



Water Quality Progress Report

San Francisco Bay – Mercury

(Approved 2008)

WATER QUALITY STATUS

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

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Total Maximum Daily Load (TMDL) Summary

Waterbody – The San Francisco Bay is located on the Central Coast of California. It is a broad and shallow natural embayment. The northern part of the Bay has more flushing than the southern portion because the Sacramento and San Joaquin rivers discharge into the northern segment, while smaller, local watersheds provide freshwater to the southern part. The northern and southern portions of the Bay are linked by the Central Bay, which provides the connection to the Pacific Ocean.

All segments of San Francisco Bay are included in this TMDL, including marine and estuarine waters adjacent to the Bay (Sacramento/San Joaquin River Delta within San Francisco Bay region, Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay including the Lower South Bay) (see map below). Three additional mercury-impaired waterbodies that are specific areas within these larger segments are also included in this TMDL (Castro Cove, Oakland Inner Harbor, and San Leandro Bay).



Segments of San Francisco Bay

Water Quality Goals

Mercury water quality objectives were identified to protect both people who consume Bay fish and aquatic organisms and wildlife:

To protect human health: Not to exceed 0.2 mg mercury per kg (mg/kg) (average wet weight of the edible portion) in trophic level¹ (TL) 3 and 4 fish.

This objective applies to the five most commonly consumed Bay fish. Compliance is determined by comparing this objective to concentrations in the edible portion of the five most commonly consumed fish (based on average evaluation lengths): 60 centimeters (cm) striped bass (TL4) muscle without skin, 75 cm California halibut (TL4) muscle without skin, 25 cm jacksmelt (TL3) muscle with skin and skeleton, 135 cm white sturgeon (TL4) muscle without skin, and 25 cm white croaker (TL4) muscle with skin.

To protect aquatic organisms and wildlife: Not to exceed 0.03 mg mercury per kg fish (average wet weight of whole fish 3 to 5 cm in length).

In addition, an acute water quality objective of 2.1 micrograms per liter ($\mu\text{g/L}$) is associated with the ambient water column concentration of San Francisco Bay. This objective is evaluated as a one-hour average concentration.

Targeted Attainment Date – Not specified in the TMDL; however, due to the nature of legacy pollutants such as mercury, water quality can take decades to show improvement. Achievement of the allocations for three of the largest source categories (Central Valley Watershed, urban stormwater runoff, and the Guadalupe River Watershed) is projected to take 20 years, with an interim 10-year milestone of fifty percent achievement.

Water Quality Impairment – Mercury in San Francisco Bay comes from historic mining activity, 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. Studies have shown that birds consuming fish and other organisms from San Francisco Bay pass mercury to their eggs, leading to a higher number of eggs that fail to hatch. 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.

Fish tissue collected from San Francisco Bay often contains relatively high concentrations of mercury. This has prompted the California Office of Environmental Health Hazard Assessment to issue a fish consumption advisory in the 1990s and the advisory was updated in November [2011](#). This advisory recommends people limit their consumption of Bay fish and certain species should not be eaten at all. In addition, mercury levels are high enough to harm wildlife. Specifically, birds (including the endangered California least tern) that consume fish with high levels of mercury pass that mercury into their eggs, which can result in eggs failing to hatch. Mercury is

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.

ultimately impairing several of the Bay beneficial uses, such as sport fishing, wildlife habitat, and preservation of rare and endangered species; and is therefore on the California List of Impaired Waterbodies.

