Total Maximum Daily Load

for

Mercury

In the Walker Creek Watershed

Staff Report

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San Francisco Bay Region

January 16, 2007
With Minor Revisions April 4, 2008

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1 INTRODUCTION

Walker Creek, located in Western Marin County, California, is a 21-kilometer stream that flows through a historic mercury mining district and into Tomales Bay (Figure 1.1). According to requirements of the Clean Water Act, this creek is listed on the 303(d) list as impaired by mercury to the extent that it fails to meet water quality standards. Soulajule Reservoir, which drains to Walker Creek, is also listed on the 303(d) list as impaired by mercury.

The San Francisco Bay Basin Water Quality Control Plan (Basin Plan) (SFBRWQCB 1995) is the document that contains water quality standards applicable to the San Francisco Bay region.[1] A water quality standard defines water quality goals for a waterbody by designating uses for the water (beneficial uses), setting numeric or narrative water quality objectives necessary to protect these uses, and preventing degradation of water quality through antidegradation provisions.

Figure 1.1 Location Map

Section 303(d) of the Clean Water Act requires states to compile a list of "impaired" water bodies that do not meet applicable water quality standards. For these "impaired" water bodies, states are required to establish total maximum daily loads (TMDLs) for the pollutants causing impairment. TMDLs must be established at levels necessary to attain water quality standards.

This report provides the technical background and basis for a future amendment to Basin Plan to address mercury contamination in Walker Creek. If adopted, the amendment would establish new water quality objectives for methylmercury in fish tissue, a TMDL for mercury in Walker Creek and Soulajule Reservoir, and an implementation strategy to achieve and support the TMDL.

In this report, we discuss background conditions and mercury loads and concentrations in the Walker Creek watershed (including Chileno and Salmon creeks, tributaries to Walker Creek). We will describe how the TMDL and its associated implementation plan will ensure attainment of water quality objectives and protect beneficial uses of surface waters in the watershed consistent with state and federal antidegradation policies. We also provide the scientific basis for establishing two new methylmercury Water Quality Objectives and vacating an outdated one.

The process for establishing this TMDL has included:

- Compiling and assessing available data and information (such as existing instream and upland conditions)
- Conducting analyses relevant to defining the impairment problem
- Assessing any significant mercury sources that impact beneficial uses
- Identifying in-stream numeric targets that are consistent with the narrative and numeric water quality standards

[1] The California Toxic Rule, promulgated by the United States Environmental Protection Agency also contains water quality standards applicable to the San Francisco Bay region.

- Estimating the maximum mercury loading capacity for Walker Creek and its tributaries necessary to attain numeric targets
- Allocating loads among different mercury source categories
- Developing an implementation plan to solve the problem and monitor progress

1.1 Report Organization

This report includes nine sections that address the key technical elements of a TMDL:

1) *The Introduction* provides background information on the TMDL process.
2) *Project Background* provides an overview of mercury in the environment and in Walker Creek and Soulajule Reservoir and their tributaries (Walker Creek watershed).
3) *Problem Statement* describes how mercury is impairing beneficial uses in the Walker Creek watershed.
4) *Source Assessment* identifies and quantifies contributions of mercury to waterbodies in the Walker Creek watershed from various sources.
5) *Proposed Water Quality Objectives* describes two proposed new water quality objectives for the Walker Creek watershed to protect aquatic life and wildlife, how they are protective of human health, and the rationale for vacating the existing objective in Walker Creek
6) *Numeric Targets* describes the desired future water quality conditions (known as targets) for the Walker Creek watershed.
7) *Linkage Analysis* describes the relationship between mercury sources and the proposed targets, and provides a rationale for recommended actions.
8) *Allocations* proposes load allocations for various source types in the Walker Creek watershed and describes the margin of safety afforded by the analysis in Sections 4-8, as well as methods used to account for seasonal variations and critical conditions.
9) *Implementation Plan* proposes the mercury control actions necessary to reach the proposed targets, describes specific monitoring mechanisms that will be used to evaluate progress toward meeting the targets, and describes the process of gathering and evaluating new information as it becomes available.
10) *Monitoring and Evaluation Program* describes water quality and implementation monitoring actions necessary to track the TMDL progress and modify the TMDL and implementation plans if necessary.
11) *Regulatory Analysis* includes the required State and Federal analyses and summarizes the conclusions of the environmental impact assessment, evaluates alternatives to the proposed Basin Plan amendment, and considers economic factors relating to the amendment.
12) *CEQA Checklist* contains the environmental checklist for the proposed Basin Plan amendment.

A list of References includes sources used to in preparation of this document.

1.2 Next Steps

We are soliciting comments from the public on this report. The Basin Plan amendment and staff report will be revised according to comments we receive, as appropriate, before bringing this TMDL to the Water Board for a public hearing. At the Water Board hearing, staff will present the proposed Basin Plan amendment and Staff Report for the Board's consideration and adoption (authorized under California Water Code §13240).

Following adoption by the Regional Water Board and before a TMDL becomes effective, it must be approved by the State Water Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency.

2 PROJECT BACKGROUND

The goal of this TMDL is to establish and maintain environmental conditions that will result in the attainment of beneficial uses of Walker Creek and its tributaries. This will be accomplished by both reducing mercury entering the aquatic ecosystem and minimizing the potential for mercury to be transformed into its toxic and bioavailable form, methylmercury. This TMDL applies to freshwater portions of Walker Creek and tributaries draining to the freshwater (i.e. non tidally influenced) reaches of Walker Creek. Mercury impairment in the tidally influenced reaches of Walker Creek and Tomales Bay will be addressed in a subsequent TMDL.

This section provides a general overview of mercury in the environment, mercury fate and transport processes, and the biological resources in the Walker Creek watershed. Sections 3 (Problem Statement) and Section 4 (Source Analysis) discuss mercury in the watershed in more detail.

2.1 Physical Setting

The Walker Creek watershed is part of the Marin Coastal Basin. The following water bodies are downstream of historic mercury mines and addressed by this TMDL: Soulajule Reservoir, Arroyo Sausal, Walker, Salmon, and Chileno Creeks. (Figure 2-1) (See Sections 2.2 and 4.3 for a discussion of historic mines in the watershed).

Walker Creek is a moderate to high-gradient perennial stream 21 kilometers in length. The watershed is comprised of 197 square kilometers of low rolling hills and steep canyons and drains into the northern end of Tomales Bay. Walker Creek is the bay’s second-largest tributary, has an annual rainfall of 24–32 inches and supplies about 25 percent of the annual runoff into Tomales Bay (Fischer 1996, TBSTAC 2000). Typically, there is little or no precipitation from May to October. During the November to March rainy season, rainfall and runoff are often intense over relatively short periods. It is during this time that the creek transports a majority of its sediment and mercury loads and when downstream deposits may be eroded. Wildlife habitat in this watershed consists of a mosaic of grassland, valley foothill riparian forest, coastal scrub, and oak bay woodland (Zumwalt 1972). The watershed is underlain by the Late Jurassic to Cretaceous Franciscan Complex, which consists of sandstone, interbedded shales, mudstone, chert, greywacke, and minor conglomerate (USGS 2000). High grade, localized, and small mercury deposits containing cinnabar (a mercury sulfide ore) are found along Miocene Age faults that dissect the area. Mercury concentrations in soils and water are likely to be naturally enriched in this watershed.

2.2 Mercury in the Walker Creek Watershed

Mercury is a persistent bioaccumulative toxic pollutant that occurs naturally in cinnabar deposits in California’s Coast Range. It was mined in the Walker Creek watershed in the 1960’s and early 1970’s. Mercury mined during this period was used for gold mining and industrial and military purposes. The Gambonini Mine, the largest mercury mine in the watershed, was active from 1964 to 1970. Other inactive mine sites in the Walker Creek watershed include the Franciscan, Cycle and Chileno Valley mines. They all operated during the same period; the majority of their ore was hauled to the Gambonini property for processing. Mine operators used a mechanical separator and retort facility to extract the mercury from the ore and dumped the mercury-laden waste material in ravines and on the hill slopes below the processing facility. Thus the Gambonini property served as both a source and a repository for mining waste.

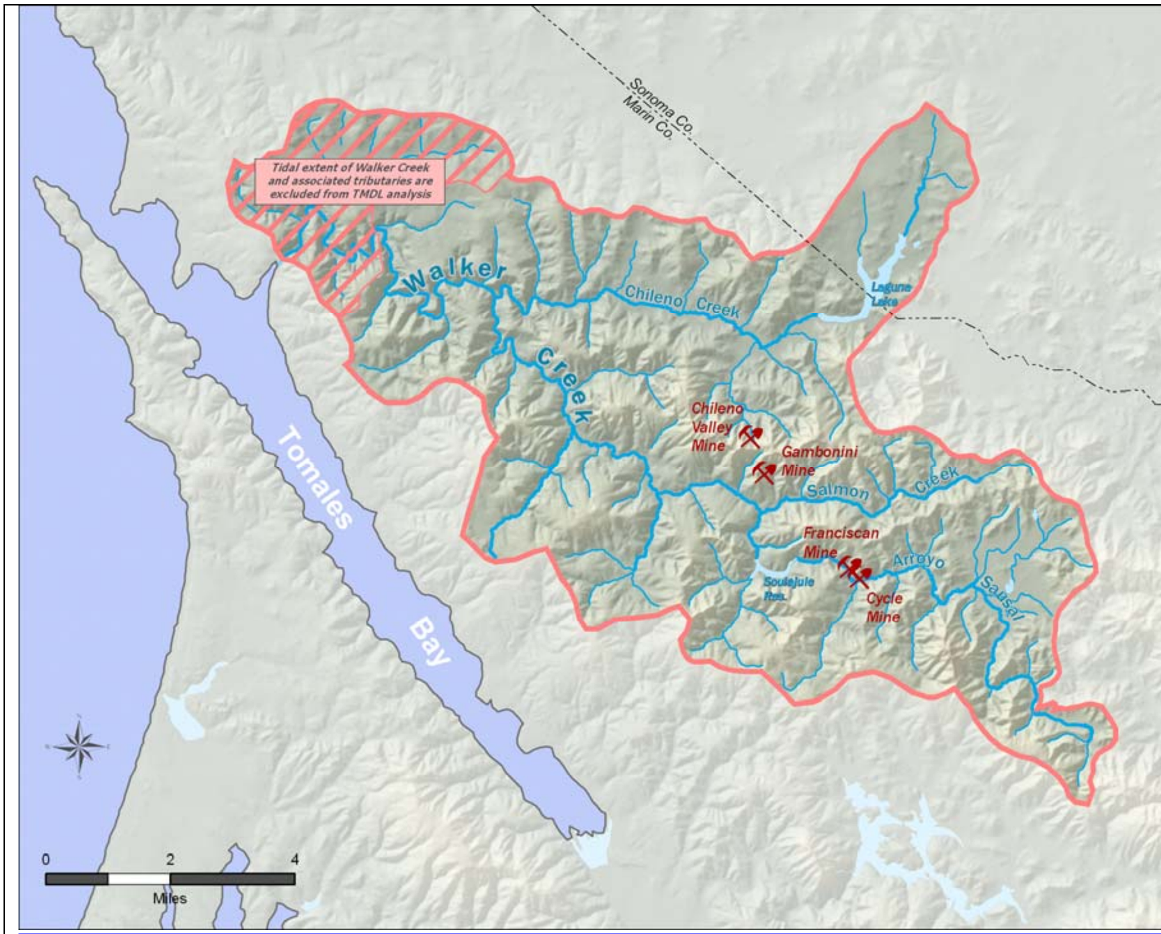

Figure 2.1 Walker Creek Watershed

The Walker Creek watershed includes four inactive mercury mines. This TMDL addresses the following water bodies downstream of these inactive mines: Soulajule Reservoir, Arroyo Sausal, Chileno, Salmon and Walker creeks.

From 1970 to 1982, at the Gambonini site, mining waste was trapped behind an earthen dam built across a steep canyon channel just down-slope of the former mine operations (indicated as “mine channel” on Figure 2.2). This dam failed during unusually heavy rains in the winter of 1982, inundating the channel and surrounding floodplains below with mercury-laden mine waste. In the 1990s the Gambonini mine site contained over 300,000 m^3 of erodable mining waste (Whyte & Kirchner 2000). Water quality studies suggest that hundreds to thousands of kilograms of mercury were discharged from the mine site to downstream waters in the years immediately following the 1982 dam failure (Whyte & Ganguli 2000).

Figure 2.2 Gambonini Mercury Mine

Photo of the Gambonini Mercury Mine taken after mining operations ceased. The mining waste pile drains to the mine channel, which discharges to Salmon Creek, a tributary of Walker Creek.

By 1972, all mining had ceased in the watershed. (See Section 4, Source Analysis, for a more detailed description of mercury sources in the Walker Creek watershed.) In 1999, the Water Board and the U.S. Environmental Protection Agency (U.S. EPA) initiated an emergency superfund cleanup at the Gambonini Mine site. Remediation focused on minimizing the runoff of mercury-laden sediment by using a combination of geotechnical engineering, revegetation, biostabilzation, channel reconfiguration, and runoff control techniques. (See Section 3, Problem Statement and Section 4, Source Analysis for more information on mercury loads generated from the Gambonini mine site pre and post-remediation.)

2.3 Methylmercury, Watershed Processes, And Mercury Transport

A conceptual model is a graphical, numerical, or narrative description of a system's components and their interactions. The narrative conceptual model we have developed to explain mercury transport and storage in the Walker Creek watershed is a tool for staff and stakeholders to use in assessing potential sources and developing implementation strategies to address impairment from these source areas. This is based on our understanding and observations of watershed processes, analysis of water and sediment samples, and a survey of inactive mercury mines in the watershed that compared the contemporary landscape with historical aerial photos.

Mercury enters the Walker Creek watershed's aquatic ecosystem via sediment transport of naturally occurring mercury found in soils, erosion of mining debris, runoff of water containing naturally occurring amounts of mercury and atmospheric deposition (volcanoes and the burning of fossil fuels emit mercury, for example). Mercury occurs in different forms. Elemental (liquid) mercury, can be found in small quantities in high-grade ore deposits or in mining waste piles. More commonly, and in much greater abundance, cinnabar—a mercury sulfide and inorganic form of mercury—is found in rocks and soils. These forms of mercury can be transformed by biological and chemical processes into the chemical form of greatest concern, organic methylmercury. Before we explore methylmercury and bioaccumulation, let us explore the forms of inorganic mercury.

Christopher Kim and others studied the geological and anthropogenic factors influencing mercury speciation in California coastal range mercury mine wastes, including wastes from the Gambonini Mine (Kim et al. 2003). They found that "(c)alcined wastes in which Hg ore was crushed and roasted in excess of 600 (degrees Celsius), contain high proportions of metacinnabar while the main Hg-containing phase in unroasted waste rock samples from the same mines is cinnabar." Cinnabar and metacinnabar have the same chemistry (mercuric sulfide), but in a different physical arrangement. Cinnabar is the highly organized hexagonal crystal form, whereas metacinnabar tends to have some impurities and as a result less organized crystals in the cubic form. They noted that compared to the quartz and metal oxides that comprise the bulk of mine wastes, "insoluble yet soft Hg-sulfides are subject to preferential weathering and become enriched in the fine-grain fraction … The speciation of Hg in mine wastes is similar to that in distributed sediments located down-stream from the same waste piles, indicating that the transport of Hg from mine waste piles does not significantly impact Hg speciation." In their conclusion they noted that "the conversion of cinnabar to metacinnabar… may not be significant, however, as the solubilities of both phases are equally low." Therefore, in this conceptual model of mercury in the Walker Creek watershed, we consider all inorganic forms of mercury as having equal potential to become methylmercury.

Methylmercury is bioavailable to the plants and animals at the base of the aquatic food web. As these organisms pass methylmercury up the food chain, it biomagnifies: levels in fish can be 1–10 million times higher than levels in the waters in which they live (Wiener et al. 2003).

Methylmercury formation is a multi-step process. The primary agents are bacteria commonly found in the low-oxygen interface between sediment and water in wetlands, floodplains, and reservoirs. Other factors such as high dissolved oxygen levels can lead to the reverse process: demethylation. The rate of methylation or demethylation is influenced by a wide variety of factors in the aquatic environment, including temperature, depth, sunlight penetration, oxygen levels, plant growth, salinity, sulfur, and carbon levels. Nutrients can increase the rate of methylmercury production by stimulating the methlylating bacteria (Beckvar et. al, 1996). In general, the optimum conditions for methylmercury production occur during the warm, low-flow dry season, particularly in low-oxygen conditions in wetlands, stagnant pools in creeks and floodplains, and in deep waters in thermally stratified reservoirs.

Due to its geochemical properties, mercury strongly adheres to sediment. In the riverine ecosystem of Walker Creek, mercury's transport through the watershed originates when runoff delivers sediment-bound mercury (either naturally occurring or from mining waste) from hillslopes down into stream channels. Sediment and therefore mercury transport is strongly influenced by the landscape's physical attributes (i.e., topography), stream power (energy available to transport sediments in the creek), and land uses.

The Walker Creek watershed is bounded on the west by the San Andreas fault (which runs through Tomales Bay), and is dissected by numerous smaller faults. Due to active tectonics, the watershed includes a great many steep headwater streams that drain through hilly canyon terrain. Floodplains in the canyon portion of the watershed are not extensive.

Streams can generally be divided into sediment production zones (also referred to as source zones), sediment transfer zones, and sediment deposition zones. Sediment production zones occur in the upper parts of a watershed, often on the smaller headwater tributaries (such as the intermittent channel that drains the Gambonini Mine site), where the streams pick up sediment generated by processes such as overland flow, gullying, debris flow, and deep-seated landslides. Sediment transfer zones receive sediment from sediment production areas or from transfer zones farther upstream. In these areas there is little net accumulation of sediment (aggradation) (sediment accumulation) or degradation (loss of sediment). These are short-term storage areas for sediment passing through the drainage. Sediment depositional zones, on the other hand, reflect sediment "sinks" in the watershed. Of course, none of these general classifications is absolute. Production zones can and do store sediment, whether in pockets behind boulders or on small benches adjacent to the stream channel. Depositional areas can be sources of sediment through bank erosion and erosion of floodplains during large storm events.

Figure 2.3 illustrates the general transfer, depositional, and production zones in the Walker Creek watershed. The production zones are the smaller streams not labeled on the figure. The steep headwater channel draining the Gambonini Mine is in a production zone. In its upper reaches Walker Creek is incising due to long-term climate changes and impacts from land use. Downstream it transitions to a moderately incised transfer/deposition zone. The lower downstream reach is depositional (see Figure 2.3) (Haible 1976, Marin RCD 2005). In other words, the water in the creek and the sediment it carries no longer slows or deposits in the upper reaches. Instead, the relatively flat, meandering reaches near the mouth of the creek have become active deposition zones.

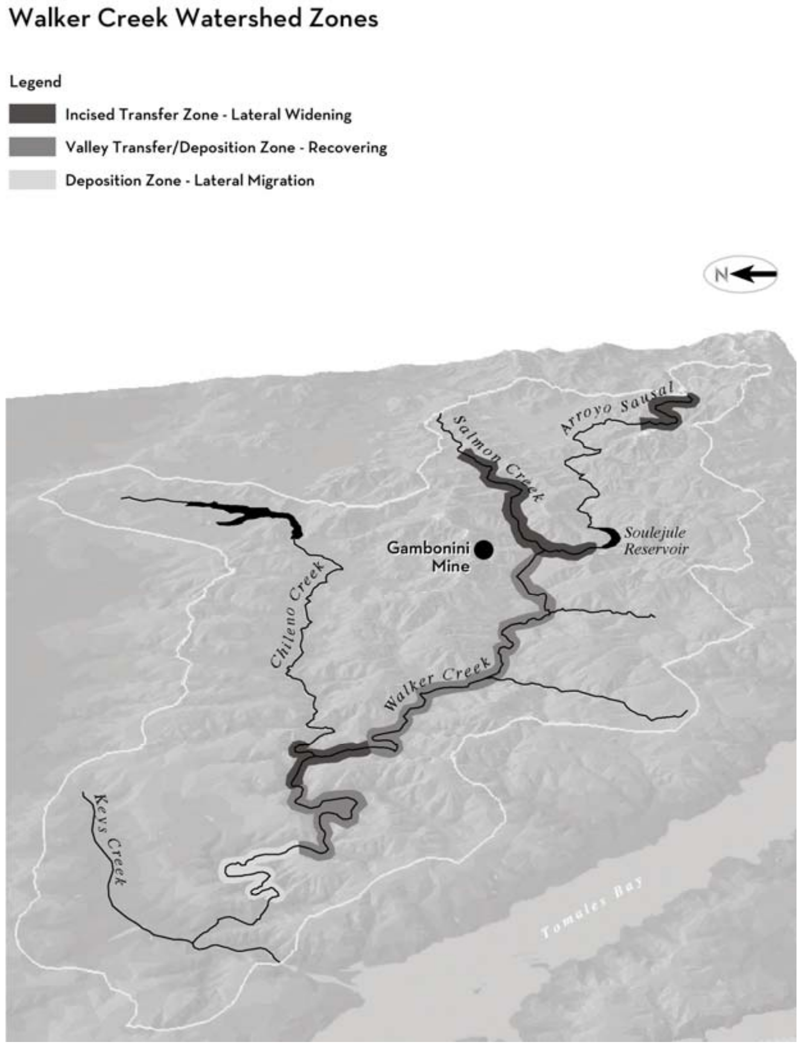

Figure 2.3 Walker Creek Transfer and Deposition Zones

Channel reach classification in the Walker Creek watershed. The Gambonini mine drainage is considered a production zone, as are many of the smaller, steeper tributaries not delineated on this general map. Downstream of the Gambonini Mine (Gambonini drainage) and the Cycle and Franciscan Mines (Arroyo Sausal drainage), Walker Creek is classified as a transfer/deposition zone. Only the very lower part of the watershed is considered a depositional zone. (Modified graphic from Marin RCD 2005)

During very rainy years, a stream may deposit sediments across its entire floodplain. But in hilly or steep locations where there is no room for the water to spread out during storms (“confined” areas), a creek will cut down into its bed, deepening the channel (a process called incision). At some point, when the channel is deep enough, moderate size storms will no longer overtop the banks and deposit sediment on the floodplains as they used to do on a regular basis. In moderately incised streams floodplains are “perched” (elevated above the previously flooded area). In these places sediments that in the past would have been mobilized by frequent storms are now only mobilized by larger storms that carry enough water to overtop the incised banks and reach the perched floodplain deposits.

In Walker Creek, the lower floodplain extends approximately one hundred meters to the base of the hills. Many of the watershed’s upper streams are incising and now deposit sediments on the upper and middle watershed’s floodplains only during large storm events. While most of the creek network is incised or is just stabililizing after a period of incision (Marin RCD 2005), there is the potential for instream storage of mercury-laden sediments (both as in-bar features and within the creek bed itself). Additionally there is the potential for source material to be redeposited on banks and floodplains downstream of the original mercury mine sources in the watershed.

(See Section 4, Source Analysis, for a discussion of mercury storage areas in Walker Creek downstream of the original source areas.)

Mercury-laden sediments discharged from production areas such as the small intermittent channel on the Gambonini property derive from areas that in general do not have high methylation potential. The Gambonini channel's steep slope ranges from four to ten percent over much of its length. It is heavily shaded and has very little floodplain area. Mercury-laden sediments stored in areas such as floodplains downstream of the Gambonini mine site are a mercury source that continues to pose a threat to water quality. The threat posed varies and is dependent on the various chemical, biological, or physical processes active at the time.

2.4 Biological Resources

The Walker Creek watershed provides habitat for anadromous salmonid species, central California coast coho salmon (*Oncorhynchus kisutch)*and steelhead trout (*Oncorhynchus mykiss*). Both are listed federally as threatened, and as "species of concern" in California. Historically, Walker Creek had excellent spawning populations of coho salmon and steelhead trout (CDFG 1984). In 2001, the California Department of Fish and Game (CDFG) surveyed two reaches (10 pools each) in Walker Creek to look for coho salmon (CDFG 2001). While coho were not found in either reach, steelhead was the dominant species in both segments. In 2002 and 2003, the CDFG collected coho fingerlings from Olema Creek (a stream in an adjoining watershed that also drains to Tomales Bay) in an effort to stock and rebuild populations of coho in Walker Creek's historic salmon habitat. In January 2004 eighty-eight adult hatchery-reared coho were planted in Walker Creek (CDFG 2004a). Subsequent fishery surveys have Coho fingerlings in Walker Creek in 2004 and 2005 (CDFG 2004a, MMWD 2005).

Walker Creek also provides habitat for a diverse array of wildlife species. The watershed is, designated as critical habitat for the California red-legged frog (*Rana aurura draytonii,* U.S. threatened) and California freshwater shrimp (*Syncaris pacifica*, U.S. and California endangered) (USFWS 2004). Other special status species include the Tomales roach (*Lavinia symmetricus ssp*., California species of concern) and Northwestern pond turtle (*Clemmys maramorata*, U.S. species of concern). Bird surveys, particularly for piscivorous (fish-eating) birds, have not been conducted in the watershed. However, it is likely that kingfishers and heron are found in the freshwater portion of the watershed (Kelly 2005).

3 PROBLEM STATEMENT

Due to the occurrence of historic mining in the Walker Creek watershed, mercury levels pose a threat to water quality and beneficial uses are impaired. This section discusses applicable water quality standards and how they relate to observed mercury levels in biota, water, and sediment in the Walker Creek watershed.

3.1 Applicable Water Quality Standards

The water quality standards for Walker Creek include beneficial uses, narrative water quality objectives, numeric water quality objectives, and antidegradation provisions. Protected beneficial uses in the Walker Creek watershed include: Agricultural Supply (AGR); Cold Freshwater Habitat (COLD); Fish Migration (MIGR); Preservation of Rare and Endangered Species (RARE); Water Contact Recreation (REC1); Noncontact Water Recreation (REC2); Fish Spawning (SPWN); Warm Freshwater Habitat (WARM); and Wildlife Habitat (WILD). Existing beneficial uses impaired by mercury include: wildlife habitat and aquatic life uses (cold freshwater habitat, preservation of rare and endangered species, and fish spawning). In Soulajule Reservoir, the beneficial use of REC1 is impaired due to high levels of methylmercury in sport fish typically consumed by humans. Soulajule Reservoir is the only location in the watershed where REC1 is the designated beneficial use, intended to protect the health of humans who choose to consume local fish. The Department of Fish and Game prohibits sport fishing in Walker Creek. Downstream, in Tomales Bay, REC1 is a recognized beneficial use that will be addressed as part of the Tomales Bay mercury TMDL.

The Basin Plan includes narrative objectives for bioaccumulation and toxicity and numeric mercury water quality objectives (Tables 3-5 and 3-4 of the Basin Plan) that apply in the watershed. Numeric water quality total mercury objectives protect drinking water (2.0 µg mercury per liter of water) and aquatic uses (2.4 µg/l one-hour average and 0.025 µg/l four-day average). These aquatic use objectives are based on the U.S. Environmental Protection Agency's *Ambient Water Quality Criteria for Mercury – 1984* (USEPA 1985). In addition, the California Toxics Rule (CTR) mercury criteria, incorporated into the Basin Plan by reference, apply. The CTR values are intended to protect human health. When REC1 or MUN is the beneficial use, the value is 0.050 µg/l (30-day average).

We are proposing to vacate the outdated 0.025 µg mercury per liter of water four-day average numeric water quality objective and replace it with fish tissue methylmercury values that better reflects current scientific information and the latest USFWS guidance. The proposed new objectives are discussed in Section 5.

The Basin Plan's narrative bioaccumulation objective states:

> *Many pollutants can accumulate on particles in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water-quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.*

3.2 Beneficial Uses Impacted by Mercury in the Walker Creek Watershed

Beneficial uses impacted by mercury in the Walker Creek watershed include: Wildlife habitat (WILD), beneficial uses intended to protect aquatic organisms (COLD, RARE, WARM, SPWN), and sport fishing in Soulajule Reservoir (REC1). The beneficial use "Wildlife Habitat" refers to habitat for species not encompassed by other beneficial uses (such as species covered by "cold freshwater habitat"), and refers to terrestrial species.

Terrestrial species that are primarily or exclusively piscivorous (fish-eating) are most likely to be at risk from exposure to mercury in the aquatic environment. Birds such as kingfishers and herons feed on higher trophic level[2] fish. As discussed below, mercury has been found in trophic level 3 fish in the Walker Creek watershed. Piscivorous birds, such as kingfishers and herons, are considered to be particularly at risk because they are likely to ingest methylmercury that has bioaccumulated and biomagnified in their food sources (Weiner et. al. 2003). Because mercury has been found in trophic level 3 fish common to piscivorous bird's diet, wildlife habitat is impacted by mercury in the Walker Creek watershed.

Unlike piscivorous birds, rare and endangered species, such as coho salmon and red-legged frog, are not exclusive consumers of aquatic species in the Walker Creek drainage. Salmon, as an anadromous species, feed in the ocean after migrating out to sea; red-legged frogs consume both terrestrial and aquatic species (USFWS 2005).

Humans, consuming Soulajule fish, are at risk from mercury exposure. Because methylmercury can accumulate in the human body, frequent consumption of fish from the reservoir could, over time, result in harm to the development of fetuses and children, affect the nervous or immune systems in adults, and could increase the long-term risk of cancer (OEHHA, 2004)

Due to fishing restrictions and a lack of resident trophic level 4 fish, humans are not at risk due to mercury levels in Walker Creek. However, they are, at risk due to elevated mercury levels in Soulajule Reservoir fish (OHEAA, 2004). In order to protect native anadromous fish stocks sport fishing is not allowed in the Walker Creek watershed, with two exceptions: Soulajule Reservoir and the tidal (non-freshwater) portion of Walker Creek (Fish and Game Commission, 2006). The tidal portion of Walker Creek is not covered under the scope of this TMDL.

While sport fishing is not allowed in Walker Creek, the ban does not preclude the possibility of fishing in Walker Creek. However, due to limited public access to the creek and lack of species typically sought after by anglers, consumption of fish from Walker Creek is unlikely.

