/2013	Complete	• Completed by the Army Corps of Engineers as part of the Phase I Control Studies.
Department of Water Resources (DWR) to submit **strategy to reduce mercury loading from the Cache Creek Settling Basin**.	10/20/2013	In Progress	• Periodic progress reports are submitted that describe work completed to date and the strategy.
DWR to submit a **feasibility study** for improvements to the **Cache Creek Settling Basin**.	10/20/2015	In Progress	Pending effort.
DWR to submit **Cache Creek settling basin improvement plans**.	10/20/2017	In Progress	Pending effort.

Implementation Activity	Target Date	Status	Progress Details
Develop **mercury control programs** for tributary inputs from **Feather, Sacramento, San Joaquin, Mokelumne, American, and Cosumnes Rivers, and Marsh, Putah, and Morrison Creeks**.	through 2017	In Progress	• Will be included in TMDL that is in development for Central Valley rivers.
Phase 2: **compliance monitoring** and implementation of **upstream control** programs.	Annually beginning in 2022	In Progress	Pending effort.
Phase 2: implement **methylmercury control programs** and continue **inorganic (total) mercury reduction** programs.	By 2030	In Progress	Pending effort.
Central Valley Water Board staff will report progress of TMDL implementation.	Annually	In Progress	• Water Board is reporting to their Board annually.
Develop agency agreements with State Water Board, Air Resources Board, and U.S. Environmental Protection Agency (EPA) to evaluate and reduce atmospheric mercury sources.	None specified	In Progress	• A Water Board evaluation of air sources is underway.
TMDL Compliance Monitoring			
Fish tissue sampling for trophic level 3	Every 10 years beginning in 2025	In Progress	Pending effort.
Fish tissue sampling for trophic level 4	Every 10 years beginning in 2025	In Progress	Pending effort.
Whole fish sampling for small trophic level 2/3	Every 10 years beginning in 2025	In Progress	Pending effort.
Water methylmercury and total mercury compliance monitoring	Throughout Phase 1	In Progress	• Compliance monitoring is underway and is being reported in annual reports as part of permit conditions.

What Next?

Additional reductions are needed to achieve water quality goals. Completing a robust set of Phase I Control Studies that can be used to determine what is feasible to be regulated will be an important next step for implementation. Of note, more information on tidal and managed wetlands is needed and feasibility of management practices for nonpoint sources. Starting in November 2014, the Delta Mercury Exposure Reduction Program was funded for three years. Assessing its effectiveness and continuing it as needed will be important to reducing exposure.

Information Source Documents

- **Central Valley Water Board Basin Plan Amendment Staff Report –** Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total Mercury in the Sacramento-San Joaquin Delta Estuary, Staff Report, April 2010 (link)

- **Sacramento-San Joaquin Delta Estuary Total Maximum Daily Load for Mercury,** Staff Report, April 2010 (link)
- **Central Valley Water Board Final Basin Plan Amendment** – Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Methylmercury and Total mercury in the Sacramento-San Joaquin Delta Estuary, Resolution No. R5-2010-0043 (link)
- **Delta Mercury TMDL Implementation Phase 1** website (link)
- **Methylmercury Control Study Guidance For the Delta Methylmercury Control Program Implementation Phase I,** Central Valley Water Board, May 15, 2012 (link)
- **Delta Mercury Exposure Reduction Program** (link)
- **Central Valley Clean Water Association** (link)
- **Delta Methylmercury TMDL Nonpoint Sources Workgroup** (link)
- **Methylmercury Cycling, Bioaccumulation, and Export from Rice Fields and Wetlands in the Yolo Bypass**, US Geological Survey and Department of Fish and Game Moss Landing Marine Laboratories, September 2010 (link)
- **Assessment of Methylmercury Contributions from Sacramento-San Joaquin Delta Farmed Islands**, Moss Landing Marine Laboratories and HydroFocus, August 2009 (link)
- **Characterizing High Mercury Exposure Rates of Delta Subsistence Fishers**, UC Davis (link)
- **A Review of Methylmercury and Total Mercury Discharges from NPDES Facilities in California's Central Valley**, Final Staff Report, March 2010 (link)
- **Regional Mercury Load Reduction Evaluation Report** , Tetra Tech EMI, August 2008 (link)
- **Waste Discharge Requirements, Cities of Citrus Heights, Elk Grove, Folsom, Galt, Rancho Cordova, Sacramento, and County of Sacramento Storm Water Discharges from Municipal Separate Storm Sewer System Sacramento County**, Order No. R5-2008-0142, NPDES No. CAS082597 (link)
    - **Stormwater Improvement Plan for Sacramento County MS4** (link)
    - **Sacramento Stormwater Quality Partnership** (link)
- **East Contra Costa County Municipal NPDES Permit Waste Discharge Requirements**, Order No. R5-2010-0102, NPDES Permit No. CAS083313 (link)
    - **Contra Costa Clean Water Program** (link)
- **Waste Discharge Requirements, City of Stockton and County of San Joaquin Storm Water Discharges from Municipal Separate Storm Sewer System San Joaquin County**, Order No. R5-2007-0173, NPDES No. CAS083470 (link)
    - **Stormwater Quality Control Criteria Plan** (link)