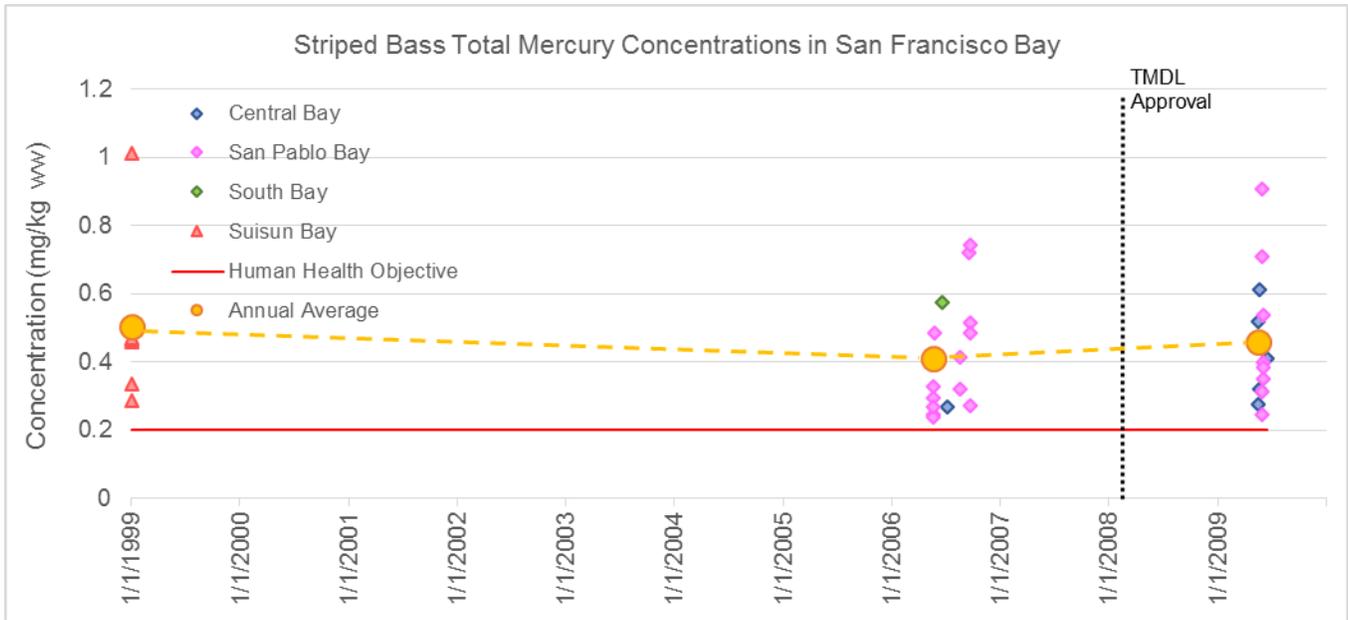
Pollutant Sources – The San Francisco Bay lies within a region naturally enriched in mercury. Mercury found in the Coast Ranges was mined and used as part of the gold extraction process during California’s Gold Rush in the 1800s. Much of this mercury then washed downstream to the San Francisco Bay, especially through the Central Valley. In addition, legacy mercury pollution in piles of waste rock, surface soils, and stream sediment originate from the historic mercury mines in the San Francisco Bay Area, including from the Guadalupe River watershed, and these sources contribute mercury to the Bay. Other sources of mercury include stormwater runoff (both urban and non-urban), wastewater discharges (municipal and industrial), atmospheric deposition, and bed erosion of historic deposits of mercury-laden sediment already in San Francisco Bay. Bed erosion and inputs from the Central Valley watershed made up nearly 75 percent of the mercury load to the Bay in 2003.

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 water quality objectives. The mercury loading capacity and source allocations in this TMDL are equal to loads to the Bay (in kilograms per year [kg/yr]) that will still meet water quality objectives. The loading capacity is 700 kg/yr. The load and wasteload allocations are presented by source categories. In addition, for the wasteload allocation source categories, allocations are provided for the individual wastewater and urban stormwater dischargers to the Bay.