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[2] Trophic levels (TL) are the hierarchical strata of a food web characterized by organisms that are the same number of steps removed from the primary producers. The U.S. EPA's 1997 Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism's feeding habits:
Trophic level 1: Phytoplankton.
Trophic level 2: Zooplankton and benthic invertebrates.
Trophic level 3: Organisms that consume zooplankton, benthic invertebrates, and TL2 organisms.
Trophic level 4: Organisms that consume TL3 organisms.

3.3 Overview of Mercury in the Walker Creek Watershed

In the next three sections, we summarize mercury levels in biota, in water and sediment and discuss mercury loads in the Walker Creek watershed.

MERCURY IN BIOTA

Fish tissue, collected as part of the State Water Resource Control Board's Toxic Substance Monitoring Program (TSMP) in Walker Creek, contained mercury above acceptable levels. Table 3.1 summarizes the available fish tissue data in Walker Creek (SWRCB n.d.). As discussed in Section 6, Numeric Targets, a safe level of mercury in TL3 fish consumed by piscivorous birds such as the kingfisher, would be a maximum of 0.05 mg of mercury per kg of fish tissue. All Walker Creek fish samples are above this level.

Table 3.1 Available Fish Tissue Mercury Data Walker Creek

(SWRCB n.d.) Note: Samples taken at Walker Creek Ranch are in the freshwater portion of Walker Creek Samples taken in Walker Creek near Hwy 1 are in the tidal portion of Walker Creek,

Date	Common Name	Composite Sample Size	Age (years)	Weight (g)	Mean Length (mm)	Average Mercury (mg/kg wet weight)	Sample Location
7/16/1991	Pacific Staghorn Sculpin	13	0-2	7.0	80.5	0.160	Walker Creek, near Hwy 1
7/27/1992	Threespine Stickleback	36	1-2	1.8	51.7	0.190	Walker Creek, near Hwy 1
8/25/1993	Rainbow Trout	8	0	16.4	104	0.330	Walker Creek, near Hwy 1
10/5/1995	Pacific Staghorn Sculpin	20	0-1	3.0	58.1	0.230	Walker Creek, near Hwy 1
2/3/1994	California Roach	9	2-3	11.1	90.2	0.340	Walker Creek Ranch
10/5/1995	California Roach	9	3	9.7	91.2	0.370	Walker Creek Ranch

Fish tissue, collected as part of the Surface Water Ambient Monitoring Program in Soulajule Reservoir, contained mercury above acceptable levels. Table 3.2 summarizes the available fish tissue data for Soulajule Reservoir (SFBRWQCB 2005). As discussed in Section 6, Numeric Targets, the mercury level that protects piscivorous birds such as the kingfishers that consume prey fish 5-15 cm in length is 0.05 mg mercury per kg fish tissue. For piscivorous birds such ospreys that typically feed on larger fish in reservoirs and lakes, the safe mercury level for prey fish 15-35 cm in length is 0.1 mg mercury per kg fish tissue. The black crappie and largemouth bass caught in Soulajule are above levels of concern for the osprey.

U.S. EPA recommends that states use screening values when monitoring fish for contaminants to help determine which species are of potential concern to human health. For mercury in fish tissue, the OEEHA screening value and U.S. EPA criterion is 0.3 milligrams methylmercury per kilogram of fish.(SFBRWQCB 2005 ,USEPA 2001). All of the largemouth bass and black crappie samples taken from Soulajule exceeded this criterion.

Table 3.2 Available Fish Tissue Mercury Data, Soulajule Reservoir

(SFBRWQCB 2005)

Date	Common Name	Composite Sample Size	Age (years)	Weight (g)	Mean Length (mm)	Average Mercury (mg/kg wet weight)
9/20/2001	Channel Catfish	1	8	3958	620	0.229
9/20/2001	Channel Catfish	1	8	3901	605	0.294
5/2/2001	Black Crappie	5	2-3	83.0`	171	0.355
5/2/2001	Black Crappie	5	2-3	86.6	173	0.306
5/2/2001	Black Crappie	5	2-3	77.5	164	0.336
5/2/2000	Largemouth Bass	6	2-4	640.9	326	0.812
5/2/2000	Largemouth Bass	5	2-4	940.5	373	1.030
5/2/2000	Largemouth Bass	6	1-2	163.4	216	0.405
9/20/2001	Largemouth Bass	4	2-3	475.8	297	0.671
9/20/2001	Largemouth Bass	4	3-4	834.0	343	0.752
9/20/2001	Largemouth Bass	1	4	1004.9	370	.880
9/20/2001	Largemouth Bass	1	4	1068.8	380	0.540
9/20/2001	Largemouth Bass	1	6	1925.7	465	1.450
9/20/2001	Largemouth Bass	1	6	1925.7	495	1.870

MERCURY IN THE WATER COLUMN

TOTAL MERCURY

Appendix A includes total and particulate mercury concentrations in water samples collected by the Water Board for two periods; 1995-1998 (pre-remediation of the Gambonini Mercury mine site) and 2000-2003 (post- remediation).

Aquatic life beneficial uses are impaired due to high levels of total mercury in the water column. Water Board staff began water column sampling in 1995, and conducted comprehensive sampling during significant rain events beginning in the 1997-1998 wet season. The results indicate that large releases of mercury from the Gambonini mercury mine occurred during episodic flow events (See Section 4, Source Analysis). The extreme rain events of 1998 allowed staff to document excessive loads of mercury moving through the Walker Creek watershed. In January and February 1998, the mine released an alarmingly high pulse of mercury, 82 kilograms, to downstream waters. The majority of the mercury moved during brief periods of intense rainstorms and high flow. The 1998 monitoring results qualified the mine site for emergency action under U.S. EPA's "Superfund" cleanup program. Beginning in 1999, U.S. EPA and the Water Board remediated a large part of the Gambonini Mine site to minimize mercury transport to the Walker Creek watershed.

The Basin Plan one-hour total mercury objective of 2.4 µg mercury per liter of water, intended to protect aquatic organisms from acute effects, was exceeded three out of ten time in samples taken at Walker Creek Ranch, during the winters of 1995-1998 (the pre remediation period). Post remediation, the one-hour total mercury objective was exceeded once out of sixteen sampling events (See Figure 3.1 and Appendix A).

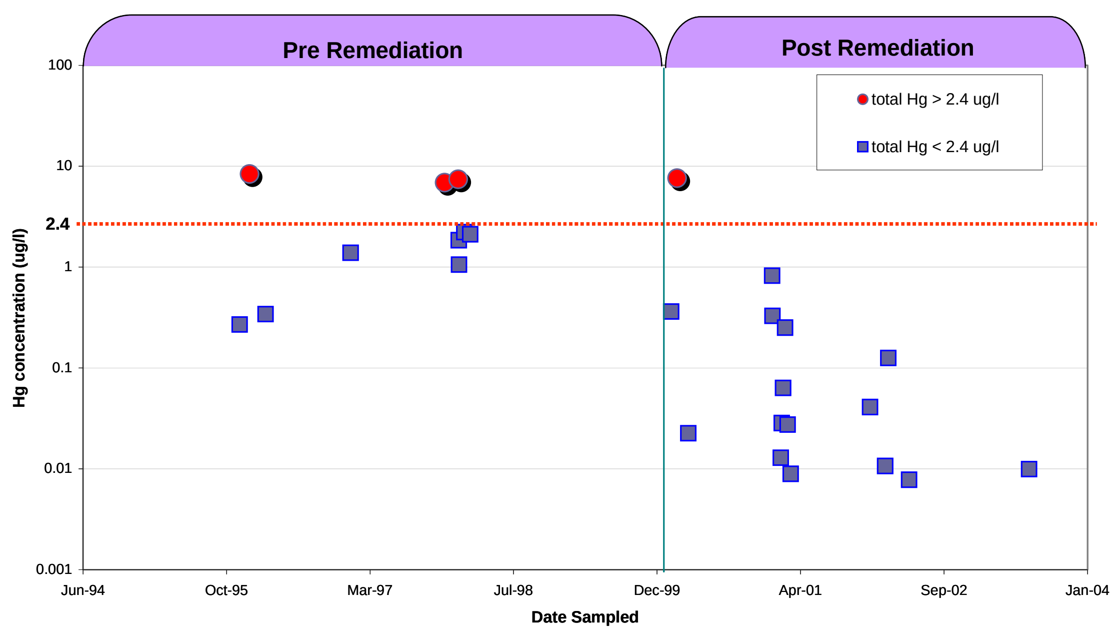


Figure 3.1 Mercury Concentrations in Walker Creek

Pre- and post- remediation water column mercury concentrations downstream of the Gambonini Mercury Mine at Walker Creek Ranch. Horizontal line indicates the aquatic life one-hour water quality objective (2.4 µg/l).

PARTICULATE MERCURY

As discussed in Section 7 (Linkage Analysis) and Section 8 (TMDL and Allocations), particulate mercury concentrations can be linked to mercury in fish tissue. Wildlife beneficial uses are impaired due to mercury, which likely enters Walker Creek in the particulate form, then is transformed and available for uptake by fish, and finally transferred to piscivorous wildlife.

Particulate mercury, or mercury attached to fines[3], is important to track in the watershed. It is the primary source of mercury in the water column. By measuring particulate mercury, we can better understand mercury transport and uptake in the watershed. As discussed in Section 8, a safe level of particulate mercury in the water column for piscivorous birds is 0.5 mg of mercury per kg of sediment.

Particulate mercury concentrations in the water column exceeded 0.5 mg of mercury per kg of sediment in all nine samples collected in Walker Creek during the pre-remediation period. Post remediation particulate mercury samples exceeded 0.5 mg of mercury per kg of sediment 13 out of 16 times. The mean particulate mercury concentration has decreased by approximately 50 percent throughout the watershed as a result of remediation at the Gambonini Mine site (Figures 3.2 and Appendix A).

MERCURY ON LANDS ADJOINING WALKER CREEK

Particulate mercury concentrations exceed background concentrations on creekside properties downstream of the Gambonini Mine site. Mercury can be transported from source areas and stored downstream on lands adjoining Walker Creek. As discussed in Section 2.3 (Geomorphology, Watershed Processes and Mercury Transport), depositional zones are storage areas for sediment and therefore mercury. Also discussed in Section 2.3 is the concept that depositional areas can release sediment back into a water column, either through events such as bank failure and channel migration, or by floodwater “plucking’ sediments off of the floodplain during storm events. This mercury-laden sediment has the potential to increase mercury concentrations in the water column, and impair water quality for wildlife. In June 2003, staff collected 31 sediment samples from depositional features (channel banks, the floodplain, and active point bars) on a property 1.6 kilometers above the mouth of Walker Creek, where it drains into Tomales Bay. Mercury concentrations ranged from 0.05 mg/kg to 8.09 mg/kg (dry weight) and over 70 percent of the samples had mercury concentrations higher than background sediment concentrations (0.2 mg/kg) (SFBRWQCB 2004a).

3.4 Mercury Loads

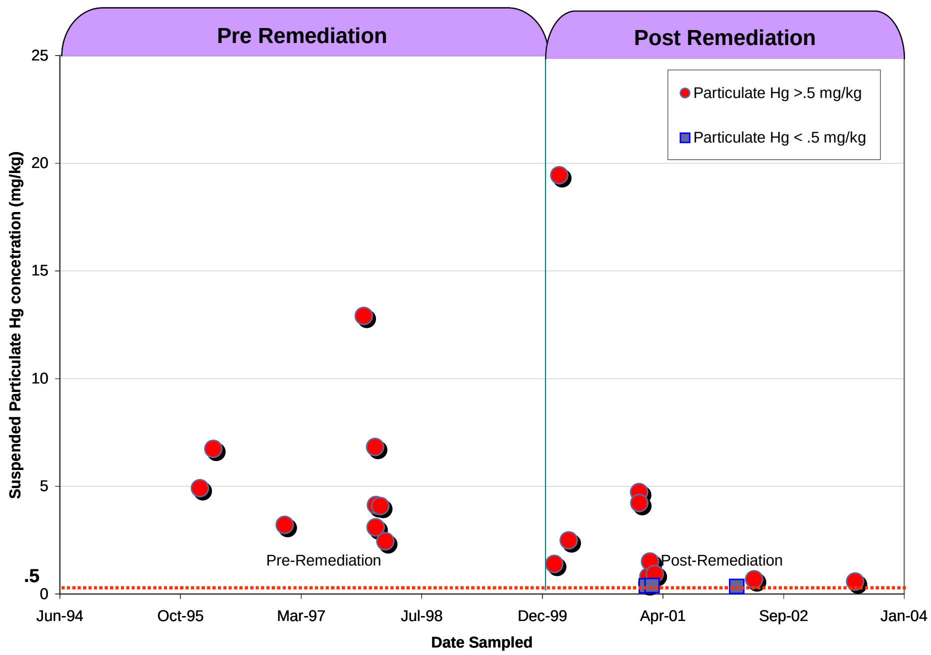
Pollutant loads are typically estimated by multiplying contaminant concentrations in water by flow, and integrating the results over time. We calculated that over 75% of the mercury loads emanating from the Gambonini mine site during the 1998 winter season occurred in less than 10% of the total time (Whyte & Kirchner 2000). We were able to calculate a short-term mercury load for this highly episodic drainage due to a concentrated sampling effort and the high correlation between mercury and particulates at this particular site. Over a 59-day period (January 1, 1998- February 26, 1998), we

---

[3] Fines refers to silt or clay sized particles. Particulate mercury attaches to fines and once attached to fines, is of a size that can be suspended in the water column and transported downstream during storm events.

calculated a short-term load of 82 kgs of mercury was discharged from the Gambonini Mine site. In one 30-hour period, the load was 30 kg (Whyte & Kirchner 2000).

Figure 3.2 Suspended Particulate Mercury Sampling Results



Pre- and post- remediation suspended particulate mercury concentrations downstream of the Gambonini Mercury Mine at Walker Creek Ranch. Horizontal line indicates a wildlife-safe particulate mercury concentration (0.5 mg/kg). Sections 7 and 8 discuss the relationship between particulate mercury concentrations in the water column and consumption of fish by piscivorous birds.

4 SOURCE ANALYSIS

In this section, we present information on sources of mercury in the Walker Creek watershed. There are four major sources of mercury in the Walker Creek watershed:

> **Gambonini Mine site –** A now-abandoned mercury mine and the largest mercury processing facility in the watershed. Mining waste was not properly contained on-site, and consequently the site discharged large quantities of mercury-laden sediments prior to site cleanup (initiated in 1998).
>
> **Soulajule Reservoir and watershed –** Two former mercury mines are located in this watershed. Soulajule Reservoir discharges into Walker Creek just downstream of the Gambonini Mine drainage.
>
> **Downstream depositional features –** Mercury-laden sediments are prevalent in depositional areas (creek beds, banks, and floodplains) downstream of the mercury mines.
>
> **Background –** Mercury is present in soils, at generally low concentrations, throughout the watershed. Background levels include atmospheric deposition as well as naturally occurring mercury common in many portions of California's Coast Range. The Walker Creek watershed's background suspended sediment mercury concentration is 0.2 mg mercury per kg dry sediment.

Most of the mercury in the Walker Creek watershed is bound to sediment, either in the native soils or in disturbed areas containing mining waste. As described in the following sections, it appears that relatively little mercury-laden sediment is currently stored in the creek's incised canyon-bounded reaches (the valley transfer/deposition zone), at least in comparison with the amount of mercury stored in the same reaches in the decade following mine operations in the watershed. We hypothesize that the incising nature of Walker Creek, coupled with a catastrophic dam failure at the Gambonini Mine site, led to pulses of mercury-laden sediment moving off the lower reaches of the mine drainage on the Gambonini property and out of temporary in-stream storage below the mine site in the transfer zone, and flowing to lower-elevation floodplains (deposition zone) and into Tomales Bay.

Mercury concentrations in sediment deposits in the lower watershed reflect a mix of background and mining-related, mercury-laden sediments that have been transported through the Walker Creek stream system and deposited either temporarily or for long term storage. Our conceptual model suggests that the greatest volume of mercury-laden sediment has already moved through the valley deposition /transfer zone and is now stored in the depositional zone of the lower watershed. Mercury concentration in sediments in depositional areas at the bottom of the watershed will continue to be higher than background as long as mining waste is discharged from the Gambonini Mine site or downstream storage areas. Over time, storm events will likely transport most of the stored mercury-laden sediments to Tomales Bay.

MINING HISTORY AND MERCURY SOURCES

Between 1955 and 1970 four mercury mines operated in the Walker Creek watershed. As we have said, the Gambonini Mine was the largest mine and the major source of mercury to the waters of the Walker Creek watershed. Two mines contributed mercury to the

Soulajule Reservoir: the Franciscan and Cycle Mines (Arroyo Sausal Creek watershed); the Chileno Valley Mine is located on Chileno Creek.

The Franciscan and Cycle mines are located near the southeastern end of Soulajule Reservoir. They operated only briefly, from 1970 to 1971, near the southeastern end of the reservoir (Figure 4.2).

The Chileno Valley Mine (also referred to as the Bentley Ranch Mine) was active from 1955 to around 1971. Here mercury was mined underground. Reconnaissance surveys at the Chileno Valley mine by Water Board staff found no evidence of tailings or excessive erosion in the area affected by mining activity (SFBRWQCB 1998). Mercury levels in water samples taken downstream of the mine are similar to naturally occurring background levels of mercury (Marshall 2004, Marshall 2006).

The Gambonini mining operation included an onsite retort facility where ore from many of the mines in the area was processed. Workers piled waste rock on the steep hillsides and in ravines below the processing facility. Containment consisted of an earthen tailings dam across a steep intermittent drainage just below the mine (Figure 2.1).

Following major storms in 1982, the tailings dam failed and discharged a large quantity of mercury-rich sediments and waste rock (TBWC 2003). Mine waste and contaminated sediments filled the channel below the Gambonini mine and large quantities continued to erode into the creek during winter storms until the mine site was stabilized in 1998 (Whyte and Kirchner 2000).

AERIAL PHOTO ANALYSIS

Staff used aerial photography to make inferences about the mine's impact on the downstream geomorphology. Comparison of aerial photographs of the mine and downstream reaches made at intervals from 1965 to 1995 reveals shifts in the creek's sediment transport capacity and depositional features.

- The Gambonini property was mined and operated as a processing facility from approximately 1960-1970. Photos of Walker Creek from 1965, the middle of the period during which the Gambonini mine was in operation, show depositional features typical of coastal creeks with a similar widespread agricultural land use history.
- The mine stopped operating in 1970. Photos of the creek from the post-mining period (1973) reveal in-stream braided creek conditions downstream of the mine, typical of conditions where a stream's sediment load has exceeded its transport capacity.
- Aerial photos from 1984 show extreme aggradation in the mine's drainage channel, incision below Soulajule Reservoir, and development of in-stream depositional features further downstream in Walker Creek. We surmise that the downstream deposition was an artifact of excess sediment originating from landslides, dam failure and associated downstream discharge of mine tailings, and upstream incision into the creek bed and banks—all caused by the unusually heavy storms of 1982. The January 4, 1982 storm is generally considered to have been a 100-year storm event for northern Marin and Southern Sonoma Counties (Marin RCD 2005).

- Photos taken in 1993 and 1995 (the next large storm year) show a shift in depositional features from just below the mine site to further downstream. We infer that the sediment deposits from the 1982 storms were transported downstream at some point before the onset of the 1995 winter storms.

The Marin Resource Conservation District, as part of a separate Walker Creek geomorphic study, analyzed air photos from 1942, 1950, 1984, 1988 and 1998. They found that the photos show "dramatic changes in sediment volume, transport, and depositional features in mainstem Walker Creek over the 56-year study period (Marin RCD 2005). They also note the transition in Walker Creek downstream of the Gambonini Mine from large gravel bars dominating the floodplains in 1984 (indicating excessive sediment loads) to a more balanced sediment load with very few large gravel bars in 1998. This supports our field observations and aerial photo analysis that that Walker Creek downstream of the Gambonini mine has functioned as a short-term storage area and is now primarily a transfer zone for mercury.

4.1 General Approach to Mercury Source Analysis

We used our conceptual model for mercury transport to select sampling locations in the watershed. Our focus has been on determining frequency and magnitude of mercury discharged from the four source categories listed at the beginning of this section: historic mining sites on Walker, Arroyo Sausal, and Chileno Creeks; lower Walker Creek in-stream deposits; downstream depositional areas; and background soil mercury concentrations. Our analysis utilized water quality data collected upstream of the Gambonini mine site, downstream of the mine at a USGS gage station, at the mouth of Walker Creek, and from the adjoining Chileno Creek watershed (see Figure 4.1).

In the Walker Creek watershed, mercury is delivered to the aquatic ecosystem attached to sediments. By measuring particulate mercury in the water column, we can quantify the amount of mercury being delivered to the water column from upland and upstream sources. The amount of particulate mercury in the water column can be derived by subtracting the amount of dissolved mercury from the total mercury and dividing this value by the amount of total suspended solids (TSS) in the water column. Particulate mercury concentrations are calculated using the following formula:

$$[\text{mercury}]_{\text{particulate}} = \frac{[\text{mercury}]_{\text{total in water}} - [\text{mercury}]_{\text{dissolved in water}}}{[\text{suspended sediment}]_{\text{total in water}}}$$

Staff began collecting water quality samples in the Walker Creek watershed in 1995. Our sample set is comprised of data collected both pre-remediation (1995-1998) and post-remediation (2000-2003). Staff has collected data upstream of the Gambonini property, on the Gambonini Mine site, in the adjoining Chileno Creek watershed, and downstream of the mine site (Figure 4.2).

Staff collected 129 water samples during a wide variety of creek flows throughout the watershed. We selected sampling parameters and locations based on weather conditions, site conditions, and budget constraints. Water quality parameters included total mercury, dissolved mercury, total methylmercury, dissolved methylmercury, and total suspended solids (collected using a depth integrated sampler and/or calibrated against an optical backscatter device.)

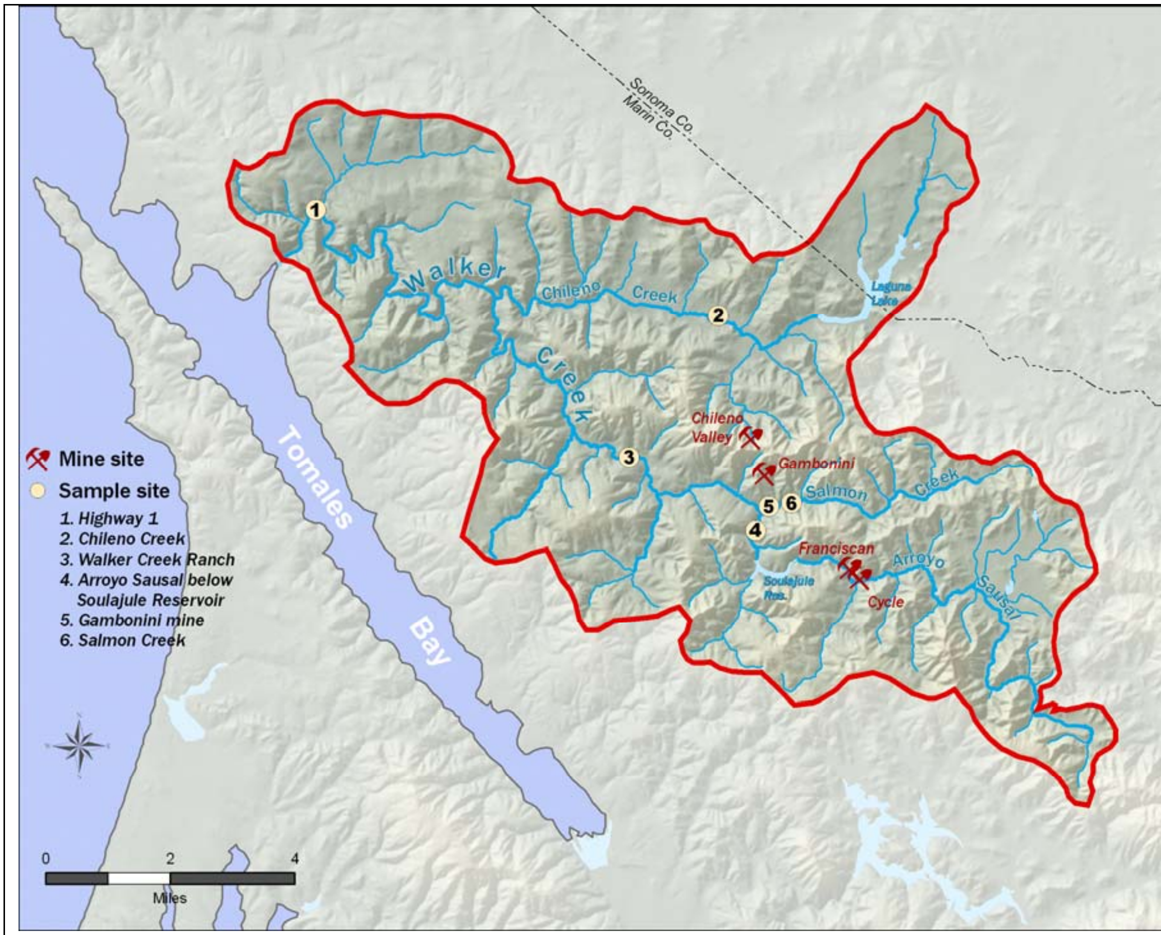


Figure 4.1 Mercury Mines and Water Sampling Locations

The Salmon Creek sampling point is upstream of any mining influences. A USGS gage and a continuous suspended solids data logger are located at Walker Creek Ranch.

In the following sections, we discuss site-specific results of our source assessment investigations, followed by a summary of information gained by contrasting and comparing among different sampling sites.

4.2 Gambonini Mine Source Analysis

In 1998 (pre-remediation), the first significant water year after sampling began, total mercury concentrations in the mine drainage were highly variable, ranging from 0.485 to 1,040 parts per billion (ppb). The mean concentration of 122 ppb significantly exceeded the Basin Plan's one-hour average water quality objective of 2.4 ppb.

Data collected before and after remediation clearly shows that remediation reduced particulate mercury concentrations by about 50 percent, both at the mine site and at downstream sampling sites (See Table 4.1). Total suspended sediment and particulate mercury concentrations have generally declined each year post- remediation. However, levels of particulate mercury remain higher than background.

Table 4.1 Walker Creek Watershed Suspended Particulate Mercury Concentrations, Pre- and Post- Remediation

Pre Remediation 1995-1998

Particulate Hg (mg/kg)	Chileno	Walker Creek Upstream	Gambonini Mine	Walker Creek Ranch	Highway 1
Mean			**66.93**	**5.36**	**1.73**
Median			59.75	4.13	1.96
Std Dev			47.65	3.21	0.53
Std Err Mean			9.00	1.07	0.19
N			28	9	8
Range			4.1 to 260	2.45 to 13	.64 to 2.2

Post Remediation 2000-2003

Particulate Hg (mg/kg)	Chileno	Walker Creek Upstream	Gambonini Mine	Walker Creek Ranch	Highway 1
Mean	0.16	0.16	**35.29**	**2.74**	**0.87**
Median	0.14	0.14	24.74	0.87	0.66
Std Dev	0.06	0.09	39.78	4.99	0.66
Std Err Mean	0.02	0.03	9.13	1.33	0.22
N	9	9	19	14	9
Range	.08 to .24	.11 to .35	3.0 to 180	.36 to 19	.07 to 2.0

The mean particulate mercury value has dropped approximately 50% throughout the watershed. The median particulate mercury value has dropped close to 70% due to a reduction in mercury loads discharged from the Gambonini Mine site. No particulate mercury data were collected pre-remediation for Chileno or Walker Creek upstream of the Gambonini Mine site.

4.3 Soulajule Reservoir Source Analysis

Marin Municipal Water District constructed Soulajule Reservoir in 1979 as a drinking water supply, impounding water from the Arroyo Sausal watershed. The reservoir's capacity is 10,572 acre feet. When the Arroyo Sausal valley was flooded to create Soulajule Reservoir, the impoundment's watershed included two inactive mercury mines (the Cycle and Franciscan Mines). The mines drain into or are periodically submerged in Soulajule Reservoir. Water Board staff observed no mine waste piles or tailings during a 2006 field visit or in aerial photos of the area. Remnants of the mine operations remain along the shoreline of Soulajule Reservoir.

We are lacking data on the significance of the reservoir's mercury loads to the watershed. Mercury levels in fish are elevated and greater than fish from other Bay Area reservoirs that do not contain mining waste (OEHHA 2004, SFBRWQCB 2005). As discussed in

Section 9 (Implementation), and Section 10 (Monitoring and Evaluation), we recommend additional studies to characterize mercury concentrations and loadings from Soulajule Reservoir.

4.4 Downstream Depositional Features Source Analysis

Downstream of the Gambonini Mercury Mine site and Soulajule Reservoir, mercury moves from the source areas into the watershed's transfer and deposition zones. (See Section 2.3, Figure 2.3 and Figure 4.3.) As described below, the transfer zone receives sediment from upstream sources, but there is little net aggradation or deposition. The deposition zone, by contrast, is a sediment sink that can be a significant source of mercury during large storm events.

VALLEY TRANSFER DEPOSITION ZONE

Water Board staff reviewed water quality samples, aerial photographs, topographic maps, and written reports to identify and evaluate potential source areas for mercury-laden sediment stored in Walker Creek downstream of the Gambonini mercury mine (SFBRWQCB 2004a, SFBRWQCB 2004b). Section 3.3 discusses total and particulate mercury concentrations in the water column downstream of the Gambonini Mine site.

