

Chapter 4.2

WATER QUALITY AND TOXICOLOGY

4.2.1 Introduction

CDFG's suction dredging permit program is statewide. Thus the affected environment is all water-bodies in the state where dredging may occur, and the adjacent shoreline zones which dredge operators use to base their activities.

4.2.2 Regulatory Setting

Federal Laws, Regulations, and Policies

Clean Water Act and Associated Programs

There are several sections of the Federal Water Pollution Control Act (33 U.S. Government Code [U.S.C.] §1251 et seq. (1972)), a.k.a. "Clean Water Act" (CWA), which is administered primarily by the U.S. Environmental Protection Agency (EPA) that pertain to regulating discharges of waste to waters of the United States, including Sections 303, 401, 402, and 404. Each of these regulatory sections of the CWA is described below.

Congress enacted the federal CWA "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."¹ Section 301 of the CWA prohibits "the discharge of any pollutant by any person" except in compliance with the CWA; i.e., without obtaining a permit.² The "discharge of any pollutant" means any addition of any pollutant to navigable waters from any point source. One type of permit authorized by CWA Section 402 is National Pollutant Discharge Elimination System (NPDES) permits.

Section 303

As defined by U.S. EPA, water quality standards consist of: 1) the designated beneficial uses of a water segment, 2) the water quality criteria (referred to as "objectives" by the state) necessary to support those uses, and 3) an antidegradation policy that protects existing uses, future uses, and high water quality. The State of California adopts water quality standards (see discussion of state water quality standards below) to protect beneficial uses of state waters as required by Section 303 of the CWA and the Porter-Cologne Water Quality Control Act of 1969 (Porter-Cologne). Section 303(d) of the CWA requires States to develop lists of water bodies (or sections of water bodies) that will not attain water quality standards after implementation of minimum required levels of treatment by point-source dischargers (i.e., municipalities and industries). Section 303(d) requires States to develop a total maximum daily load (TMDL) for each of the listed pollutants and water bodies, which is intended to guide the attainment of state water quality standards. A TMDL is an estimate

¹ 33 U.S.C. § 1251(a).

² 33 U.S.C. § 1311(a).

of the total load of pollutants from point, non-point, and natural sources that a water body may receive without exceeding applicable water quality standards (with a “factor of safety” included). Once established, the TMDL allocates the permissible contaminant loading among current and future pollutant sources to the water body to ensure that water bodies maintain compliance with the established water quality standards.

Sections 401 and 404

For an applicant of a federal permit or license to conduct any activity that may result in a discharge of a pollutant to a water of the United States, Section 401 of the CWA requires the state to issue a certification that the activity is consistent with the state’s water quality standards. The state may grant, grant with technical conditions imposed on the project activity, or deny the Section 401 certification.

The discharge of dredged or fill material into waters of the United States, including wetlands, as determined by the U.S. Army Corps of Engineers (USACE), is subject to permitting specified under Section 404 of the CWA (Discharges of Dredge or Fill Material), which is administered by USACE. A Section 401 water quality certification is required for all Section 404 permitted activities.

Section 402

The 1972 amendments to the Federal Water Pollution Control Act established the NPDES permit program to control discharges of pollutants from point sources (Section 402). NPDES is the primary federal program that regulates point-source discharges to waters of the United States. The 1987 amendments to the CWA created a new sub-section of the CWA devoted to stormwater permitting (Section 402[p]). Section 402 of the CWA authorizes the EPA, or a state with an approved program, to issue NPDES permits for the discharge of pollutants other than dredged or fill material.³ Within California, the Legislature has delegated its rights and responsibilities under the CWA, including the issuance of NPDES permits, to the State Water Resources Control Board (SWRCB).

Suction dredging involves the removal of material from the streambed to a sluice box. The material is separated into recoverable gold and remaining spoil. The spoil is then discharged from the sluice box directly back into the stream. Congress defined “pollutant” to include “dredged spoil, rock, sand...”⁴ The discharge of the spoil from a suction dredging sluice box has been determined by the courts to constitute a discharge that may be regulated with permits issued pursuant to Section 402 of the CWA.⁵ As such, the SWRCB or the Regional Water Quality Control Boards (RWQCBs) may require suction dredge operators to obtain NPDES permits in order to ensure that they are in compliance with the CWA and with California’s water quality standards. Several other western states also regulate recreational dredging activities through permit procedures associated with their wastewater discharge statutes and regulations; a summary of these other state’s permit procedures is provided in Appendix E.

³ 33 U.S.C. § 1342.

⁴ 33 U.S.C. § 1362(6).

⁵ *Rybachek v. U.S. Environmental Protection Agency* (9th Cir. 1990) 904 F.2d 1276.

National Toxics Rule and California Toxics Rule

The National Toxics Rule (NTR) was issued by the EPA on December 22, 1992, and amended on May 4, 1995, and November 9, 1999, to establish numeric criteria for 42 priority toxic pollutants. As a result of a court-ordered revocation of California's statewide water quality control plan for priority pollutants in September 1994, the EPA initiated efforts to issue numeric water quality criteria for California. On May 18, 2000, the EPA promulgated the California Toxics Rule (CTR) in the Federal Register as a final rule (Federal Register, Volume 65, page 31682 [65 FR 31682]). The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that were applicable in the state. For California, the criteria in the CTR supplement the criteria in the NTR (i.e., the CTR does not change or supersede any criteria previously promulgated for California in the NTR, but it does include them in the table of criteria for convenience).

Federal Anti-degradation Policy

The federal anti-degradation policy is designed to protect existing beneficial uses and the level of water quality necessary to protect existing uses, and provide protection for high quality waters and national water resources. The federal policy directs states to adopt a statewide policy that includes the following primary provisions (40 CFR 131.12):

(1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

(2) Where the quality of waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the state finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located...

(3) Where high quality waters constitute an outstanding National resource, such as waters of National and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

Federal Mining and Land Use Regulations

Many of the water bodies where suction dredging may occur in California occur on federal lands under the jurisdiction of either the U.S. Bureau of Land Management (BLM) or the U.S. Forest Service (USFS) National Forest system. Other federal lands (i.e., National Park Service, National Monument, military bases), Indian reservations, and U.S. Bureau of Reclamation reservoirs are not typically open to mineral exploration. The General Mining Law of 1872 and accompanying BLM regulations (43 CFR Parts 3800-3870) provide the primary rules governing mineral prospecting activities on public lands, including the filing of claims and patents and environmental provisions (excepting activities that started prior to October 1976 and have not undergone any changes). Similarly, federal regulations applicable to the USFS contain provisions for minerals exploration (36 CFR Part 228). The environmental protection requirements for BLM (43 CFR Part 3802.3) and USFS (36 CFR

Part 228.9) are similar and generally require activities to abide by state and Federal water quality standards, solid waste disposal and removal (i.e., trash, wastes), and construction of access routes in a manner to provide adequate drainage (i.e., dips, water bars, culverts), be shaped to as near a natural contour as practicable, be stabilized, and be reclaimed and revegetated when activities are discontinued.

State Laws, Regulations, and Policies

Porter-Cologne Water Quality Control Act and California Water Code

The Porter-Cologne Water Quality Control Act, passed in 1969, implements the CWA in California. It established the SWRCB and divided the state into nine regions, each overseen by a Regional Water Quality Control Board. The SWRCB is the primary state agency responsible for protecting the quality of the state's surface and groundwater supplies, but much of its daily implementation authority is delegated to the nine RWQCBs, which are responsible for implementing CWA Sections 401, 402, and 303(d). In general, the SWRCB manages both water rights and statewide regulation of water quality, while the RWQCBs focus exclusively on water quality within their regions. Porter-Cologne authorizes the RWQCBs to issue waste discharge requirements (WDRs), including NPDES permits, and requires the RWQCBs to adopt water quality control plans (Basin Plans) for the protection of surface water and groundwater quality. Additionally, the SWRCB may adopt water quality control plans for waters of the state. A Basin Plan must identify beneficial uses of surface water or groundwater to be protected, establish water quality objectives to ensure the reasonable protection of beneficial uses, and establish a program for implementing and achieving the water quality objectives. Basin Plans also incorporate by reference the state's "Anti-degradation Policy," which is discussed further below.

Section 13050(f) of the Porter-Cologne Act defines "beneficial uses" as uses of waters of the state (i.e., surface water or groundwater) that must be protected against water quality degradation. Potential beneficial uses include domestic and municipal, agricultural, and industrial water supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves (Section 13050[f]). Most water bodies have multiple designated beneficial uses. SWRCB policies have provided additional guidance regarding how the SWRCB and RWQCBs must regulate discharges to waters of the state in order to protect beneficial uses.

In 1988, the SWRCB adopted Resolution 88-63, the Sources of Drinking Water Policy. This policy stated, "All surface and ground waters of the state are considered to be suitable, or potentially suitable, for municipal or domestic water supply and should be so designated by the Regional Boards..." with a few minor exceptions. Therefore, the SWRCB and RWQCBs regulate almost all surface water and groundwater of the state as a potential drinking water source.

Basin Plans establish specific numeric and narrative water quality objectives for a number of physical parameters, chemical inorganic and organic constituents, biological factors, and toxic priority trace metal and organic compounds. Numerical objectives are typically applied to conventional parameters such as coliform bacteria, dissolved oxygen (DO), pH, pesticides, electrical conductivity (EC), total dissolved solids, temperature, or turbidity. Several of the Basin Plans also contain specific numerical objectives for some of the trace metals or organic compounds. Basin Plans also commonly contain narrative water quality

objectives for parameters such as suspended sediment, taste and odor, color, biostimulatory substances, oil and grease, pesticides, and toxicity. Water quality objectives for toxic pollutants in the Basin Plan complement the federal water quality standards adopted in the CTR and NTR. State objectives may be equal to, or more restrictive than federal criteria, but cannot be less restrictive than federal criteria.

Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

In 1994, the SWRCB and the EPA agreed to a coordinated approach for addressing priority toxic pollutants in inland surface waters, enclosed bays, and estuaries of California. In March 2000, the SWRCB adopted the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, commonly referred to as the State Implementation Policy (or SIP). The SIP implements NTR and CTR criteria, and applicable Basin Plan objectives, for toxic pollutants. When the RWQCBs issue any permit allowing the discharge of any toxic pollutant(s) pursuant to the CWA or the Porter-Cologne, the permit's promulgation and implementation must be consistent with the SIP's substantive or procedural requirements. Any deviation from the SIP requires the concurrence of U.S. EPA if the RWQCBs are issuing any permit pursuant to the CWA.

California Anti-Degradation Policy (SWRCB Resolution No. 68-16)

The goal of SWRCB Resolution No. 68-16 ("Statement of Policy With Respect to Maintaining High Quality Waters in California") is to maintain high quality waters where they exist in the State. State Board Resolution No. 68-16 states, in part:

"1. Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.

2. Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

The SWRCB has interpreted Resolution No. 68-16 to incorporate the federal anti-degradation policy, which is applicable if a discharge that began after November 28, 1975, will lower existing surface water quality.

California Fish and Game Code Sections 5650-5652 and 5655

The California Fish and Game Code section 5650 prohibits the discharge of petroleum products and other miscellaneous materials, or any substance deleterious to fish, plant life, mammals, or bird life into waters of the state. For conditions where CDFG finds that a

continuing and chronic condition of pollution exists, section 5651 requires CDFG to coordinate with the RWQCBs in obtaining correction and abatement of the problem. Section 5652 prohibits discharge of refuse to waters of the state or within 150 feet of the high water mark of waters of the state. Section 5655 allows CDFG to collect funds and conduct cleanup and abatement actions for spills of petroleum or petroleum products by a discharger, or require the discharger who caused the spill to conduct the cleanup.

Local Laws and Regulations

Because suction dredging typically occurs as temporary activities, involves access and setup of small and dispersed sites in remote locations, and often access through Federal public lands, the activities are unlikely to require application or approval under local land use regulations that may involve water quality protection either directly or indirectly (e.g., grading and erosion control ordinances, building permits, stormwater management regulations).