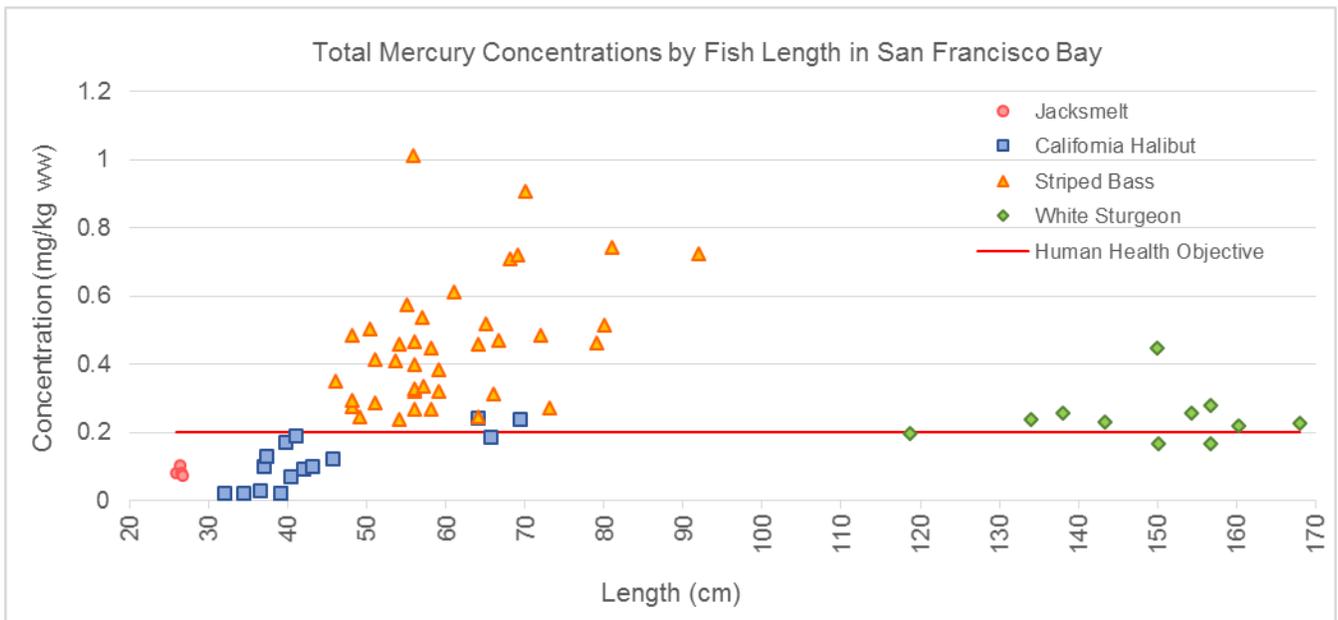
The selected water quality objective of mercury in fish tissue provides protection to fish consumers and the most direct assessment of fishery conditions and improvement. Meeting the 0.2 mg/kg mercury objective would require an estimated 40 percent reduction from current fish tissue levels. The overall load reductions to the Bay are also approximately 40 percent and are distributed among the following source categories: bed erosion, Central Valley watershed, urban stormwater runoff, Guadalupe River watershed, and municipal wastewater. The Bay will attain the applicable water quality standards when the overall mercury load is reduced to the loading capacity and mercury methylation control measures are implemented, reducing the conversion of total mercury into methylmercury (which is bioavailable and therefore more harmful to humans and wildlife).

Is Water Quality Improving?

Fish are collected for analysis every three years as part of the Regional Monitoring Program (RMP). The striped bass (TL4) data associated with fish in the small and medium size categories are presented below (note: this is consistent with the compliance monitoring described in the TMDL report). These data, which were obtained from the California Environmental Data Exchange Network (CEDEN, www.ceden.org), show that fish tissue concentrations have remained stable since the late 1990s (note: the TMDL was approved by the Environmental Protection Agency (EPA) in 2008; it is expected to take many years to observe improvements in fish tissue concentrations). All samples analyzed were above the human health objective of 0.2 mg/kg. In addition, the maximum observed concentration has not decreased significantly when compared to samples collected in 1999 and don’t appear to show any spatial or temporal trends, yet. The annual average concentration is also shown on the plot (connected by dashed lines), also confirming the lack of a temporal trend for the available data.



The available fish tissue data were further evaluated to compare tissue mercury concentrations by fish length. Concentrations associated with the most commonly consumed Bay fish were graphed by fish length. This analysis only included samples with both length and concentration data. It also included all lengths, not just those close to the proposed evaluation lengths. The striped bass data showed the highest concentrations, when compared to other fish. All of these samples were above the human health objective. The white sturgeon had the second highest concentrations, with most of the values above the human health objective, but generally within 0.1 mg/kg. Jacksmelt were the smallest fish and were all below the objective. Similarly, the California halibut concentrations were generally below the human health objective. Any observed measurements for halibut above this value were associated with larger fish.



Through implementation of management measures associated with the mercury sources described above, these fish tissue concentrations are expected to decrease. The TMDL implementation plan includes activities that span two decades, so it will be many years before the tissue data show lower concentrations in response to the reduced loads to the Bay.