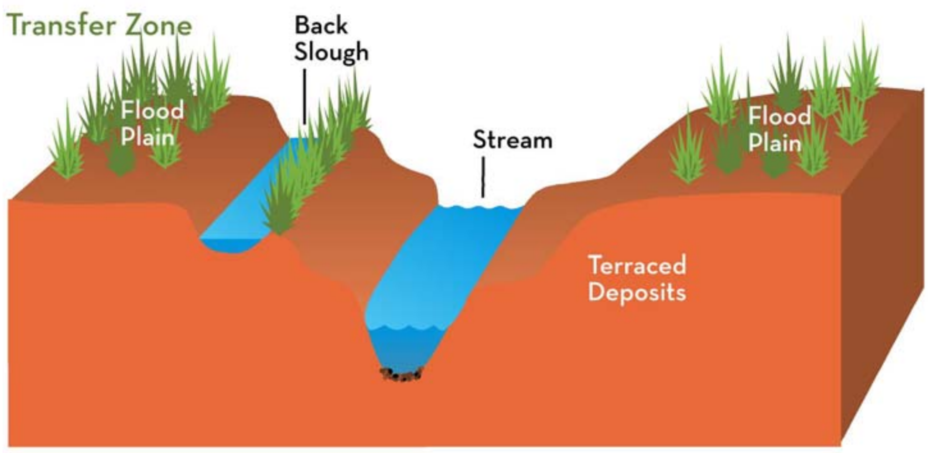


Figure 4.3 Valley Transfer and Deposition Zone

The area downstream of Soulajule Reservoir and the Gambonini Mercury mine site is a transfer-deposition zone. Mercury-laden sediments are deposited on the floodplains, in backwater sloughs on the floodplain, and in-stream at locations such as point bars. Typically, floodplains in the valley transfer deposition zone are much narrower than in the downstream depositional reaches

Downstream of the mine, mainstem Walker Creek channel has remained relatively stable over time and appears to store sediment inputs for short periods in-channel, and for potentially longer periods in side channels and on the floodplain. Additional study is needed to understand what size flow events result in increased deposition, re-suspension of material stored in the creek bed, or mobilization of mercury-laden sediments from other storage areas. Downstream of the Gambonini Mine site, on properties adjoining

Walker Creek, the floodplains, creek banks, and depositional features in the creek itself constitute a source area and should managed accordingly (See Figure 4.3).

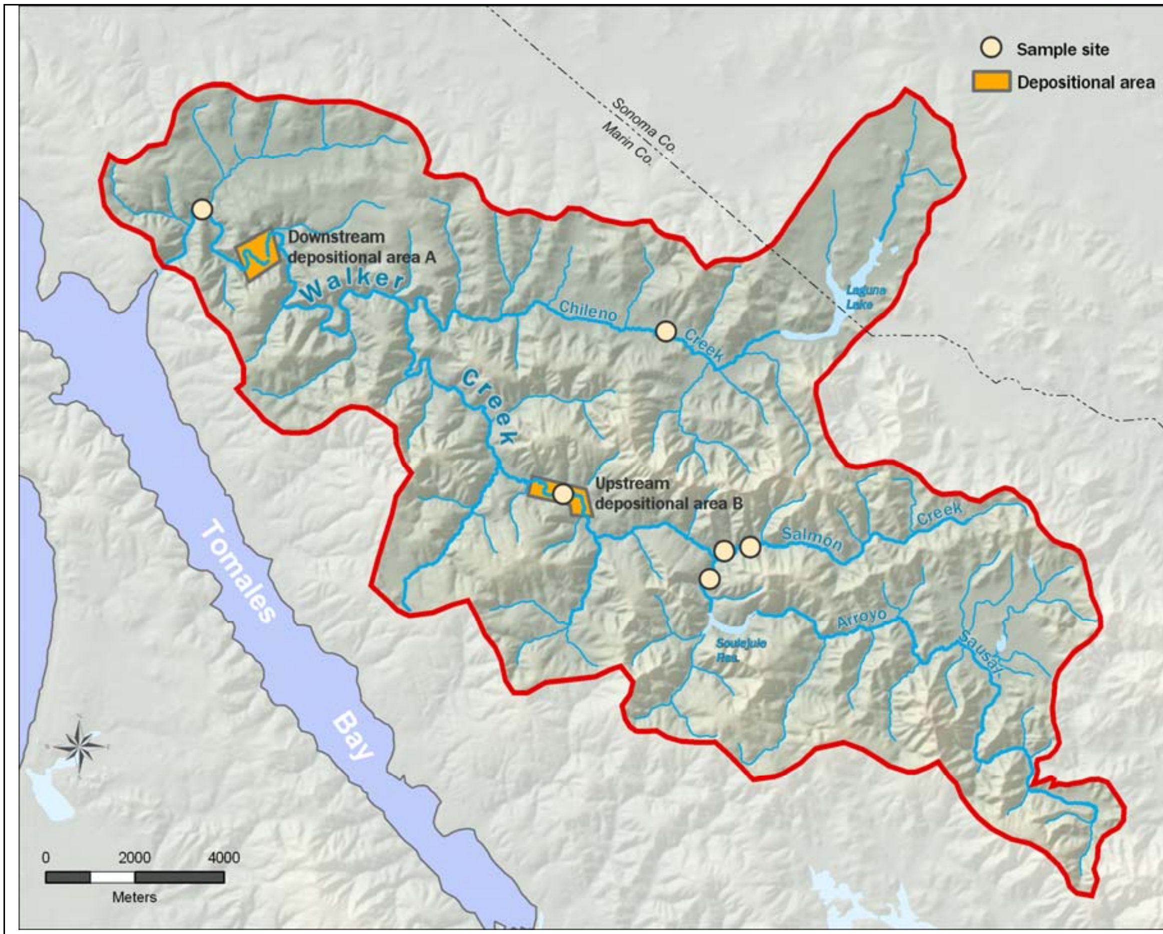


Figure 4.4 Known Depositional Areas

The watershed's largest known depositional area (Area A) is located approximately 1.6 kilometers above the mouth of Walker Creek, just above the tidal portion of the creek in the deposition zone. Area B, located in the transfer-deposition zone, stores a much smaller volume of mercury-laden sediment.

4.5 Deposition Zones

The largest depositional area that staff has identified in the Walker Creek watershed is located approximately 1.6 kilometers above the creek mouth (See Figure 4.4). This 350,000-400,000 square meter zone extends across several properties. We have visited one property in this depositional area and evaluated mercury levels in soils on the floodplain, from vertical sections of the creek banks, and from in-stream deposits. Based on aerial photos and our understanding of transport and deposition in this watershed, we are confident in extrapolating observations made on this section of Walker Creek to reaches with similar geomorphology in the immediate area.

Figure 4.5 Depositional Reach

These photos are of the large depositional area above the mouth of Walker Creek. This section of the creek is inundated yearly, and the banks are actively eroding.

Walker Creek at depositional Area A is actively eroding its banks and has large in-channel deposits consisting of clays, sands, gravels, and cobbles. The wide floodplain, extending across the valley floor, floods yearly, stores sediment deposits and is a mercury source area due to periodic erosion (SFBRWQCB 2004a). In June 2003, staff collected

31 sediment grab samples from representative depositional features (channel banks, the floodplain, and active point bars). Mercury concentrations ranged from 0.05 mg of mercury per kg of sediment to 8.09 mg/kg (dry weight). Over 70 percent of samples had mercury concentrations higher than background (0.2 mg/kg) (SFBRWQCB 2004a).

Comparison of mercury concentrations in sediments from Depositional Area A and samples from the Tomales Bay/Walker Creek Delta is provided in Table 4.2. Both sampling locations have the same average total mercury concentration of 1.40 mg of mercury per kg of sediment—seven times greater than background. As predicted by the conceptual model, the downstream depositional area integrates mercury-laden sediment originating at the Gambonini mine site with sediment from elsewhere in the watershed (containing mercury naturally occurring in local soils, and mercury from atmospheric deposition). While the Gambonini Mine remains the *primary* source of mercury in the Walker Creek and Tomales Bay watersheds, Depositional Area A is likely the largest *mercury* source in terms of current loading to Tomales Bay.

We should note that other depositional reaches along Walker Creek are also sources of mercury. However, they do not appear to have either the capacity or the geomorphic attributes to store as large a volume of sediment as Area A. Upstream reaches such as Walker Creek Ranch, for example, have higher gradients and narrower floodplains, which results in active sediment transport rather than long-term storage.

Table 4.2 Mercury in Downstream Samples

Total Hg (dry weight, ng/g [ppb])	**Depositional Reach Site A**	**Walker Creek Delta in Tomales Bay**
	Samples collected 2003	Samples collected 2000
Minimum	0.05	0.06
Median	0.54	0.80
Average	1.40	1.40
Maximum	8.09	7.56
n	31	54

4.6 Background Mercury Concentrations

The remaining sources of mercury in the Walker Creek watershed are unrelated to mining: atmospheric deposition and naturally occurring mercury in soil (background). Mercury in the atmosphere enters the watershed during both dry weather (dry deposition) and rainy weather (wet deposition). Because there is much more land surface than water surface in the Walker Creek watershed, most mercury from the atmosphere is deposited directly onto land, where it binds to soil particles. Therefore, measurements of mercury in background watershed soils contain mercury from two sources, naturally occurring mercury, and atmospheric deposition.

Alternatively, mercury loads can also be inferred by monitoring dry and wet deposition. In the San Francisco Bay Region, the Regional Monitoring Program for Trace Substances collected ambient air and precipitation samples at three Bay Area sites. This study estimated the average dry and wet deposition rate to be 23.2 micrograms of mercury per square meter per year (SFEI 2001). The estimate developed for San Francisco Bay may differ from actual conditions in Walker Creek. For example, Walker Creek could potentially have higher air deposition due to off-gassing or legacy effects from mercury processing. Conversely, mercury concentrations in San Francisco Bay could be higher due to the influence of local urban sources not present in the Walker Creek watershed. However, the SFEI estimate is the only local data available. At these deposition rates, the atmospheric deposition of mercury to the Walker Creek watershed is 0.03 kilograms per year.

Water Board staff evaluated water quality data from a location on Salmon Creek, upstream of Gambonini Mine, to determine the background concentration of particulate mercury in the watershed's soils (Table 4.3). We were not surprised to find that particulate mercury concentrations on Salmon Creek are much lower than concentrations measured downstream of the Gambonini site. We use the Salmon Creek data set to represent the background particulate mercury concentration for the watershed (Marshall 2006).

Table 4.3 Raw Data Used To Calculate Background Values

Date	Sample Location	Particulate Hg (mg/kg)
1/11/2001	Salmon Creek upstream of mine	0.32
2/9/2001	Salmon Creek upstream of mine	0.14
2/12/2001	Salmon Creek upstream of mine	0.12
2/17/2001	Salmon Creek upstream of mine	0.35
3/5/2001	Salmon Creek upstream of mine	0.14
3/16/2001	Salmon Creek upstream of mine	0.15
2/19/2002	Salmon Creek upstream of mine	0.11
5/2/2002	Salmon Creek upstream of mine	0.20
6/24/2003	Salmon Creek upstream of mine	0.11
3/38/2005	Salmon Creek upstream of mine	0.14

The sections above describe the four mercury source areas in the watershed (Gambonini Mine Site, Soulajule Reservoir and watershed, downstream depositional areas, and background). Table 4.4 summarizes our current water quality information. Since remediation of the Gambonini mine site, mercury concentrations have decreased at every downstream sampling location. The highest mercury concentrations are still found on the Gambonini mine property; concentrations decrease with increasing distance downstream from the site.

Table 4.4 Summary of Water Quality Sampling

(SFBRWQCB 2004b)

LOCATION – CREEK	SAMPLE SITE	CONCLUSIONS
Gambonini Mine site	Flume installed in mine drainage channel.	In the past the main source of mercury in the watershed. Particulate mercury concentrations have decreased substantially post-remediation.
Walker Creek Ranch	USGS gaging station 2.7 kilometers downstream from the Gambonini site.	Only one sample out of sixteen collected post-remediation exceeded the Basin Plan's water quality objective (1-hour average) for mercury in the wet season, compared to three pre- remediation exceedances (out of ten). Mean particulate mercury concentrations decreased by 50% post-remediation.
Highway 1-Walker Creek	Mouth of Walker Creek just upstream of the discharge point into Tomales Bay. Tidally influenced.	Instantaneous grab samples in the wet season have not exceeded the 1-hr average water quality objective of 2.4 µg/l. Mean mercury particulate concentrations decreased 50% pre- to post- remediation.
Salmon Creek	Upstream of Gambonini Mine, background monitoring location	Mean suspended particulate mercury concentrations are much lower than samples downstream of the mine.
Chileno Creek	Tributary to Walker Creek. Receives no drainage from the Gambonini mine site.	Statistically indistinguishable from samples collected at the background site on Salmon Creek. Water quality data suggest that the Chileno Creek drainage, which contains the Chileno Valley Mine, is not a source area. Contributes background concentrations of mercury to Walker Creek.

5 PROPOSED WATER QUALITY OBJECTIVES

Water quality objectives for mercury in waters of the San Francisco Bay region may vary from watershed to watershed based on geography, salinity, and beneficial uses.

The amendment we are proposing g to the San Francisco Basin Plan will add two new freshwater mercury water quality objectives and vacate an outdated objective for Walker Creek, Soulajule Reservoir, and all tributaries. The proposed objectives to protect aquatic organisms and wildlife apply to fish (5–15 cm in length and 15-35 cm in length) consumed by fish-eating birds in the watershed. The objectives are 0.05 mg methylmercury per kg fish (average wet weight concentration) for fish 5-15cm in length and 0.1 mg methylmercury per kg fish (average wet weight concentration) for fish 15-35 cm in length.

The new objectives will replace the water column four-day average freshwater mercury objective, which will no longer apply to Walker Creek, Soulajule, and all tributary waters.

Replacement of the four-day average freshwater mercury objective with these fish tissue objectives reflects current scientific information and the latest U.S. EPA and U.S. Fish and Wildlife Service (USFWS) guidance.[4] In fact, specifying methylmercury water quality objectives as fish tissue concentrations rather than water column concentrations is becoming common in California. The Central Valley Water Board recently adopted fish tissue methylmercury objectives concurrently with their mercury TMDLs for Clear Lake and Cache Creek watersheds. Central Valley Water Board staff calculated methylmercury fish tissue levels needed to protect aquatic organisms and wildlife using a method recommended by USFWS. Details of these objectives are provided on the Central Valley Water Board's website at http://www.waterboards.ca.gov/centralvalley/programs/tmdl/ . We use the same method herein.

5.1 Proposed Aquatic Organisms and Wildlife Objectives

Numerous studies document mercury bioaccumulation in the aquatic food web and its toxic effects on birds (Wiener et al. 2003). In the Bay Area, birds that feed on fish and other aquatic organisms are among the most sensitive wildlife mercury receptors (Davis et al. 2003). Because methylmercury bioaccumulates in the tissues of animals that ingest it, the highest mercury levels are found in the highest trophic level[5] resident fish-eating (piscivorous) species. In this TMDL, staff proposes fish tissue methylmercury objectives that will protect the highest trophic level at-risk bird species in the Walker Creek watershed.

The U.S. Fish and Wildlife Service (USFWS) examined species at risk from food web mercury exposure, and determined a safe prey-fish methylmercury concentration for each species. The Service used published results of mallard feeding studies to estimate the safe daily exposure to methylmercury and a no-observable-adverse-effects-concentration for birds.

[4] Mercury water quality objectives for all other water bodies in the San Francisco Bay Region will be updated either as part of a statewide action or as TMDLs are developed for mercury impaired waters.

USFWS developed fish tissue targets for five piscivorous bird species:

Common merganser (*Mergus merganser*)

Osprey (*Pandion haliaetus*)

Belted kingfisher (*Ceryle alcyon*)

Great blue heron (*Ardea herodias*)

Forster's tern (*Sterna forsteri*).

USFWS reviewed published literature and determined that these species are likely to consume four categories of fish found in Walker Creek: TL3 fish less than 5 centimeters (cm) in length; TL3 fish from 5-15 cm; TL3 fish from 15-35 cm; and TL4 fish from 15-35 cm. The size and trophic level of prey fish and the rate at which the birds consume them were evaluated for each of the five bird species.

The Service concluded that a methylmercury target that protects fish-eating (piscivorous) birds will also protect the rest of the species in the riparian food web including, in the case of Walker Creek, two State or federally listed threatened or endangered species, the California red-legged frog and the Central California Coast steelhead (USFWS 2005, Russell 2005).

In the riverine portion of the Walker Creek watershed, the belted kingfisher is the species most likely to acquire large body burdens of mercury, both because these birds are the piscivorous feeders (Kelly 2005), and because they are resident in the watershed during the breeding season. Ospreys are most likely the highest trophic level piscivorous feeders in Soulajule Reservoir. In 2003 the Marin Municipal Water District constructed a number of osprey nesting platforms near the reservoir and in the nearby Nicasio watershed.

Table 5.1 lists the known fish species in Walker Creek, categorized by trophic level. Piscivorous birds, such as the kingfisher, consume these species, and are at risk from resident species. (Anadromous species such as steelhead spend only part of their lives in the river, and accumulate less mercury.) California roach, threespine stickleback, and sculpin (resident TL3 species) collected for the California Toxics Substances Monitoring Program all had elevated levels of mercury, with roach having the highest levels of mercury (SWRCB n.d.).

Table 5.1 Walker Creek Fish Species (TL= Trophic Level)

TL2	TL3	TL4
None	Pacific lamprey, mosquitofish, California roach, three-spine stickleback, sculpin, steelhead trout[6], coho salmon	Anadromous steelhead trout and coho salmon

Note: Trophic levels are generalized to the nearest primary level.

Based on information from the California's Toxic Substances Monitoring Program data set (SWRCB n.d.) and from Bill Cox, District Fishery Biologist for Marin and Sonoma counties, California Department of Fish and Game.

Table 5.2 Soulajule Fish Species (TL= Trophic Level)		
TL2	**TL3**	**TL4**
None	Black crappie	Largemouth bass and channel catfish
Note: Trophic levels are generalized to the nearest primary level. Based on information from the California Water Resources Control Board's Surface Water Ambient Monitoring Program (Years 2000-2001).		

The only known study on fish species in Soulajule Reservoir focused on fish that are frequently caught and consumed by anglers. Older fish were collected for this study, at least as big as the legal angling/practical eating size for each species (SFBRWQCB 2005). Channel catfish, black crappie and largemouth bass all had elevated levels of mercury, with largemouth bass having the highest levels (Table 5.2 and Section 3, Problem Statement).

Table 5.3 lists the levels of methylmercury in fish that USFWS determined to be safe for wildlife in the Walker Creek watershed. USFWS determined that the target for belted kingfisher (0.05 ppm methylmercury in the tissue of TL3 fish 5-15 cm in length) is sufficient to protect the great blue heron, and due to the concept of proportional bioaccumulation, it should also be protective of the Forster's tern. Similarly, the target for the common merganser (0.10 ppm methylmercury in TL3 fish 15-35 cm long) is also protective of osprey because only about 10 percent of ospreys' diet consists of TL4 fish from this watershed. It is important to note that due to their diets, fish in the same size class may be in different trophic levels (i.e. have more or less mercury than other fish the same size).

Table 5.3 Safe Fish Methylmercury Levels for Wildlife (mg Hg/kg fish tissue, wet weight)				
	TL3 Fish < 5 cm	**TL3 Fish 5-15 cm**	**TL3 Fish 15-35 cm**	**TL4 Fish 15-35 cm**
Great blue heron		0.12		
Osprey			0.10	0.20
Common merganser			0.10	
Forster's tern	0.05			
Belted kingfisher		0.05		

To protect wildlife, Water Board staff propose two fish tissue-based water quality objectives:

- **0.05 mg methylmercury per kg fish tissue in TL3 fish between 5 and 15 cm in length**
- **0.1 mg methylmercury per kg fish tissue *(rounded to one significant digit)* in TL 3 fish between 15 and 35 cm in length.**

USFWS recommends that a fish tissue monitoring plan be developed to determine whether the assumptions it relied on to develop the targets are valid for this watershed. Section 10 describes our proposed monitoring plan. The targets' effectiveness and applicability to all wildlife, including rare and endangered species, will be assessed in the future through the adaptive implementation process described in Section 9 (Implementation Plan).

5.2 Wildlife Water Quality Objectives and Human Health

The new mercury water quality objectives proposed in Section 5.1 are intended to protect aquatic organisms and wildlife. These objectives have been calculated to protect piscivorous birds that, pound for pound, consume more fish than humans do. Therefore, we expect these wildlife objectives to be protective of human health. In this section we provide a quantitative analysis to demonstrate that this is the case.

When the wildlife water quality objective of 0.1 mg/kg average is achieved for 15-35 cm fish in the watershed, it is expected that the lower trophic level fish in the size class will have less mercury than the higher trophic level fish in the same class, and that the overall fish diet for piscivorous birds will average 0.1 mg/kg methylmercury. In our human health analysis, we assume that 1) the wildlife water quality objective of 0.1 mg/kg applies to TL3 fish only, and 2), a higher average methylmercury fish tissue concentration will be found in TL4 fish. This assumption is conservative in view of our goal of protecting human health.

A *trophic level ratio* (TLR) expresses changes in mercury bioaccumulation from one level in the food web to another, derived using fish of the same size classification (CVRWQCB 2004). Similarly, a *food chain multiplier* (FCM) expresses changes in mercury bioaccumulation from one level in the food web to the next, derived from our understanding of predator-prey relationships (*ibid.*). USFWS states that TLRs and FCMs are equally valid, and "if sufficient data on existing fish tissue methylmercury concentrations are available, food chain multipliers can also be established using the ratio of these concentrations between trophic levels" (USFWS 2005). USFWS goes on to advise that that the FCM approach should be used with following caveat:

> Calculating methylmercury targets for specific trophic levels requires that resultant limiting concentrations be applied to the appropriate food chain cohorts (e.g. a limiting concentration for TL3 must be applied to applied to the species and size class of fish that would be consumed by larger predatory TL4 fish (USFWS 2005).

Based on extensive largemouth bass foraging studies in the Central Valley, the black crappie and largemouth bass fish data from Soulajule Reservoir are the appropriate size classes for a FCM (Keith 2006a, Keith 2006b, Moyle 2002), hence we have employed the FCM approach.

We used the summary data from Soulajule presented in Table 5.4 is used to calculate a fish FCM from trophic level 3 to 4 (see Table 3.2 for complete data and citation). The FCM, calculated by dividing the average largemouth bass (TL4) mercury concentration by the average black crappie (TL3) mercury concentration, yields a FCM of 2.2. This is nearly equal to the 2.0 TLR calculated by the Central Valley Regional Water Quality Control Board for large TL4 fish (>15 cm length) and large TL3 fish (>15 cm length) in the Cache Creek watershed (CVRWQCB 2004). The Soulajule FCM is in the range of multipliers calculated for a national data set in 1994 by Bahnick et al., summarized in U.S. EPA's *Water Quality Criterion for the Protection of Human Health: Methylmercury* (USEPA 2001).

Table 5.4 Soulajule Reservoir Average Fish Mercury Concentrations

	Black Crappie (Trophic Level 3)	Largemouth Bass (Trophic Level 4)
Fish length (mean, cm)	164 - 173	216 - 495
n	3 composites of 5 fish	5 composites of 4-6 fish, and 4 individual samples
Average mercury (weighted for n[7])	0.33	0.79

The FCM can be used to calculate the trophic level 4 mercury concentration given a trophic level 3 mercury concentration by using Equation 5.1:

Equation 5.1 [Hg in TL3] x FCM = [Hg in TL4]

When the wildlife water quality objective of 0.1 mg/kg is attained in trophic level 3, using the FCM of 2.4 in Equation 5.1, it will translate to 0.2 mg/kg in trophic level 4 fish (rounded to one significant figure)[8].

Next, we calculate the trophic level 4 fish methylmercury concentration safe for human consumption, and compare it to 0.2 mg/kg.

The U.S. EPA has developed a methylmercury criterion for the protection of human health of 0.3 mg/kg, average, in fish (USEPA 2001). This criterion applies to the average concentration of fish consumed, commonly referred to as the "take home basket". It can be used to determine safe fish levels for specific trophic level fish consumed by humans by estimating and the proportion and consumption rate of fish in the various trophic levels. The criterion is based on a national default consumption rate of 17.5 grams of fish per day (g/d), consisting of 3.8 g/d trophic level 2, 8.0 g/d trophic level 3, and 5.7 g/d trophic level 4 fish (USEPA 2001). However, there are no trophic level 2 fish sufficiently large enough for human consumption in the Walker Creek watershed. Therefore, below we estimate safe human health fish concentrations using a fish consumption rate at 10.5 g/d trophic level 3 and 7.0 g/d trophic level 4, which we base on the national default rates of 60% trophic level 3 and 40% trophic level 4.

> The criterion of 0.3 mg/kg is equal to the sum of the trophic level consumption rates multiplied by their respective fish methylmercury concentrations, as follows:
>
> 0.3 mg/kg = [60% x TL3] + [40% x TL4]
>
> Reorder Equation 5.1 and substitute:
>
> 0.3 mg/kg = [60% x (TL4/FCM)] + [40% x TL4]
>
> Where FCM = 2.4, trophic level 4 fish show a methylmercury concentration of 0.45 mg/kg. Rounding to one significant figure results in a trophic level 4 fish methylmercury concentration of 0.5 mg/kg.

Based on our knowledge of local fish species present in the watershed and using US EPA's criterion and associated methodology, trophic level 4 fish with methylmercury concentrations of 0.5 mg/kg are protective of human health. Our proposed objective to protect wildlife translates to 0.2 methylmg/kg mercury for trophic level 4 fish. Therefore, this TMDL's wildlife water quality objective is protective of human health.

This analysis is provided to illustrate that the proposed wildlife fish tissue objectives are protective of human health. Since wildlife is the most sensitive receptor in the watershed, we are not proposing these objectives for the protection of human health. The proposed objectives are designated for the protection of aquatic life and wildlife. If the State proposes and adopts statewide human health fish tissue objectives for mercury, those objectives will apply in this watershed as well.

5.3 Vacate 4-day Average Marine Water Quality Objective

The Basin Plan four-day average freshwater mercury water quality objective is based on science over two decades old (USEPA 1985). It is derived from the most sensitive adverse chronic effect, the U.S. Food and Drug Administration's (USFDA) action level to protect human health for mercury in commercial fish and shellfish (1.0 ppm) (USEPA 1985). The final residual value was calculated by dividing the lowest maximum permissible tissue concentration (USFDA action level of 1.0 mg mercury per kg fish) by the bioconcentration factor of 81,700 (the relative methylmercury concentration found in the fathead minnow compared to the total mercury concentration in the water fathead minnow lives in), which yields 0.012 µg/l, four-day average concentration not to be exceeded more than once every three years on average. In 1986, when promulgated in the Basin Plan, the U.S. EPA freshwater criterion for mercury of 0.012 µg/l was below the detection limit of 0.025 µg/l[9]. Therefore, the freshwater water quality objective for mercury was set at the 1986 detection limit of 0.025 µg/l. Every subsequent Basin Plan update has retained the 1986 Water Quality Objective. We propose that the proposed aquatic organism and wildlife objectives replace this four-day average water quality objective.

Although the Basin Plan 1-hour average marine and freshwater objectives are also based on this 1985 document, they are derived from toxicity tests on aquatic species themselves. Staff does not propose to vacate the 1-hour objective.

6 TMDL WATER QUALITY TARGETS

A TMDL target can be 1) a numeric water quality objective, 2) a numeric interpretation of a narrative objective, or 3) a numeric measure of some other parameter necessary to meet water quality standards. Targets must be measurable, and they must be designed to demonstrate attainment of water quality standards. All four proposed water quality targets are the same or more stringent than the ~~as~~ existing or proposed water quality objectives.

Water Board staff propose four TMDL water quality targets for Walker Creek:

1) To protect **wildlife:** Mercury levels in fish consumed by piscivorous birds (trophic level 3 fish, 5-15 cm long) shall not exceed 0.05 mg mercury per kg fish tissue (average wet weight concentration).

2) To protect **wildlife**: Mercury levels in fish consumed by piscivorous birds (trophic level 3 fish, 15-35 cm long) shall not exceed 0.1 mg mercury per kg fish tissue (average wet weight concentration).

These two targets, which apply to Walker Creek, its tributaries, and Soulajule Reservoir, are designed to protect the most sensitive wildlife in the watershed, including rare and endangered species. They are the same ~~as~~ or more stringent than the proposed aquatic organism and wildlife objectives.

3) To protect **aquatic organisms:** Mercury concentrations in Walker Creek and Soulajule Reservoir must not exceed 2.4 μg/l (one-hour average). This target is the same as the existing water quality objective designed to protect aquatic life from the acute effects of mercury.

4) To protect **humans** who consume reservoir fish or who may in the future consume fish from Walker Creek: Mercury concentrations in Walker Creek and Soulajule Reservoir must not exceed 0.050 μg/l (30-day average). This value is the concentration specified in the California Toxics Rule (CTR; 40 CFR § 131.38) for consumption of organisms and water.

7 LINKAGE ANALYSIS

In this section we describe the relationship between mercury sources in the Walker Creek watershed and the proposed numeric targets. This relationship provides a basis for estimating total assimilative (loading) capacity and identifying mechanisms for load reductions.

The following sub-sections describe the conceptual linkage model and data used to evaluate current mercury loads to Walker Creek and the watershed's capacity to assimilate these loads. We discuss three kinds of linkages: 1) linkages between particulate mercury and methylmercury concentrations in fish tissue (relevant to protection of wildlife in the riverine portions of Walker Creek watershed), 2) linkages between particulate mercury and total mercury in the water column (relevant to protection of aquatic life), and 3) linkages between methylmercury and mercury concentration in fish tissue (relevant to protection of wildlife in the Soulajule Reservoir).

7.1 Linkages between Sources and the Aquatic Food Web

In the Walker Creek watershed, the Gambonini mine is the primary source of mercury related to human activity, both directly (mercury running off mining waste piles left at the site) and indirectly (mercury-laden sediment transported downstream from the mine and stored in the creeks' beds, banks and floodplains; see Section 4). Bottom sediments in Soulajule Reservoir are both an in situ source of methylmercury and a potential source of mercury-laden sediment and methylmercury to downstream waters. Figure 7.1 is a schematic illustration of mercury's pathway from these sources to bioaccumulation in wildlife in the Walker Creek watershed. The figure and the narrative below provide a conceptual model[10] that describes the linkages between sources of mercury and uptake by the aquatic food web. The principal linkages are as follows:

1) Stormwater runoff and erosion processes transport mercury from the Gambonini Mine site into the property's drainage channel, either as ore or as mercury attached to fine sediments.