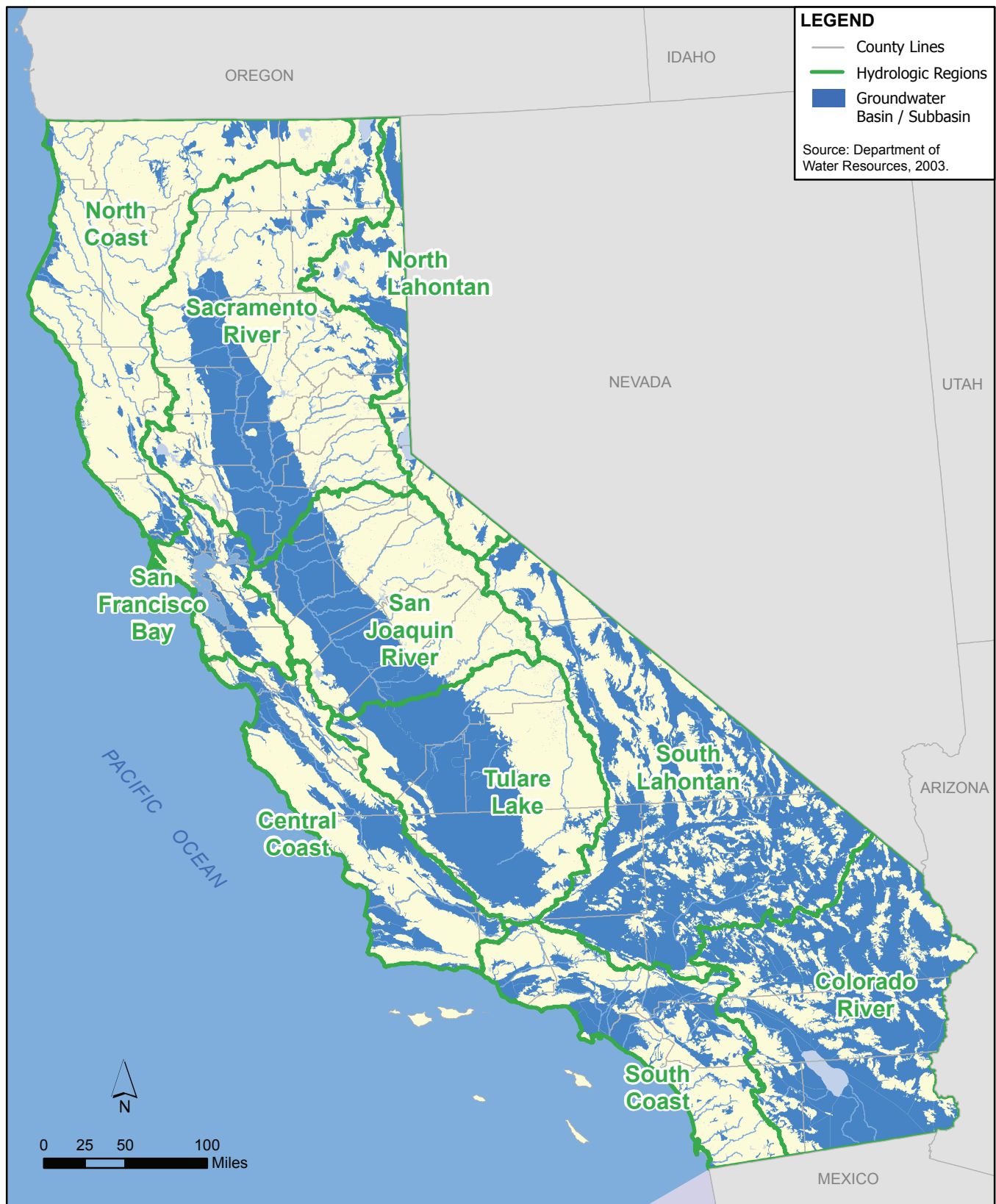
4.2.3 Environmental Setting

A Literature Review (Appendix D) was conducted in preparing this EIR section to identify and evaluate available information that exists regarding the potential environmental effects to water resources that suction dredging activity may cause. Based on the Literature Review, and the results of the agency and public issues-scoping process conducted for this EIR, it was determined that the major water quality issues of potential concern associated with suction dredging activity under the Proposed Program were waste discharges of dispersed encampments, instream waste discharges from dredging equipment, and instream resuspension of sediments and related sediment-derived contaminants. As proposed, the Program will apply statewide, thus the setting below addresses existing conditions at an appropriate regional scale. The following sections describe relevant regional climate, hydrology, water quality, and environmental toxicology conditions in California that may be affected by suction dredging activity, or may influence the environmental effects of suction dredging activity.

Regional Climate and Hydrology

The Department of Water Resources (DWR) divides the state into ten hydrologic regions which are designated in Water Code Section 13200, and based on boundaries of major river system watersheds. The boundaries of the nine RWQCBs also are defined (for the most part) by these boundaries. These hydrologic region boundaries are shown in Figure 4.2-1, along with major defined groundwater basins of the state (DWR, 2003). The location of groundwater basins are only partially related to the boundaries of major surface watersheds.

Most of California experiences a Mediterranean climate with cool, wet winters and warm, dry summers. However, the state also contains deserts that experience arid climatic conditions and mountains with subarctic climate patterns. In California, most precipitation (i.e., rain and snow) and peak stream runoff events occur primarily during the months of October–April, and are usually most extreme between November and March. Precipitation rates vary greatly across the state from the northern to southern regions, and the state contains many desert regions where annual total precipitation averages less than about 7 inches. In general, the April to July period is characterized by moderately high runoff from



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snowmelt in watersheds that receive a substantial snowpack, much of which is captured in reservoirs. Mountain snowmelt and seasonal release of stored water from the reservoirs generally provides surface water flows into or throughout the summer months in the major streams and rivers located downstream in the Sacramento Valley, San Joaquin Valley, and northern California.

Many rivers are controlled by dams and levees for a variety of purposes, including but not limited to, flood control, water storage and transport, and recreation. Rivers and streams in the Klamath/North Coast region are largely uncontrolled, with the exception of the Trinity River where Lewiston Reservoir provides substantial storage and flows are diverted into the Sacramento River basin, and the Klamath River. Most of the rivers on the west side of the Sierra Nevada Mountains are controlled, to some degree, by dams and diversions. The climate and hydrology of each hydrologic region are described in detail below.

North Coast Hydrologic Region

The North Coast hydrologic region covers approximately 12.46 million acres (19,470 square miles) and encompasses Siskiyou, Del Norte, Trinity, Humboldt, Mendocino, Sonoma, and small areas of Marin Counties. The region extends from the Oregon border south to Tomales Bay and includes portions of the northern Coast Ranges, the Mad River drainage, the Klamath Mountains, and the coastal mountains. The majority of the population is located along the Pacific Coast and in the inland valleys north of the San Francisco Bay Area. The northern mountainous portion of the region is rural and sparsely populated, and most of the area is heavily forested. Average annual precipitation in this hydrologic region ranges from 100 inches in the Smith River drainage to 29 inches in the Santa Rosa area.

The climate in inland areas is characterized by distinct rainy, cool winters and hot, dry summers, while coastal areas experience cool and wet conditions year-round with little temperature variation. Precipitation is predominantly rainfall, and average annual precipitation in the region is 53 inches. Runoff characteristics include the highest peak discharges recorded and highest total sediment yields in the state.

San Francisco Bay Hydrologic Region

The San Francisco Bay hydrologic region covers approximately 2.88 million acres (4,500 square miles) and encompasses San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, and Alameda Counties. The San Francisco Bay hydrologic region is dominated by the Coast Ranges. Significant geographic features include the Marin and San Francisco peninsulas; San Francisco, Suisun, and San Pablo bays; and the Santa Cruz Mountains, Diablo Range, Bolinas Ridge, and Vaca Mountains of the Coast Ranges. Although this is the smallest hydrologic region in the state, it contains the second largest human population.

The climate in coastal areas is characterized by cool and foggy conditions year-round, with rain in the winter and small seasonal temperature variations, while inland areas experience warmer, dry summers with cooler, rainy winters. Precipitation is mostly rainfall, with insignificant snowfall. Average annual precipitation is 31 inches, with greater than 50 inches in some parts. Runoff characteristics include high peak discharges due to small, steep watersheds. Local rivers are susceptible to severe flooding during high rainfall events. Some watersheds produce high sediment yields due to unstable rock types/soils.

Central Coast Hydrologic Region

The Central Coast hydrologic region covers approximately 7.22 million acres (11,300 square miles) in central California and includes all of Santa Cruz, Monterey, San Luis Obispo, and Santa Barbara Counties, most of San Benito County, and parts of San Mateo, Santa Clara, and Ventura Counties. The climate and runoff experienced is similar to that described above for the San Francisco Bay Hydrologic Region. Annual average precipitation is 20 inches.

South Coast Hydrologic Region

The South Coast hydrologic region includes all of Orange County; most of San Diego and Los Angeles Counties; parts of Riverside, San Bernardino, and Ventura Counties; and a small portion of Kern and Santa Barbara Counties. Approximately half of California's population, or about 17 million people, live within the boundaries of the South Coast hydrologic region. This, combined with its comparatively small surface area of approximately 6.78 million acres (10,600 square miles) gives it the highest population density of any hydrologic region in California.

The region has a Mediterranean climate with mostly dry years interrupted by infrequent high precipitation years. It is generally characterized by warm, dry summers and mild, wet winters, though it also can experience intense subtropical storms. Precipitation is generally rainfall, with insignificant snowfall contribution. Average annual precipitation is 18.5 inches. Locally heavy storms have the highest 24-hour rainfall totals in the state. Rivers and streams are largely ephemeral and fed by rainfall. Rivers are susceptible to frequent flooding due to high peak discharge events. Sediment yields are locally high due to intense urbanization, low vegetation cover and unstable soils. Debris flows and mudflows are frequent in some drainages.

Central Valley Hydrologic Region

At over 38 million acres (59,450 square miles), the Central Valley hydrologic region is the largest in California, and encompasses the three subregions described below. The climate in the Central Valley is characterized by hot, dry summers and cool, wet winters, while mountainous areas experience mild summers with intermittent thundershowers and heavy winter snowfalls above 5,000 feet. Lowland areas receive winter rainfall, and mountains receive moderate to heavy snowfall. Total average annual precipitation ranges from 36 inches in the Sacramento River region to 13-14 inches for the San Joaquin Valley and Tulare Lake regions. Runoff is characterized by prolonged spring runoff fed by Sierra Nevada snowpack. The region experiences generally low sediment yields due to widespread vegetation and stable rock types/soils, though high sediment yields are experienced locally due to land uses (e.g., logging, grazing, and urbanization). The natural hydrology has been highly modified by the introduction of dams, timing and location of water uses, and conveyance systems.

Sacramento River Hydrologic Subregion

The Sacramento River hydrologic subregion covers 27,250 square miles and includes all or a portion of 20 predominantly rural northern California counties. The city of Sacramento is the most densely populated portion of this region. The region extends from the crest of the Sierra Nevada in the east to the summit of the Coast Ranges in the west, and from the

Oregon border north downstream to the Sacramento–San Joaquin Delta. It includes the entire drainage area of the Sacramento River, the largest river in California, and its tributaries.

San Joaquin River Hydrologic Subregion

The San Joaquin River hydrologic subregion is bordered on the east by the crest of the Sierra Nevada Mountains and on the west by the crest of the coastal mountains of the Diablo Range. It extends from the southern boundary of the Sacramento–San Joaquin Delta to the southern extent of the San Joaquin River drainage in Madera County. It consists of the drainage area of the San Joaquin River, which at approximately 300 miles long is one of California's longest rivers, although substantial portions have only intermittent flow, and also encompasses approximately half of the Sacramento–San Joaquin Delta. The San Joaquin River hydrologic region covers approximately 9.7 million acres (15,200 square miles).

Tulare Lake Hydrologic Subregion

The Tulare Lake hydrologic subregion is located in the southern end of the San Joaquin Valley and includes all of Tulare and Kings Counties and most of Fresno and Kern Counties. Major cities include Fresno, Bakersfield, and Visalia. The region covers approximately 10.9 million acres (17,000 square miles). The surface water hydrology of this region has been greatly modified and there is generally no discharge of river flow out of the region, with the exception of infrequent high flow events when there may be some flow into the San Joaquin basin to the north. The ancestral Tulare Lake is now completely under agriculture.

Lahontan Hydrologic Region

The Lahontan hydrologic region encompasses the North and South Lahontan subregions covering approximately 25.1 million acres (39, 200 square miles). Valleys are semi-arid high desert with hot, dry summers, mild, dry winters, and locally intense thunderstorms. Mountainous areas experience cool to mild summers and cold winters. Precipitation is low to moderate in valleys due to the rain-shadow effects of the Sierra Nevada and Cascade Mountains. The mountains experience regionally heavy winter snowfall and intense summer thunderstorms. Average annual precipitation ranges from 8 inches in the south to 32 inches in the north.

North Lahontan Hydrologic Subregion

The North Lahontan hydrologic subregion extends south from the Oregon border approximately 270 miles to the South Lahontan region. Extending east to the Nevada border, it consists of the western edge of the Great Basin, and water in the region drains eastward toward Nevada. The subregion, corresponding to approximately the northern half of the Lahontan RWQCB, covers approximately 3.91 million acres (6,110 square miles) and includes portions of Modoc, Lassen, Sierra, Nevada, Placer, El Dorado, Alpine, Mono, and Tuolumne Counties.