TMDL Progress – Implementation activities and milestones

Implementation Activity	Target Date	Status	Progress Details
Attainment of the load reductions from the Central Valley watershed through implementation of the mercury TMDL for the Sacramento-San Joaquin Delta.	2031	In progress	<ul style="list-style-type: none"> Delta Mercury TMDL was approved by EPA in October 2011 (TMDL Staff Report link and Basin Plan Amendment Staff Report link). Implementation documented on the Central Valley Water Board website (link).
Water Board to incorporate urban stormwater wasteload allocations into the National Pollutant Discharge Elimination System (NPDES) stormwater permits issued to municipalities and Caltrans, including specific requirements associated with mercury control (see page 15 of the Basin Plan Amendment).	None specified	Complete	<ul style="list-style-type: none"> Municipal Regional Stormwater NPDES Permit No. CAS612008 (Order No. R2-2009-0074) was adopted on October 14, 2009 and Revised on November 28, 2011 (link). Caltrans Municipal Separate Storm Sewer System (MS4) Permit No. CAS000003 (Order No. 2012-0011-DWQ) adopted in September 2012 and effective July 1, 2013 (link).
Urban stormwater management agencies are responsible for the specific requirements associated with mercury control in their permit (see page 15 of the Basin Plan Amendment)	5 years after effective date of TMDL (2013)	In progress	<ul style="list-style-type: none"> Permittees submit annual reports documenting the collective and individual efforts associated with mercury load reduction, among other pollutants (link). Mercury monitoring is conducted through the Regional Monitoring Program (RMP) (link).

Implementation Activity	Target Date	Status	Progress Details
Implementation of best management practices and control measures by urban runoff management agencies to achieve wasteload allocations.	2028 (final) 2018 (interim)	In progress	<ul style="list-style-type: none"> • Stormwater load reductions have not yet been achieved. • Work under the first permit term includes pilot projects regarding mercury control measures as well as a monitoring program that will determine loads from local tributaries and conveyances over time. This approach assesses the feasibility of the TMDL reductions, which will be implemented through the Municipal Regional Stormwater Permit (MRP). • Permittees submit annual reports documenting the collective and individual efforts associated with mercury load reduction, among other pollutants (link). • Mercury monitoring is conducted through the Regional Monitoring Program (RMP) (link).
Caltrans-specific implementation actions (see page 16 of the Basin Plan Amendment).	None specified	In progress	<ul style="list-style-type: none"> • Caltrans develops annual reports and other documentation of best management practices and NPDES permit implementation (link). • In 2013-2014, the Caltrans Annual Report did not specify mercury load quantification or reduction actions.
Attainment of the load reductions in the Guadalupe River watershed mercury TMDL.	2030	In progress	<ul style="list-style-type: none"> • TMDL was approved by EPA in June 2010 (Basin Plan Amendment link and TMDL Staff Report link). • Progress is documented on the San Francisco Bay Water Board website (link).
The Water Board will issue a San Francisco Bay watershed mercury NPDES permit to all municipal wastewater dischargers listed in Table 4-x of the Basin Plan Amendment to implement the individual and aggregate mass limits.	None specified	Complete	<ul style="list-style-type: none"> • On November 1, 2007, the Water Board adopted a Watershed Permit for industrial and municipal wastewater discharges (aggregate permit limit was 17 kg mercury/yr). The permit was reissued in 2012 (link) (aggregate permit limit was 11 kg mercury/yr). This incorporates the wasteload allocations and specific requirements of the mercury TMDL.