2) This mercury moves downstream, transported in pulses by storm events. Mercury is subsequently stored in creek beds, banks or floodplains and, depending upon the flow regime (i.e. magnitude, frequency and duration of flow) and the particulate size (e.g., fine silts and clays are more easily transported than sands or gravels), it may or may not be available for transport by future storms. For example, large pulses of mercury laden-sediments deposited on a floodplain may become unavailable if the floodplain subsequently develops a healthy riparian corridor. Conversely, multiple small mercury deposits may be remobilized in an area undergoing significant bank erosion. In Soulajule Reservoir, mercury is stored in bottom sediments and may be discharged to downstream waters.

3) Most of the mercury in the Walker Creek watershed, as is typical in most surface waters, binds to sediment where it is subject to biological, chemical and/or physical processes.

4) Chemical and biological processes act on sediment-bound inorganic mercury to first dissolve it and then transform the dissolved mercury into organic

mercury. The greatest concern is the transformation of inorganic mercury to methylmercury, a highly toxic organic form of mercury. This transformation typically occurs under anoxic (low oxygen) conditions. The reservoir hypolimnion (deep water) in the dry season is largest volume of anoxic water in the watershed, and therefore the greatest potential source of methylmercury.

5) Methylmercury is easily taken up by small aquatic plants (phytoplankton) where it is then passed it up the food web to higher trophic level organisms.

6) At the base of the food web are plants, which are consumed by herbivores, which in turn are consumed by predators, which are consumed by top predators. Each level in the food web accumulates methylmercury from all the levels below (bioaccumulation).

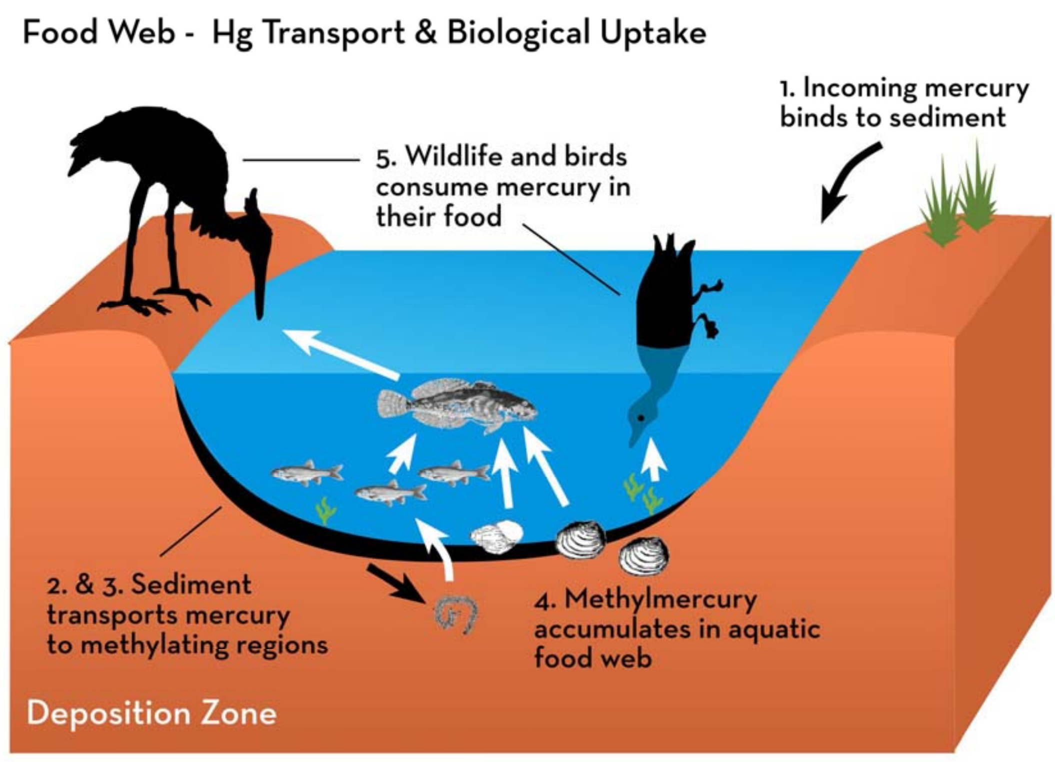


Figure 7.1 Mercury Transport and Biological Uptake

This graphic depicts the mechanisms that link mercury in mining waste to the biological organisms at varied trophic levels in a food web.

7.2 Particulate Mercury Sources and Fish in Walker Creek

Relationships between particulate mercury sources, total mercury in the water column, and mercury in fish tissue can be inferred from two data sets. We used this information to determine the highest particulate mercury concentration that will meet the fish tissue target.

- The Toxic Substance Monitoring Program (TSMP) collected fish samples from Walker Creek at Walker Creek Ranch (downstream of the mine site) during years 1991-1995, prior to remediation actions on the mine site (initiated in 1999). (See Table 3.1.)
- Water Board staff collected water quality samples prior to remediation activities.

To protect wildlife, a mercury target and methylmercury water quality objective of 0.05 mg mercury per kg fish tissue in TL3 fish 5-15 cm in length and 0.1 mg mercury per kg fish tissue in TL3 fish 15-35 cm in length is proposed. The two proposed water quality objectives (and corresponding TMDL targets) will protect wildlife such as common messengers, great blue herons, Forster's terns, and belted kingfishers that consume resident smaller trophic level 3 fish and osprey that potentially consume both smaller and larger resident TL3 fish from Soulajule Reservoir (Sections 5 and 6). Larger TL3 fish (greater than 15 cm) are not found in Walker Creek These target values represent the desired future condition for fish in Walker Creek and its tributaries.

7.3 Linking Sources and Wildlife Targets in Walker Creek

The following section outlines the reductions in particulate mercury that are needed to attain targets. The only actions taken to control continued mercury contamination of the Walker Creek watershed have been the remediation projects on the Gambonini property. The remediation work focused on minimizing the input of particulate mercury into the Walker Creek drainage. The mean particulate and total mercury value have dropped by approximately 50 percent since remediation began (Figure 3.2). Based on comparison of water quality data pre- and post-remediation, reducing particulate mercury concentrations in Walker Creek and its tributaries will result in a reduction in total mercury in the water column. Applying this information to our understanding of mercury transport and mercury uptake in the food web, we infer the following linkages:

1) Most of the total mercury remaining in Walker Creek is bound to sediment.
2) Some of this sediment-bound mercury will convert to methylmercury.
3) Erosion control actions on lands with elevated mercury concentrations will reduce the amount of mercury-laden sediment entering the Walker Creek and in-stream sediment mercury levels will decline.
4) Sediment contributed from background sources will dilute or bury mercury-laden sediments in storage. Over time, the concentration of mercury discharged from the bed, banks, and floodplains will diminish.
5) If there is less sediment bound mercury in the riverine portions of the watershed, less mercury will be available for methylation.
6) Reducing the amount of methylmercury available to small aquatic organisms, such as plankton will reduce mercury in fish.
7) Lowering levels of methylmercury in fish will transfer less methylmercury up the aquatic food web to birds and wildlife, protecting an important beneficial use of these waters.

We considered Walker Creek biota, water, and sediment mercury data in developing the conceptual linkage model and use this information to describe relationships between mercury sources and targets. While we recognize that linking fish mercury concentrations with water column methylmercury is an ideal link, we do not have water column methylmercury and fish tissue mercury data from the same period (either pre- or post-remediation) that would allow us to develop a quantitative relationship between these two variables. Fish tissue concentrations have likely changed post remediation due to a reduction in mercury loads from the Gambonini Mine site. Available pre-remediation data includes mercury fish tissue, total mercury, and particulate water column concentrations. While post-remediation we have water column data, including, methylmercury concentrations, but no fish tissue data for Walker Creek. For this reason, we used the only contemporaneous creek and fish tissue mercury concentration data we have, which is pre-remediation. Therefore, we based our analysis on the following framework of assumptions and parameters for achieving desired future conditions in the Walker Creek watershed. This analysis forms the basis for our linkage analysis.

1) Staff determined that of the fish species represented in the TSMP data set, the California roach (trophic level 3) is the most representative species consumed by piscivorous wildlife. Because roach had the highest mercury concentrations of the fish collected, using it to represent pre-remediation tissue concentrations provides the most conservative option. California Roach were collected by the TSMP at Walker Creek Ranch, a site the Water Board has been monitoring.

2) Mean values for particulate mercury in the water column better represent fish exposure to mercury over time than the median (central tendency) value. The mean value represents the amount of mercury that is available for methylation in Walker Creek

3) Mercury concentrations in fish tissue represent the watershed's mercury loads and methylation rates over time. We assume a one-to-one relationship between reductions in particulate mercury (averaged over time and space) and reductions in mercury in fish tissue.

   We also assume that the production of methylmercury positively relates with the concentration of mercury in particulate surface sediments. We recognize that methylmercury production in a flowing creek is variable due to seasonal variations in bacterial activity, flow, and sediment transport. However, over the long term the one to one relationship is more plausible. This is an area of active research and the scientific literature does not suggest an alternative approach.

4) We use the ratio of the desired fish tissue concentration to the pre-remediation fish tissue concentration to calculate the percent difference between pre-remediation particulate sediment concentrations and desired future particulate sediment concentrations (the target value) (See Equation 7.1).

5) We further assume a one-to-one relationship between fish tissue mercury and water column particulate mercury concentrations. Based on this assumption, we calculated reductions needed from pre-remediation particulate mercury levels in the watershed (Equation 7.2) to meet safe mercury levels for wildlife (0.05 mg Hg/kg sediment)

We can use this framework to examine the relationship between sources of mercury in the watershed and the proposed wildlife target of 0.05 mg mercury per kg of fish tissue (in trophic level 3 fish, 5cm–15cm in length). We employed two equations (Equations 7.1 and 7.2) to apply fish tissue and particulate mercury data to the general assumptions and relationships discussed above.

The desired fish tissue mercury concentration (based on USFWS recommendations) is 0.05 mg/kg, which is 14 percent of the pre-remediation fish mercury concentrations. Therefore we need an 86 percent reduction in particulate mercury levels from the pre-remediation concentration average of 5.4 mg/kg to 0.76 mg/kg.

Equation 7.1 Ratio of desired conditions (target value) to pre-remediation fish tissue

$$\frac{0.05 \text{ mg Hg per kg fish tissue}}{0.36 \text{ mg Hg per kg fish tissue}} = 0.14$$

Equation 7.2 Desired future condition: Particulate mercury protective of wildlife

$$0.14 \times 5.4 \text{ mg Hg per kg sediment} = 0.76 \text{ mg particulate Hg per kg sediment}$$

Rounding to one significant figure results in a particulate mercury value of 0.8 mg mercury per kg sediment.

Table 7.1 Mercury levels prior to mine site remediation; levels needed to attain targets

	Pre Remediation mercury levels (mg/kg)	**Mercury levels needed to attain targets (mg/kg)**
Fish Tissue Hg (California roach) mg/kg (TSMP data set- Walker Creek Ranch, 1994-1995)	0.36 (mean)	0.05
Particulate Hg $_{\text{<water>}}$ mg/kg **(Water Board data set- Walker Creek Ranch, 1995-1998)**	5.4 (mean)	**0.76** Calculated using Equation7.2

Based on the above analysis, particulate mercury concentrations could range up to 0.8 mg mercury per kg sediment in Walker Creek and still meet the fish tissue target. We calculated a background value of 0.2 mg of mercury per kg of sediment particulate mercury in the Walker Creek watershed (Marshall 2006). As discussed in Section 8 Allocations, much of the watershed is outside of the mines' influence and receives sediment from background sources only. In these areas, suspended particulate mercury concentrations are well below the 0.8 mg mercury per kilogram sediment concentration value necessary to meet the fish target.

As discussed in Section 10, Monitoring and Evaluation, future monitoring in the watershed will evaluate linkages between methylmercury contributions from Soulajule Reservoir and in-situ production in Walker Creek to fish, particularly smaller fish that are likely to respond relatively rapidly to changes in their environmental methylmercury burden.

7.4 Linking Sources and Targets in Soulajule Reservoir

Unlike Walker Creek, where sources of particulate mercury are understood to be controllable, the two mercury sources to Soulajule Reservoir are, arguably, uncontrollable: atmospheric deposition and mercury mining wastes within the reservoir itself. Our analysis of the linkage between reservoir conditions and mercury in fish is as follows:

1) Soulajule Reservoir overlays a pre-existing mining operation in the Arroyo Sausal watershed.
2) The mining waste is now intermixed with reservoir bottom sediments.
3) Some of this sediment-bound mercury will convert to methylmercury, when the reservoir undergoes the natural process of thermal stratification that causes the hypolimnion[11] to become anoxic.
4) Reducing the amount of methylmercury available to aquatic organisms low in the food web, such as plankton, will reduce methylmercury in fish.
5) Lowering levels of methylmercury in the water column will transfer less methylmercury up the aquatic food web to birds and wildlife, protecting an important beneficial use of these waters.

The production and biomagnification of methylmercury in Soulajule Reservoir are described narratively rather than quantitatively because aqueous methylmercury data needed to develop a site-specific mathematical relationship between aqueous and biotic methylmercury concentrations are currently lacking. Therefore, we use bioaccumulation factors based on data from other waterbodies to derive an aqueous methylmercury concentration goal that is linked to our numeric targets for ~~methyl~~mercury in fish tissue in this TMDL.

A bioaccumulation factor (BAF) is "a numeric value showing the amount of contaminant uptake into biota, relative to concentrations in the water column" (USFWS, 2005).

Equation 7.3

$$\text{Bioaccumulation Factor (BAF)} = CT/CW * 10^6$$

where:

CT = Methylmercury concentration in fish tissue, mg/kg
CW= Dissolved methylmercury concentration in the water, ng/l

In its methylmercury criterion for the protection of human health, the U.S. EPA calculated a draft national BAF of 1,300,000 for dissolved methylmercury in lakes and methylmercury in trophic level 3 fish (Table A-1, USEPA 2001). The wildlife water quality objective for TL3 fish 5-15 cm in length is 0.05 mg/kg. Dividing the desired fish tissue concentration by the average BAF (0.05 mg/kg divided by 1,300,000) and multiplying by 10^6 (to convert from milligrams to nanograms) yields 0.04 nanograms dissolved -methylmercury per liter of water. This calculation accounts for seasonality of methylmercury production since the BAF incorporates both high and low seasonal values. During implementation of this TMDL, after sufficient data are collected from Soulajule Reservoir, we anticipate revising this methylmercury concentration goal to reflect site-specific conditions (see Adaptive Implementation in Section 10.3).

7.5 Linking Sources, the Aquatic Organism Target and the CTR Mercury Limit

As discussed in Section 6, we recommend a separate target to protect aquatic life from acute effects: 2.4 micrograms of mercury per liter of water (one-hour average). As we have shown, mercury is transported from land sources to the water column. When we know the concentration of suspended sediment in the water column (TSS), the following formula allows us to calculate total mercury in the water column:

$[Hg]_{sediment} = 10^6$ x $[Hg]_{total}$ - $[Hg]_{dissolved}$

[suspended sediment]

where:

$[Hg]_{sediment}$= mercury concentration in suspended sediment

(milligrams mercury per kilogram dry sediment)

$[Hg]_{total}$ = total mercury concentration in water

(milligrams mercury per liter water)

$[Hg]_{dissolved}$= dissolved mercury concentration in water

(milligrams mercury per liter water)

[suspended sediment] = suspended sediment concentration

(milligrams suspended sediment per liter water)

The United States Geological Survey (USGS 2005) has been monitoring suspended sediment concentrations in the water column at Walker Creek Ranch since October 2003. The most recently available data set consists of 241 daily TSS values (10/01/03-5/31/04.) As discussed in Section 3.1 (Applicable Water Quality Standards), the California Toxics Rule (CTR) criterion for mercury (0.050 ppb 30-day average) applies to the Walker Creek. Water Board staff used the Walker Creek USGS TSS data set to estimate potential 30-day average mercury water column values from particulate mercury concentrations. Multiplying the daily TSS values provided by the USGS with the particulate mercury value we estimate is needed to meet the wildlife fish tissue target (0.8 mg per kg of sediment) and calculating a 30-day running average, we found 28 exceedances of the CTR limit for mercury. Using the same method, particulate mercury concentrations do not exceed the CTR limit for mercury when the particulate mercury concentration is 0.5 mg mercury per kg sediment. In addition, with particulate mercury levels at either 0.8 or 0.5, mercury water column concentrations never exceeded the aquatic life target of 2.4 μg/L (one-hour average).[12]

Limiting particulate mercury concentrations to 0.5 mg mercury per kg sediment in Walker Creek will protect wildlife and aquatic life from chronic and acute exposure to mercury and result in attainment of the CTR water quality criterion.

7.6 Assimilative Capacity

A TMDL can be expressed in terms of “mass per time,” “toxicity,” or any other appropriate measure, depending on the circumstances of the impairment (Title 40, Code of Federal Regulations, §130.2[i]). In the specific case of mercury in this watershed, expressing the total maximum load in terms of “mass per time” is impractical due to the episodic nature of particulate mercury discharges and the indirect relationships between methylmercury production and the amounts of mercury-laden sediment that are potentially stored, transported or buried at any one time. For these reasons, the assimilative capacity or TMDL is concentration-based for both Walker Creek and Soulajule Reservoir. For the riverine portions of the watershed the TMDL, expressed in terms of particulate mercury concentration, is suspended particulates averaging 0.5 mg mercury per kg sediment. For Soulajule Reservoir, the TMDL, expressed in terms of dissolved methylmercury concentration, is 0.04 ng mercury per liter water (annual average).

8 TMDL ALLOCATIONS

As discussed in Section 7, in order to meet targets and protect beneficial uses, particulate total mercury concentrations must not exceed 0.5 mg mercury per kilogram sediment (as suspended particulates in the riverine portions of the watershed). Dissolved methylmercury must not exceed 0.04 ng/l annual average in Soulajule Reservoir. The allocations described below ensure that concentrations do not exceed the assimilative capacity of Walker Creek, its tributaries, and Soulajule Reservoir, thereby ensuring that water quality standards are met.

TMDL allocations (the distribution of the total maximum daily load to sources or source categories) represent long-term averages and account for long-term variability, including seasonal variability. Since a TMDL can be expressed in terms of "mass over time," "toxicity," or any other appropriate measure (Title 40, Code of Federal Regulations, §130.2[i]), allocations may also be expressed in such terms (USEPA 2000d). We have chosen to express both allocations of mercury and the Walker Creek TMDL in terms of the particulate total mercury concentration, with an implicit margin of safety.

The allocations are intended to represent long-term averages and account for long-term variability, including seasonal variability. As discussed in Section 4 (Source Analysis) there are four sources of mercury in the Walker Creek watershed:

- **Background –** Mercury present at low concentrations (0.2 mg mercury per kg sediment) throughout the watershed
- **Downstream depositional features–**Mercury-laden sediments in depositional areas (creek beds, banks, and floodplains) downstream of the mercury mines
- **Soulajule Reservoir and its watershed –** Two abandoned mercury mines are located in this watershed
- **Gambonini Mine site –** An abandoned mercury mine, formerly the largest mercury processing facility in the watershed

8.1 Background Allocation

As discussed in Section 4.6 the background soil concentration of mercury (includes naturally occurring and deposited form the atmosphere) in the watershed averages 0.2 mg mercury per kg sediment upstream of the Gambonini mine site, in downstream areas unaffected by deposition from the Gambonini Mine site (i.e. areas upland from the zone of deposition) and in the Chileno Creek watershed. Therefore, the allocation to the discharge of sediments from all lands unaffected by drainage from the Gambonini Mine site is 0.2 mg mercury per kg sediment.

8.2 Downstream Depositional Areas Allocation

As discussed in Section 7.6, the assimilative capacity of Walker Creek is 0.5 mg/kg mercury in suspended particulates. The downstream depositional areas' allocation is a maximum of 0.5 mg/kg of suspended particulate total mercury downstream of creekside lands adjacent to Arroyo Sausal, Salmon and Walker creeks. This allocation is limited to creekside areas downstream of the Gambonini Mine site and Soulajule Reservoir with depositional features (including floodplains, beds and banks of creek channels, in-stream depositional features such as point bars, and backwater channels or floodplain wetlands) that discharge sediments into the Creek. The boundaries of this depositional zone extend to the highest elevations that can be inundated by Arroyo Sausal downstream of Soulajule Creek and Salmon and Walker Creek downstream of the Gambonini Mine site.

8.3 Soulajule Reservoir Allocation

As discussed in Section 7.6, the assimilative capacity in riverine portions of the watershed is 0.5 mg mercury per kilogram suspended sediments. As described in Section 8.2 above, this concentration limit applies to creekside properties. Also as discussed in Section 7.6, the assimilative capacity of Soulajule Reservoir is 0.04 nanograms of dissolved methylmercury per liter of water.

8.4 Gambonini Mine Site Allocation

The proposed allocation for discharges from the Gambonini Mine site (at the confluence of the Gambonini Mine Drainage and Salmon Creek) is 5 mg mercury per kilogram suspended sediments. Outside the heavily contaminated Gambonini Mine site drainage, Walker Creek supports a diverse array of aquatic species and wildlife. The most upstream point in the Walker Creek watershed where wildlife could be impacted by mercury is the section of Salmon Creek where the Gambonini Mine drainage discharges into it. We derive the allocation for the mine site using a “weighted average” sediment mercury concentration (described below) that will allow for a safe level of particulate mercury at the confluence of the mine drainage and Salmon Creek and in all reaches downstream of this point, where the 0.5 mg/kg TMDL applies.

It is not reasonable to expect mercury concentrations on the mine site to drop as low as background concentrations upstream of the mine, given that pre-mining, the area likely discharged elevated levels of mercury. A goal of this TMDL is to control mercury coming from the mine site so that, when diluted by mixing with the background sediments in upstream flow (coming from Salmon Creek) we can achieve the allowable TMDL and protect beneficial uses. In order to develop an allocation for the Gambonini Mine that will achieve the TMDL targets in Walker Creek downstream of the mine, we segmented the creek and its tributaries into subwatersheds that contribute different amounts of sediment and mercury. Several segmenting approaches were considered in developing the Gambonini Mine site allocation. Figure 8.1 illustrates the approach used, while Section 8.4 describes other possible approaches and the primary conservative assumptions that were chosen to add a margin of safety.

As discussed in Section 4, “Source Assessment,” the Gambonini Mine drainage carries mercury-laden sediments from the Gambonini Mine site into Salmon Creek and they then are transported downstream into Walker Creek. Sediment transport in this small sub-watershed is related to episodic high flow events. In developing an allocation for this area, we assumed that the entire Gambonini Mine site watershed is contributing mercury-laden sediment to Walker Creek every time it rains. In reality, because the mine’s drainage is intermittent, there is often little to no flow in the mine’s drainage during small storm events and for the first few storms of the rainy season, and during these times, sediment transport is minimal.

When discharges from separate sources are combined, the concentration of their combined discharge is not simply the sum of the individual concentrations, but rather a weighted average. A weighted average takes into account the proportional relevance of each component, rather than treating each equally. In this case, rather than treating lands upstream of the Gambonini Mine site and the Gambonini Mine site watershed as if they contribute equally to sediment and associated mercury concentration at their confluence, we weight the contributions based on percentages of contributing land area multiplied by each subwatershed's average sediment mercury concentration. This approach essentially accounts for the dilution of mine discharges from clean upstream sediment where the mine discharges to Salmon Creek. As equation 8.1 shows, to reach the weighted average target value we multiply the background sediment mercury concentration (0.2 mg/kg mercury background soils) by the percentage of upstream watershed land assumed to contribute sediment and calculate the desired mercury sediment concentration for the mine area (Gambonini Mine allocation) by estimating the mine drainage's relative land area sediment contribution. The TMDL for Walker Creek (0.5mg/kg) is used in the equation as it represents the desired suspended sediment concentration that needs to be attained at the confluence of the Gambonini Mine drainage and upper Salmon Creek.

Equation 8.1- Weighted Average Concentration

[(Background Hg concentration) x (% Upper Salmon Creek watershed area)] +[Desired Gambonini Hg concentration) x (% Gambonini watershed area)] = Weighted Average concentration at confluence (TMDL)

For the weighted area calculation, we considered sediment discharges from all of the sub-watersheds lands above the Gambonini Mine drainage outlet (See Figure 8.1). We calculated the land areas of:

- Salmon Creek watershed above the mine (background allocation)
- Gambonini Mine watershed (the unknown allocation)

The weighted average combines the contributions from background sediments upstream in Salmon Creek (94 percent of the upper watershed) with mine waste discharges (6 percent of the upper watershed).

Table 8.1 Comparing Sediment Contributions from Upper Sub-Watersheds		
	Sub-Watershed Area (square meters)	**Percent Area - Salmon Creek Confluence with GMD**
Gambonini Mine Drainage (GMD)	7.64×10^5	6%
Salmon Creek above Gambonini Mine site	1.26×10^7	94%
Total Area (square meters)	1.33×10^7	

CALCULATIONS USED FOR GAMBONINI MINE SITE ALLOCATION

In the calculations below the individual watersheds' drainage areas serve as proxies for the relative sediment contribution from each watershed.

Equation 8.1a Weighted Average Concentration with values inserted

Applying the percentage values from Table 8.1 (far right column) and the known contributing concentrations gives the following weighted average:

$$0.5 \text{ mg/kg Hg} = \left(0.2 \text{ mg/kg Hg} * 0.94\right) + \left(x \text{ mg/kg Hg} * 0.06\right)$$

Equation 8.1b

We can rearrange the values and solve for x:

$$x = \frac{\left(0.5 \text{ mg/kg Hg}\right) - \left(0.94 * 0.2 \text{ mg/kg Hg}\right)}{0.06}$$

x = 5.2 mg/kg Hg

Rounding to one significant figure results in a value of 5 mg mercury per kg suspended sediment.

Therefore, up to 5 mg/kg of particulate mercury can be discharged from the mine drainage and the TMDL for Walker Creek will be attained.

ASSUMPTIONS AND UNKNOWNS

While we can calculate the area of any of the contributing watershed lands, the width of stream channels or floodplains is harder to calculate, as they vary considerably and are not precisely delineated on available maps. Because of seasonal variability, we do not know the percentage of sediment moving downstream from in-stream, bank, or floodplain sediments, or from eroding hillslopes. However, we do know that the typical

Walker Creek morphology is an incised channel bounded by canyon topography. We can assume that 1) most sediment transport comes from a similar distribution of hillslope and alluvial sources, and 2) unpredictable events such as landslides (which may release significant additional amounts of mercury into the soils are evenly distributed across the landscape. While many landslide prone terrains include limited regions of repeat activity, West Marin's Franciscan mélange is extremely landslide and debris flow prone. A majority of the upland areas in Marin County and especially West Marin are potentially susceptible to landslide hazard (Marin County 2002, USGS 1982).

For the purpose of developing the mine site allocation we considered the percentage of sediment contributed by not only upper Salmon Creek and the Gambonini watersheds, but potential contributions from the Arroyo Sausal watershed above Soulajule Reservoir, below Soulajule Reservoir, and from the reservoir itself. The confluence of Arroyo Sausal and Salmon Creek is 281 meters downstream of the confluence of the Gambonini Mine drainage and Salmon Creek and it would be reasonable to establish the TMDL for this location because it is a logical sediment integration point for the upper watershed. We chose not to use this area in our allocation calculations, and instead use a more conservative approach by calculating the allocation based on where the Gambonini Mine drainage first joins Salmon Creek. Our assumptions are discussed below.

In order to understand the mercury contributions from Arroyo Sausal Creek below Soulajule, we need to better understand how the reservoir itself handles sediment, and mercury. Unfortunately, there is little information available on the influence of Soulajule Reservoir on suspended sediment loads downstream of its outlet. Although the Marin Municipal Water District monitors total suspended sediment concentrations monthly on Arroyo Sausal Creek, discharge information is not recorded. Moreover, sampling is done on a regular schedule and does not take place during storm events (Andrew 2005). Therefore, the Water District data does not help us understand the influence of Soulajule Reservoir on downstream waters, and it cannot be used to calculate sediment or mercury loads.