South Lahontan Hydrologic Subregion

The South Lahontan hydrologic subregion in eastern California, which includes approximately 21% of the state, covers approximately 21.2 million acres (33,100 square miles). This region contains both the highest (Mount Whitney) and lowest (Death Valley) surface elevations of the contiguous United States. It is bounded on the west by the crest of

the Sierra Nevada and on the north by the watershed divide between Mono Lake and East Walker River drainages; on the east by Nevada and the south by the crest of the San Gabriel and San Bernardino mountains and the divide between watersheds draining south toward the Colorado River and those draining northward. The subregion includes all of Inyo County and parts of Mono, San Bernardino, Kern, and Los Angeles Counties.

Colorado River Hydrologic Region

The southeast portion of California comprises the Colorado River hydrologic region, which contains 12% of the state's land area at approximately 12.8 million acres (20,000 square miles). The Colorado River forms most of the region's eastern boundary except for a portion of Nevada at the northeast, and extends south to the Mexican border. The region includes all of Imperial County, approximately the eastern one-fourth of San Diego County, the eastern two-thirds of Riverside County, and the southeastern one-third of San Bernardino County. It includes a large portion of the Mojave Desert and has variable, arid desert terrain that includes many bowl-shaped valleys, broad alluvial fans, sandy washes, and hills and mountains.

This is an arid desert region with hot, dry summers, locally intense thunderstorms, and mild winters. Rainfall is limited to a few storms per year. All precipitation falls in the form of rain. This region has the lowest annual precipitation totals in the state, with some areas receiving less than 2 inches. Average annual regional rainfall region-wide rainfall is 5.5 inches. Runoff is low due to limited rainfall, but locally heavy during infrequent storm events. Overall sediment yields are low, but produce debris flows during storms.

Water Quality

As determined in the Literature Review (Appendix D), and further detailed below under the "Impact Analysis – Methodology" section, research studies, surveys, and other resource agency information have been compiled that have evaluated the water quality effects of suction dredging activities that have been conducted in the past in California and in other states. Based on the Literature Review, the major water quality constituents of potential concern associated with suction dredging activity are expected to be associated with waste discharges that occur in relation to instream resuspension of sediments and related sediment-derived contaminants. Therefore, the following section describes available and relevant information on existing regional water quality conditions that may be affected by suction dredging activity.

The water quality of surface waters and groundwater varies throughout California. Potential sources of water quality impairments include point sources (direct discharges to water bodies) and non-point sources. Pollutants from non-point sources are transported primarily via surface water runoff, but in some cases by groundwater discharge. In urban areas, typical non-point pollutant sources include city streets, parking lots, lawns, gardens, and industrial areas. Runoff from roads and parking lots carry oil and other gasoline-related contaminants, as well as trace metals such as copper and zinc. Typical pollutants in stormwater runoff from lawns and agricultural areas include pesticides, herbicides, and nutrients from fertilizers. Other non-point pollutants include trash, sediments, and pathogens. Surface waters such as rivers and streams may be affected by a large variety of pollutants, including sediments, pathogens, pesticides, trace metals, and legacy contaminants (pollutants that have been banned or replaced and are no longer supplied to

the environment in large quantities, but that remain in the environment for an extended period after deposition with little degradation) such as dichlorodiphenyltrichloroethane (DDT) and other chlorinated hydrocarbon pesticides, and polychlorinated biphenyl compounds (PCBs).

Primary water quality issues vary around the state depending on the location and type of water resources present in an area, the size and extent of the watershed and regional water resources, the location of the water body with respect to potential pollutant sources, seasonal and climatic factors, and many other interacting physical, chemical, and biological processes.

Water Quality Monitoring and Section 303(d) Listed Water Bodies

Monitoring for water quality protection purposes is conducted through a variety of federal, state, and local programs. The SWRCB conducts monitoring of surface waters through the Surface Water Ambient Monitoring Program (SWAMP). Water quality monitoring is conducted for the State Water Project (SWP) administered by the Department of Water Resources, and Central Valley Project (CVP) administered by the U.S. Bureau of Reclamation. In particular, extensive monitoring and special studies have been conducted in the Sacramento River-San Joaquin River Delta (Delta), San Francisco Bay, and surrounding tributaries over the past 30 years to manage the SWP/CVP operations and understand chemical fate and transport processes affecting these water bodies. Additionally, the U.S. Geological Survey (USGS) has conducted assessments through the National Water-Quality Assessment Program (NAWQA) of the Sacramento River, San Joaquin-Tulare, and Santa Ana Basins to understand the status of water quality trends and how natural and anthropogenic factors affect water quality.

The state evaluates current water quality conditions and prioritizes funding efforts for protection, cleanup, and monitoring programs through individual water quality assessments that are compiled into the Section 305(b) reporting process, which is mandated under the federal CWA. The most recent Section 305(b) report was prepared in 2002 and reported that of 32,536 miles of rivers/streams assessed, 27,449 miles were impaired for one or more beneficial uses. Out of 576,013 acres of lakes/reservoirs assessed, 361,128 acres were impaired for one or more beneficial uses (SWRCB, 2003).

CWA Section 303(d) lists identify water bodies that do not meet applicable water quality standards or designated beneficial uses that are subject to technology-based controls for waste discharges. Table 4.2-1 shows the number of water bodies on the 2006 statewide 303(d) list by region and pollutant type. Of the total number of listings, 2,238 require preparation of TMDLs, reflecting either a new listing since the prior 2004 list or an existing listed water body awaiting development of the TMDL. The number of TMDLs that have been prepared to date is substantially less than the actual number of 303(d) listings. The state has completed compilation of the recommended 2010 update of the Section 303(d) list of impaired water bodies in an Integrated Report (SWRCB, 2010), and EPA approval of the list is pending, at which point the state will have a fully adopted 2010 Section 303(d) list. The 2010 Integrated Report identifies that there are an additional 1,464 listings that will require TMDL development, and 195 recommended delistings. Because the 303(d) listing process is data driven, and as evidenced by the large number of new listings for 2010, it should be noted that the 303(d) listing process does not necessarily completely represent

the actual number of impaired water bodies. In particular, water bodies in rural or remote areas where there is not an active data collection program may not be represented in the listing process.

Constituents of Concern for the Proposed Program

As noted above, the Literature Review (see Appendix D) was conducted to identify potential water quality effects that suction dredging may have, to identify information gaps on water quality topics important to the assessment, and to direct the development of the assessment methodology. The following sections summarize information from the Literature Review regarding the characteristics of suction dredging activity that can lead to waste discharges from: (a) encampment activities; (b) sediment resuspension; (c) dredging discharges of sediment-associated and elemental Hg; and, (d) dredging discharges of other metals or organic compounds. A final section summarizes the key findings of the Literature Review regarding the water quality concerns of chemical constituents that may be discharged, the routes of exposure to sensitive beneficial uses of the water bodies affected, and the status of the available data (or data gaps) and level of understanding of suction dredging effects.

Contaminant Discharges from Onshore Dredge Site Encampments

Many areas where suction dredging is conducted are remote and distant from developed facilities. As such, activities associated with suction dredging may include gaining access to stream sites with motorized transportation (e.g., boats, automobiles, off-highway vehicles), establishment and occupation of temporary encampments for extended stay periods, use of fuels for suction dredges and other hazardous substances (e.g., oil for equipment maintenance, and use of chemicals for dredge material processing including primarily nitric acid and/or mercury), creation of wastewater if encampments are remotely located from campground or overnight facilities, or incidental discharges of trash or other debris. Suction dredges operate using internal combustion engines while floating on the surface of the water. Therefore, the potential exists for oil and gas leaks or spills to occur, resulting in direct discharges of these contaminants to water bodies and possible adverse water quality affects. There have been no specific technical studies that have evaluated the effects of suction dredging encampments on water quality.

TABLE 4.2-1. NUMBER OF WATER-BODIES WITH 303(d) LISTINGS (I.E., IMPAIRED WATER BODIES) FOR WATER QUALITY CONSTITUENTS, BY REGION

Pollutant Type	REGION NUMBER									
	1	2	3	4	5	6	7	8	9	Total
Hydromodification				10						10
Mercury	10	100	2	8	51	3	1	2	1	178
Other Metals		55	15	115	77	75	6	18	46	407
Miscellaneous ¹	201	13	1	28	16			2	22	283
Nuisance ²				14					11	25
Nutrients	110	27	114	104	21	254	10	20	81	741
Other Inorganics ³		4		19		5			10	38
Other Organics ⁴	2	69	12	89	10	2	17	10	12	223
Pathogens	10	48	141	122	33	45	7	30	55	491
Pesticides		99	69	177	145		18	16	18	542
Salinity	1	3	20	30	16	42	3	2	52	169

Pollutant Type	REGION NUMBER									Total
	1	2	3	4	5	6	7	8	9	
Sediment	410	20	150	23	5	85	3	15	17	728
Toxicity		3	4	32	30	1	1	7	18	96
Trash		1		37			1		3	42
Grand Total	744	442	528	808	404	512	67	122	346	3,973

¹ = Includes 303d-listed temperature, pH, and exotic species.

² = Includes odor and scum formation.

³ = Includes hydrogen sulfide, sulfates, and cyanide.

⁴ = Includes PCBs, dioxin/furan compounds, and polycyclic aromatic hydrocarbons (PAHs).

Turbidity and Total Suspended Solids

Turbidity is the optical property of a suspension that causes light to be scattered and absorbed rather than transmitted through the water column. The scattering and absorption of light is caused by: 1) water; 2) suspended particulate matter ranging in size from colloidal to coarse dispersions; and 3) dissolved chemicals. Suspended materials may include suspended sediments, finely divided organic and inorganic compounds, plankton, and other microscopic organisms. Because turbidity is primarily caused by suspended solids, these two parameters are often discussed together. Suspended solids concentration in water is quantified by filtering a known volume of water through a weighed standard glass-fiber filter, and drying the residue retained on the filter to a constant weight at 103-105°C. The total suspended solids (TSS) concentration within the sample is then reported as milligrams of dried residue per liter of water filtered (mg/L). Although the terms “suspended solids” and “turbidity” are sometimes used synonymously, the degree of turbidity is not equal to the suspended solids concentration; rather, turbidity is an expression of only one effect of suspended solids upon the character of water (i.e., the ability of light to penetrate through the water column). Because the particle size and nature (e.g., organic vs. inorganic) of the suspended solids affect the light scattering, different turbidities can be measured for waters having the same TSS concentration (McKee and Wolf, 1963).

All surface water bodies have quantifiable levels of suspended solids and turbidity. Turbidity levels of fresh waters vary greatly with location and season, with headwaters of streams and rivers generally having low turbidities (e.g., often below 5 Nephelometric Turbidity Units [NTUs]) throughout the year. Larger rivers, located at lower elevations, typically have higher turbidities (e.g., <10 to over 100 NTUs). The turbidity of water bodies increases during and following precipitation events that result in highly turbid runoff. TSS levels in natural waters seldom exceed 20,000 mg/L for more than a few days (Boyd, 1990).

Both turbidity and TSS are regulated water quality parameters in all of the state’s RWQCBs’ Basin Plans. Beneficial uses considered most sensitive to ambient levels of turbidity and TSS and/or the degree of changes in turbidity/TSS levels which may be caused by natural runoff events or manmade discharges are aquatic life and their habitats, municipal and domestic water supply, industrial water supply, and recreational/aesthetic uses. However there are no set absolute numerical turbidity or TSS objectives applicable to ambient water quality. Rather, all of the Basin Plans contain a narrative objective for TSS, generally requiring the suspended sediment load and suspended sediment discharge rate of surface waters to not be altered in such a manner as to cause nuisance or adversely affect beneficial uses. All of the state’s Basin Plans contain similar numerical turbidity objectives that limit

the allowable increase over background levels. The Basin Plan for the Central Valley Region (which includes most of the Sierra Nevada gold mining region) contains the most specific turbidity objectives in the State, as follows:

- Where natural turbidity is less than 1 NTU, controllable factors shall not cause downstream turbidity to exceed 2 NTUs;
- Where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU;
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20%;
- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs; and
- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10%.

Additionally, the Central Valley Region Basin Plan states: "In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected." Moreover, the Basin Plan provides for exceptions to the above limits for dredging operations that cause an increase in turbidity stating, "In those cases, an allowable zone of dilution within which turbidity in excess of the limits may be tolerated will be defined for the operation and prescribed in a discharge permit." The North Coast Region (which includes the Klamath-Trinity gold country) limits turbidity to no more than 20 percent above naturally occurring background levels and allows zones of dilution within which higher percentages can be tolerated for specific discharges. The turbidity objectives vary among the other Basin Plans, and not all regions include considerations for mixing zones and averaging periods.

Environmental Toxicology of Metals and Organic Compounds

Environmental toxicology is the study of environmental contaminants and the health risks to humans and wildlife (including fish and aquatic organisms) associated with various routes of exposure (e.g., ingestion, drinking water, and air). Several constituent groups are of known concern for toxicological risk to fisheries and human health in water bodies in California. These include mercury, other trace metals, and synthetic organic compounds. Mercury (Hg) is the constituent that poses the greatest toxicological risk to humans and fish and wildlife in areas where suction dredging activity might occur. Potential impacts of Hg and other heavy metals on fish and aquatic organisms are also discussed in Chapter 4.3 *Biological Resources*.