Implementation Activity	Target Date	Status	Progress Details
Attainment of the municipal wastewater wasteload allocations.	2028 (final) 2018 (interim)	Complete/ Ongoing	<ul style="list-style-type: none"> • Municipal dischargers have performed pollution prevention efforts, solids removal, and capital upgrades at some treatment plants. • In 2012, the municipal wastewater load was 3.2 kg mercury/year. The average municipal wastewater load for the past five years has been about 3.9 kg mercury/year, more than 75 percent below its aggregate permit limit of 17 kg mercury/year (effective through 2012), and less than half the final TMDL limit of 11 kg mercury/year (note: 11 kg/yr is also the lower aggregate permit limit effective January 1, 2013).
The Water Board will incorporate the mass limits into NPDES permits for all industrial wastewater dischargers listed in Table 4-y and Table 4-z of the Basin Plan Amendment.	None specified	Complete	<ul style="list-style-type: none"> • On November 1, 2007, the Water Board adopted a Watershed Permit for industrial and municipal wastewater discharges (aggregate permit limit was 1.3 kg mercury/yr). The permit was reissued in 2012 (link) (aggregate permit limit was 1 kg mercury/yr). This incorporates the wasteload allocations and specific requirements of the mercury TMDL.
Attainment of the industrial wastewater wasteload allocations.	2028 (final) 2018 (interim)	Complete/ Ongoing	<ul style="list-style-type: none"> • Industrial discharge loads can vary from year to year and additional improvements in pretreatment will reduce loadings. • In 2012, the industrial wastewater load to the Bay was 0.62 kg mercury/year, their highest level in the past five years but still well below the final permitted allocation of 1.0 kg mercury/year (note: this is also equal to the aggregate permit limit as of January 1, 2013).

Implementation Activity	Target Date	Status	Progress Details
<p>Bay Area petroleum refineries will work collaboratively with the Water Board to investigate the environmental fate of mercury in crude oil and report findings to the Water Board within five years of the effective date of the San Francisco Bay mercury TMDL implementation plan (may be implemented via the Water Board's authority under Section 13267 of the California Water Code or petroleum refinery wastewater NPDES permits).</p>	2013	Complete	<ul style="list-style-type: none"> • San Francisco Bay Water Board submit requirements under Section 13267 for submittal of technical reports (link), including a schedule of deliverables. • Final Report on Bay Area Petroleum Refinery Mercury Air Emissions, Deposition, and Fate developed in June 2009 (link)
<p>Waste Discharge Requirements for dredging and disposal operations shall include requirements to conduct or cause to be conducted studies to better understand how their operations affect mercury fate, transport, and biological uptake.</p>	None specified	In Progress	<ul style="list-style-type: none"> • San Francisco Bay Water Board has a combined 401 certification/waiver of WDRs application form to ensure that applicants do not need to file both a report of waste discharge and an application for 401 certification (link). • The current application instructions do not discuss mercury impact or processes. • San Francisco Bay Water Board began implementing specific dredging requirements for redefining ambient and making in-Bay disposal decisions. • Monitoring and surveillance are required as part of the 401 program requirements for tidal restoration projects.
<p>The mercury concentration in dredged material disposed of in the Bay shall not exceed the 99th percentile mercury concentration of the previous 10 years of Bay sediment samples collected through RMP.</p>	None specified	In Progress	<p>Pending additional data to assess achievement of this target.</p>

Implementation Activity	Target Date	Status	Progress Details
<p>The U.S. Environmental Protection Agency should investigate the significance of atmospheric deposition and actively pursue national and international efforts to reduce the amount of mercury released through combustion of fossil fuels.</p>	<p>None specified</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • EPA’s National Emission Standards for Hazardous Air Pollutants for the Portland Cement Manufacturing Industry and Standards of Performance for Portland Cement Plants (link). • EPA’s Office of Science and Technology information on mercury (link) includes information on treatment technologies and monitoring. • United Nations Environmental Programme Global Mercury Partnership (link) provides information and reports on global assessments, guide for reducing uses and releases of mercury, among other materials. • Minamata Convention on Mercury is a global treaty to protect human health and the environment from the adverse effects of mercury (link).
<p>The Bay Area Air Quality Management District (BAAQMD) should conduct a local mercury emissions inventory, investigate the significance of local mercury air emissions, evaluate the effectiveness of existing control measures, and the feasibility of additional controls.</p>	<p>None specified</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • Annual inventory performed at various stations, including mercury loading (link). • BAAQMD Regulation 11, Hazardous Pollutants, Rule 5, Mercury (link). • Draft Bay Area 2010 Clean Air Plan, Volume II, Section A, Stationary Source Measures (link) identifies control measures for a cement manufacturing facility in the Bay Area that may be a local source of mercury emissions.
<p>Local inactive mercury mines shall be addressed through continued implementation of the Mines and Mineral Producers Discharge Control Program (Mines Program).</p>		<p>In Progress</p>	<ul style="list-style-type: none"> • Effort is currently focused on two high priority mercury mines, Bella Oaks mine in Napa County and St. John’s mine in Solano County. Staff recommends erosion control (grading and vegetation) of the calcine piles at the Bella Oaks Mine and identified a regulatory or funding path to accomplish remediation. St. John’s mine has only small piles of mining waste and very steep slopes. For the next fiscal year, staff plans to review the mercury discharge threat posed by St. John’s mining wastes. • Progress on the Guadalupe Watershed mercury TMDL, including mine cleanup activities, is documented on the San Francisco Bay Water Board website (link).