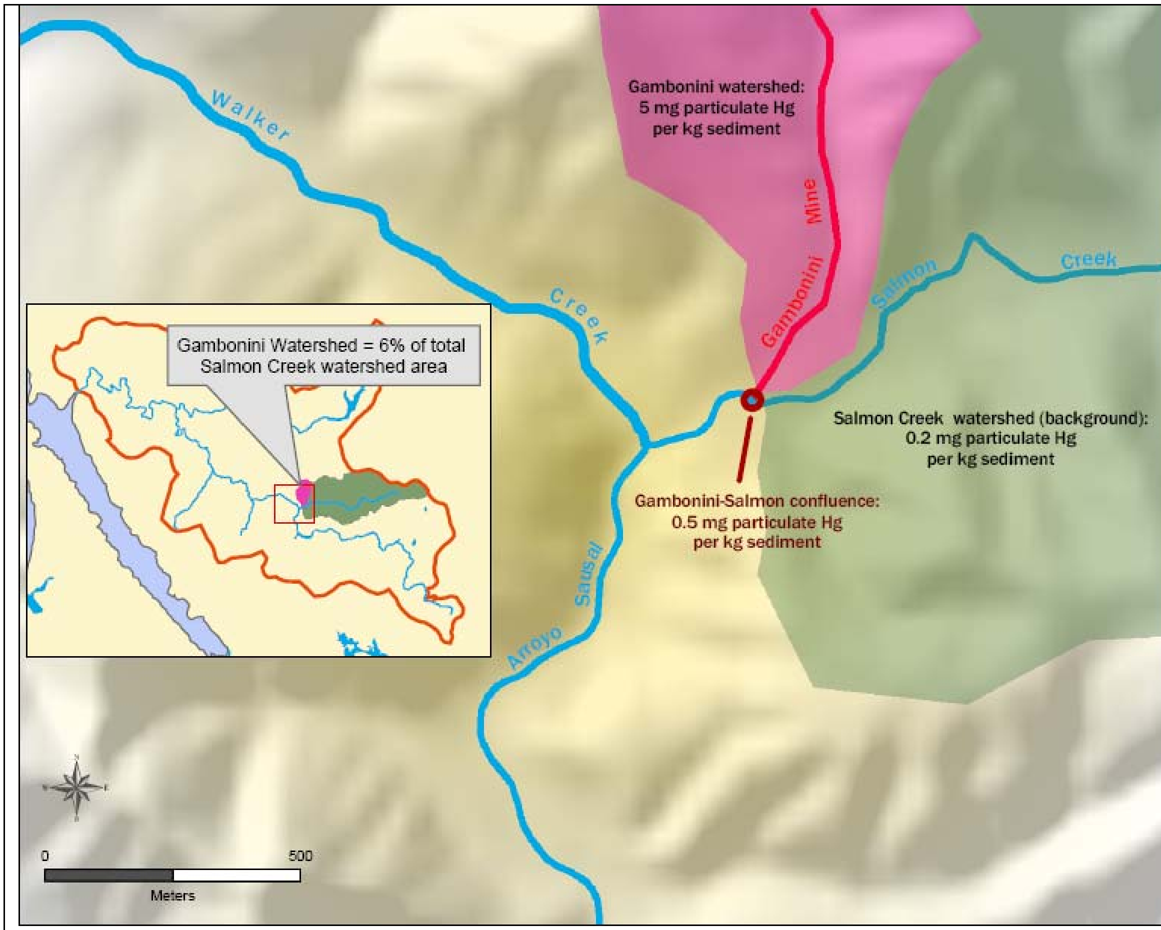


Figure 8.1 Mixing Mercury Concentrations from Different Sources

A weighted average approach is used to calculate an allocation for the Gambonini Mine Site. The inset graphic illustrates the drainage areas for the Gambonini Mine site and the upper Salmon Creek watershed. At the confluence of Salmon Creek and the Gambonini Mine drainage, the combined mercury concentration equals the TMDL 0.5 mg/kg.

As discussed in Section 8.2, the allocations to areas downstream of Soulajule Reservoir and the Gambonini Mine site are 0.5 mg mercury per kg sediment. Therefore the mercury concentration is not expected to increase downstream of the Gambonini Mine site.

In summary, the Gambonini Mine site allocation is a maximum of 0 5mg/kg of particulate total mercury discharged from the mine drainage into Salmon Creek. As discussed above, these mercury-enriched sediments will be diluted when they enter Salmon Creek (sufficiently to meet the downstream allocation of 0.5 mg/kg). Further dilution is likely to occur farther downstream where soils containing background mercury concentrations enter the creek. This dilution is not accounted for in the allocation scheme and is a conservative assumption that adds to the implicit margin of safety.

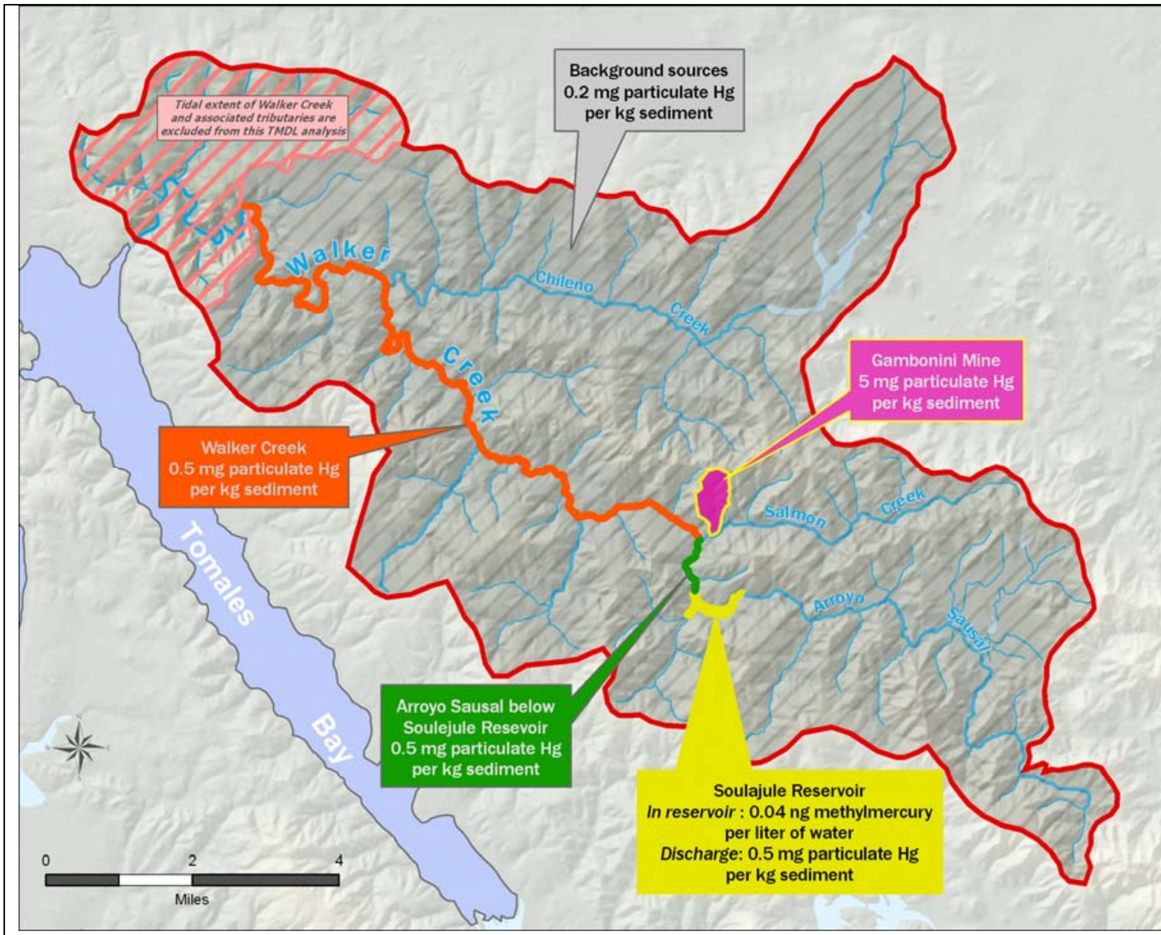


Figure 8.2 Allocations by Sources

TMDL allocations for the mercury source areas in the watershed.

8.5 Margin of Safety and Seasonal Considerations

MARGIN OF SAFETY

A margin of safety is intended to account for uncertainty (in this case resulting from a lack of easily obtainable data) about the relationship between pollutant loads and water quality in the receiving water.

A margin of safety can be applied either explicitly or implicitly. An explicit margin of safety would reserve, for instance, a specific amount of mercury, which is not allocated in the load allocation scheme. An implicit margin of safety derives from the use of conservative, protective assumptions in the analysis. As discussed in the previous section, the key conservation assumption used in our analysis relates to calculation of the mine site and downstream depositional areas' allocations. We did not include in our calculations hillslope sediment inputs that contribute clean sediments downstream of the mine site. The net effect of these clean sediments is that the mercury-laden sediments from the mine will continue to be diluted in the downstream reaches of the creek. Methylmercury as a percentage of total mercury in fish tissue may range as low as 83%

(Mason 2006), and varies between species. There is insufficient data on methylmercury as a percentage of total mercury in Walker Creek fish tissue to establish an explicit margin of safety. Nonetheless, the proposed fish tissue targets are for total mercury, which also provides an additional implicit margin of safety.

SEASONAL VARIATIONS AND CRITICAL CONDITIONS

As discussed in Sections 8.1 and 4.2, water column total mercury concentrations can vary by orders of magnitude in Walker Creek and in the smaller, flashier tributaries (such as the intermittent mine drainage) depending on the size of storms. This is why we are basing allocations on particulate mercury concentrations, which are less influenced by flow and precipitation variability—instead of using an allocation scheme based on loads.

Methylmercury concentrations also vary seasonally, as described in Section 7.4. Also as noted in Section 7.4, aqueous methylmercury data are currently lacking to quantitatively describe the dry season peak of methylmercury in Soulajule Reservoir.

Because wildlife beneficial uses are present in Walker Creek and many of its tributaries year-round, and because the Basin Plan's water quality objectives and the methylmercury BAF calculation make no seasonal distinction, the proposed targets and allocations are also valid year-round.

9 IMPLEMENTATION PLAN

9.1 Introduction to Implementation Plan

The overall intent of this implementation plan is to restore and protect beneficial uses of Walker Creek by reducing mercury loadings and methylmercury production. This section describes the Water Board's implementation goals, regulatory authority, and associated regulatory programs, and identifies actions needed (by source category) and responsible parties.

This implementation plan builds upon existing efforts that have successfully reduced mercury loads and recognizes existing regulatory programs, such as the Clean Water Act's Section 401/404 permit program, and Marin County's nonpoint source program, as mechanisms to achieve the plan's goal in an efficient and cost effective manner.

The Water Board completed the Tomales Bay Pathogen TMDL in 2005 and plans to establish nutrient and sediment TMDLs in the Tomales Bay watershed within the next 5 years. The Water Board encourages source control management measures for mercury and methylmercury that also reduce pathogen, sediment and nutrient loads ("multi-objective projects"), as this may preclude the need for additional measures. A multi-objective project could, for example, provide livestock with off-stream water sources, fence them out of the riparian zone, then revegetate the riparian zone. Such a project would not only reduce nutrient and sediment loads, but also the amount of energy livestock expend searching for water. Likewise, if the riparian zone includes a mercury-laden depositional area, the fencing and increased plant cover will not only reduce loss of property through sediment erosion but also any associated mercury releases into the creek. Reducing nutrient and sediment inputs, while increasing shading from riparian plants, may improve oxygen levels in the water. With more dissolved oxygen present, less methylmercury may be produced.

As discussed in Section 8 (Allocations), of the four source categories; 1) the Gambonini Mine Site, 2) Downstream Depositional Features 3) Soulajule Watershed and Reservoir, and 4) Background, only the Background category is currently not posing a threat to water quality. Therefore, we are not proposing any implementation actions for background areas. TMDL Implementation tasks for the Water Board are outlined in Table 9.1. TMDL implementation actions for sources are identified in Table 9.2 and are discussed below. Implementation actions need to be "trackable" to ensure that the goals of the plan are being met. The Water Board or a designated third party must easily be able to track progress in implementing such actions, or to quantify the results of actions over time.

9.2 Legal Authorities and Requirements

The Water Board has the responsibility and authority for regional water quality control and planning per the state's Porter-Cologne Water Quality Control Act. The State's Porter Cologne Water Quality Control Act gives the Water Board authority to issue Waste Discharge Requirements (WDRs) for point and nonpoint sources of contamination.

Under federal Clean Water Act (CWA) Section 401, every applicant for a federal permit or license for any activity which may result in a discharge to a water body must obtain State Water Quality Certification that the proposed activity will comply with state water quality standards. Waters of the State are defined as any surface water or groundwater, including saline waters, within the boundaries of the state. Examples include, but are not limited to, rivers, streams, lakes, bays, marshes, mudflats, unvegetated seasonally ponded areas, drainage swales, sloughs, wet meadows, natural ponds, vernal pools, diked baylands, seasonal wetlands, and riparian woodlands.

The Water Board regulates point source pollution by implementing a variety of programs, including the NPDES Program for point and nonpoint sources discharging into waters of the United States. The Industrial Storm Water General Permit (Order 97-03) is an NPDES permit that regulates discharges associated with 10 broad categories of industrial activities. One of the regulated categories is mining, including inactive mining operations. The Gambonini Mine is subject to the Industrial Storm Water General Permit. Other inactive mines in the watershed, may also be subject to NPDES permit requirements if Stormwater comes into contact with mining waste.

The Water Board has a comprehensive municipal stormwater runoff control program that is designed to be consistent with Federal regulations (40 CFR 122-124) and is implemented by issuing NPDES permits to owners and operators of large storm drain systems and systems discharging significant amounts of pollutants, including municipal facilities such as county roads. Each municipal stormwater permit requires that the entities responsible for the system develop and implement comprehensive control programs. The Marin County Department of Public Works/Flood Control administers the Marin County Stormwater Pollution Prevention Program (MCSTOPP) program under a NPDES permit. While the County is not required to implement their program in the unincorporated area of west Marin (where the Walker Creek watershed is located), they choose to in order to assure water quality is protected countywide.

The goals of MCSTOPP: to protect and enhance water quality in creeks and wetlands, preserve beneficial uses of local waterways and comply with State and Federal regulations; complement the goals of this TMDL. In order to meet County and NPDES goals, Marin County issues permits for creek modification activities in unincorporated areas and is responsible for minimizing potential pollutants discharged from county roads and maintenance activities (i.e. culvert or road repairs). The MCSTOPP Action Plan 2010 outlines the current management actions agreed to by the cities and county of Marin (as part of the NPDES permit) including coordination with the Water Board in implementing TMDLS (MCSTOPP 2005).

9.3 Implementation Actions

This section describes management measures for each mercury source category in the Walker Creek watershed. The Water Board, landowners, and local or regional programs managing water quality share responsibility for the successful implementation of this TMDL.

Active participation from local entities and third parties within the Walker Creek watershed will be essential for attainment of water quality standards. To help ensure implementation of actions anticipated from other entities, such as the Marin Resource Conservation District and U.C. Cooperative Extension, the Water Board will rely on interagency coordination, grant funding, and research and monitoring.

Opportunities and benefits for interagency and third party participation may need to be further explored. Some third parties have offered technical assistance, (e.g. U.C. Cooperative Extension with dairies and grazing lands). The Water Board will continue to explore methods for clarifying the role that third parties can play including: identifying their responsibilities in official Water Board documents (including WDRs); requesting reports from them; developing memoranda of understanding between the Water Board and third parties; and continuing ongoing, informal collaboration.

Many implementation activities focused on reducing sediment, pathogen and nutrient discharges are already underway in the watershed. These actions compliment desired implementation actions for reducing mercury concentrations in Walker Creek and its tributaries. The Water Board strongly supports these activities and recommends that these efforts be continued. Implementation of mercury control measures may also reduce nutrient and sediment loads and may preclude the need for additional implementation of management measures for these sources.

IMPLEMENTATION ACTIONS FOR GAMBONINI MINE SITE

Implementation actions are required for the Gambonini Mine site to eliminate, to the maximum extent feasible, discharge of mercury-laden sediments. Past actions have included geotechnical stabilization of mining waste piles, re-grading unpaved mine roads, channel restoration below mining waste piles, stabilization of the downstream floodplain area, site revegetation, physical barriers to livestock access and livestock access restrictions. To date, implementation actions on the mine site have been successful and we have observed a large reduction in mercury loads and suspended sediment concentrations. As vegetation of the site continues to take hold, we expect mercury concentrations to continue to drop. Continued monitoring and assessment is needed to evaluate trends and the effectiveness of remediation. The Water Board is committed to continuing this work using State Cleanup and Abatement funds and funds put aside as part of the settlement that took place between the former Mine operator (Buttes Gas & Oil) and the State of California.

It is the property owner's responsibility to apply for and comply with all provisions of the State of California's Industrial Stormwater General Permit Program. The Industrial Stormwater Permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). As part of the General Industrial Stormwater Permit Program, property owners are required to submit a Storm Water Pollution Prevention Plan (SWPPP) and a monitoring plan. The property owners must submit the SWPPP to the Water Board for approval as part of the General Stormwater Permit application process.

IMPLEMENTATION ACTIONS FOR SOULAJULE MINE SITES AND RESERVOIR

Marin Municipal Water District (MMWD) owns lands surrounding Soulajule Reservoir, which contain two inactive, mine sites. MMWD operates the Soulajule Reservoir. Releases from the reservoir are regulated via a Water Rights permit issued by the State Water Board, Division of Water Rights. MMWD is responsible for managing Soulajule Reservoir and reservoir discharges in such a way that beneficial uses are not degraded or impaired.

Implementation actions are required for Soulajule Reservoir. It is the property owner or reservoir manager's responsibility to manage methylmercury production in the reservoir and discharge of mercury (total, methyl and particulates) from the reservoir to Arroyo Sausal in a way that protects beneficial uses both in the reservoir and downstream. It is recognized that in reservoirs seasonal thermal stratification can result in water chemistry that enhances methylmercury production.

Marin Municipal Water District, must submit to the Executive Officer of the Water Board for approval a monitoring plan and implementation schedule to characterize fish tissue, water, and particulate mercury concentrations, methylmercury production and linkages between methylmercury and mercury in fish tissue in Soulajule Reservoir and Arroyo Sausal Creek downstream of the reservoir. Based on these findings, MMWD will need to evaluate the feasibility and effectiveness of nutrient and other controls to minimize methylmercury production and develop an implementation plan and schedule for specific actions necessary to attain both in-reservoir and downstream TMDL targets.

IMPLEMENTATION ACTIONS FOR DOWNSTREAM DEPOSITIONAL FEATURES

Implementation actions required for the Gambonini Mine site and downstream depositional areas are site-specific management measures to prevent, to the maximum extent practicable, erosion or resuspension of mercury-laden sediment from downstream depositional areas.

For purposes of demonstrating attainment of the allocation, dischargers will only be responsible for complying with conditions specified in permits or permit waiver conditions.

Any activity covered by the Clean Water Act's 401 permit program shall be conducted in such a way so as to minimize particulate and aqueous mercury and methylmercury discharges to Walker Creek and its tributaries. When designing wetland and riparian restoration projects, it is important to consider alternatives that will minimize the input of mercury-laden sediment into the channel. For example, for bank erosion and channel modification projects, bioengineering (using plants for structure) may be preferable as opposed to exposing mercury-laden deposits to resuspension through bank recontouring. Wetland restoration projects may be a source of methylmercury, however, because most floodplains in the watershed are infrequently inundated, and the percent of the downstream depositional area is very minor compared to the contributing watershed area, we expect the impacts from wetland restoration to be short term, and mitigated through burial from incoming cleaner sediments. The best design option for some of these projects may include excavation and disposal of mercury-laden sediments, which is the most permanent means to reduce mercury loads and methylmercury production in Walker Creek.

Marin County has agreed to update its *Creek Permit Guidance for Unincorporated Areas of Marin* to include specific guidance for projects in areas that may contain mercury-enriched sediments. All creekside property owners in the Walker Creek Watershed shall follow this guidance after it is developed.

Applicants seeking coverage under WDRs or Waiver of WDRs to control pathogens, nutrients or sediments in the Walker Creek watershed must also incorporate Best Management Practices (BMPs) to limit unnecessary increases in total, methyl or particulate mercury production or discharges.

9.4 Proposed Mercury Reduction Implementation Actions

Table 9.1 Proposed Water Board Implementation Actions to Reduce Mercury Loading

1.	In coordination with responsible parties and interested third parties in the watershed, monitor progress toward attainment of water quality objectives, attainment of benchmarks, and compliance with TMDL implementation plan.
2.	Assist in identifying funding mechanisms for implementation and monitoring.
3.	Report to stakeholders on progress in meeting implementation of management measures and attainment of water quality objectives, including a discussion of options for regulatory action and follow-up, as needed.
4.	Review all 401 permit applications to minimize additional mercury impacts to beneficial uses.
5.	Implement, as necessary, WDRs or waivers of WDRs related to mercury reduction.
6.	Work with Marin County on updating *Creek Permit Guidance for Unincorporated Areas of Marin* to include specific guidance for projects in areas that may contain mercury-enriched sediments.

Table 9.2 Implementation Measures			
Source	**Action**	**Implementing Parties**	**Completion Date**
Gambonini Mine Site	Apply for coverage under the State of California's Industrial Stormwater General Permit	Gambonini Mine Site owner(s)	2007
	Submit to the Water Board for approval a Storm Water Pollution Prevention Plan (SWPPP), implementation schedule, and monitoring plan.		
Soulajule Reservoir	Submit to Water Board Executive Officer for approval a monitoring and implementation plan and schedule to 1) characterize fish tissue, water, and suspended sediment mercury concentrations in Soulajule Reservoir and Arroyo Sausal Creek, and 2) develop and implement methylmercury production controls necessary to attain both in-reservoir and downstream TMDL targets.	Marin Municipal Water District	2009
Downstream Depositional Areas	Applicants seeking coverage under waste discharge requirements (WDRs) or waivers of WDRs to control pathogens, nutrients, or sediments discharges in the Walker Creek watershed must incorporate management practices that minimize mercury discharges and methylmercury production.	All creek side property owners downstream of Gambonini Mine and Soulajule Reservoir	2009
	All projects regulated under Clean Water Act Section 401 shall include provisions to minimize mercury discharges and methylmercury production.		
	Comply with conditions of Marin County's Creek Permit Program.		
	Update Marin County's *Creek Permit Guidance for Unincorporated Areas of Marin* to include specific guidance for projects in areas that may contain mercury-enriched sediments.	County of Marin	2008

9.5 Evaluating Progress Toward Attaining Implementation Goals

Beginning with 2012, and approximately every five years after the adoption of the TMDL, the Water Board will evaluate site-specific, subwatershed-specific, and watershed-wide compliance with the trackable implementation action described in Tables 9.1-9.3. In evaluating compliance with the trackable implementation actions, the Water Board will consider the level of participation of each source category as well as individual dischargers (as documented by Water Board staff or designated third parties).

If a discharger demonstrates that all implementation measures have been undertaken or that it is infeasible to meet their allocation due to uncontrollable contributions, the Water Board will consider revising allocations as appropriate. If source control actions are fully implemented throughout the Watershed and the TMDL targets are not met, the Water Board may consider re-evaluating or revising the TMDL and allocations. If, on the other hand, the required actions are not implemented, or are partially implemented, the Water Board may consider regulatory or enforcement action against parties or individual dischargers not in compliance.

10 MONITORING AND EVALUATION PROGRAM

10.1 Overview

It is important to monitor water quality progress, track TMDL implementation, and modify TMDLs and implementation plans as necessary, in order to:

- Assess trends in water quality to ensure that improvement is being made;
- Address any uncertainty in various aspects of TMDL development;
- TMDL implementation to ensure that implementation measures are being carried out; and
- Ensure that the TMDL remains effective, given changes that may occur in the watershed after TMDL development.

The primary measure of success for this TMDL is attainment or continuous progress toward attainment of the TMDL targets and load allocations. However, in evaluating successful implementation of this TMDL, attainment of trackable implementation actions also be heavily relied upon. Therefore, two types of monitoring are proposed for this TMDL: 1) water quality monitoring, discussed below; and 2) monitoring of implementation of actions, discussed in Section 10.5.

10.2 Water Quality Monitoring

Water Board staff will conduct water quality monitoring to evaluate mercury concentrations in Walker Creek and its tributaries as part of the Surface Water Ambient Monitoring Program (SWAMP). All water quality monitoring (including quality assurance and quality control procedures) will be performed pursuant to the State Water Board's Quality Assurance Management Plan for this program. The main objectives of the monitoring are:

- Assess attainment of TMDL targets
- Evaluate spatial and temporal water quality trends
- Refine our understanding of mercury loading in downstream depositional areas
- Collect sufficient data to prioritize implementation efforts and assess the effectiveness of source control actions

Table 10.1 presents locations in the Walker Creek watershed for baseline water quality monitoring. These sites will be monitored for suspended particulate, methyl- and total mercury concentrations during the wet and dry seasons. Wet season sampling will focus on characterizing conditions during peak flow events. SWAMP monitoring will be conducted based on availability of funds.

Walker Creek Ranch is an "integration" site for the watershed. Water quality data collected at Walker Creek Ranch integrates Salmon Creek background concentrations with loads from the Gambonini Mine Site, Soulajule Reservoir, and some downstream depositional features. Mercury levels in 5–15 cm fish in Walker Creek will be monitored every five years at Walker Creek Ranch to assess progress towards attaining the wildlife target. In addition, the Water Board, in cooperation with the United States Geological Survey, maintains a continuous data recorder at Walker Creek Ranch that monitors suspended sediment and particulate mercury concentrations in Walker Creek.

We anticipate that fish tissue mercury concentrations at Walker Creek Ranch will show a reduction in mercury concentrations over a relatively short time scale (less than a decade and that we will most likely see the benefit of source reduction at the mine site first. Walker Creek Ranch is well shaded and as discussed in Section 2.3 (Methylmercury, watershed processes and mercury transport), this stable reach is considered a transfer/deposition zone and is an area of minimum deposition and rapid downstream transport. Given the size fish consumed by wildlife in Walker Creek, the timescale of response should be trackable early on in the monitoring program. In the lower reaches of the watershed (Deposition Zone), reductions in mercury fish tissue concentrations are likely to take a longer period due several factors including:

- the magnitude, frequency and timing of rain events, coupled with
- the magnitude and frequency of mine waste resuspension and transport
- the impact of nutrient loads on methylmercury production,
- methylmercury loading from Soulajule Reservoir , and
- how fast mercury-laden sediment deposits are controlled on adjoining floodplains through restoration and erosion control actions.

Five years after adoption of this TMDL, the Water Board will evaluate monitoring results and assess progress made toward attaining targets and load allocations. Beginning In 2012 and approximately every five years thereafter, the Water Board will evaluate site specific, sub-watershed-specific, and watershed-wide compliance with the trackable implementation measures specified in Table 9.2.

Table 10.1 Baseline Monitoring Sites
Salmon Creek, upstream of the Gambonini Mercury Mine Site
Walker Creek at Walker Creek Ranch
Walker Creek at Highway 1
Chileno Creek downstream of the inactive Chileno Mine
Soulajule Reservoir
Arroyo Sausal Creek downstream of Soulajule Reservoir

10.3 Adaptive Implementation

Approximately every five years, the Water Board will review the Walker Creek Mercury TMDL and evaluate new and relevant information from monitoring, special studies, and the scientific literature. At a minimum, the following questions will be incorporated into the reviews. Additional questions will be developed in collaboration with stakeholders during each review cycle.

- Are the Creek and the tributaries progressing toward TMDL targets as expected? If progress is unclear, how should monitoring efforts be modified to detect trends? If there has not been adequate progress, how should the implementation actions or allocations be modified?
- What are the pollutant loads for the various sources? Have these loads changed over time? How do they vary seasonally? How might source control measures be modified to improve load reduction?
- What wetland and creek restoration methods should be used to minimize mercury discharges and methylmercury production while enhancing and restoring habitat values?
- Are wildlife feeding in Soulajule Reservoir at risk? If so, how can Soulajule Reservoir be managed to reduce this risk?
- Does additional sediment, water column, or fish tissue total or methylmercury data support our understanding of linkages in the watershed or suggest an alternative allocation strategy?
- Is there new, reliable, and widely accepted scientific information that suggests modifications to targets, allocations, or implementation actions? If so, how should the TMDL be modified?

Reviews will be coordinated through the Water Board's continuing planning program, with stakeholder participation. Any necessary modifications to the targets, allocations, or implementation plan will be incorporated into the Basin Plan via an amendment process. In evaluating necessary modifications, the Water Board will favor actions that reduce sediment and nutrient loads, pollutants for which the Walker Creek is also impaired.

11 Regulatory Analyses

This section includes the required analyses for the proposed Basin Plan amendment. The proposed Basin Plan amendment includes the following regulatory provisions:

- Two freshwater fish tissue water quality objectives for Walker Creek, Soulajule Reservoir, and all tributary waters
- TMDL targets and allocations
- Required TMDL implementation actions to the extent they are not already mandated by existing law

For the proposed water quality objectives, set forth below are the required analyses under the Water Code (§§ 13241 and13242), State and federal anti-degradation requirements, and federal water quality criteria requirements (40 C.F.R. § 131.11). For the entire Basin Plan amendment, set forth below and in Section 12 of this Staff Report are the required analyses under the California Environmental Quality Act (CEQA). Additionally, we explain below how the regulatory provisions of the proposed Basin Plan amendment satisfy peer review requirements (Health and Safety Code § 57004).

11.1 California Water Code § 13241

With respect to the proposed fish tissue water quality objectives,[13] the Water Board is authorized to adopt water quality objectives under California Water Code §13241 which identifies six factors that must be considered when establishing a water quality objective. These factors are considered below:

a) Past, present and probable future beneficial uses of water
b) Environmental characteristics of the hydrographic unit under consideration including the quality of water available thereto
c) Water quality conditions that could reasonably be achieved through the coordinated control of all factors that affect water quality in the area
d) Economic considerations
e) The need for developing housing within the region
f) The need to develop and use recycled water

a) Past, Present and Probable Future Beneficial Uses

Existing and potential beneficial uses of Walker Creek are cold freshwater habitat, municipal water supply, fish migration, preservation of rare and endangered species, water contact recreation, noncontact water recreation, fish spawning, warm freshwater habitat and wildlife habitat. Wildlife habitat and water contact recreation beneficial uses are considered impaired due to mercury. When the proposed mercury water quality objectives are attained, these beneficial uses will be restored and protected.

b) Environmental Characteristics of the Hydrographic Unit

Walker Creek is a subunit of the Tomales Bay Hydrologic area, which is part of the Coastal Marin hydrographic unit. The sub-hydrographic unit considered in this TMDL is the freshwater portion of Walker Creek. The Walker Creek watershed includes the following water bodies:

- Chileno Creek and its tributaries
- Salmon Creek and its tributaries
- Soulajule Reservoir
- Laguna Lake
- Frink Canyon Creek
- Verde Canyon Creek

Walker Creek is a high-gradient perennial stream, which drains to the northern end of Tomales Bay. Walker Creek is the Bay's second largest tributary and supplies about 25% of the Bay's annual runoff. The creek runs through steep hills and a narrow, incising alluvial valley. Only the lower portion of the watershed has broad floodplains. Winter flows from Walker Creek inundate these lower floodplains most years.