As noted in the Literature Review (Appendix D), suction dredging activities typically target the known gold-bearing streams and rivers of California where much of the historic mining activity took place after the California gold rush of 1849. Elemental (i.e., liquid) mercury was used extensively in gold mining processes and much of the mercury was discharged or wasted directly to streams and river channels, resulting in extensive areas of mercury enriched channel sediments and watershed-wide contamination with elemental mercury. Based on the Literature Review, mercury is the primary constituent of concern that occurs in aquatic sediments where suction dredging might occur under the Program. Mercury is a toxic constituent that bioaccumulates in the foodchain of aquatic organisms and terrestrial

wildlife, and is ultimately a human health concern primarily through the consumption of Hg-contaminated fish. Methylmercury (MeHg) is a more bioavailable form of Hg that is produced from inorganic Hg by specific types of aquatic bacteria in rivers and reservoirs. This section briefly discusses available information regarding the extent of mercury contamination and related concerns pertaining to bioaccumulation in the food chain, which is the primary concern for Hg contamination in water bodies.

The major pathway for human and wildlife exposure to methylmercury (MeHg) is consumption of Hg-contaminated fish. Dietary MeHg is almost completely absorbed into the blood and is distributed to all tissues including the brain. In pregnant women, it also readily passes through the placenta to the fetus and fetal brain. MeHg is a highly toxic substance with a number of adverse health effects associated with its exposure in humans and animals. High-dose human exposure results in mental retardation, cerebral palsy, deafness, blindness, and dysarthria in utero and in sensory and motor impairment in adults. Although developmental neurotoxicity is currently considered the most sensitive health endpoint, data on cardiovascular and immunological effects are beginning to be reported and provide more evidence for toxicity from low-dose MeHg exposure (U.S. EPA, 2001). In birds and mammalian wildlife, high levels of MeHg can result in death, reduced reproduction, slower growth and development, and abnormal behavior (U.S. EPA, 2010).

Criteria and screening values have been developed for the protection of human health and fish-eating wildlife for Hg in fish tissue and unfiltered water-column 30-day Hg concentrations. A selection of the most relevant criteria is shown in Table 4.2-2.

Table 4.2-3 shows those water bodies in California for which the state Office of Environmental Health Hazard Assessment (OEHHA) fish tissue advisories have been issued for Hg in areas where the Hg contamination is associated with historic gold mining. Also shown are the species with the highest mean tissue concentration, what that concentration is, and the number of samples used to calculate the mean. Water bodies with Hg levels that are primarily a result of historic Hg mines or industrial sources (such as Clear Lake and San Francisco Bay area reservoirs) are not shown. All water bodies shown in the table are within the Central Valley Hydrologic Region (Region 5) or the North Coast Hydrologic Region (Region 1). However, some water bodies in the San Gabriel Mountains exhibit sufficient recent fish tissue Hg data to qualify for advisories, for example, Pyramid Lake, Lake Piru, Castaic Lake, and Lake Hansen within the South Coast Hydrologic Region (Davis et al., 2009).

Other Trace Metals and Organic Compounds

Other natural or human-generated contaminants such as trace metals or synthetic organic compounds (e.g., pesticides) may be present in the sediments where suction dredging activities typically occur. Other trace metals that may be present in California water bodies include, but are not limited to, arsenic, copper, silver, zinc, lead, chromium, nickel, antimony, cadmium, and selenium. Release of these metals is dependent on many factors, including levels present in sediment, which are variable from stream to stream and between reaches of a single stream. Little data is available to comprehensively characterize concentrations of these constituents in California rivers and streams.

TABLE 4.2-2. MERCURY CRITERIA IN FISH TISSUE AND WATER FOR PROTECTION OF HUMAN HEALTH AND WILDLIFE

Medium	Basis	Target Population	Criterion (mg/kg)	Reference Dose, µg/kg/d	Body Wt, kg	Consumption Rate, kg/day	Reference
Fish-tissue	Human Health	US General Population mean	0.3	0.1	70	0.0175	U.S. EPA, 2001
		California General Population mean	0.17	0.1	70	0.0305	U.S. EPA, 2001; Office of Environmental Health Hazard Assessment (OEHHA), 2001
		California 95th percentile	0.06	0.1	70	0.0852	USEPA, 2001; OEHHA, 2001
		California Sensitive Populations [Fish Contaminant Goal]	0.22	0.1	70	0.032	OEHHA, 2008
	Wildlife	Mammalian	0.1	18	*	*	U.S. EPA, 1995; Yeardley, 1998
		Avian	0.02	21	*	*	USEPA, 1995; Yeardley, 1998
Water (unfiltered)		Human	1.8 nanograms per liter (ng/L)				U.S. EPA, 1995
		Fish-eating Wildlife	1.3 ng/L				U.S. EPA, 1995

**=Mammalian criterion based on geometric mean of criteria for mink and river otter, whose body weights are 0.6 and 6.7 kilograms (kg), respectively, and consumption rates are 0.14 and 1.124 kg/day, respectively. Avian criterion based on geometric mean of criteria for Bald Eagle, Osprey, and Belted Kingfisher, whose body weights are 5.25, 1.75, and 0.15 kg, respectively, and whose consumption rates are 0.566, 0.350, and 0.068 kg, respectively.*

TABLE 4.2-3. WATER BODIES IN CALIFORNIA WHERE OEHHHA CONSUMPTION ADVISORIES HAVE BEEN ISSUED FOR MERCURY IN ASSOCIATION WITH HISTORIC GOLD MINING

Water Body	Species with Highest Mean Tissue Concentration (n >= 6)	Highest Species Mean Tissue Concentration (mg/kg, wet weight) ¹	N ²	Region
Lower Feather River	Striped Bass	1.27	6	5
Englebright Lake	Bass	0.45	56	5
Camp Far West Reservoir	Largemouth and Spotted Bass	0.85	38	5
Lake Combie	Largemouth Bass	0.9	19	5
Rollins Reservoir	Channel Catfish	0.36	13	5
Lower American River	Largemouth Bass	0.81	48	5
Lake Natoma	Channel Catfish	1.474	11	5
Lake Folsom	Spotted Bass	0.71	16	5
Cosumnes River	Crappie	1.38	11	5
Lower Mokelumne River	Pikeminnow	0.82	11	5
Lower Sacramento River and North Delta	Smallmouth Bass	0.86	13	5
Central and South Delta	Largemouth Bass	0.3	369	5
Trinity River Watershed	Largemouth Bass	0.55	24	1

¹ OEHHHA fish tissue concentration thresholds for establishing fish consumption advisories vary from 0.06-0.22 milligrams per kilogram (mg/kg) depending on exposure routes and affected population of concern.

² N = number of samples of all fish species monitored and assessed.

Legacy chlorinated hydrocarbon pesticides (e.g., dieldrin, DDT, and chlordane) and PCBs can be transported to remote or high altitude waterways by atmospheric deposition. Legacy pesticides are rarely above public health thresholds in fish in upper watershed streams and lakes. PCBs have been found above threshold values in fish from lakes primarily in lowland areas of the state (Davis et al., 2009). PCB concentrations were uniformly below threshold values in fish from high elevation lakes of the Sierra Nevada and northern California mountains (Davis et al., 2009).

4.2.4 Impact Analysis

The methodology described below accounts for activities conducted in accordance with the proposed regulations contained in Chapter 2. Additional or more extensive impacts related to water quality may result for those suction dredge activities requiring notification under Fish and Game Code section 1602. Notification is required for the following activities:

- Use of gas or electric powered winches for the movement of instream boulders or wood to facilitate suction dredge activities;
- Temporary or permanent flow diversions, impoundments, or dams constructed for the purposes of facilitating suction dredge activities;

- Suction dredging within lakes; and
- Use of a dredge with an intake nozzle greater than 4 inches in diameter.

A general description of how such activities requiring Fish and Game Code section 1602 notification would deviate from the impact findings are described at the end of the impact section below.

Findings of 1994 Environmental Impact Report

The water quality impacts analyzed in the 1994 EIR analyzed included impacts resulting from accidental spills, turbidity, and heavy metals. Findings for each of these issues were as follows:

Accidental Spills

The 1994 EIR found that effects on water quality as a result of accidental oil or gas spills from the engine component of the dredges are less-than-significant. Although the regulations do not specifically address water quality issues except as they relate to fish, the 1994 EIR notes that suction dredgers are required to comply with Fish and Game Code 5650 which prohibits the deposition of petroleum or other materials deleterious to fish and wildlife into state waters.

Turbidity

The 1994 EIR found that suction dredge mining would have a less-than-significant impact on water quality related to temporary increased turbidity levels caused by the resuspension of stream bed sediments.

Heavy Metals

The 1994 EIR found that suction dredge mining would have a less-than-significant impact on water quality as it relates to mercury present in streams. At the time of the 1994 Report, adverse effects related to mercury were cited as being those associated with re-release of mercury after capture in the dredging equipment. The report noted that Fish and Game Code 5650 addresses pollution of this nature.

In addition, the 1994 Report found that suction dredging would have a beneficial impact related to the capture and removal of lead from waterways, which would help to keep lead from entering the foodchain (i.e., primarily waterfowl).

Methodology

The following sections describe: (a) a summary of the Literature Review (see Appendix D) that provided the focus for this Water Quality and Toxicology assessment; (b) screening of potential constituents of concern to be assessed in detail; and, (c) the methodologies used to assess the effects of suction dredging activity that might occur through implementation of the Program.

Literature Review of Water Quality Effects of Suction Dredging

The major findings of the Literature Review (Appendix D) related to water quality and toxicology that were used, in part, to inform and direct the focus of the water quality impact assessments are as follows.

- There is little information available regarding the environmental effects of dredge site development such as site access, land-side encampments, and fuel/chemical spills. There remains a lack of any rigorous studies on this subject.
- All scientific studies to date suggest that the effects of suction dredging on turbidity and suspended sediment concentrations as it relates to water clarity are limited to the area immediately downstream of the dredging for the duration of active dredging.
- The effects of Hg contamination from historic activities in California are being extensively studied and there is substantial literature regarding Hg fate and transport. However, there are very few published studies specifically addressing the effects of suction dredging on Hg fate and transport processes. Since the time the Literature Review (Appendix D) was prepared, USGS scientists and Hg experts provided CDFG with preliminary results of their recent research in the Yuba River which is specifically focused on assessing the potential discharge of elemental Hg and Hg enriched suspended sediment from suction dredging activities. This new information and data from USGS was used in formulating the approach to this assessment of the Program. Ongoing studies are evaluating the relative magnitude of dredging-related effects on Hg discharges compared to other causes.
- The human and aquatic toxicity of Hg discharged from suction dredging operations has not been studied. Studies have shown that remobilized Hg can be converted to MeHg, which can bioaccumulate up the food chain, and is therefore of concern to biota and human health through fish and shellfish consumption. Mercury hotspots (i.e., places where large amounts of Hg are concentrated) are known to exist but there has been no concerted effort to locate them. Fine particles (<63 µm) in sediment in historic gold mining regions have been shown to contain at least an order of magnitude higher concentration of Hg than larger size fractions. The suspended particle size fractions that are enriched in Hg and discharged from suction dredges is under investigation by USGS in the Yuba River system described above. The reactivity and speciation of mercury-enriched sediment resuspended by dredging operations is also under investigation. The transport, reactivity, and speciation of “floured” Hg (i.e., microscopic-size particles of elemental Hg created by the physical agitation and fractionation of larger particles) has not been studied. Dissolved Hg, elemental Hg, and fine particle/colloid bound Hg may be of concern for methylation (i.e., conversion to methyl mercury, which is a bioavailable form that can result in toxic effects and bioaccumulation up the food chain) in the vicinity of dredge sites if conditions are favorable or transported long distances to downstream environments (e.g., reservoirs, wetlands) favorable to methylation. Therefore, potential impacts may occur both near and away from the actual dredging locations.

- There is very little information available on the potential operations-related effects of dredging to discharges of other constituents that might reasonably be present in sediment and discharged to the water when disturbed by suction dredging activity (e.g., trace metals, organic compounds, and nutrients) or otherwise be affected by physical changes in the environment (e.g., water temperature and dissolved oxygen concentrations). Other metals that may be discharged during suction dredging include arsenic, copper, silver, zinc, lead, chromium, nickel, antimony, cadmium, and selenium, but the distribution of metals on different particle sizes, transport of released metals, biotic uptake, etc., have not been studied. Similarly, there have been no studies undertaken to determine whether suction dredging releases legacy pesticides and, if so, what the fate, transport, and effects of the chemicals are downstream.