Implementation Activity	Target Date	Status	Progress Details
<p>The Water Board will incorporate requirements on page 23 of the Basin Plan Amendment into any relevant site cleanup plans to address Bay margin contaminated sites.</p>	<p>2013 for plan update 2018 for full implementation</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • San Francisco Bay Water Board has a combined 401 certification/waiver of WDRs application form to ensure that applicants do not need to file both a report of waste discharge and an application for 401 certification (link). • The current application instructions do not discuss mercury impact or processes. • Wetlands and stream protection information available on the San Francisco Bay Water Board website (link). • Several Bay margin site cleanup projects have been completed: <ul style="list-style-type: none"> ○ Castro Cove ○ Oyster Point ○ Alameda Naval Air Station Seaplane Lagoon ○ Treasure Island (lead offshore) ○ Hamilton Air Force Base (coastal salt marsh)
<p>Waste Discharge Requirements and Section 401 certifications for wetland projects shall include provisions that the restored wetland region be designed and operated to minimize methylmercury production and biological uptake, and result in no net increase in mercury or methylmercury loads to the Bay.</p>	<p>None specified</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • Monitoring and surveillance are required as part of the 401 program requirements for tidal restoration projects. • Extensive work has been conducted in the South Bay Salt Ponds Restoration Project associated with methylmercury production and biological update (link).

Implementation Activity	Target Date	Status	Progress Details
<p>Risk Management Activities</p> <ul style="list-style-type: none"> • Provide multilingual fish-consumption advice to the public to help reduce methylmercury exposure through community outreach, broadcast and print media, and signs posted at popular fishing locations. • Regularly informing the public about monitoring data and findings regarding hazards of eating mercury-contaminated fish. • Performing special studies needed to support health risk assessment and risk communication. • Investigate ways to address public health impacts of mercury in San Francisco Bay/Delta fish, including activities that reduce actual and potential exposure of and mitigate health impacts to those people and communities most likely to be affected by mercury in San Francisco Bay caught fish, such as subsistence fishers and their families. 		In Progress	<ul style="list-style-type: none"> • Dischargers are implementing a regional program of risk communication activities to raise public awareness of fish contamination issues, to encourage fish-consuming populations to reduce their exposure to pollutants in contaminated fish, and to quantify the risk reduction resulting from these communication activities. • Dischargers funded the California Department of Public Health to lead efforts to engage stakeholders, including local agencies, tribes, and community groups, in educating the public on how to reduce their exposure to PCBs and mercury when consuming Bay fish. • Project funded four community-based organizations (California Indian Environmental Alliance, Asian Perinatal Advocates, Greenaction for Health and Environmental Justice, and Kids for the Bay) to undertake risk communication outreach efforts to specific communities at risk of exposure to chemicals from eating fish caught in the Bay. Outreach efforts reached over 7000 individuals, and these individuals have over 22,000 family members who eat San Francisco Bay fish. Pre- and post-activity surveys indicate positive behavior change ranging from 60 percent to 96 percent.