Flows are gauged on Walker Creek by the USGS at Walker Creek Ranch. In the dry season flows typically range from 5 to 20 cubic feet per second (cfs) and in the wet season may reach as high 3800 cfs during storm events. The gauging station is located upstream of the confluence of Walker Creek and Chileno Creek and therefore only accounts for approximately half of the flows in lower Walker Creek.

Arroyo Sausal Creek, once a significant tributary, is now impounded behind Soulajule Reservoir, a drinking water supply for Marin Municipal Water District (MMWD). Soulajule's capacity is 10, 572 acre-feet. To protect salmonid populations in Walker Creek, the California Department of Fish and Game requires MMWD to release a minimum discharge of 20 5 cubic feet per second (cfs) in normal winter years, 10 cfs in dry years and in critically dry years, 0.5 cfs year round. In the summer, MMWD is required to maintain flows of 5 cfs, 2 cfs and 0.5 in normal, dry and critically dry years respectively (Marin RCD 1989).

Land use changes have altered the environmental characteristics of the watershed. Historical and current land use practices have altered the creek's hydrology and sediment erosion and deposition patterns, and degraded in-stream channel and riparian habitats. (Marin RCD 2005).

In addition to mercury, Walker Creek is impaired by pathogens, nutrients, and sediment.

c) Water Quality Conditions That Could Reasonably Be Achieved Through Coordinated Control of All Factors Affecting Water Quality

The proposed water quality objectives reflect the desired water quality conditions for Walker Creek, its tributaries and Soulajule Reservoir such that beneficial uses will not be adversely affected by mercury. Factors that affect mercury concentrations in Walker Creek include the discharge of mercury-laden sediment from: inactive mine sites, depositional areas downstream of the mines sites, eroding creek banks and beds, resuspension of bed material, Soulajule Reservoir discharges, and atmospheric deposition. Factors that affect mercury concentrations in biota include mercury levels in stream sediments and water, and methylmercury discharges and in-stream production. In Soulajule Reservoir, factors such as nutrient and dissolved oxygen concentrations may affect methylmercury production. All of the above factors are recognized in the proposed Walker Creek Mercury TMDL Basin Plan amendment, which sets forth a program of coordinated control of these factors by establishing a TMDL, allocations, and an implementation plan. Coordinated control of these factors through the TMDL will result in water quality conditions that meet the proposed water quality objectives and protect beneficial uses.

d) Economic Considerations

The proposed fish tissue water quality objectives will be implemented through the Walker Creek Mercury TMDL. Therefore, the economics considerations for the proposed water quality objectives are the same as those identified for TMDL implementation. TMDL compliance costs are analyzed in section 11.6. This analysis includes an estimate of costs associated with implementing actions that are part of an agricultural water quality control program and identification of potential sources of funding, as required under CWC §13141. Costs associated with monitoring in Soulajule Reservoir are also included in the economic analysis.
Below is a summary of the costs as described in Section 11.6 and detailed in Table 11.3.

Table 11.1 Summary of Estimated Costs for Walker Creek Watershed Mercury TMDL Implementation (Year 0 through 10)

	One-Time Cost		Annual Cost		10-year program	
	Low	High	Low	High	Low	High
Total (Gambonini Mine Site)	$1,500	$2,000	$700	$800	$8,500	$10,000
Total (Soulajule)	$538,000	$686,000	$20,000	$30,000	$738,000	$986,000
Total (Depositional Areas)	$1,505,000	$2,510,000	$12,000	$14,000	$1,625,000	$2,660,000
GRAND TOTAL	**$2,044,500**	**$3,198,000**	**$32,700**	**$44,800**	**$2,371,500**	**$3,646,000**

e) Need for Housing

Neither of the proposed water quality objectives would restrict the development of housing in the San Francisco Bay Area because they do not result in any economic costs related to housing development or restrictions. Because the Walker Creek watershed (with the exception of Marin Municipal Water District and County of Marin School District lands) is zoned as “A60” agricultural land use, property owners are restricted to only one residence per 60-acre parcel. Implementation actions necessary to protect water quality and meet water quality objectives are consistent with implementation actions that anyone considering new development would be required to take under the Clean Water Act Section 401 or under Marin County’s Stormwater Pollution Prevention Program (MCSTOPP). Property owners considering developing housing on land adjacent to Walker Creek are required to consider impacts to water quality if the project if the project encroaches on a creek or wetland under the Clean Water Act’s 401 jurisdiction. Under MCSTOPP, new developments (defined as any site impacting over an acre) are required to use best available technology and best management practices to avoid, minimize or mitigate for potential increases in sediment from the property. Thus, the proposed water quality objectives’ implementation program (the TMDL) requirement to reduce discharges of mercury–laden sediment and minimize methylmercury production are consistent with existing regulatory requirements and are not expected to have any impact on the housing supply in the Walker Creek watershed.

f) Need to Develop and Use Recycled Water

There are no present restrictions on recycling of water due to mercury. The intent of the proposed water quality objectives is to improve water quality and reduce mercury levels in Soulajule Reservoir and Walker Creek. The proposed objectives, therefore, are consistent with the need to develop and use recycled water.

11.2 California Water Code § 13242

Under the Water Code, when adopting water quality objectives in the Basin Plan, a program of implementation for achieving the objectives must be included. Water Code §13242 states that such program shall include but not be limited to: a description of the nature of actions necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or private; a time schedule for the actions to be taken; and a description of surveillance to be undertaken in order to determine compliance with the objectives.

The program of implementation to achieve the proposed water quality objectives for mercury in Walker Creek is the Walker Creek Watershed Mercury TMDL. The proposed program of implementation is described in Chapter 9. The Walker Creek Watershed Mercury TMDL sets forth appropriate actions by public and private entities, a time schedule for actions to be taken and a means to determine compliance with the TMDL targets, which are an interpretation of the proposed water quality objectives.

11.3 Code of Federal Regulations. § 131.11

With respect to the proposed water quality objectives, the federal regulations at 40 C.F.R. § 131.11 require States to adopt water quality criteria that protect the designated beneficial use, are based on sound scientific rationale, and contain sufficient parameters or constituents to protect the designated use. Where multiple use designations exist, the criteria must support the most sensitive uses. For numeric values such as the water quality objectives proposed here, the criterion should be based on Clean Water Act § 304(a) Guidance (or as modified to reflect site-specific conditions) or other scientifically defensible methods.

Section 5 “Proposed Water Quality Objectives” describes the analyses used to develop the proposed water quality objectives. As described in Section 5.1 (Proposed Aquatic Organisms and Wildlife Objectives), USFWS has determined that the proposed water quality objectives will protect the most sensitive species in the watershed, piscivorous birds. As described in Section 5.2 “Wildlife Water Quality Objectives and Human Health” the proposed objectives are more than sufficient to protect human health (which falls under the designated “Recreation 1” use).

We based our aquatic organism and wildlife fish tissue water quality objectives derivation methodology on USFWS’s assessment of U.S. EPA’s human health criterion (USFWS 2005, USEPA 2001). We then used the U. S. EPA’s Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion" (U.S.EPA

2006) to evaluate whether the proposed water quality objectives are protective of human health. Following U.S. EPA 304(a) guidance, where appropriate, this analysis was based on site-specific factors. The evaluation shows that the proposed water quality objectives will protect beneficial uses in the watershed and the proposed water quality objectives are more protective than U.S. EPA's latest 304(a) criteria guidance for methylmercury (0.3 mg methylmercury/kg fish tissue) to protect human health.

11.4 Gov. Code §. 57004 Peer Review

We sent the staff report and proposed basin plan amendments to two scientists for peer review. The two peer reviewers are Dr. Ellen Wohl, a geomorphologist at Colorado State University who specializes in hillslope and fluvial processes and Dr. Robert Mason, a geochemist at the University of Connecticut who specializes in the fate, transport, and transformation of trace metals including mercury.

The peer reviewers' response confirmed that the scientific portion of the proposed water quality objectives are based on sound scientific knowledge, method, and practices, thus satisfying Gov. Code § 57004. Dr. Wohl wrote,

> I find the document and the work that it summarizes to be very thorough and well conceived. The individuals involved in the Walker Creek assessment have carefully identified sources of mercury within the watershed, processes of mercury dissemination through the watershed, and methods for monitoring mercury storage and transport within the watershed. I think that the conceptual model of geomorphic processes (source, transport, depositional zones within the watershed) influencing mercury dynamics is particularly effective. In my judgment, the problem statement, source assessment, water quality objectives and numeric targets, linkage analysis, total maximum daily load and allocations, implementation, and monitoring are all based upon sound scientific knowledge, methods, and practices (Wohl, 2006).

Dr. Mason wrote, "Overall, the approach as far as identifying the major sources of mercury (Hg) to the system covered by the TMDL appear to be appropriate and the overall general conceptualization of the situation appears to be scientifically sound. . . . The statement of Water Quality Objectives is sufficiently detailed and gives an adequate discussion on the potential risks" (Mason 2006).

Dr. Mason raised some questions with respect to variable rates of mercury methylation for different sources, and the percentage of methylmercury in fish. For many fish in the watershed, our assumption is more conservative than the studies showing that not all mercury in fish is bioavalailable. We modified the report to clarify how this assumption contributes to our implicit margin of safety. We also modified the report to clarify sources and our assumptions regarding sources and methylation potential.

Dr. Mason expressed concern about the derivation of the allocations and offered suggestions on additional analyses that we could conduct using additional data. Dr Mason suggested that we more closely examine other mercury sources to determine whether they pose a greater threat than mercury-laden mining waste explicitly addressed by the TMDL. While we agree that different sources may have variable methylation rates, we were disappointed to see that Dr. Mason did not consider the orders of magnitude difference between mercury contributed by atmospheric deposition as compared to mercury coming from mine source (approximately 2700 times greater). The signal from mercury mine associated discharges overwhelms any potential difference in methylation rates. We modified the report to more explicitly describe particulate mercury loading in the watershed and the relationship to spatial and temporal variability in methylmercury production depending on the geomorphic zone (as discussed in Section 2.3 "Methylmercury, Watershed Processes, And Mercury Transport"). Mining waste is a controllable source that is covered under the Water Board's regulatory authority. Therefore, in the absence of any suggested alternative allocation approach, and given the existing data set, we believe the proposed riverine allocations are appropriate. We modified the staff report (Section 5.3) to address Dr. Mason's suggestion that we explicitly describe whether the proposed water quality objectives protect humans at risk from mercury in the watershed. We modified the allocations for Soulajule Reservoir based on bioaccumulation factors (BAFs) derived from a national dataset.

In response to Dr. Mason's concerns, we expanded the adaptive implementation and monitoring component of this TMDL to explicitly explore alternatives to our linkage analysis and confirm or refine, as necessary, the TMDL. Monitoring and assessment will help us refine our understanding of mercury in the watershed and is supported by both peer reviewers.

11.5 Antidegradation

The numeric targets and proposed water quality objectives must be consistent with antidegradation policies. Title 40 of the Code of Federal Regulations (§131.12) contains the federal antidegradation policy. State Water Resources Control Board Resolution 68-16 contains California's antidegradation policy. These antidegradation policies are intended to protect beneficial uses and the water quality necessary to sustain them. When water quality is sufficient to sustain beneficial uses, it cannot be lowered unless doing so is consistent with the maximum benefit to the citizens of California. Even then, water quality must sustain existing beneficial uses

The two proposed Basin Plan water quality objectives for methylmercury in fish tissue reflect current scientific understanding and are more stringent than the existing Basin Plan four-day average total mercury objective of 0.025 µg/l. The proposed fish tissue objectives are based on our current understanding of mercury bioaccumulation and incorporate estimated "bioaccumulation factors" (BAFs) that describe mathematically how mercury is concentrated up the food chain from one trophic level to the next. The existing Basin Plan objective is based on science from over two decades ago, which used "bioconcentration factors" (BCFs) which described how mercury concentrated from water into an aquatic species, but did not describe the bioaccumulation across trophic levels. This objective was also derived to attain 1 mg mercury per kg in fish tissue. The two proposed objectives are more stringent (0.05 and 0.1 mg methylmercury per kg in fish tissue). The TMDL implementation plan is designed to attain the existing Basin Plan narrative water quality objective for bioaccumulation and the two proposed Basin Plan water quality objectives for mercury in fish tissue. The two proposed water quality objectives are more stringent than the existing numeric water quality objective they will replace. Therefore, the proposed objectives and TMDL are consistent with the antidegradation policies and the protection of water quality and beneficial uses.

11.6 Environmental Checklist

CEQA requires agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires agencies to adopt feasible measures to mitigate potentially significant impacts. Section 12 contains the environmental checklist for the proposed Basin Plan amendment. An explanation follows the environmental checklist and provides details concerning the environmental impact assessment, including the reasonably foreseeable methods of compliance with the Basin Plan amendment. The analysis concludes that adopting the proposed Basin Plan amendment will not have any significant adverse environmental effects.

11.7 Proposed Project, Mitigation Measures, and Alternatives

The proposed project is the adoption of a Basin Plan amendment that would: 1) establish two new water quality objectives (discussed in Section 5.1) and vacate an outdated water quality objective (discussed in Section 5.3), 2) establish TMDL mercury targets to protect piscivorous birds, aquatic organisms, and, humans who consume fish (discussed in Section 6), 4) assign load and wasteload allocations to the various mercury source categories to achieve the targets, and 5) the TMDL implementation plan.
As discussed in Section 12, the Basin Plan amendment does not pose any significant adverse environmental impacts; therefore, neither mitigation measures nor alternatives are required under CEQA. The Water Board's CEQA regulations nevertheless require an evaluation of alternatives. The following alternative scenarios involve different scope, targets, and allocations: 1) no Basin Plan amendment; 2) reduced TMDL geographic scope; 3) Adopt U. S. EPA's Methylmercury Criterion as a water quality objective; and 4) alternative water quality objectives and targets.

Alternative 1: No Basin Plan Amendment (No Project Alternative)

Under this alternative, the Water Board would not amend the Basin Plan to adopt the proposed mercury TMDL. Neither the proposed targets nor the proposed allocations would be adopted, and no new implementation activities would be initiated. In the event that no actions were taken to address the Walker Creek's mercury impairment, mercury concentrations would likely either stay the same or decrease over a much longer timeframe, due to continued discharge of mercury presently stored in the watershed.

If the Water Board were to decline to adopt the mercury TMDL, the Clean Water Act requires the U.S. Environmental Protection Agency (U.S. EPA) to complete a TMDL for the Walker Creek watershed. How U.S. EPA's TMDL would differ from the TMDL described in the proposed Basin Plan amendment is unknown. U.S. EPA would likely rely, at least in part, on analyses completed to date; however, U.S. EPA would be free to develop its own TMDL in any manner it deemed appropriate, within legal constraints. U.S. EPA would identify targets and allocate mercury loads. U.S. EPA would not impose an implementation plan directly. However, the Water Board would be expected to incorporate U.S. EPA's TMDL and appropriate implementation actions into the Basin Plan through the continuing planning process.

This alternative would involve the Water Board declining to exercise the authority and responsibility delegated to it by U.S. EPA to implement Section 303(d) of the Clean Water Act. As a result, TMDL implementation would be delayed for an unknown period of time. The impacts associated with this alternative are greater than the proposed project because implementation actions would be delayed and mercury discharges will continue in the meantime.

Alternative 2: Reduce Scope of the TMDL

Under this alternative, the Walker Creek mercury TMDL's geographic scope would be limited to the riverine portion of Walker Creek, downstream of the Gambonini Mercury Mine site.

Water Board staff have been working with stakeholders and collecting water quality data in the riverine portion of Walker Creek since 1995, and have developed a conceptual model that describes and predicts mercury transport pathways in the watershed. We used the conceptual model to develop targets and allocations for the riverine portion of Walker Creek. We know very little about sediment transport or methylmercury production in Soulajule Reservoir. Subsequent to a riverine only Walker Creek mercury TMDL, staff could wait and develop a separate mercury TMDL for Soulajule Reservoir. This alternative would allow Marin Municipal Water District the opportunity to characterize fish tissue, water, and suspended mercury concentrations in Soulajule Reservoir and Arroyo Sausal Creek before assigning allocations.

The alternative may not protect beneficial uses in the Walker Creek watershed or could slow down attainment of water quality standards if Marin Municipal Water District does not initiate actions in a timely fashion. The proposed TMDL requires Marin Municipal Water District to undertake actions as part of the adaptive implementation program. In addition, reductions in mercury from the Gambonini Mine site and downstream depositional areas could be negated by discharges from the Arroyo Sausal watershed. Wildlife and humans, consuming fish from Soulajule Reservoir, would continue to be at risk due to mercury regardless of the water quality downstream of the reservoir. Therefore, impacts associated with this alternative are greater than the proposed project because implementation actions would be delayed and mercury discharges will continue in the meantime.

Alternative 3: Adopt U.S. EPA's Methylmercury Criterion

Under this alternative, the fish tissue target would be set equal to the U.S. EPA fish tissue residue criterion of 0.3 mg methylmercury per kg fish tissue. This criterion is intended to protect human who consume fish. The proposed TMDL target and existing water quality standard intended to protect humans who consume Soulajule Reservoir fish is the CTR water column value of 0.050 µg/l (30-day average). The State Water Resources Control Board is in the process of developing a statewide mercury standard that would update or replace this CTR value. This new standard will be consistent with the method used to develop EPA's criterion and EPA guidance and will likely include California specific fish consumption values. The proposed Basin Plan amendment recognizes this effort and will be revised when this statewide standard is established. Undertaking a separate standard action at this time to address human health would be an inefficient use of Regional Water Board staff resources.

In addition, EPA's fish tissue criterion may not protect wildlife, such as osprey feeding in Soulajule Reservoir and therefore is less protective that the proposed water quality objective and TMDL targets. If EPA's methylmercury criterion were included it would not reduce the number of proposed water quality objectives necessary for protection of beneficial uses in Soulajule Reservoir or change the implementation actions. Therefore, impacts associated with this alternative are greater than the proposed project because wildlife would not be fully protected.

Preferred Alternative

Because the proposed Basin Plan amendment will not pose any significant adverse environmental impacts, the alternatives would not avoid or lessen any significant impacts.

None of the three alternatives meets the goal of the TMDL: establish and maintain environmental conditions that will result in attainment of beneficial uses of Walker Creek and its tributaries. Alternatives 1 (*No Project*), 2 (*Limit Geographic Scope)*, and 3 (*Adopt Methylmercury Criterion*), are not considered to be environmentally superior nor will they have less impact than the proposed project. The proposed Basin Plan amendment is the preferred project.

11.8 Economic Considerations

OVERVIEW

The California Environmental Quality Act requires that whenever one of California's nine Regional Water Quality Control Boards, such as the San Francisco Bay Regional Water Quality Control Board (Water Board), adopts a rule that requires the installation of pollution control equipment or establishes a performance standard or treatment requirement (here, the proposed water quality objectives, the TMDL targets, allocations and required implementation actions), it must conduct an environmental analysis for reasonably foreseeable methods of compliance (Public Resources Code 21159). This analysis must include economic factors. If the rule includes an agricultural control plan, then the total cost of the program must be estimated and potential sources of funding must be identified (Water Code 13141). Additionally, as discussed above, Water Code § 13241 requires the consideration of economics when adopting water quality objectives—specifically, whether the proposed objectives are currently being attained; if not, what methods are available to achieve compliance with the objectives; and the costs of those methods. The costs detailed below are associated with implementing the TMDL are also the costs associated with achieving compliance with the objectives.

Set forth in this section are economic considerations required in the above-referenced laws. While economics are an important consideration, it is worth noting that when adopting the Porter-Cologne Act, the Legislature declared that all values of the water should be considered, but then went on to provide only broad, non-specific direction for considering economics in the regulation of water quality.

> "The Legislature further finds and declares that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible" (CWC §13000).

The Porter-Cologne Act directes regulatory agencies to pursue the highest water quality that is reasonable, and one of the factors used to determine what is reasonable is economics. It is clear, though, that economic factors cannot be used to justify a result that would be inconsistent with the federal Clean Water Act or the Porter-Cologne Act. The Water Board is obligated to restore and protect water quality and beneficial uses.

The objective of this analysis is to estimate the costs of compliance with the TMDL (which will result in compliance with the proposed water quality objectives) for mercury reduction in the Walker Creek watershed. Water Board staff have determined that mercury originating from the Gambonini Mine site, Soulajule Reservoir and watershed, and downstream depositional features can be reduced to achieve the goals of the TMDL. Mercury generally present in the soil (background) is assigned an allocation in the proposed Basin Plan amendment (BPA), but is not believed to be a significant source of mercury in the watershed. In the proposed BPA, the Water Board has proposed implementation measures for each mercury source, except for background sources. For the Gambonini Mine site and downstream depositional areas, the reasonably foreseeable methods of compliance consist primarily of erosion control and monitoring. For Soulajule Reservoir and watershed, the reasonably foreseeable methods of compliance consist of assessment and management of the reservoir's methylmercury production and managing the discharge of particulate, total and methylmercury from the reservoir to downstream waters.

The TMDL implementation costs are estimated for each source category (with the exception of background) and for each of the proposed implementation actions contained in the BPA. Summary tables provide the cost estimates. We provide an upper and lower range of cost estimates since there is uncertainty about the exact costs. In most cases, the particular elements of the implementation action are required to be developed at some point in the future, and therefore, the specifics are unknown. For cases in which it is possible to make educated guesses about the likely elements of an implementation action, cost estimates are included. For other cases, estimating the elements of a program would be decidedly speculative, and therefore, no cost estimates are developed. Cost estimates are projected for a 10-year planning horizon. Costs of implementing existing requirements are not included.

COST ESTIMATES

GAMBONINI MINE SITE

The Water Board's Mines and Minerals Producers Discharge Control program (Mines Program) outlines a strategy to manage active and inactive mines in the Region. Under the California Code of Regulations, Title 23, Chapter 15, Article 7, the Regional Board has the authority to regulate mining activities that result in a waste discharge to land through the use of waste discharge requirements. Additionally, the federal NPDES stormwater regulations (40 CFR Parts 122, 123, and 124) require active and inactive mining operations to obtain NPDES permit coverage for the discharge of stormwater contaminated by contact with any overburden, raw material, intermediate products, finished products, byproducts, or waste products. The Water Board can implement the NPDES requirements through the Industrial Stormwater General Program or through individual permits.

PERMIT REQUIREMENTS

The Gambonini Mine site requires an NPDES permit (through the Industrial Stormwater General Permit Program) to discharge stormwater contaminated by contact with mining material. Applicants applying for coverage under the Industrial Stormwater General Program (SWPPP) are required to pay an annual application fee in addition to submitting a SWPPP, monitoring plan and annual reports. The Basin Plan amendment requires the Gambonini Mercury Mine site owners to prepare and submit a Storm Water Pollution Prevention Plan in accordance with the provisions of the Industrial Stormwater General Permit. The submittal (to be approved by the Water Board) should include an implementation schedule and monitoring plan.

This application fee is required independent of the TMDL under the Industrial Stormwater General Permit Program. Therefore, we have not estimated costs for the annual filing fee. Because we are asking for a SWPPP and monitoring plan submittal to the Water Board (rather than the standard submittal procedures), we have estimated costs for evaluation below. The monitoring requirements differ from standard monitoring requirements. Therefore, we have estimated costs for monitoring below.

EVALUATION AND MONITORING

Under the Industrial Stormwater General Permit Program, dischargers are required at a minimum to monitor discharges from the site for dissolved oxygen, pH, total suspended sediments, total organic carbon, and specific conductance. These parameters are not sufficient to determine if existing erosion control measures, designed to contain mercury-laden sediments on the property, are sufficient to protect downstream water quality. The Gambonini Mine channel carries mercury-laden sediment loads episodically during intense rain events. An annual monitoring program downstream of the mine site will not capture discharges from these flashy storm events. Without inspecting the property, before and following storm events, it would be impossible to determine if sediment discharges were from naturally occurring landslides on the property or failure of erosion control measures on the mine site. Any monitoring plan will need to take these factors into account and will likely include measures specific to the Gambonini Mercury Mine site's geomorphology and remediation design elements. Initial costs to develop a Stormwater Pollution Prevention Plan are estimated to range from $1500-$2000. Monitoring and reporting costs estimates are $700-$800 per year (L. Mattison 2006).

SOULAJULE RESERVOIR

The Basin Plan amendment requires the Marin Municipal Water District (MMWD) to submit to Water Board Executive Officer, for approval, a monitoring and implementation plan and schedule to 1) characterize fish tissue, water, and suspended sediment mercury concentrations in Soulajule Reservoir and Arroyo Sausal Creek, and 2) develop and implement methylmercury production controls necessary to attain TMDL targets both in-Soulajule Reservoir and in Arroyo Sausal Creek, downstream of the reservoir.

EVALUATION AND MONITORING

In order to assess options for minimizing methylmercury production in the reservoir, and, if necessary, minimize the discharge of total, particulate or methylmercury from the reservoir, MMWD will need to evaluate and monitor mercury both in and downstream of Soulajule Reservoir. Studies of this nature are often iterative, and until preliminary work is done to determine a) the spatial distribution of mining waste in the reservoir, and c) methlylating mechanisms in the watershed, MMWD will not be able to develop a comprehensive evaluation and monitoring program. A reasonable feasible method of compliance is developing and implementing a monitoring plan that includes total and methylmercury samples in water and sediment and biota, both in and downstream of the reservoir. Based on a similar study done in the Guadalupe watershed, we estimate costs at $12,000 to $16,000 for the study design, and from $70,000 to $150,000 for sampling and evaluation (Drury 2006).

IMPLEMENTATION

Until MMWD characterizes mercury sources and loads in the Soulajule Reservoir and the Arroyo Sausal watershed, it is difficult to address the specifics of potential methylmercury production controls

Controlling methylmercury production falls into two general categories 1) remove or reduce the amount of mercury entering the reservoir and in bottom sediments, and 2) reduce methlylating conditions. Reducing nutrient inputs or oxygenating the reservoir’s water column are examples of approaches to reducing methlylating conditions.

Oxygenating the reservoir’s water is the most reasonable and feasible method of compliance for reducing methylmercury production in Soulajule Reservoir. Santa Clara Valley Water District has been researching installing hypolimnetic oxygenation systems in reservoirs below the New Almaden Mining District. The systems operate during a reservoir’s stratification period to reduce or prevent anoxic conditions. Estimated costs for a hypolimnetic oxygenation system for Almaden reservoir (1600 acres compared to Soulajule’s 1100 acres) ranges from $456,000 to $520,000 (SCVWD 2006). MMWD will need to allocate additional funds for administrative costs such as environmental permits, contract management, maintenance, and electricity. Administrative costs are expected to be low (less than 10 % of staff time). A conservative estimate for staff costs is $10,000 a year (.10 * $100,000 staff salary). Maintenance and electricity costs are difficult to predict. It is likely that maintenance costs will decrease over time while electricity costs will rise over time. Maintenance and electricity combined are estimated at $10,000 - $20,000 per year (McGuire 2006).

A foreseeable alternative to oxygenating the reservoir is removal of Soulajule Reservoir. By removing the reservoir, future methylmercury production would be reduced. Mercury-laden sediments could be stabilized on site using the successful erosion control methods in place at the Gambonini Mine site. Some or all of the reservoir’s bottom sediment may need to be disposed of at a hazardous waste facility depending on its mercury concentration. The region occupied by the former reservoir would then contain a river channel and floodplain. The alternative is foreseeable but it is not reasonable due to mitigation costs associated with replacement of the water supply and potential environmental impacts associated with the removal process.

IMPLEMENTATION ACTIONS FOR DOWNSTREAM DEPOSITIONAL FEATURES

The Basin Plan amendment requires that landowners and the County of Marin manage downstream depositional areas to minimize mercury discharges and methylmercury production. The downstream depositional area's land use is predominated grazing. We have no data relating to location and practices regarding grazing on downstream depositional features (on the floodplain, within the riparian corridor, or in creeks). For cost estimation purposes, we employ the conservative assumption that 100% of the property owners downstream of the Soulajule Reservoir or the Gambonini Mercury Mine site allow grazing along the creeks in areas with depositional features.

PERMITS AND TECHNICAL ASSISTANCE

Under the federal Clean Water Act either dredging or wetland fill activities require permits from the Army Corps of Engineers. Under the Clean Water Act Section 401 program, the Water Board certifies that these federal permits meet State water quality standards. Therefore, the Water Board needs to review and approve dredging and fill projects. If a 401 applicant has mercury on their property, a permit application would be required to demonstrate that the project did not impact water quality. Therefore the applicant would, if necessary, be required to reduce mercury discharges and methylmercury production to ensure that water quality standards are met before the permit action could be approved. This action is required independent of the TMDL. Therefore, we have not estimated costs for complying with the 401 program.

Marin County, through their Storm Water Pollution Prevention Program (MCSTOPP), issues permits for creek modification activities in unincorporated areas. The county is also responsible for minimizing pollutants discharged from roads and maintenance activities such as culvert and road repairs. The Basin Plan amendment requires the county update their "Creek Guidance for Unincorporated Areas in Marin" to include specific guidance for projects in areas that may contain mercury-enriched sediments. We estimate staff costs to the county to modify their permit program, revise internal maintenance guidelines, and provide advice to those seeking to minimize potential mercury discharges or methylmercury production to range from $2,000 to $6,000 per year. We estimate first year costs to modify the program will range between $5,000 and $10,0000.

The Marin Resource Conservation District (MRCD) and the Natural Resource Conservation Service (NRCS) jointly manage a consolidated stream permit program. This permit program provides landowners a "one-stop permit shop" for stream activities in West Marin that are funded and constructed by the MRCD or the NRCS. Multiple regulatory agencies, including the Water Board, have granted the two agencies a general permit for erosion control and restoration projects that use one or more of 16 approved conservation practices. In order to comply with 401 permit requirements, MRCD and NRCS staff will need to invest additional time to demonstrate compliance when submitting permit applications. Estimated cost to the permit program is $10,000 per year (Scolari 2006).