Screening of Constituents for Assessment Purposes

Results of the Literature Review as summarized above, and in detail in Appendix D, were used to determine constituents requiring further detailed assessment and whether the impact assessment for a given water quality constituent would be qualitative (e.g., contaminants from dredge site development and use, due to the lack of quantitative information available), semi-quantitative (e.g., Hg, due to the availability of some quantitative information), or fully quantitative. Furthermore, results of the Literature Review showed that Hg was the constituent for which the assessment would be most complex.

Constituents of Concern Raised in Public Review Comments

Comments were received that indicated a concern for the effects of suction dredging on water temperature and effects of blue-green algae on suction dredgers themselves. As previously noted, the literature review provided a primary basis of information for identifying constituents of concern to be addressed by the water quality impact assessment. However, no scientific literature was identified that indicated temperature or nuisance blue-green algae were constituents of concern for suction dredging activity. Because data are lacking with respect to the effects of dredging-related turbidity and suspended sediment on water temperature, the assessment relies on scientific principles, facts, assumptions based on facts, and professional judgment.

With respect to the effects of blue-green algae (i.e., cyanobacteria) on suction dredgers, the exposure of dredging operators to nuisance blue-green algae blooms would be a risk incurred by the operators. Many blue-green algal species, when present at high enough population levels (i.e., known as blooms) and in concert with other factors (e.g., warm weather and water temperatures, sufficient light and algal nutrients), have the potential to produce specific intercellular toxins which can cause a variety of health effects to humans and animals (SWRCB, 2008). The potential health effects can be associated with skin contact (e.g., rashes, eye irritation), ingestion (e.g., gastrointestinal illness, liver damage), or inhalation exposure routes. Blue-green blooms that reach levels where presence of cyanotoxin production could produce health effects are typically associated with calm or stagnant water conditions (e.g., lakes, ponds) and do not usually attain high population densities in highly flushed environments with retention times (i.e. the time it takes for the water volume to be exchanged once) of less than 5-10 days, or in the open channels of flowing rivers (SWRCB, 2008). The risks to dredging operators from potential exposure to

blue-green algae blooms and cyanotoxins, which are a background condition that might occur where dredging is conducted, is not a responsibility of the state. Moreover, CDFG's adoption of dredging regulations under the Program would not in itself affect the allowable dredging activity such that exposure of operators to cyanotoxins would be higher than without the Program. In fact, the Program generally prohibits dredging activity in lakes and reservoirs without specific approval from CDFG and applicable RWQCB, and thus would limit potential exposure in these quiescent water bodies where blue-green algae blooms are more likely to occur. Therefore, because the Program would not adversely affect the exposure of operators to existing or potential future blue-green algae cyanotoxins, this issue is not addressed further in this assessment.

Assessment Methods for Effects of Dredge Site Development and Use

As noted in the Literature Review, there is very little new data available since the preparation of the 1994 EIR, and no substantial changes in the scientific understanding of the effects from development and operations of encampments used for suction dredging operations. Previous suction dredging activity in California permitted through CDFG's former permit system did not include formal record keeping, monitoring, or inspection protocols. Therefore, there is no specific information available regarding the distribution or location of dredging activities associated with the permits that were issued in previous years. There also is no available information maintained on any enforcement actions under the previous permit system. The Suction Dredger Survey conducted by CDFG as part of this EIR provides some level of information on the level of suction dredging activity, locations, frequency, and methods used in 2008. The representativeness of survey information used in the impact assessment was considered, as it is likely that there is no consistent and comprehensive information available. Due to the lack of specific and quantitative information, the assessment of effects from encampments on water quality is necessarily qualitative. The assessment of potential effects associated with encampment activities is qualitative and based on the Literature Review and knowledge of potential waste discharges, applicable existing regulations and terms and conditions of the Program that would serve to limit pollutant discharges, and considers dredging equipment features and practices that would be expected to influence the magnitude of potential adverse effects on water quality.

Assessment Methods for Effects of Dredging-Related Increases in Turbidity/TSS

As noted in the Literature Review, there is very little new dredging-specific data available since the preparation of the 1994 EIR, and no substantial changes in the scientific understanding of the effects of increased turbidity/TSS from suction dredging operations with respect to water clarity. The impact assessment is based on the location, frequency, duration, and size of discharge plumes, and characterization of turbidity/TSS levels within suction dredger plumes, that are anticipated to occur downstream of the dredging site based on the available literature. Prior literature studies regarding the effects of dredging activity on sediment disturbance and related effects to turbidity/TSS discharges have addressed a relatively wide range of environmental conditions. However, as the scope of any individual such study was typically project-specific, or addressed a limited set of variables (e.g., location, equipment, monitoring parameters), the available data likely does not address every possible combination of variables in which turbidity/TSS discharges may occur. Consequently, the assessment of effects of turbidity/TSS on beneficial uses necessarily involves qualitative analysis based on best professional judgment of the

scientific evidence. The turbidity/TSS levels created by suction dredging activities were compared to regulatory objectives and to tolerances of fish and aquatic organisms, and other applicable thresholds considered protective of beneficial uses. Recreational activity (e.g., swimming, boating) and visual resources may be affected by water clarity and specific turbidity/TSS discharge conditions associated with suction dredging. The “Aesthetics” and “Recreation” chapters have additional information regarding the potential effects that suction dredging activity may have on these resources. In assessing the potential effects and magnitude of turbidity/TSS caused by dredging activities, the dispersion and attenuation of the dredging plume that occurs downstream of dredging was considered.

Assessment Methods for Effects of Dredging-Related Mercury Discharges

A methodology was developed to address whether suction dredging causes water quality conditions that would exceed thresholds of significance. A conceptual model, described below, was developed to examine the discharge, transport, transformation and bioaccumulation of Hg in aquatic organisms from suction dredging and background watershed sources and the potential for environmental effects of Hg resuspension and discharge from suction dredging operations. Potential toxicological risks of Hg to higher trophic levels in the wildlife food chain are also discussed in Chapter 4.3 *Biological Resources*.

Geographic Assessment

Where high sediment Hg levels and suction dredging occur in the same areas, the resuspension of sediment-associated Hg may have the potential to increase the bioaccumulation of Hg in wildlife (including fish and aquatic organisms), and thereby result in increased human health risks to people and wildlife that eat these organisms. Suction dredgers were not required to report their dredging locations under CDFG’s previous suction dredging permit system, so it is not possible to document exactly where in the state suction dredging occurred and how frequently it occurred at various locations. CDFG’s Suction Dredger Survey of 2008 permit holders indicates that most dredging activity occurred in the central Sierra Nevada Mountain counties, with lesser amounts in the known gold-bearing areas of Shasta and Trinity counties and several southern California counties. Given that gold still occurs in watersheds in historic gold mining areas, the spatial distribution of historic gold mining districts and mines themselves can be used to identify watersheds where suction dredging would resume upon implementation of the Program. Moreover, Hg was used in large quantities at historic gold mines and was discharged with mine waste (hydraulic mining debris, mill tailings, and dredge spoils from dragline and bucket-line dredging) into nearby watersheds. Consequently, suspended sediment enriched in Hg and elemental Hg can be found in these watersheds. A number of TMDLs have been developed or are being developed in California for mercury. Of most relevance to suction dredging are the American River Mercury TMDL (in development), Sacramento-San Joaquin Delta Methylmercury TMDL (in development), and San Francisco Bay Mercury TMDL (adopted). Because watersheds draining into these areas also contain gold and gold bound with Hg, they are targeted by suction dredgers.

Three regions where the assessment focused are based on anecdotal evidence of where suction dredging occurs and where gold has been historically located. These are the Sierra Nevada, the Klamath-Trinity Mountains, and the San Gabriel Mountains (Figure 4.2-2). Researchers from USGS have collected sediment Hg data in the Trinity River system, but at

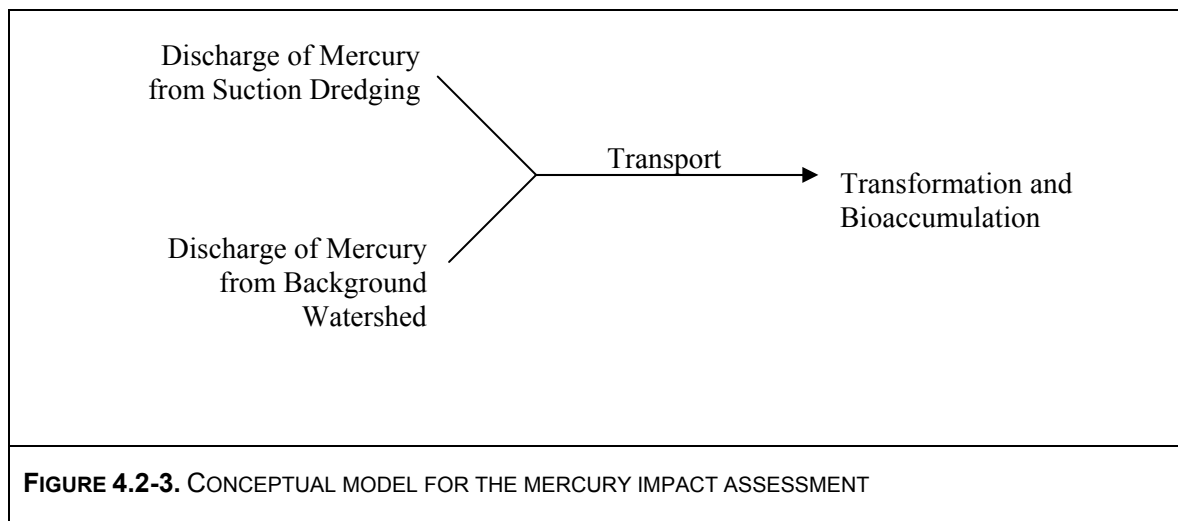


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the time of this writing, these data were not available for analysis. Little data exists in the rest of the Klamath-Trinity and San Gabriel mountains. For the purposes of the detailed quantitative assessment, the focus will be on the Sierra Nevada, and the South Yuba River will be used as a representative of Sierra Nevada streams and rivers due to the relatively large number of studies and amount of data available for this river. Assessments were accomplished for the following locations: 1) in-stream, 2) Englebright Lake, the first reservoir downstream, and 3) the San Francisco-San Joaquin River Delta. There are several reasons why such an assessment provides a good surrogate for all Sierra Nevada streams. Most Sierra Nevada streams possess similar geology, experience similar climate and rainfall, were located near extensive gold-mining operations, have at least one reservoir before joining the Sacramento or San Joaquin Rivers (with the exception of the Cosumnes River), and eventually drain into the Delta. The South Yuba River watershed experienced the most intensive level of hydraulic mining, in which mercury-contaminated hydraulic mining debris was produced and discharged into the watershed. When normalized by watershed area, it still received the greatest volume of hydraulic mining sediment production, but was only slightly above its smaller neighbors Deer Creek, the Bear River, and the similarly sized North Fork of the American River (James, 1999). Methodology for translating results of the assessment to other water-bodies and geographical regions is discussed in the section "Geographic Translation."

Conceptual Model and Quantitative Assessment Approach

The assessment of suction dredging-related effects on the potential for Hg discharge, transport, and contribution to fish uptake and bioaccumulation involved conducting quantitative discharge, transport, and fate calculations based primarily on recent field sediment and special study data collected by the USGS. A conceptual model was developed to frame the assessment. The model consists of four elements: 1) discharge of Hg to the stream from suction dredging; 2) discharge of Hg from background watershed sources; 3) transport of discharged Hg; and, 4) transformation/bioaccumulation of Hg. The elements of the conceptual model are shown in Figure 4.2-3. The elements of the model do not necessarily occur sequentially or at the same time. Transformation and bioaccumulation can occur simultaneously with transport and discharge. The specific assessment approach for each element is detailed in the impact assessment discussion.



Briefly, discharge of Hg from suction dredging was based primarily on field characterization of Hg contaminated sediments (Fleck et al., 2011). Background watershed Hg loading estimates were utilized to compare to suction dredge discharge estimates (Alpers et al., in prep). Transport of Hg associated with sediments was based on particle size distribution characterization of suspended sediments (Curtis et al., 2006) and assessment of net deposition in Englebright Lake (Alpers et al., in prep; Alpers et al., 2006). Transformation and bioaccumulation characteristics were derived from a variety of literature sources. Additional information characterizing potential impacts of elemental Hg was also used in the assessment.

Other Trace Metals

As noted in the Literature Review (Appendix D), there are very little data regarding the effects of suction dredging on trace metals mobilization. Due to the limited quantitative information, the water quality impact assessment for trace metals is largely qualitative and based on the anticipated level and nature of dredging activity that is projected to occur. Results of the Literature Review were used to characterize existing measurements of trace metals in suction dredge plumes. Measured sediment concentrations of arsenic, copper, silver, zinc, lead, chromium, nickel, and cadmium were combined with different TSS levels to characterize the potential to increase receiving water metals concentrations above aquatic life criteria. The frequency, magnitude, and size of discharge plumes were assessed relative to dilution and near field settling.