Implementation Activity	Target Date	Status	Progress Details
<p>Review the San Francisco Bay mercury TMDL and evaluate new and relevant information from monitoring, special studies, and scientific literature. Determine if modifications to the targets, allocations, or implementation plan are necessary.</p>	<p>Every 5 years</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • San Francisco Bay Mercury TMDL Report Card is in preparation by the Water Board. • Water Board staff collaborated with the San Francisco Estuary Institute (SFEI) to prepare a synthesizing mercury-related data for San Francisco Bay, focusing on reducing methylmercury contamination in the Bay Area's aquatic food webs (link). • For urban stormwater, the Water Board took a pilot case study approach to assess the feasibility of reductions required by the TMDL. They are still working to implement these reductions through the MRP. The Water Board has decided not to revise the TMDL at present and wait for another permit term under the MRP.
TMDL Compliance Monitoring			
<p>Fish tissue sampling for average wet weight fish tissue muscle concentrations in small and medium striped bass.</p>	<p>Every 3 years</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • RMP has been monitoring mercury and other contaminants in larger fish since 1994. • The RMP data (link) show that the mercury water quality objective for the protection of human health is still exceeded regularly.
<p>Whole fish sampling (3-5 cm long)</p>	<p>None specified</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • RMP has been monitoring contaminants in small fish for several years. • Summary report on the data for small fish indicate that may of the small fish exceed the water quality objective for the protection of wildlife (link)
<p>Suspended sediment mercury concentrations (compared to 0.2 mg/kg dry sediment target), calculated as the difference between total and dissolved mercury concentration in a water sample divided by the suspended sediment concentration for that sample.</p>	<p>None specified</p>	<p>In Progress</p>	<ul style="list-style-type: none"> • Data collection and modeling are being conducted to estimate pollutant loads associated with suspended sediment input from tributaries (link). • Additional data analysis is needed to determine trends in the available datasets.

What Next?

Additional reductions are needed to achieve water quality goals. However, implementation activities are underway. Completion of the planned implementation activities for this TMDL as well as those associated with the Guadalupe Watershed and Delta mercury TMDLs will be necessary to achieve the targets.

Information Source Documents

- **Mercury in San Francisco Bay: Proposed Basin Plan Amendment and Staff Report for Total Maximum Daily Load Report and Proposed Mercury Water Quality Objectives** ([link](#))
- **San Francisco Bay RWQCB Adopted Amendment** – Amendments to the San Francisco Bay Basin Water Quality Control Plan ([link](#))
- **San Francisco Bay RWQCB TMDL Resolution Approval** – Amending the Water Quality Control Plan for the San Francisco Bay Region to Establish New Mercury Water Quality Objectives and to Amend the Total Maximum Daily Load and Implementation Plan for Mercury in San Francisco Bay, Resolution No. R2-2006-0052 ([link](#))
- **Water Board’s San Francisco Bay Mercury TMDL website** ([link](#))
- **Waste Discharge Requirements for Municipal and Industrial Wastewater Discharges of Mercury to San Francisco Bay**, NPDES No. CA0038849 (Order Nos. R2-2012-0096 [link](#) and R2-2007-0077 [link](#))
- **NPDES MS4 Permit** – California Regional Water Quality Control Board San Francisco Bay Region, Municipal Regional Stormwater NPDES Permit, Order No. R2-2009-0074, NPDES No. CAS612008 ([link](#))
- **Annual Reports for Municipal Regional NPDES Permit** ([link](#))
- **Caltrans MS4 Permit** – California State Water Resources Control Board, National Pollutant Discharge Elimination System (NPDES) Statewide Storm Water Permit Waste Discharge Requirements (WDRs) for State of California Department of Transportation, Order No. 2012-0011-DW Q, NPDES No. CAS000003 ([link](#))
- **California Environmental Data Exchange Network** ([link](#))
- **Regional Monitoring Program (RMP) Data Query Tool by San Francisco Estuary Institute** – Contaminant Data Display and Download ([link](#))
- **Reducing methylmercury accumulation in the food webs of San Francisco Bay and its local watersheds** ([link](#))
- **Reports of Monitoring Data**
 - **Mercury in San Francisco Bay forage fish** ([link](#))
 - **Patterns in Mercury and Trace Organic Contamination of Sport Fish and Sediments in San Francisco Bay Compared to the Offshore Coast** ([link](#))
 - **Mercury Contamination and The South Bay Salt Pond Restoration Project** ([link](#))
- **Requirement Under California Water Code Section 13267 For Submittal of Technical Reports on Mercury in Crude Oil and Associated Product and Waste Streams in Bay Area Petroleum Refineries To Assess Potential Discharges of Mercury Into San Francisco Bay** ([link](#))
- **Bay Area Petroleum Refinery Mercury Air Emissions, Deposition, and Fate**, Prepared for Western States Petroleum Association ([link](#))