IMPLEMENTATION

As part of the Tomales Bay Pathogen TMDL (adopted by the Water Board in June 2006), grazing operators are required to submit a Report of Waste Discharge that identifies site-specific grazing management measures and includes an implementation schedule to reduce animal runoff. The Tomales Bay Pathogen TMDL anticipates that the Water Board will develop waiver of Waste Discharge Requirements (WDRs) conditions for grazing land operators. The Basin Plan amendment requires applicants seeking coverage under Waste Discharge Requirements or waivers of WDRs for pathogens, nutrients, or sediment discharges in the Walker Creek watershed must incorporate management practices that minimize mercury discharges and methylmercury production. Therefore, landowners required to submit a WDR for pathogens in Tomales Bay, will be required to describe and implement mercury management measures. At this point, the site-specific actions or general waiver conditions are unknown.

The Tomales Bay Pathogen TMDL examined implementation measures and associated costs as part of the Basin Plan amendment process. Potential implementation measures considered included livestock rotation through pastures, fencing animals out of the waterways, and installing off-stream water troughs. Since fencing is likely to be the most costly management practice, this was used as a conservative cost estimate. All of the proposed Tomales Bay Pathogen implementation measures will minimize the discharge of mercury-laden sediments and help reduce methylmercury production by reducing bank erosion and nutrient loading (thereby reducing potentially anoxic conditions). Property owners will need to choose pathogen management measures that meet the goals of both the Tomales Bay Pathogen TMDL and this TMDL. For example, vegetated buffer zones are a potential management measure for pathogens. To minimize methylmercury production, a vegetated buffer strip would be better design option than a vegetated swale or detention basin where ponded water in an anoxic setting could increase methylmercury production.

In evaluating reasonably foreseeable methods of compliance and associated costs for landowners with downstream depositional features on their properties, we divided implementation costs into two categories, based on two stream types, the depositional and transfer zones (See Section 4.4 for a discussion of Walker Creek's mercury transport and deposition in the transfer and deposition zones.)

Properties in the lower depositional reaches will require more active intervention to manage their mercury deposits. As discussed in Section 4.5, Deposition Zones, the downstream depositional reaches have actively eroding creek banks comprised of mercury-laden sediments. On these properties, fencing the waterways, livestock rotation and installing off-stream water troughs will not prevent continued bank erosion. Properties with actively eroding banks may have to consider intervention measures such as laying back creek banks, bank stabilization, or reconfiguring the channel morphology to address excessive erosion. For cost estimation purposes, we assumed that 100 % of the properties in the downstream depositional reach would require active intervention (based on site visits and aerial photo analysis). In estimating linear feet of creek bank needing erosion control, we made the additional conservative assumption that intervention would be required on both right and left banks.

The MRCD (2005) estimate that 28% or the properties on Walker and Creek upstream of the depositional reach (the transfer zone) have actively eroding banks. In the transfer zone, the eroding banks tend to be confined to one side of the creek or the other, and we therefore assume that only one bank will require active intervention. We assumed that those properties in the transfer zone downstream of Gambonini Mine Site that do not have eroding banks would meet the goals of this TMDL by implementing management measures as part of the Tomales Bay Pathogen TMDL. Of the properties requiring intervention, we estimated 25% of the properties needed more extensive stream restoration such as reconfiguring the banks and using bioengineering to provide structure, while the remaining 75% will require minor mercury control measures such as redirecting erosive upland drainage or restoring riparian vegetation.

Table 11.1 Sites Requiring Actions to Reduce Mercury Loading

	% Bank Erosion Sites	Erosion Sites-Total Bank Length (m)	Engineered Mercury Control Measures	Minor Mercury Control Measures
Depositional Zone	100 %	7062	100* (7062 m)	0 % (0 m)
Transfer Zone	28 %	3313	25 % (828 m)	75% (2485 m)

Costs for minimizing mercury discharges and methylmercury production will depend on land use intensity, channel morphology, upstream impacts, land access, project complexity, and the landowner's design objectives. In estimating costs associated with reducing mercury discharges and methylmercury production, we relied on cost estimates for stream bank improvements presented in the Californian Coho Salmon Recovery Plan (CDFG, 2004b), and estimates provided by Prunuske and Chatham (L. Prunuske, 2006). Our cost estimates include those for project management, and administration, project design, project permitting and monitoring. Estimates for a combination of erosion control, bank stabilization and stream restoration projects in all downstream areas requiring active intervention (beyond measures that might be implemented through other TMDLs) range from $1.5 million to $2.5 million.

The best design option for some of these projects may include excavation and disposal of mercury-laden sediments, as this is the most permanent means to reduce mercury loads and methylmercury production in Walker Creek. Excavation and disposal of mercury-laden sediments is also a reasonable and feasible alternative to stream restoration or bank stabilization. However, stream restoration or bank stabilization measures that incorporate sediment, pathogen and nutrient reduction measures may be more cost effective for meeting multiple management objectives in the Walker Creek watershed. Additional sampling and site characterization would be needed to estimate costs associated with excavation and disposal.

Table 11.2 Summary of Estimated Costs for Walker Creek Watershed Mercury TMDL Implementation (Year 0 through 10)

	One-Time Cost		Annual Cost		10-year program	
Gambonini Mine Site	Low	High	Low	High	Low	High
1. Permit Requirements	$0	$0	$0	$0	$0	$0
2. SWPPP Implementation and Reporting	$1,500	$2,000	$700	$800	$8,500	$10,000
Total (Gambonini Mine Site)	$1,500	$2,000	$700	$800	$8,500	$10,000
Soulajule Reservoir						
1. Evaluation and Monitoring	$82,000	$166,000	$0	$0	$82,000	$166,000
2.Methylmercury Reduction Implementation	$456,000	$520,000	$20,000	$30,000	$656,000	$820,000
Total (Soulajule)	$538,000	$686,000	$20,000	$30,000	$738,000	$986,000
Downstream Depositional Areas						
1. Technical Assistance/ Programmatic Outreach	$5,000	$10,000	$12,000	$14,000	$125,000	$150,000
2. Implement Management Measures	$1,500,000	$2,500,000	$0	$ -	$1,500,000	$2,500,000
Total (Depositional Areas)	$1,505,000	$2,510,000	$12,000	$14,000	$1,625,000	$2,660,000
GRAND TOTAL	**$2,044,500**	**$3,198,000**	**$32,700**	**$44,800**	**$2,371,500**	**$3,646,000**

AGRICULTURAL PROGRAM COSTS

Implementation measures for grazing lands constitute an agricultural cost. We estimate that 100% of the downstream depositional areas can be considered grazing lands. Costs estimated above for reducing mercury discharges and methylmercury production on grazing lands are $1.5 to 2.5 million over a ten-year period. These costs are associated with reducing sediment discharges and enhancing habitat conditions on Walker Creek and its tributaries. Considering potential benefits to the public in terms of habitat restoration and water quality, we expect that a significant portion of the costs will be paid for with public funds.

POTENTIAL SOURCES OF FUNDING

In 2004, the California Water Resources Control Board awarded $125,000 in public funds to the MRCD to perform a geomorphic assessment of the Walker Creek watershed in order to assist in the development of sediment and mercury TMDLs. This successful effort demonstrated how potential sources of funding can be used to facilitate meeting multiple stakeholders' objectives in the watershed, including erosion control, habitat protection and enhancement, and TMDL implementation.

Water Board staff are committed to working with local landowners, the Marin Resource Conservation District, the National Resource Conservation District and the County of Marin to manage mercury discharges and methylmercury production in the watershed. Several state and federal grant programs are aimed at non-point source pollution control and implementing TMDL actions. Potential funding sources for mercury reduction measures include Watershed Protection Programs (funded by CALFED, Prop. 13, Prop. 40, and Prop. 50) and Nonpoint Source Pollution Control Programs (funded by EPA via the 319 grant program, Prop. 13, Prop. 40, and Prop. 50). The State Water Resources Control Board administers a consolidated grant program to award and manage these funding sources. Funds for improvements to agricultural lands are available through the Natural Resources Conservation Service

The Water Board staff manages funds from the State Water Pollution Cleanup and Abatement Account specifically allocated for implementation actions in the Walker Creek watershed. In the past, funds from this account were used successfully for erosion control, revegetation and bioengineering to reduce mercury discharges from the Gambonini Mercury Mine site. We anticipate using existing funds for similar projects on properties downstream of the Gambonini Mercury Mine site.

12 ENVIRONMENTAL CHECKLIST

1.	**Project Title:**	Mercury in Walker Creek Watershed Total Maximum Daily Load (TMDL) Basin Plan Amendment including Proposed Water Quality Objectives
2.	**Lead Agency Name and Address:**	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612
3.	**Contact Person and Phone Number:**	Jill Marshall (510) 622-2388
4.	**Project Location:**	Walker Creek watershed, Marin County, San Francisco Bay Region
5.	**Project Sponsor's Name and Address:**	California Regional Water Quality Control Board, San Francisco Bay Region 1515 Clay Street, Suite 1400 Oakland, California 94612
6.	**General Plan Designation:**	Not Applicable
7.	**Zoning:**	Not Applicable

8. **Description of Project:**

The project is a proposed Basin Plan amendment that would establish a TMDL for mercury in Walker Creek, Soulajule Reservoir, and Soulajule Watershed, two new water quality objectives, and implementation plan to attain the TMDL and water quality objectives. The project would involve numerous actions to reduce mercury concentrations in Walker Creek and its tributaries. Additional details are provided in Section 12.1

9. **Surrounding Land Uses and Setting:**

The proposed Basin Plan amendment would affect the Arroyo Sausal watershed and all freshwater segments of the Walker Creek watershed below the Gambonini Mine site. Implementation would involve specific actions by mine site and creek side property owners, and Reservoir managers located in specified areas within the Watershed. The Walker Creek Watershed land uses include a mix of open space, grassland/rangeland, agriculture, and developed residential.

10. **Other public agencies whose approval is required** (e.g., permits, financing approval, or participation agreement.)

The California State Water Resources Control Board, the California Office of Administrative Law, and the U.S. Environmental Protection Agency must approve the proposed Basin Plan amendment.

ENVIRONMENTAL IMPACTS:

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☒	☐
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☒	☐
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☐	☒
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. **Would the project:**				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☒	☐
c) Involve other changes in the existing environment, which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. **Would the project:**				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
III. AIR QUALITY—(cont.):				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions, which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
IV. BIOLOGICAL RESOURCES—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	☐	☐	☒	☐
IV. BIOLOGICAL RESOURCES—(cont.):				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☐	☒
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	☐	☐	☐	☒
V. CULTURAL RESOURCES—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☒	☐
b) Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to §15064.5?	☐	☐	☒	☐

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☒	☐
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☒	☐
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the state geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
VI. GEOLOGY AND SOILS—(cont.):				
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒

Less Than

Issues:	*Potentially Significant Impact*	*Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
e) Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS -- (cont.):				
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion of siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY—(cont.):				
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures, which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation of seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	☐	☐	☐	☒
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	☐	☐	☒	☐
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES --				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:				
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION—				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION /TRAFFIC—Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume-to-capacity ratio on roads, or congestion at intersections)?	☐	☐	☐	☒
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
XV. TRANSPORTATION /TRAFFIC–(cont.):				
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVI. UTILITIES AND SERVICE SYSTEMS— Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☒	☐
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☒	☐
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	*Potentially Significant Impact*	*Less Than Significant With Mitigation Incorporation*	*Less Than Significant Impact*	*No Impact*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☐	☐	☒
b) Does the project have impacts that are individually limited, but cumulative considerable? ("Cumulative considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

12.1 Explanation

Project Description

The Basin Plan amendment would prescribe target fish tissue and water column mercury concentrations for Walker Creek and its tributaries, assign allocations to achieve the targets and add two fish tissue water quality objectives. The TMDL implementation plan would involve numerous actions to achieve the targets and allocations. The Basin Plan amendment would affect Arroyo Sausal watershed and all freshwater segments of the Walker Creek watershed below the Gambonini Mine site. Implementation actions may occur throughout the Walker Creek watershed in Marin County, California.

The proposed targets and allocations are measures of performance. The implementation plan outlines the Water Board's approach to meeting these measures of performance. To reduce mercury concentrations in the Walker Creek Watershed, the plan describes actions the Water Board would take, actions expected of dischargers in the watershed, and actions the Water Board might take to compel, as necessary, entities to comply with all applicable requirements. The implementation actions are directed at reducing mercury impacts from three source categories: 1) the Gambonini Mine site, 2) Soulajule Reservoir and watershed, and 3) downstream depositional features. Reasonable foreseeable methods of compliance include: monitoring and assessment of mercury sources, mine waste erosion control, installation of an oxygenation system to reduce methlylating conditions in Soulajule Reservoir, riparian revegetation, bank stabilization or stream restoration in downstream reaches, excavation and disposal of mercury-laden sediments, development of educational outreach materials, and permit compliance oversight.

The Water Board would not directly undertake any actions that could physically change the environment, but adopting the proposed Basin Plan amendment could indirectly result in other parties (e.g., land owners, government entities, and special districts) undertaking projects to satisfy requirements derived from the Basin Plan amendment. These projects could physically change the environment. Construction projects may result in short term impacts to air quality, biological resources, hydrology, noise, and transportation. These impacts can be mitigated through compliance with federal, state and local regulations. The adverse environmental impacts of such physical changes are evaluated below to the extent that they are reasonably foreseeable. Changes that are speculative in nature do not require environmental review.

Until the parties that must comply with requirements derived from the Basin Plan amendment propose specific projects, many physical changes cannot be anticipated. These specific projects could be subject to environmental review under the California Environmental Quality Act (CEQA), and CEQA compliance for specific projects, when they are developed, would be the responsibility of the lead agency for proposing or approving such project. The environmental reviews would identify any potentially significant adverse environmental impacts of the specific proposals, along with appropriate mitigation measures. Until such projects are proposed, however, identifying specific impacts and mitigation measures would require inappropriate speculation. Moreover, any mitigation deemed necessary by the lead agencies for those projects would not be within the jurisdiction of the Water Board to require.

Direct and Indirect Physical Changes

Table 12.1 summarizes the actions that could conceivably be undertaken if the proposed Basin Plan amendment were adopted, and explains the rationale for including them or not including them in this environmental review. The physical changes that require evaluation are those associated with (1) earthmoving and erosion control and grading operations and (2) minor construction. Although these activities are reasonably foreseeable, the implementation plan does not specify the nature of these actions. Therefore, this analysis considers these actions in general programmatic terms. To illustrate the possible nature of these activities, some examples are described below.

Table 12.1 Implementation Actions Subject to Environmental Review

Possible Actions	Environmental Change Subject to Review
Storm water pollution prevention *(Gambonini Mine Site, Soulajule Watershed Mine Sites)*	Minor earthmoving, erosion control and grading
Inspection of inactive mine sites *(Gambonini Mine Site)*	None—No physical environmental change
Inspections of grazing operations (*Downstream Depositional Features)*	None—No physical environmental change
Implement Best Management Practices; fence construction, development of off-stream water sources, road management (*All Sources)*	Minor Construction
Data collection and analysis (*Soulajule Reservoir)*	Earthmoving operations[14]
Construct methylmercury production controls *(Soulajule Reservoir and Watershed)*	Minor Construction, earthmoving operations
Riparian corridor and wetland management to minimize methylmercury production	Earth moving operations, minor hydrologic or vegetative modifications

- *Earthmoving Operations.* The Basin Plan amendment could result in the use of heavy equipment to move soils from one place to another. For example, excessive erosion from a mine waste pile may require capping, slope stabilization, or landscaping. Pilot projects associated with special studies (e.g. experimental wetlands) could also require earthmoving.
- *Minor Construction.* The Basin Plan amendment could result in the construction of structures to reduce mercury loading to Walker Creek and/or methylmercury production in Soulajule reservoir. For example, to minimize mercury discharges, a creek restoration option may include construction of

bank stabilization structures. Minimizing methylmercury production in Soulajule Reservoir could include construction of an in-reservoir aeration system. Individual landowners may also undertake minimal construction activities such as fence construction and off-creek water troughs to reduce mercury-laden runoff resulting from grazing operations.

These examples are not intended to be exhaustive or exclusive. As specific implementation proposals are developed and proposed, lead agencies will need to undertake environmental review and could identify specific environmental impacts and appropriate mitigation measures.

Changes Likely With or Without the Basin Plan Amendment

The implementation plan relies on some actions that will occur with or without the proposed Basin Plan amendment. Because these actions do not result from the Basin Plan amendment, environmental review is not included in this analysis. Some implementation actions for the Walker Creek Watershed are likely to occur with or without the proposed TMDL Basin Plan amendment because of existing (Tomales Bay pathogen) and proposed TMDLs (Walker Creek sediment and nutrient) in the watershed. Many of the actions intended to reduce nutrient, pathogen and sediment loading to the watershed will also reduce mercury loading and methylmercury production. Additional environmental review will occur as the nutrient and sediment TMDLs are completed.

Other actions likely to occur with or without the Basin Plan amendment include implementing Phase II of the storm water management plan pollution prevention program, actions required under the mines and mineral producers program and cooperative sediment management and stream restoration efforts among the watershed’s stakeholders.

12.2 Environmental Analysis

The proposed Basin Plan amendment does not define the specific actions entities could take to comply with requirements derived from the Basin Plan amendment. As discussed above, physical changes resulting from the Basin Plan amendment are foreseeable, but the attributes of specific implementation actions (e.g., location, extent, etc.) are unknown, pending specific proposals to comply with Basin Plan amendment requirements. CEQA requires lead agencies to review the potential for their actions to result in adverse environmental impacts. CEQA further requires lead agencies to adopt feasible measures to mitigate potentially significant impacts. Therefore, the analysis below assumes that lead agencies would adopt mitigation measures necessary to address potentially significant impacts as long as appropriate measures are readily available. As explained below, mitigation measures are readily available to address all the foreseeable impacts of the Basin Plan amendment, including possible local agency actions to the extent that they can be anticipated. Therefore, the potential impacts of the proposed Basin Plan amendment would be less-than-significant.

An explanation for each box checked on the environmental checklist is provided below:

I. Aesthetics

a–b) Any physical changes to the aesthetic environment as a result of the Basin Plan amendment would be small in scale. Possible management practices that could be implemented on individual properties, such as fence construction or off-stream water troughs, are common practices that would have less-than-significant impacts on the aesthetic environment. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require environmental review and any necessary mitigation. Therefore, the proposed project would result in less-than-significant impact to scenic vistas and resources.

c–d) The Basin Plan amendment would not degrade the existing visual character or quality of any site or its surroundings. Potential minor construction would be consistent with the open space and low density residential land uses in the area. Methylation controls are not expected to degrade the existing visual character of Soulajule Reservoir or any creekside properties. It would not create any new source of light or glare.

II. Agriculture Resources

a–c) The Basin Plan amendment would not involve the conversion of farmland to non-agricultural use. It would not affect agricultural zoning or any Williamson Act contract. Small streamside areas with contaminated areas may need to be excluded from grazing, which could result in a reduction of herd size. The streamside area is small percentage of available grazing land both watershed-wide and on individual properties as currently delineated. Therefore, the percentage of potentially restricted grazing land would not impact overall herd size.

III. Air Quality

a) Because the Basin Plan amendment would not cause any change in population or employment, it would not generate ongoing traffic-related emissions. It would also not involve the construction of any permanent emissions sources. For these reasons, no permanent change in air emissions would occur, and the Basin Plan amendment would not conflict with applicable air quality plans.

b) The Basin Plan amendment would not involve the construction of any permanent emissions sources or generate ongoing traffic-related emissions. Construction that would occur as a result of Basin Plan amendment implementation, including earthmoving operations, would be short-term. Fine particulate matter (PM_{10}) is the pollutant of greatest concern with respect to construction. PM_{10} emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle and equipment exhaust. If specific construction projects were proposed to comply with requirements derived from the proposed Basin Plan amendment, local agencies would require any necessary mitigation through their environmental reviews. The Bay Area Air Quality Management District has identified readily available measures to control construction-related air quality emissions (BAAQMD 1999). These measures include watering active construction areas; covering trucks hauling soil; paving, applying water, or applying soil stabilizers on unpaved areas; sweeping paved areas; and sweeping public streets. Lead agencies would ensure that appropriate emissions control measures are implemented. Therefore, the Basin Plan amendment would not violate any air quality standard or contribute substantially to any air quality violation, and its temporary construction-related air quality impacts would be less-than-significant.

c) Because the Basin Plan amendment would not generate ongoing traffic-related emissions or involve the construction of any permanent emissions sources, it would not contribute considerably to cumulative emissions. Construction related traffic is expected to have a short-term duration. Implementation actions such as construction of methylmercury reduction controls will not result in a cumulative increase in any criteria pollutant.

d–e) Because the Basin Plan amendment would not involve the construction of any permanent emissions sources, it would not expose sensitive receptors to ongoing pollutant emissions posing health risks or creating objectionable odors.

IV. Biological Resources

a-b) The Basin Plan amendment is designed to benefit water quality for biological resources, including wildlife and rare and endangered species. If, pursuant to the proposed Basin Plan amendment, specific projects were proposed that were to involve construction and earthmoving activities that could modify habitats, adversely affect special-status species, or disturb riparian habitat or sensitive natural communities, then local agencies would conduct environmental review and identify necessary mitigation measures. Through the CEQA and permitting processes, lead agencies would ensure that readily available mitigation measures are implemented, such as limiting methylmercury production in wetlands and, avoiding or, if feasible, relocating or replacing sensitive habitat. Fences that may be constructed could be designed to restrict cattle without impeding wildlife movement. Therefore, the Basin Plan amendment would not substantially affect habitats, special-status species, sensitive communities, wetlands, wildlife movement, migratory corridors, or nurseries and its review would ensure that readily available measures are implemented, such as avoiding construction during the breeding season, avoiding sensitive habitat areas, and minimizing disturbances and its impacts would be less-than-significant.

c) Basin Plan amendment-related studies could indirectly result in wetlands (e.g., marshes etc.) being managed differently so as to minimize methylmercury production. If, pursuant to requirements derived from the proposed Basin Plan amendment, specific projects were to be proposed involving construction or earthmoving activities that could adversely affect wetlands, then local agencies would require necessary mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as avoiding sensitive wetland and riparian habitat or mitigating for unavoidable fill. Therefore, the Basin Plan amendment would not adversely affect wetlands, and its impacts would be less-than-significant.

d) If, pursuant to Basin Plan amendment requirements, specific projects were proposed that were to involve construction or earthmoving activities that could interfere with fish or wildlife movement, migratory corridors, or nurseries, then local agencies would require necessary mitigation through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as avoiding construction during the breeding season, avoiding sensitive habitat areas, and minimizing disturbances. Therefore, the Basin Plan amendment would not substantially affect fish or wildlife movement, migratory corridors, or nurseries, and its impacts would be less-than-significant.

e-f) If, pursuant to Basin Plan amendment requirements, specific projects were proposed that were to involve construction or earthmoving activities, then the project proponents would develop such proposals in accordance with the local policies and ordinances, including any applicable habitat conservation plans, natural community conservation plans, or other plans. Therefore, the Basin Plan amendment would not conflict with local policies, ordinances or adopted plans.

V. Cultural Resources

a–d) Local agencies could propose specific projects involving earthmoving or construction to comply with requirements derived from the proposed Basin Plan amendment. Construction would generally be small in scale, and earthmoving would likely occur in areas already disturbed by recent human activity. If necessary to protect historical, archaeological, or paleontological resources, local agencies would require mitigation through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as requiring a trained professional to observe major earthmoving work and stop the work if evidence of cultural resources is discovered. Therefore, the Basin Plan amendment would not substantially affect any cultural resource, and its impacts would be less-than-significant.

VI. Geology and Soils

a) The Basin Plan amendment would not involve the construction of habitable structures; therefore, it would not involve any human safety risks related to fault rupture, seismic ground-shaking, ground failure, or landslides.

b) Local agencies or individual landowners could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. To meet the proposed Basin Plan amendment targets, projects could be designed to reduce discharge of mercury-laden soil into the waters of the Walker Creek watershed. However, temporary earthmoving operations could result in short-term erosion. Local agencies would require necessary mitigation measures through their environmental review and grading permit processes. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control best management practices (BMPs), and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial soil erosion, and its impacts would be less-than-significant.

c–d) The Basin Plan amendment would not involve the construction of habitable structures, and any construction would be relatively small in scale. Local agencies proposing construction to comply with requirements derived from the Basin Plan amendment would undertake engineering and environmental studies to ensure that they do not locate structures on unsuitable soil, including expansive soil. Construction would be designed to minimize any potential for landslides, lateral spreading, subsidence, liquefaction, or collapse. Therefore, the Basin Plan amendment would not create safety or property risks due to unstable or expansive soil.

e) The Basin Plan amendment would not require wastewater disposal systems; therefore, affected soils need not be capable of supporting the use of septic tanks or alternative wastewater disposal systems.

VII. Hazards and Hazardous Materials

a–h) This Basin Plan amendment would not affect the transportation or potential release of hazardous materials (as defined by The California Department of Toxic Substances Control), nor create a significant public or environmental hazard beyond any hazards currently in existence. Plan amendment-related activities would not interfere with any emergency response plans or emergency evacuation plans and would not affect the potential for wildland fires.

Remediation actions could require the disposal of mercury-contaminated soils, but such waste streams would be generated for a limited, short-term duration. The California Department of Toxic Substances Control oversees hazardous waste handing and disposal. The U.S. Department of Transportation specifies requirements for hazardous materials transportation. Proper handling in accordance with relevant laws and regulations would minimize hazards to the public or the environment, and the potential for accidents or upsets. Therefore, hazardous waste transport and disposal would not create a significant public or environmental hazard, and impacts would be less-than-significant.

VIII. Hydrology and Water Quality

a) The project would amend the Basin Plan, which articulates applicable water quality standards; therefore, it would not violate standards or waste discharge requirements.

b) The Basin Plan amendment would not decrease groundwater supplies or interfere with groundwater recharge. Construction of facilities such as retention or detention basins, infiltration basins, or vegetated swales could increase groundwater recharge.

c) Local agencies could propose specific projects involving earthmoving or construction activities to comply with requirements derived from the proposed Basin Plan amendment. Such projects could affect existing drainage patterns. However, to meet the proposed Basin Plan amendment targets, they would be designed to reduce overall soil erosion and mercury loads associated with erosion.

Nevertheless, temporary earthmoving operations could result in short-term erosion. If necessary to address specific impacts, local agencies would require mitigation measures through their environmental reviews. Lead agencies would ensure that readily available measures are implemented, such as dust suppression (e.g., spraying water), use of erosion control BMPs, and proper construction site management. In addition, construction projects over one acre in size would require a general construction National Pollutant Discharge Elimination System permit and implementation of a storm water pollution prevention plan. Therefore, the Basin Plan amendment would not result in substantial erosion, and its impacts would be less-than-significant.

d) The Basin Plan amendment could involve some earthmoving operations that could affect existing drainage patterns in the short term, but Basin Plan amendment-related activities would not increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or result in flooding.

e–f) Basin Plan amendment-related activities would not substantially increase the amount of impervious surfaces in any watershed. Therefore, the Basin Plan amendment would not increase the rate or amount of runoff, or exceed the capacity of storm water drainage systems. Because the proposed Basin Plan amendment is intended to reduce mercury-laden runoff, it would not be a source of new polluted runoff, or degrade water quality.

g–i) Basin Plan amendment-related construction would be small in scale and would not include housing or structures that would pose or be subject to flood hazards.

j) Basin Plan amendment-related construction would not be subject to substantial risks due to inundation by seiche, tsunami, or mudflow.

IX. Land Use and Planning

a) Basin Plan amendment-related construction would be too small in scale to divide any established community.

b–c) The Basin Plan amendment would not conflict with any land use plan, policy, or regulation, and would not conflict with any habitat conservation plan or natural community conservation plan.

X. Mineral Resources

a–b) Basin Plan amendment-related earthmoving (i.e., excavation) and construction would be relatively small in scale and would not result in the loss of availability of any known mineral resources.

XI. Noise

a-b) Earthmoving and construction could temporarily generate noise, ground-borne vibration, or ground-borne noise. Lead agencies would ensure that readily available measures are implemented, such as restricting the hours of operations and ensuring that earthmoving equipment is equipped with mufflers to reduce noise. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant

c-d) The Basin Plan amendment would not cause any permanent increase in ambient noise levels. Any noise would be short-term. Noise-generating operations would comply with local noise minimization requirements, including local noise ordinances. If necessary, lead agencies could require that noise reduction mitigation measures are implemented, such as restricting the hours of noise-generating operations. Therefore, the Basin Plan amendment would not result in substantial noise, and its impacts would be less-than-significant.

e–f) The Basin Plan amendment would not cause any permanent increase in ambient noise levels, including aircraft noise. Therefore, it would not expose people living within an area subject to an airport land use plan or in the vicinity of a private airstrip to excessive noise.

XII. Population and Housing

a–c) The Basin Plan amendment would not affect the population of the Walker Creek Watershed. It would not induce growth through such means as constructing new housing or businesses, or by extending roads or infrastructure. The Basin Plan amendment would also not displace any existing housing or any people that would need replacement housing.

XIII. Public Services

a) The Basin Plan amendment would not affect populations or involve construction of substantial new government facilities. The Basin Plan amendment would not affect service ratios, response times, or other performance objectives for any public services, including fire protection, police protection, schools, or parks.

XIV. Recreation

a–b) Because the Basin Plan amendment would not affect population levels, it would not affect the use of existing parks or recreational facilities. No recreational facilities would need to be constructed or expanded.

XV. Transportation /Traffic

a–b) Because the Basin Plan amendment would not increase population or provide employment, it would not generate any ongoing motor vehicle trips. Earthmoving and construction would be temporary, and related traffic would be of short-term duration. Therefore, the Basin Plan amendment would not substantially increase traffic in relation to existing conditions. Levels of service would be unchanged.

c) The Basin Plan amendment would not affect air traffic.

d) Because the Basin Plan amendment would not affect any roads or the uses of any roads, it would not result in hazardous design features or incompatible uses.

e) The small-scale construction that could occur as a result of the Basin Plan amendment would not likely restrict emergency access. Local agencies would confirm that specific proposals would not restrict emergency access through their environmental reviews.

f) Because the Basin Plan amendment would not increase population or provide employment, it would not affect parking demand or supply.

g) Because the Basin Plan amendment would not generate ongoing motor vehicle trips, it would not conflict with adopted policies, plans, or programs supporting alternative transportation.