Organic Chemicals

As noted in the Literature Review (Appendix D), there is very little data regarding the effects of suction dredging on synthetic organic compounds mobilization. Moreover, there is no comprehensive information regarding presence of organic compounds in aquatic sediments in the areas of California where suction dredging is likely to occur. Unlike Hg or any other metals present as a result of natural ore, there is little reason to suspect that significant numbers of hot-spots exist containing synthetic organic compounds, or that their magnitude relative to average background levels is very great. Due to the lack of specific and quantitative information, the water quality impact assessment for organic compounds is necessarily qualitative to characterize the potential to cause receiving water concentrations to exceed applicable criteria.

Criteria for Determining Significance

For the purposes of this analysis, the Proposed Program would result in a significant impact if it would:

- Increase levels of any priority pollutant or other regulated water quality parameter in a water body such that the water body would be expected to exceed state or federal numeric or narrative water quality criteria, or other relevant effect thresholds identified for this assessment, by frequency, magnitude, and geographic extent that would result in adverse effects on one or more beneficial uses.
- Result in substantial, long-term degradation of existing water quality that would cause substantial adverse effects to one or more beneficial uses of a water body.

- Increase levels of any bioaccumulative pollutant in a water body by frequency and magnitude such that body burdens in populations of aquatic organisms would be expected to measurably increase, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming these organisms.

4.2.5 Environmental Impacts

Impact WQ-1. Effects of Contaminant Discharges from Dredge Site Development and Use (Less than Significant)

Persons conducting suction dredging may develop encampments near the locations where they are mining for short to extended periods of time. Development of camps on undeveloped lands, certain camping activities, and mining activities that occur within the camps have the potential to result in the additional discharges of wastes to water bodies, relative to baseline conditions. Encampment activities considered to have the potential to cause adverse water quality effects include development of access roads/trails, campsite development, and travel to and from the site. Development of new campsites at previously undisturbed locations, or establishing undeveloped campsites each year on private or public lands, may include disturbance or clearing of native vegetation and soils that could result in additional runoff and soil erosion during rain events, thus contributing to turbidity and suspended solids levels in surface water bodies. Miscellaneous camping activities include cooking, cleaning, pets, sanitary practices, and garbage disposal that, if not properly managed or occurring too close to water, can result in direct discharges of wastes into water bodies. Contaminants associated with these miscellaneous activities include organic matter, pathogens from fecal wastes, oil and grease, or synthetic chemicals in cleaning products. Activities related to mining include ore processing with chemicals such as nitric acid and general equipment maintenance, fuel storage, and fueling operations. Accidental spills of fuel or chemicals pose the greatest risk of contaminant discharges to the soil and water bodies. The most likely contaminants that could enter water bodies from different waste discharges associated with dredger encampments include sediment from land disturbances, decomposable organic matter, trash, inorganic chemicals [e.g., salts, nitrogen, and phosphorus], or pathogens, which are all generally non-toxic and are not bioaccumulative in organisms. Wastes in accidental spills may include oils, solvents, or other household products which may contain priority pollutants regulated under CTR criteria such as trace metals (e.g., copper, zinc) or synthetic organic compounds, which are capable of causing toxic effects. In general, the beneficial uses of water most likely to be affected by the contaminants potentially discharged by camping activities are aquatic life from the potential toxicity posed by compounds, and contact recreation and drinking water from contaminants that cause adverse human health problems when ingested (e.g., pathogens).

In general, it is anticipated that the types of encampment activities used by dredgers would depend on the presence of nearby facilities (e.g., restrooms, showers), environmental conditions, personal requirements, access, and expected duration of stay. Larger public park areas and private mining clubs often offer campgrounds and lodging facilities. Mining clubs also may try to limit the quantity of fuels brought in to campsites and recommend clearing of trash prior to departure. The more heavily used camping areas typically also provide chemical toilets and basic shower facilities. And, in addition to RV's and campers equipped with restroom facilities, personal port-a-potties and storage tanks are commonly

1 used by those who do not have easy access to existing facilities. Camping activities in
2 developed private or public campgrounds are considered to provide sufficient features such
3 as waste disposal and sanitary sewage systems that water resources would generally be
4 protected from contamination by wastes.

5 CDFG does not monitor or record the type or amount of camping activities of those that
6 have obtained dredging permits in the past. The results of the Suction Dredger Survey
7 conducted by CDFG for this EIR included questions requesting information on the locations
8 of dredging activity, types and amount of camping activities, and amount of off-road vehicle
9 travel that occurred in the 2008 dredging season, which may provide some indication of the
10 typical level of remote camping activity that occurs relative to the amount that occurs in
11 developed areas or not involving camping activities. The Suction Dredger Survey results of
12 in-state permit holders indicate that camping was the preferred option when dredging
13 involved an overnight stay with stays at hotels/motels or with friends/family being much
14 less frequent. Approximately 54% of the in-state permit holders reported camping in
15 undeveloped campgrounds at least once, and 44% used developed campsites at least once.
16 Compared to resident permit holders, a higher percentage of out-of-state permit holders
17 stay overnight when dredging but the percentage of use for undeveloped campsites (54%)
18 and developed campsite use (51%) is similar to resident permit holders. In general,
19 although not fully quantified, the survey data indicate that the number of new encampments
20 in previously undeveloped areas each year by recreational dredging activities is likely to be
21 small. This is because suction dredgers reoccupy campsites in undeveloped area, and use
22 developed facilities or self-contained recreational vehicles when possible. Encampments at
23 undeveloped sites are also likely to be relatively dispersed.

24 No studies were found that evaluated problematic waste discharges at campsites used by
25 suction dredgers. However, Department wardens have observed camps strewn with
26 household garbage, industrial waste, large gas barrels, dilapidated vehicles, and human
27 waste in the past (CDFG, 1994; Sierra Fund, 1999).

28 The Program itself does not address encampments, since such encampments are outside of
29 the statutory authority granted to CDFG under Fish and Game Code Section 5653. However,
30 existing federal land use regulations of the USFS and BLM regarding waste disposal and
31 road construction methods exist to prevent erosion and drainage problems. Fish and Game
32 Code sections 5650-5652 prohibit the discharge of petroleum products and (any substance
33 or material deleterious to fish, plant life, mammals, or birds) and trash to waters of the
34 state. Similar requirements generally apply to camping activities on other public or private
35 lands. In addition, tips on keeping sanitary camps and guidance on proper waste control
36 and disposal will be included in the "Best Management Practices" pamphlet, described in
37 Chapter 2. Thus, existing federal, state and local regulations provide enforceable conditions
38 for which CDFG and other local, state, or federal law enforcement officers can act to stop
39 activities that may result in waste discharges from encampments.

40 Suction dredging encampments have the potential to result in waste discharges not
41 occurring under the existing conditions. However, based on the limited amount of
42 information available, suction dredging encampments are not anticipated to cause
43 substantial erosion, runoff, or discharges of wastes and contaminants.. In particular,
44 undeveloped encampment activities for dredging are typically dispersed and along streams
45 in primarily rural areas of the state, and conducted on a seasonal and temporary basis.

Thus, implementation of the Program would not be anticipated to result in contaminant discharges that would be of sufficient magnitude, frequency, or geographic extent to adversely affect beneficial uses. Additionally, because of the seasonal, temporary, and intermittent character of most dredging activity, any water quality degradation that may occur is expected to be infrequent and dispersed and thus would not cause substantial or long-term degradation of water quality. Finally, development and use of encampments for suction dredging activities could result in the discharge of bioaccumulative constituents but the levels or frequencies would be too small to increase body burdens in aquatic organisms, or increase the health risks to wildlife (including fish and aquatic organisms) or humans consuming these organisms. Therefore, this impact is considered to be less than significant.

Impact WQ-2: Effects of Contaminant Discharges of Oil or Gasoline Used in Suction Dredges (Less than Significant)

Suction dredging operations subject to the Program are generally powered with a dredge-mounted gasoline engine. The size of motors used for dredging machines typically ranges from about 2 to 50 horsepower, depending on the nozzle size, which controls the rate and volume of sediment that can be moved in a period of time. Depending on the duration of dredging activity during a day, engines must be refueled and engine oil may need to be added or changed. Refueling and servicing of dredge motors, if not conducted responsibly, has the potential to result in accidental spills and discharges of fuel and oil to water or soil, where it may remain to be transported offsite by rainfall and runoff, or directly into water bodies. Additionally, engine refueling is often done with the dredge at the dredging location, and dredge engines are not generally fitted with spill-catching equipment.

In general, the beneficial uses of water most likely to be affected by discharges of petroleum-based products are aquatic life and drinking water. Petroleum-based products contain numerous hydrocarbon compounds known to be toxic to aquatic life, and in particular the class of compounds identified as polycyclic aromatic hydrocarbons (PAHs) which can be toxic at low concentrations. Oil products discharged to water also can create thin sheens on the water surface which can restrict the passage of gases between the atmosphere and water (e.g., dissolved oxygen [DO], carbon dioxide), thereby potentially resulting in lower DO levels available to aquatic organisms. Oils also can foul stream bank sediments thereby adversely affecting the habitat of aquatic insects. Petroleum-based contaminants can also impart undesirable tastes and odors in drinking water supplies, negatively affect recreational/aesthetic uses, and pose health risks to humans if present in drinking water supplies for extended periods of time.

As noted above, CDFG does not have records of inspection or enforcement activities regarding the activities of past suction dredger permit holders. While many suction dredgers likely adhere to basic rules of responsible behavior, there have been observations by Department wardens of unkempt encampments containing gas barrels and dilapidated vehicles (CDFG, 1994; Sierra Fund, 2009). This could indicate that there may be incidences of petroleum-based product discharges and runoff from campsite activities. To address the encampment issue, the proposed Program's requirements and guidance for encampments will be provided in the "Best Management Practices" pamphlet. Additionally, the amount of fuel and oil spilled each year into surface water caused by recreational dredging activities would be anticipated to be relatively small based on the size of dredging motors, total

number of dredges anticipated to operate under the Program, and low probability that any individual dredger would cause substantial fuel or oil spills while refueling.

The regulations under the Proposed Program include the requirement to take appropriate precautions for fuel storage and dredge refueling operations, which are expected to limit the risk of accidental spills and discharges of contaminants to water bodies. Additionally, existing Fish and Game Section 5650 regulations restrict the allowable fuel handling procedures. CDFG will also provide guidance to permit holders related to appropriate spill control and response measures in the event of fuel or oil spills, or if leaks are detected. Such guidance will be incorporated into the "Best Management Practices" document. Thus, the Program and existing state regulations provide enforceable conditions for which CDFG and other local, state, or federal law enforcement officers can act to stop activities that may result in fuel/oil spills or discharges or that are inconsistent with the Program.

Based on this assessment, the Program would result in limited potential for substantial discharges of petroleum-based products. Based on the dispersed and temporary character of dredging activities, and restrictions under the Program included for the purpose of limiting accidental spills of petroleum products, it is anticipated that the potential for substantial quantities or frequent discharges of contaminants to water bodies would be limited. Thus, implementation of the Program would not be anticipated to result in contaminant discharges that would be of sufficient magnitude, frequency, and geographic extent to adversely affect beneficial uses. Because dredging activities are largely conducted on a seasonal, temporary, and intermittent basis in California, any near-term water quality degradation that may occur is expected to be dispersed. Finally, while potential discharges of petroleum products in associated with dredging activities could result in the discharge of bioaccumulative constituents, the levels or frequency would be too small to measurably increase body burdens in aquatic organisms, or increase the health risks to wildlife (including fish and aquatic organisms) or humans consuming these organisms. Therefore, this impact is considered to be less than significant.

Impact WQ-3. Effects of Turbidity/TSS Discharges from Suction Dredging (Less than Significant)

Resuspension of coarse and fine sediments into the water column by suction dredging activity is a function of several factors, which primarily include: (a) sediment substrate characteristics; (b) dredge motor horsepower and capacity for intake of material, which is dictated by the diameter of the intake nozzle and hose; (c) specific methods, rate of dredging, and skill of the dredge operator; and, (d) river conditions and streamflow characteristics (i.e., depth, velocity, and hydraulic factors). Sediment resuspension from suction dredging activity can increase water turbidity and TSS levels immediately downstream of the dredging site (i.e., near-field effects) and increase the transport of fine, colloidal material extended distances downstream (i.e., far-field effects) or otherwise contribute to additional sediment transport via exposure of deposited dredge material to later transport by higher-energy streamflow events than were present at the time the dredge material was deposited.

As determined in the Literature Review (Appendix D), the available scientific studies of suction dredging suggest that the effects on turbidity and suspended sediment concentrations on aspects of water clarity and physical effects to aquatic organisms are

limited to the area immediately downstream of the dredging for the duration of active dredging. It should be noted that the far-field transport of finer suspended sediment for greater distances downstream of dredging activity is generally considered to be a small fraction of the mass of material disturbed in the near-field dredging plume, and is not associated with visible water clarity or physical effects to organisms. However, it also should be noted that the finer suspended sediment transported long distances downstream may provide a disproportionately higher amount of surface area and binding sites for other water quality contaminants (e.g., mercury, organic compounds) that also are important to beneficial uses. The effects of far-field transport of other contaminants associated with suspended sediment is addressed further below in the impact assessments for mercury, metals, and organic compounds.

Generally, suction dredging causes turbidities of between 15 and 50 NTUs immediately downstream of the operation, with background levels returning between 50 and 160 meters downstream, and in some cases in as short as 11 meters (Harvey, 1986; Somer and Hassler, 1992; Thomas, 1985; Griffith and Andrews, 1981; Stern, 1988; Prussian et al., 1999). Among the available studies, the maximum reported TSS concentrations were up to 300-340 milligrams per liter (mg/L) immediately downstream of the dredge, decreasing to background levels within 160 meters (Thomas, 1985). Turbidity and suspended sediment levels were measured at 2 to 3 times higher than background levels at 50 meters downstream from dredging operations (Stern, 1988). Studies of large suction dredges (i.e., 8-10 inch) in Alaska indicated that turbidity plumes could be detected up to 320 meters downstream (Prussian, et. al., 1999). In one case, a turbidity plume was said to extend "well over a mile," but turbidity levels from this plume were "within limits" (USFS, 1996). The extent of the turbidity plume is influenced by the composition of the streambed; dredging in streams with higher proportions of fine materials will generate a more extensive turbidity plume (Harvey et al., 1982; Harvey, 1986). Also, observations of large dredges and many dredges in a water course suggest that turbidity increases can be large.

The assessment of potential effects of dredging-related disturbance on in-water concentrations of turbidity/TSS is based on the results of previous studies described above and on the known rate and intensity of the activities that would be anticipated to occur in California under the Program. Based on historical experience under CDFG's previous suction dredging regulations, dredging activity generally occurs only during the warmer, non-winter months. Dredging activity also is widely dispersed across the gold-bearing regions and streams in the state. CDFG's 1993 survey of the dredger community found that in-water suction dredging effort on the part of dredge operators averaged about 5 hours per day and 225 hours per year. Based on CDFG's recent survey of the recreational dredging community, the rates of participation and time spent conducting dredging is similar to historical survey results at approximately 5.4 hours of dredging per day, with in-state and out-of-state permit holders averaging 169 hours and 181 hours per year, respectively.

The beneficial uses considered to potentially be most sensitive to the increased water column concentrations of turbidity/TSS associated with recreational suction dredging activity are aquatic organisms, drinking water supplies, and recreational resources. Drinking water supplies can be adversely affected by turbidity/TSS levels if aesthetic appeal of the water supply is substantially reduced or additional treatment is required. However, based on the limited duration of dredging activity on an annual basis, dispersal of dredging operators over a large geographic area, limited size of the mixing zone and magnitude of

turbidity/TSS levels resulting from suction dredging activity, the turbidity/TSS resuspension associated with suction dredging would not be expected to adversely affect domestic or municipal drinking water supplies, recreational uses, or other non-aquatic life uses. As noted above, while available studies of suction dredging activity may not represent every possible combination of variables that may lead to creation of substantial turbidity/TSS plume conditions, the potential for adverse conditions would be anticipated to be the exception rather than commonplace. In particular, the exposure of water supply diversions to dredging-related disturbance would be anticipated to be low in rural and remote locations (i.e., potential for turbidity plumes to directly affect diversions would be unlikely). Moreover, domestic and municipal drinking water intakes are typically designed and constructed to remove, or accommodate fluctuations in turbidity/TSS changes, and small changes caused by dredging would be unlikely to result in any measurable change in water supply operations or need for additional treatment. Recreation beneficial uses potentially could be affected by dredging-related turbidity/TSS plumes if physical interference or aesthetic qualities were to be substantial enough to cause nuisance conditions. A nuisance water quality condition, as it relates to compliance with water quality standards specified in the Basin Plans for the state, is defined for a waste discharge activity under the Porter-Cologne as an effect that meets all of the following requirements:

(1) injurious to health, or indecent or offensive to the senses, or interfering with the comfortable enjoyment of life or property;

(2) affects and entire community or neighborhood, or any considerable number of persons.

Based on the typical characteristics of dredging activity (i.e., seasonal activity, dispersed) and potential effects associated with dredging-related turbidity plumes (i.e., relatively low magnitude concentrations and limited extent of downstream plumes), a single dredge would not be expected to preclude or have significant adverse effects on recreational uses or result in community-wide or offensive changes that rise to the level of nuisance conditions. As noted above, additional information regarding the effects of turbidity/TSS plumes from recreational dredging are discussed in Chapter 4.6 *Aesthetics* (Impact AES-2), and in Chapter 4.8 *Recreation* (Impact REC-1), with both analyses supporting the conclusion herein that turbidity/TSS plumes would not substantially adversely affect aesthetic and recreational resources. Consequently, the remainder of this impact assessment is focused on the potential turbidity/TSS effects of suction dredging to fisheries and aquatic resources and beneficial uses.

Comments received on the NOP for this EIR identified a concern for the potential effects of turbidity produced by suction dredging activity on water temperatures. Available information indicates that high levels of turbidity can affect shallow water temperatures in calm water bodies (e.g., lakes, reservoirs, and ponds) (Wetzel, 1983; Reed et. al., 1983). However, the large majority of heat input to a water body is a result of absorption of infrared wavelengths in the light spectrum, which occurs in a very shallow portion of the water column (i.e., less than about 1 meter) and is not affected to a large degree by differences in particulate matter content (Wetzel, 1983). Based on the relatively small area of sediment resuspension caused by dredging, transitory nature of turbidity plumes downstream of dredging through settling, dilution and dispersion, and the fact that turbidity does not result in a major contribution to the heat input to water, it is anticipated that suction dredging activity under the Program would have negligible, if even measurable,

effects on water temperature. Thus, the potential temperature effects would not exceed applicable Basin Plan temperature objectives which limit the allowable increase from controllable factors to less than 5 °F above background conditions.

Fish (and benthic macroinvertebrates) are generally not directly affected by suspended solids and turbidity, unless they reach relatively high levels. Suspended solids, particularly when at high levels, directly affect fish and macroinvertebrates through physiological effects, whereas turbidity generally has indirect effects via water clarity, primary production, food availability, and risk of predation. Numerous scientific studies conducted over the past 50–60 years indicate that there is no sharply defined concentration of turbidity or TSS above which aquatic communities are harmed. Rather, the magnitude and type of effects on aquatic life are species-specific and determined by concentration and type of suspended solids and turbidity, as well as the duration of exposure.

Numerous studies have been conducted over the years on the acute lethality of suspended solids to fish and macroinvertebrates over short (acute) exposure periods and elevated turbidity/TSS levels. Griffin (1938) stated that Pacific salmon and trout fingerlings lived for 3-4 weeks at suspended solids levels of 300-750 mg/L with short daily increases to 2,300-6,500 mg/L caused by stirring up sediments. A study published in 1951 investigated the direct short-term effects of suspended montmorillonite clay on 14 species of warmwater fishes which demonstrated that the tolerance of various fish species can differ widely, as described below (data presented in McKee and Wolf [1963]). In this study, suspended solids levels were increased for a short time each day by stirring the sediment. The lowest concentration of suspended solids for which mortality was observed was with pumpkinseed sunfish exposed to 16,500 mg/L daily for an average of 13 days. Rock bass was the species for which the lowest reported suspended solids level (38,250 mg/L) consistently caused mortality due to daily exposures of less than one week. Some level of mortality was observed for all species tested when exposed daily to 100,000 to 175,000 mg/L suspensions over a 1- to 2-week period. At suspended solids levels causing mortality, the opercular cavities of test fish were matted with clay, and the gills were covered with a layer of clay. Harmful non-lethal effects were first observed when suspended solids levels approached 20,000 mg/L. Smith, Kramer, and McLeod (1965) found that walleye experienced mortality within 72 hours of exposure to 100 mg/L of various wood pulps, but that 20,000 mg/L did not kill fathead minnows exposed for 96 hours. Lethal concentrations of suspended sediment are probably not produced by suction dredging because suction dredging activities do not produce lethal levels of TSS and because fish can usually avoid the dredging plumes (Bernell et al., 2003; Harvey, 1986). Thomas (1985) and Harvey (1986) indicate that in some streams where dredges operate at low density, suspended sediment is not a significant concern because effects are moderate, highly localized, and readily avoided by mobile organisms.

When the levels of suspended solids (and thus turbidity) become extremely high, they can adversely impact fish and macroinvertebrates by making it difficult for sight feeders to locate prey, causing abrasive injuries, clogging gills and respiratory passages, and/or by blanketing the streambed, thereby killing incubating fish eggs/larvae and benthic macroinvertebrates (McKee and Wolf, 1963; EIFAC, 1965; NAS, 1972; Alabaster and Lloyd, 1980). Decreased visibility in waters having moderately high turbidities can benefit the early life stages of fish and other prey organisms by providing visual protection from predators. Feeding by sculpin in laboratory channels was not detectably affected by

suspended sediment levels of 1,250 mg/L (Brusven and Rose, 1981). Hassler et al. (1986) found that sculpin were not significantly impaired by increased turbidity from dredges, and turbidity does not appear to affect feeding abilities of many species. Moreover, fish can avoid plumes with high concentrations. Additionally, any reduction in feeding efficiency of fish may be offset by reduced risk of predation.

Based on the available scientific literature, suction dredging activities conducted by operators permitted under the Program have the potential to cause localized, temporary, and intermittent instream resuspension of sediments, resulting in plumes containing elevated levels of turbidity and TSS (e.g., up to 300-340 mg/L) that would extend relatively short distances downstream from the dredging sites. The turbidity plumes created by suction dredging likely may exceed the applicable Basin Plan objectives, particularly in streams that have low background turbidity levels. Nevertheless, the available literature indicates that turbidity and TSS concentrations within suction dredging plumes are unlikely to exceed 50 NTUs and 340 mg/L, respectively, and are, therefore, not expected to approach or exceed the levels discussed above that would cause lethal or other adverse physiological effects to fisheries or other aquatic resources. Moreover, these potential highest dredging-caused turbidity/TSS levels would be expected to rapidly return to near background levels downstream within a few hundred meters or less of the dredge operation. Thus, while potentially exceeding a Basin Plan turbidity objective within temporary plumes created during dredging operations, suction dredging activity permitted under the Program is not expected to adversely affect aquatic organisms, which is the most sensitive beneficial use that could be affected by elevated turbidity/TSS levels.

The Program includes additional prohibitions that will largely avoid and limit the potential disturbance of fine sediments that can result in higher levels of turbidity and TSS. Prohibited activities include mechanized winching, highbanking, removal of vegetation, dredging outside of the wetted channel, and diversion of flows. Additionally, the proposed regulations require dredgers to take reasonable care to avoid dredging silt and clay materials. Thus, the Program would provide enforceable conditions by which CDFG and other local, state, or federal law enforcement officers can act to stop activities that may result in turbidity/TSS conditions that are inconsistent with the Program. It should be noted that dredging related discharges of turbidity/TSS, as an activity that has the ability to exceed numerical and narrative regulatory water quality objectives established in Basin Plans, may additionally be regulated by separate permitting authority of the RWQCBs pursuant to the CWA and Porter-Cologne. While no such permitting processes have been established by the RWQCBs for the Program discharges or for CDFG's previously authorized suction dredging program, such authority, if exercised, would have the potential to provide additional assurance that sufficient regulatory controls exist to prevent adverse effects to beneficial uses. At their discretion, individual RWQCBs or the SWRCB could develop a complementary permitting program for suction dredging activity to further address compliance with water quality regulations.

Based on this assessment, suction dredging activities anticipated to be conducted under the Program are not expected to result in substantial discharges of turbidity/TSS. Thus, implementation of the Program would not be anticipated to result in turbidity/TSS discharges that would be of sufficient magnitude, frequency, and geographic extent to adversely affect beneficial uses. Requirements of the Program are designed to prohibit and/or limit specific channel disturbance activities and thus, limit the potential for

excessively high turbidity/TSS levels from dredging activities. Because dredging activities are largely conducted on a seasonal, temporary, and intermittent basis in California, water quality degradation is expected to be infrequent and dispersed and thus not cause substantial, long-term degradation of water quality. Turbidity and TSS are not bioaccumulative constituents and thus are not a concern for uptake in the food chain or health risk to wildlife or humans. Therefore, this impact is considered to be less than significant.