XVI. Utilities and Service Systems

a) The project would amend the Basin Plan, which is the basis for wastewater treatment requirements in the Bay Area; therefore, the Basin Plan amendment would be consistent with such requirements.

b) Because the Basin Plan amendment would not affect water demands or supplies, it would not require the construction of new or expanded water facilities.

c) New or expanded stormwater drainage facilities are not called for under the proposed Basin Plan amendment.

d-e) Because the Basin Plan amendment would not increase population or provide employment, it would not require an ongoing water supply. It would also not require ongoing wastewater treatment services.

f–g) The Basin Plan amendment would not substantially affect municipal solid waste generation or landfill capacities.

XVII. Mandatory Findings of Significance

a) When taken as a whole, the Basin Plan amendment would not degrade the quality of the environment. The proposed Basin Plan amendment is intended to benefit wildlife, aquatic life and human health by decreasing mercury concentrations in the Walker Creek Watershed.

b) As discussed above, the Basin Plan amendment could pose some less-than-significant adverse environmental impacts related to earthmoving and construction operations. These impacts would be individually limited, and most would be short-term. As specific implementation proposals are developed and proposed, lead agencies would undertake environmental review and identify specific environmental impacts and appropriate mitigation measures. For cases in which potential impacts could be significant, local lead agencies would adopt readily available mitigation measures to ensure that possible impacts would be less-than-significant. Therefore, the incremental effects of the Basin Plan amendment are inconsequential. For this reason, the Basin Plan amendment's cumulative effects would be less-than-significant, and adopting the Basin Plan amendment would require no mandatory findings of significance.

c) The Basin Plan amendment would not cause any substantial adverse effects to human beings, either directly or indirectly. The Basin Plan amendment is intended to benefit human health by decreasing mercury concentrations.

13 REFERENCES

Andrew 2005	Andrew. G., Marin Municipal Water District. Personal communication to staff, September 8. 2005.
Beckvar et al., 1996	Beckvar, N., J. Field, S. Salazar, and R. Hoff . 1996. *Contaminants in Aquatic Habitats at Hazardous Waste Sites: Mercury*. NOAA Technical Memorandum, NOS ORCA 100. Seattle, Washington: Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration, pp. 7-8. Available online at http://response.restoration.noaa.gov/book_shelf/89_rpt_mercury_aquatic_habitats.pdf Accessed July 20, 2006.
CDFG 1984	California Department of Fish and Game. 1984. Fish Population Survey, Walker Creek, Marin County, 1981. Sacramento, Calif.: Anadromous Fisheries Branch. Available online at http://www.krisweb.com/biblio/walker_cdfg_emig_1984.pdf . Accessed July 20, 2006
CDFG 2001	California Department of Fish and Game. 2001. "Walker Creek, Marin County."Internal memo to file prepared by B. Cox. October 14. Available online at http://www.krisweb.com/biblio/walker_cdfg_cox_2001_cohosurvey.pdf Accessed August 2, 2006
CDFG 2004a	California Department of Fish and Game. 2004. *Coho Salmon Planting and Monitoring Project, Walker Creek Watershed, Marin County*. Yountville, Calif.: CDFG, Available online at: http://www.tomalesbaywatershed.org/salmon/coho_planting_dfg.pdf . Accessed July 20, 2006
CDFG 2004b	California Department of Fish and Game. 2004. *Recovery Strategy for California Coho Salmon, Species Recovery Strategy 2004-1*. Report the California Fish and Game Commission. Native Anadromous Fish and Watershed Branch. Sacramento, Calif. Appendix 1. Available online at http://www.dfg.ca.gov/nafwb/pubs/2004/CohoRecovery/CohoRecoveryStrategy.pdf. Accessed August 2, 2006
Cox 2005	Cox, B., Senior Fisheries Biologist, CA Dept. of Fish and Game. 2005. Personal communication to staff, December 19.
Davis et al. 2003	Davis, J., D. Yee, J. Collins, S. Schwarzbach, and S. Luoma. 2003. "Potential for Increased Mercury Accumulation in the Estuary Food Web." *Issues in San Francisco Estuary Tidal Wetlands Restoration, San Francisco Estuary and Watershed Science* 1:1, 1–8. Available online at http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art4/ . Accessed July 20,2006
Drury 2006	Drury, D. Santa Clara Valley Water District, Personal communication to staff, July 14, 2006.
Fischer et al. 1996	Fischer, D.T., S.V. Smith, and R.R. Churchill. 1996. "Simulation of a century of runoff across the Tomales watershed, Marin County, California." *Journal of*

	Hydrology 186: 187
Fish and Game Commission, 2006	California Fish and Game Commission. 2006. *California Freshwater Sport Fishing Regulations*, Effective March 1, 2006 – February 28, 2007. p. 64 Available online at: http://www.fgc.ca.gov/2006/06freshfishregbook.pdf. Accessed July 20, 2006.
Grieb et al. 1990	Grieb, T.M.; C.T. Driscoll, S.P. Gloss, C.L. Schofield, G.L. Bowie, D.B. Porcella. 1990. "Factors Affecting Mercury Accumulation in Fish in the Upper Michigan Peninsula." *Environmental Toxicology and Chemistry* 9, 919–930.
Haible 1976	Haible, W. W. 1976. *Holocene profile changes along a California coastal stream*. Master of Science thesis. U.C. Berkeley, pp. 1–2, 54.
Keith 2006	Keith, A.J., aquatic ecologist, Stillwater Sciences. Personal communication to staff, November 10, 2006.
Kelly 2005	Kelly, J., Director of Research and Resource Management, Audubon Canyon Ranch. Personal communication to staff, April 25, 2005.
Kim et al. 2003	Kim, C.S., J.J. Rytuba, an G.E. Brown, Jr. 2004. "Geological and anthropogenic factors influencing mercury speciation in mine wastes: an EXAFS spectroscopy study," *Applied Geochemistry* 19:379–393.
Marin Co. 2002	Marin County Community Development Agency, Planning Division. 2002. *Marin Countywide Plan: Geology, Mineral Resources and Hazardous Materials Technical Background Report.* San Rafael, Calif.: Marin County CDA, pp. 43–48.
MMWD 2005	Marin Municipal Water District (MMWD). 2005. "2005 Walker Creek Snorkeling Results." Internal memo to file prepared by Eric Ettinger. September 6.
Marin RCD 1989	Marin County Resource Conservation District. 1989. *Fishery Resources Habitat Surveys in Walker Creek, Marin County*, prepared by A. A. Rich and Associates. Point Reyes Station, Calif.: Marin County RCD, page 3. Available online at http://www.krisweb.com/biblio/walker_mcrcd_rich_1989_habitatsurveys.pdf . Accessed November 20, 2006.
Marin RCD 2005	Marin Resource Conservation District. 2005. *Geomorphology of the Walker Creek Watershed: Prospects for Habitat Enhancement and Sediment Management*, prepared by Lauren Hammock, Prunuske Chatham, Inc. Point Reyes Station, Calif.: Marin RCD.
Marshall 2004	Marshall, J. San Francisco Bay Regional Water Quality Control Board. 2004. "ANOVA analysis used to determine validity of background values in the Walker Creek watershed." Memo to file, February 7. Oakland, Calif.: SFBRWQCB
Marshall 2006	Marshall, J., San Francisco Bay Regional Water Quality Control Board. 2006. Memo to file, "Updated Statistical Analysis of Salmon and Chileno Creek Samples," February 6, 2005. Oakland, Calif.: SFBRWQCB.
Mason 2006	Mason, R., professor of marine sciences, University of Connecticut. Peer review of *Project Report*, August 22, 2006.
McGuire	McGuire E. Environmental Services Coordinator. Marin Municipal Water District,

2006	2006. Personal communication to staff, July 20.
Moyle 2002	Moyle, P. 2002. *Inland Fishes of California, Revised and Expanded*. Berkeley and Los Angeles, Calif.: University of California Press, pp. 395–400.
MCSTOPP 2005	Marin County Stormwater Pollution Prevention Program. 2005. *Stormwater Action Management Plan 2010, Fiscal Years 2005-2006 through 2009-2019.* San Rafael, Calif.: MCSTOPPP, pp.ES1–ES7, 69–71.
OEHHA 2004	Office of Environmental Health Hazard Assessment. 2004. "Chemicals in Fish from Ten Reservoirs in Alameda, Contra Costa, Santa Clara, and Marin Counties: Interim County Health Advisories," fact sheet. Available online at: http://www.oehha.ca.gov/fish/so_cal/pdf_zip/10resfactsheet.pdf . Accessed August 2, 2006.
Prunuske 2006	Prunuske, L., Prunuske and Chatham Inc., Personal communication to staff, July 21, 2006.
Russell 2005	Russell, D., U.S. Fish and Wildlife Service Environmental Contaminants Division. Personal communication to staff, June 15, 2005.
Scolari 2006	Scolari, N., Executive Director, Marin Resource Conservation District, Personal communication to staff, July 19, 2006.
SCVWD 2002	Santa Clara Valley Water District. 2002. *Request for Cleanup and Abatement Funds from the State Water Resources Control Board.* Application for funding. Sacramento, Calif.: California Water Resources Control Board.
SFBRWQCB 1995	San Francisco Bay Regional Water Quality Control Board. 1995. *Water Quality Control Plan San Francisco Bay Basin (Region 2)*. Oakland, Calif.: SFBRWQCB.
SFBRWQCB 1998	San Francisco Bay Regional Water Quality Control Board. 1998. *Mines Report.* Oakland, Calif.: SFBRWQCB pp 62-64, 67-69.
SFBRWQCB 2004a	San Francisco Bay Regional Water Quality Control Board. 2004a. *Preliminary Geomorphic Review and Mercury Source Assessment Walker Creek Watershed*. Oakland, Calif.: SFBRWQCB.
SFBRWQCB 2004b	San Francisco Bay Regional Water Quality Control Board. 2004b. *Water Quality Data Collection in the Walker Creek Watershed*. Oakland, Calif.: SFBRWQCB.
SFBRWQCB 2005	San Francisco Bay Regional Water Quality Control Board. 2005a. *Chemical Concentrations In Fish Tissues From Selected Reservoirs And Coastal Areas*. *Final Report.* University of California, Davis, California Department of Fish and Game, Surface Water Ambient Monitoring Program (SWAMP) San Francisco Bay Region. pp. 5, Appendix-III
SFEI 2001	San Francisco Estuary Institute. 2001. *San Francisco Bay Atmospheric Deposition Pilot Study Part 1: Mercury*. Richmond, Calif.: SFEI, pp. 8 to 21.
SWRCB n.d.	State Water Resources Control Board (n.d.). *Toxic Substances Monitoring (TSM) Program, Databases. TSM Program Data 1978-2000*. Excerpts related to Walker Creek station numbers. Database available online at: http://www.waterboards.ca.gov/programs/smw/index.html. Accessed 08/02/06

TBSTAC 2000	Tomales Bay Shellfish Technical Advisory Committee. 2000. *Tomales Bay Shellfish Technical Advisory Committee Final Report: Investigation of Nonpoint Pollution Sources Impacting Shellfish Growing Areas in Tomales Bay, 1995-96*. City, Calif.,: TBSTAC. pp. i–3.
TBWC 2003	Tomales Bay Watershed Council. 2003. *The Tomales Bay Watershed Stewardship Plan: A Framework for Action*. City, Calif.: TBWC, p. 41.
USEPA 1985	U.S. Environmental Protection Agency. 1985. *Ambient Water Quality Criteria for Mercury–1984*, EPA-440/5-84-026. Washington, D.C.: Office of Water, pp.10 to 17 and 20 to 25.
USEPA 1997	US Environmental Protection Agency. 1997. *Mercury Study Report to Congress*, EPA-452/R-97-003. Washington, DC. Office of Air Quality Planning and Standards and Office of Research and Development. p. 2-3.
USEPA 2000	U.S. Environmental Protection Agency. 2000. *Guidance for Developing TMDLs in California*. San Francisco, Calif.: Region 9 Headquarters, pp. 1-10.
USEPA 2001	U.S. Environmental Protection Agency. 2001. *Water Quality Criterion for the Protection of Human Health: Methylmercury*, EPA-823-R-01-001.Washington, D.C.: Office of Water, pp. ix–xvi, A-5, 7-1–7-2 and Table 5-24.
USEPA 2006	U.S. Environmental Protection Agency. 2006. *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, EPA-823-B-04-001. Washington, D.C., Office of Science and Technology, pp. 11–30. Available online at http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html . Accessed November 20, 2006.
USFWS 2005	U.S. Fish and Wildlife Service. 2005. *Derivation of Numeric Wildlife Targets for Methylmercury in the Development of a Total Maximum Daily Load for the Guadalupe River Watershed*. Sacramento, Calif.
USGS 1982	U. S. Geological Survey. 1982. *Landslide Overview Map of the Conterminous United States*. Geological Survey Professional Paper 1183, pp. 6–10, 27. Available at http://pubs.usgs.gov/pp/p1183/pp1183.html . Accessed November 20, 2006.
USGS 2000	U.S. Geological Survey. 2000. *Geologic map and map database of parts of Marin, San Francisco, Alameda, Contra Costa, and Sonoma Counties, California.* Pamphlet to accompany *MISCELLANEOUS FIELD STUDIES MF-2337, Online Version 1.0.* pp. 12-14. Available at: http://pubs.usgs.gov/mf/2000/2337/ Accessed August 2, 2006.
USGS 2005	U.S. Geological Survey. 2005. *Water Resources Data: California, Water Year 2004, Volume 2. Pacific Slope Basins from Arroyo Grande to Oregon State Line except Central Valley* (last updated September 16, 2005) pp.224–228. Available at http://pubs.usgs.gov/wdr/2004/wdr-ca-04-2/WDR.CA.04.vol2.pdf . Accessed August 2, 2006.
Whyte and Ganguli 2000	Whyte, D.C. and P.M. Ganguli. 2000. "The impact of mercury mining on Tomales Bay biota." Presented at EPA Conference, Assessing and Managing Mercury from Historic and Current Mining Activities; San Francisco, pp. 98- 100.

Whyte and Kirchner 2000	Whyte, D.C. and J.W. Kirchner. 2000. "Assessing water quality impacts and cleanup effectiveness in streams dominated by episodic mercury discharges." *Science of the Total Environment* 260: 1-9.
Wiener et al. 2003	Wiener, J., D. Krabbenhoft, G. Heinz, and A. Scheuhammer. 2003. "Ecotoxicology of Mercury," in *Handbook of Ecotoxicology*, 2nd ed., edited by D. Hoffman, B. Rattner, G. Burton, Jr., and J. Cairns, Jr. Boca Raton, Florida: CRC Press, pp. 409–463.
Wohl 2006	Wohl, E., professor of geology, Colorado State University. Email: peer review of *Project Report*, July 26, 2006p

APPENDIX A

Figure A-1 Sample Locations

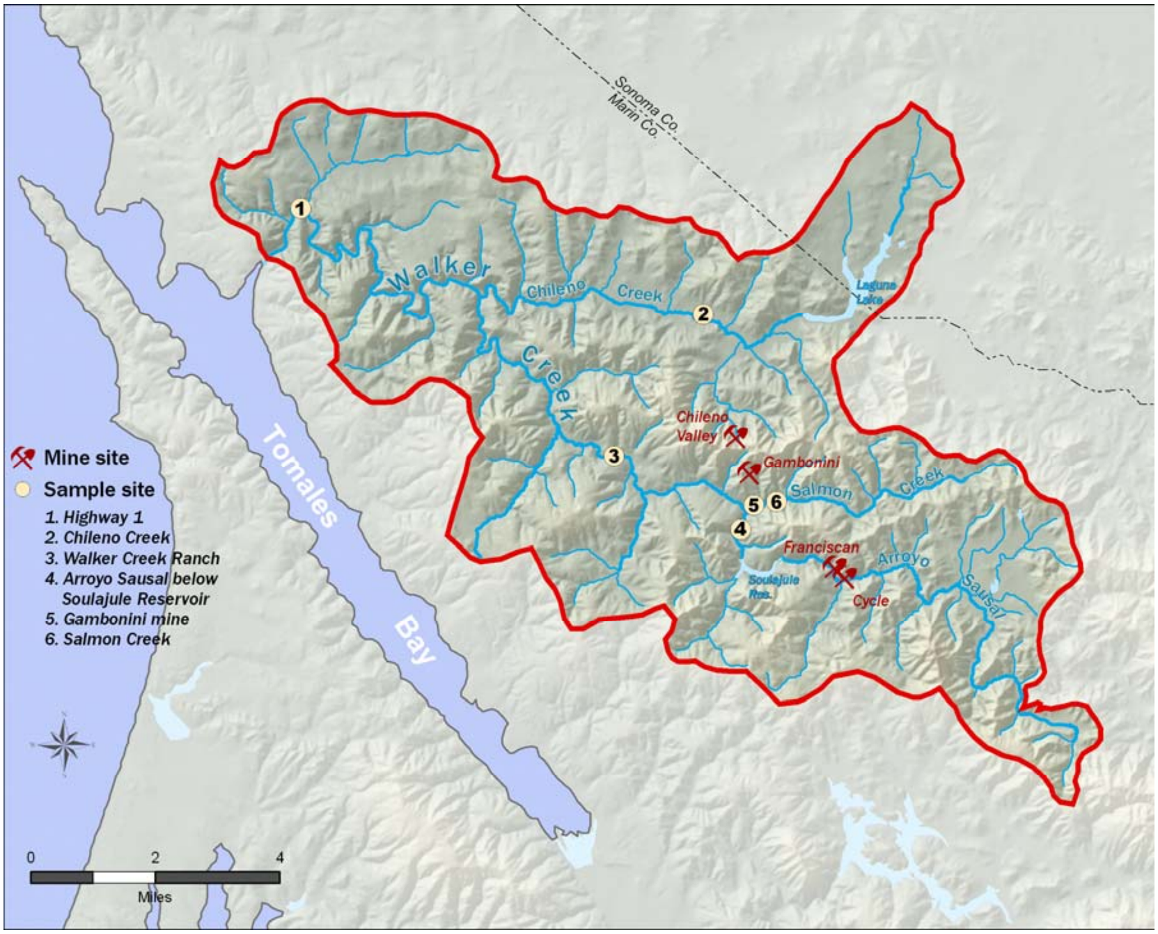


Table A-1 Sample Results

Date	Sample Location	TSS (mg/l)	Particulate Hg (ng/mg)	Hg total (ng/l)	Hg filtered (ng/l)	UnfilteredMeHg (ng/l)	Filtered MeHG (ng/l)	Discharge (l/s)
12/11/95	Gambonini Mine			36,205.0	34.4			10.0
12/13/95	Gambonini Mine			556.0	44.1			29.0
	Walker Creek Ranch			269.9	7.2			
1/16/96	Gambonini Mine	716.0	256.8	184,000.0	96.9			160.0
	Walker Creek Ranch	1,706.3	4.9	8,398.0	12.2			
2/2/96	Gambonini Mine							38.0
2/17/96	Gambonini Mine							8.0
2/19/96	Gambonini Mine							46.0
2/29/96	Gambonini Mine							48.0
3/4/96	Gambonini Mine							24.0
3/12/96	Gambonini Mine	96.3	79.9	7,727.9	35.3			43.0
	Soule Joule	79.5		3.0				
	Soule Joule	21.9						
	Soule Joule	50.7	0.2	10.8	3.0			
	Walker Creek Ranch	50.2	6.7	343.2	4.8			
4/1/96	Gambonini Mine							42.0
4/19/96	Gambonini Mine							23.0
12/5/96	Gambonini Mine	205.0	4.1	897.9	56.9			32.0
12/9/96	Gambonini Mine	156.3	42.2	6,686.3	82.6			62.0
12/29/96	Gambonini Mine	469.5	75.9	35,743.8	98.4			258.0
12/31/96	Gambonini Mine	150.1	49.9	7,543.2	45.9			212.0
1/2/97	Gambonini Mine	340.9	32.9	11,270.4	67.5			314.0
	Hwy 1	373.9	2.0	756.5	8.9			88,130.0
	Walker Creek Ranch	429.7	3.2	1,389.5	11.1			50,268.0
1/25/97	Gambonini Mine	652.5	72.0	47,036.0	51.3			280.0
11/26/97	Gambonini Mine	2,733.4	57.0	155,828.0	88.8			130.0
	Hwy 1	138.0	2.0	287.3	6.2			21,010.0
	Walker Creek Ranch	532.1	12.9	6,885.7	15.9			5,638.5
12/7/97	Gambonini Mine	107.5	21.4	2,380.6	75.4			
1/9/98	Gambonini Mine	19.0	23.7	485.2	35.0			
1/11/98	Gambonini Mine	3,514.5	68.4	240,407.0	102.4			232.2
	Hwy 1	391.0	0.6	254.7	5.6			30,290.0
1/12/98	Gambonini Mine	4,738.1	79.3	375,828.0	79.9			418.1
	Gambonini Mine	908.6	50.6	46,031.0	57.3			176.6
	Hwy 1	455.1	1.8	816.8	9.0			59,365.0
	Walker Creek Ranch	1,089.3	6.8	7,444.2	14.1			28,433.3
1/13/98	Gambonini Mine	42.6	28.7	1,262.6	40.9			105.3
1/14/98	Gambonini Mine	1,927.3	67.6	130,348.0	58.5			277.9
	Gambonini Mine	858.6	111.2	95,567.0	92.7			253.1
	Hwy 1	129.4	1.3	175.3	6.8			33,910.0
	Walker Creek Ranch	595.9	3.1	1,851.0	6.9			19,523.8
1/15/98	Gambonini Mine	595.5	75.2	44,838.0	66.7			234.0
	Hwy 1	299.0	2.0	611.7	7.7			68,866.0
	Walker Creek Ranch	254.5	4.1	1,060.0	9.0			47,351.0
2/1/98	Gambonini Mine	276.2	135.5	37,507.0	79.4			116.9
2/2/98	Gambonini Mine	1,343.0	94.2	126,615.0	96.8			143.1
	Gambonini Mine	19,752.0	52.9	1,044,479.0	139.3			827.6
	Hwy 1	578.6	2.2	1,298.1	6.4			54,218.0
	Walker Creek Ranch	543.5	4.1	2,230.2	11.1			33,332.6
2/3/98	Gambonini Mine	3,219.7	54.8	176,538.0	33.1			213.2
2/4/98	Gambonini Mine	308.7	21.1	6,540.5	31.2			75.5
2/6/98	Gambonini Mine	2,596.9	81.7	212,255.0	69.2			376.7
	Gambonini Mine	3,279.5	99.4	325,982.0	67.3			539.0
2/8/98	Gambonini Mine	1,814.9	30.1	54,636.0	43.6			133.5
2/20/98	Gambonini Mine	507.0	62.5	31,744.0	40.6			142.2
2/23/98	Gambonini Mine	1,040.0	45.0	46,876.0	52.1			105.4
	Hwy 1	836.0	1.9	1,619.2	6.2			55,243.0

Date	Sample Location	TSS (mg/l)	Particulate Hg (ng/mg)	Hg total (ng/l)	Hg filtered (ng/l)	UnfilteredMeHg (ng/l)	Filtered MeHG (ng/l)	Discharge (l/s)
	Walker Creek Ranch	865.0	2.4	2,123.6	7.9			28,430.0
↑ PRE REMEDIATION ↓ POST								
1/24/00	Chileno	141.0	0.2	36.9	6.8	0.3		2,981.0
	Gambonini Mine	56.9	37.7	2,250.0	105.0			57.6
	Walker Creek Ranch	253.0	1.4	364.0	10.1			6,364.0
2/14/00	Chileno	212.0	0.2	55.6	4.4	0.2		
	Gambonini Mine	203.0	64.3	13,100.0	46.5	0.4		149.0
	Gambonini Mine	973.0	180.8	176,000.0	48.4	2.0		178.0
	HWY 1	373.0	2.0	766.0	7.9	0.3		53,955.0
	Walker Creek Ranch	393.0	19.4	7,650.0	8.3	0.2		25,921.0
2/22/00	Gambonini Mine	31.3	22.2	736.0	39.7	0.3		26.0
	Gambonini Mine	306.0	25.8	7,970.0	79.4	0.1		49.9
	Gambonini Mine	530.0	29.1	15,500.0	88.5	1.3		80.7
	Gambonini Mine	225.0	23.6	5,400.0	99.9	0.9		67.6
	Gambonini Mine	6,680.0	79.6	532,000.0	116.0	15.8		413.0
3/24/00	Gambonini Mine			56.6	18.8	0.3		
	HWY 1	1.6	1.8	7.5	4.7	0.4		
	Walker Creek Ranch	6.5	2.5	22.6	6.4	0.3		520.0
3/27/00	Chileno	7.8	0.2	4.0	2.1	0.3		274.0
1/10/01	Gambonini Mine	440.0	26.2	11,600.0	79.5	6.6		127.0
	HWY 1	9.6	0.1	7.1	6.5	0.2		6,801.0
	Walker Creek Ranch	174.0	4.7	826.0	3.3	1.3		976.0
1/11/01	Chileno	119.0	0.1	18.0	2.5	0.4		382.0
	Gambonini Mine	123.0	24.7	3,110.0	67.5	5.7		45.4
	Salmon Creek upstream of mine	76.8	0.3	27.7	3.2	0.2		33.2
	Walker Creek Ranch	76.6	4.2	329.0	5.3	0.5		950.0
1/25/01	Gambonini Mine	89.0	18.8	1,750.0	78.8	0.8		39.6
	Gambonini Mine	513.0	25.2	13,000.0	69.5	7.0		73.7
2/9/01	HWY 1	23.5	0.5	13.2	1.4	0.3		18,139.0
	Salmon Creek upstream of mine	49.5	0.1	9.1	2.2	0.2		85.0
	Walker Creek Ranch	26.0	0.4	12.9	3.0	0.2		631.0
2/12/01	Chileno	61.0	0.1	11.0	4.2	0.3		749.0
	Gambonini Mine	43.0	14.6	687.0	59.5	0.5		34.0
	Salmon Creek upstream of mine	74.0	0.1	15.0	5.8	0.2		669.0
	Walker Creek Ranch	46.0	0.5	28.5	5.3	0.2		1,689.0
2/17/01	Gambonini Mine	169.0	41.0	6,990.0	69.0	3.5		39.6
	HWY 1	5.0	1.2	9.4	3.1	0.2		
	Salmon Creek upstream of mine	63.0	0.3	25.8	3.8	0.1		82.8
	Walker Creek Ranch	74.0	0.8	63.6	3.7	0.3		1,503.0
2/24/01	Chileno	188.0	0.1	33.6	6.6	0.3		3,558.0
	Gambonini Mine	35.3	16.1	671.0	101.0	0.4		34.0
	Walker Creek Ranch	161.0	1.5	251.0	8.6	0.3		5,859.0
3/5/01	Chileno	54.0	0.1	11.8	4.4	0.2		2,088.0
	Gambonini Mine	8.0	19.1	199.0	46.4	0.3		34.0
	Salmon Creek upstream of mine	68.0	0.1	16.4	6.8	0.1		1,225.0
	Walker Creek Ranch	51.0	0.4	27.5	7.1	0.2		2,697.0
3/16/01	Chileno	29.3	0.1	5.6	2.4	0.2		760.0
	Gambonini Mine	5.0	3.0	38.5	23.7	0.1		8.6
	Hwy1	11.0	0.5	8.6	3.5	0.4		
	Salmon Creek upstream of mine	8.0	0.1	3.3	2.2	0.1		82.1
	Walker Creek Ranch	6.0	0.9	8.9	3.3	0.3		555.0
12/17/01	Gambonini Mine			224.0	69.8	0.4		34.0
	Hwy 1			68.3	6.0	0.5		40,556.0

Date	Sample Location	TSS (mg/l)	Particulate Hg (ng/mg)	Hg total (ng/l)	Hg filtered (ng/l)	UnfilteredMeHg (ng/l)	Filtered MeHG (ng/l)	Discharge (l/s)
	Salmon Creek upstream of mine			50.4	7.5	0.2		1,274.0
	Walker Creek Ranch			41.1	7.7	0.3		3,206.0
2/8/02	Chileno			5.9	2.2	0.3	0.1	309.0
	Gambonini Mine			126.0	31.2	0.2	0.1	9.5
	Hwy 1			36.7	3.9	0.4	0.2	
	Salmon Creek upstream of mine			7.0	3.8	0.2	0.1	111.0
	Walker Creek Ranch			10.7	4.9	0.1	0.2	1,365.0
2/19/02	Gambonini Mine	89.0	8.0	749.0	37.7	0.8	0.2	89.0
	Gambonini Mine	132.0	10.8	1,510.0	78.7	1.4	0.3	112.0
	Hwy 1	14.0	0.3	8.2	3.7	0.3	0.2	
	Salmon Creek upstream of mine	923.0	0.1	102.0	4.7	0.8	0.1	1,420.0
	Walker Creek Ranch	339.0	0.4	126.0	4.9	0.8	0.1	3,846.0
5/2/02	Chileno	10.0	0.1	1.8	0.9	0.2	0.0	
	HWY 1	8.5	0.7	9.2	3.7	0.4	0.3	
	Salmon Creek upstream of mine	3.0	0.2	1.9	1.3	0.1	0.1	
	Walker Creek Ranch	4.0	0.7	7.8	5.1	0.5	0.3	
6/24/03	HWY 1	3.7	0.7	6.0	3.3			
	Salmon Creek upstream of mine	6.0	0.1	1.6	0.9			0.0
	Soule Joule	7.0	0.3	3.6	1.9			0.2
	Walker Creek Ranch	7.0	0.6	10.0	5.9			178.3