Impact WQ-4. Effects of Mercury Resuspension and Discharge from Suction Dredging (Significant and Unavoidable)

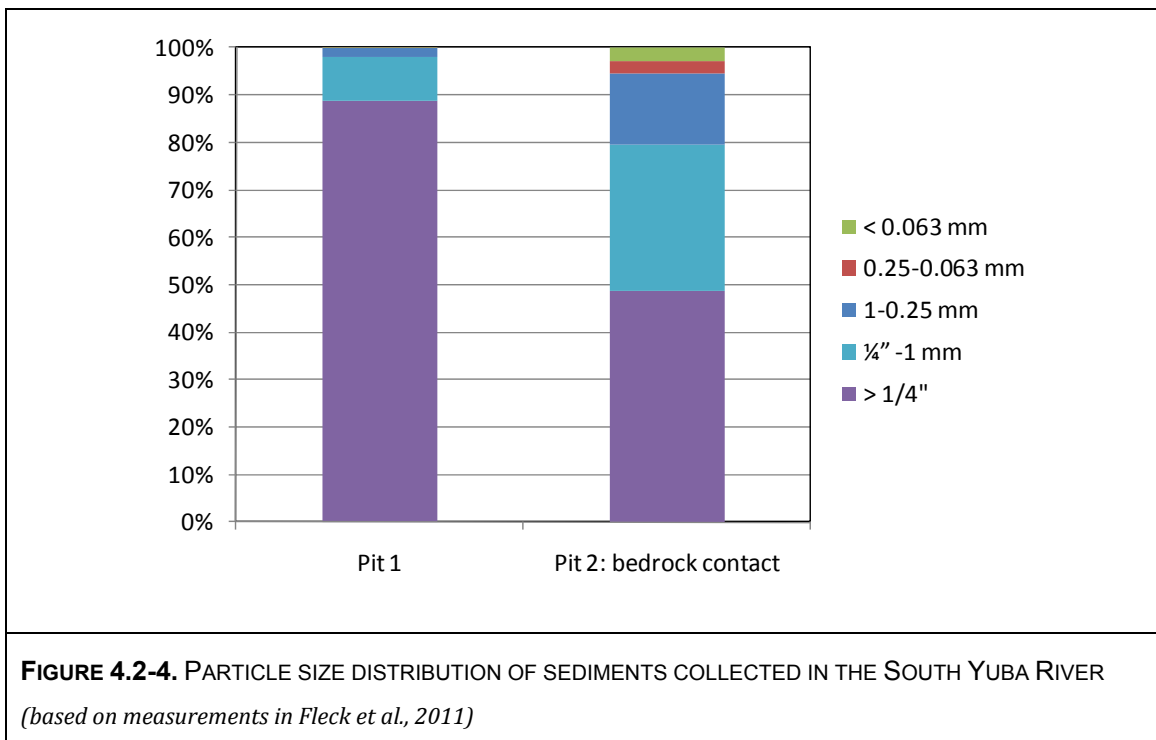
The following sections describe the results of the assessment of Hg discharge, transport, transformation and bioaccumulation projected to occur through the implementation of the Proposed Program. The assessment follows the conceptual model elements presented previously in Figure 4.2-3, which include: (1) the discharge of Hg from suction dredging which are usually seasonally out of phase with background Hg releases; (2) discharge of Hg from background watershed sources; (3) transport; and (4) transformation and bioaccumulation.

Discharge of Mercury from Suction Dredging

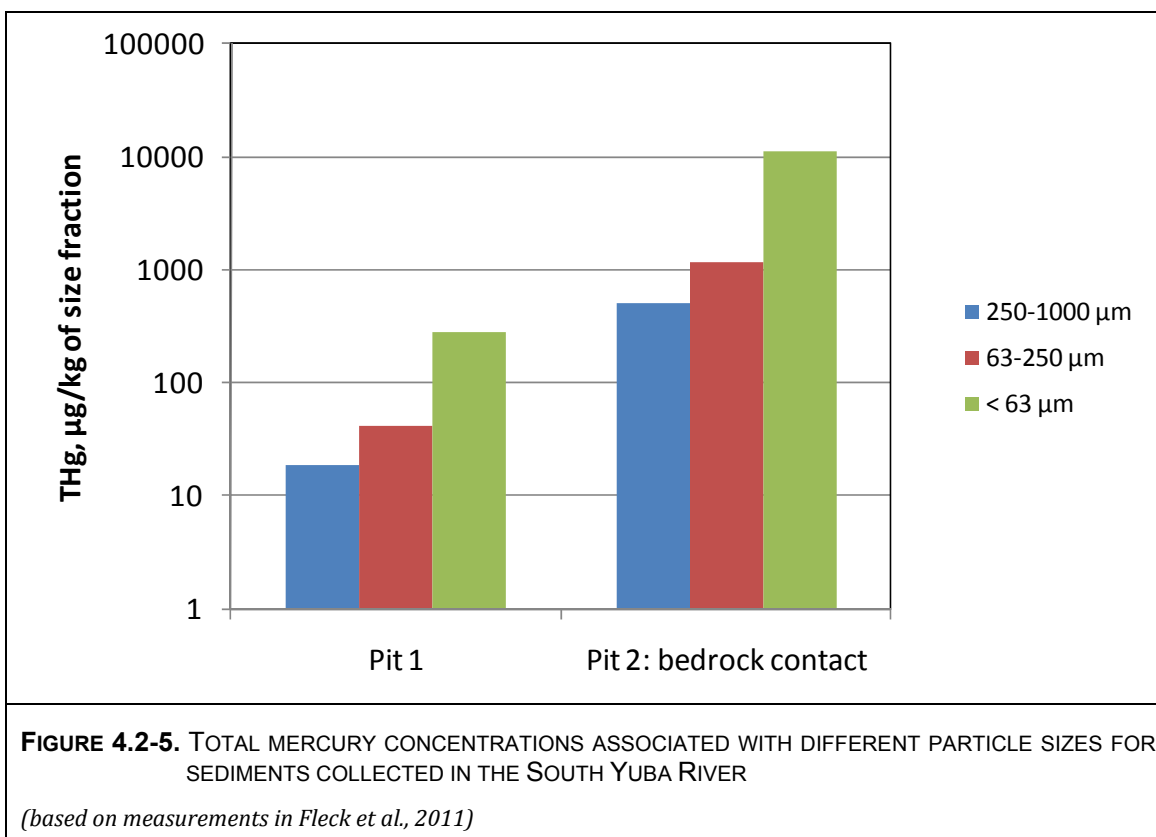
Characterization of Sediment Available to Discharge from Suction Dredging

Recent field and laboratory studies were conducted by the USGS near the confluence of Humbug Creek and the South Yuba River. The objectives of the studies were to: 1) characterize Hg concentration and speciation in sediment of various size fractions (Lab), 2) characterize Hg and MeHg concentrations in local biota (field), and 3) assess the practicality and potential impacts of using suction dredging for removing Hg from an area contaminated with Hg (field). The laboratory study determined levels of total Hg (THg) and reactive mercury (Hg(II)_{R}) in sediments collected from a mid channel bar (Pit #1), and bank sediments collected near the confluence of the South Yuba River and Humbug Creek (Pit #2). The Pit #2 location was chosen by an experienced dredger as a promising location for gold. Humbug Creek was used as a conduit for hydraulic mining debris from Malakoff Diggins and hydraulic mining debris continues to slough into the river from bench deposits at the confluence. Figure 4.2-4 shows the particle size distribution of the sediment from the two sites. Figure 4.2-5 shows the concentration of THg associated with different size fractions that could be mobilized by suction dredging. Figure 4.2-6 shows total mass of THg found in bulk sediment by particle size. Particles with diameter of < 63 micrometers (μm) are classified as silt and clay, those with diameter between 63 μm and 2 millimeters (mm) are classified as sand, and those greater than 2 mm as gravel, pebble, cobble, or boulder.

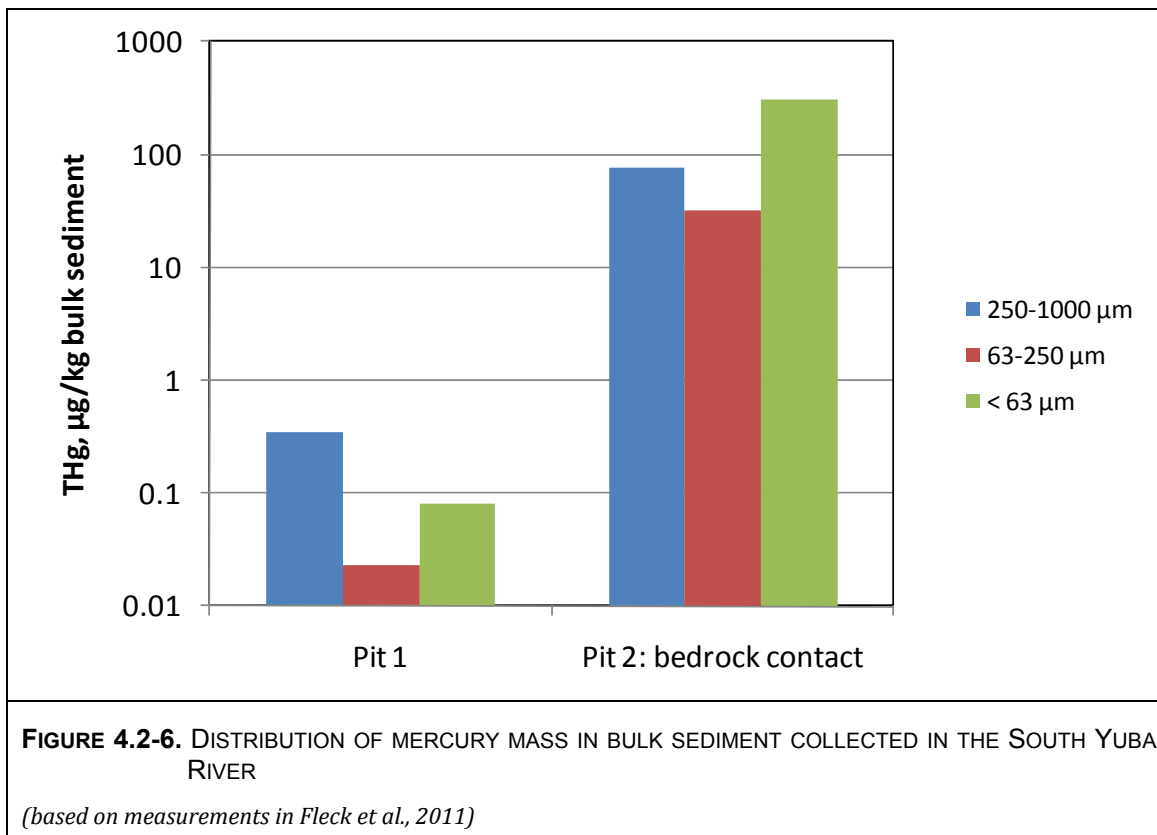
The figures indicate that Pit #2 Bedrock Contact (Pit #2:BC) has a higher percentage of fine particles and higher concentrations of mercury associated with each size fraction. Fine particles contained more mercury on a per-mass basis than coarser particles. In the bulk sediment, Pit #2:BC contains 2-3 orders of magnitude more mercury mass with each size fraction. It should also be noted that Pit #2:BC contained elevated levels of Hg(II)_{R} , which will be discussed in more detail later. Levels from the bedrock contact layer of Pit #2 (Pit #2:BC) are assumed to be worst-case from a mercury release standpoint because they are from a location known to be contaminated with historic gold-mining Hg and because they are among the highest levels measured in California.



1



2



1 Characterization of Elemental Mercury Available to Discharge from Suction Dredging

2 However, it should be noted that few, if any, other sediments containing hydraulic mine
 3 debris in California have been characterized with respect to Hg, so it is possible that other
 4 similar sites would contain similarly high levels. Levels of Hg from Pit #1 are assumed to
 5 represent a typical site in the Sierra Nevada where mercury levels have been diluted by
 6 uncontaminated sediment from mass wasting in the watershed, because levels are
 7 comparable to those found in the Lower Yuba River and Lower Sacramento River
 8 (Domagalski, 2001), Sacramento-San Joaquin River Delta (Marvin-DiPasquale, 2003), and
 9 San Francisco Bay (San Francisco Estuary Institute, 2010; Fleck et al., 2011). Little to no
 10 publicly available sediment Hg data exist for the Klamath-Trinity or San Gabriel mountains,
 11 so it is unknown whether Pit #1 and Pit #2:BC Hg levels are representative of those
 12 locations. It is not known what the relative probability of encountering either case is for a
 13 suction dredger. However, it is expected that many dredging operations within the Sierra
 14 Foothills would occur at sites of THg levels between Pit #1 and Pit #2:BC levels
 15 characterized for this assessment. Because gold has a high grain density, it has a tendency
 16 to settle out of the water column in areas where less dense materials do not. Dredgers
 17 target these areas because concentrations of gold are expected. Because Hg also has a high
 18 density, these same areas tend to be places where Hg settles out, such as Pit #2:BC. Source
 19 assessment and sniping results suggested this location is not a unique hotspot within the
 20 South Yuba River watershed. Sniping is a method used by recreational gold miners to search
 21 for gold and other minerals of high grain density in bedrock fractures and other natural
 22 hydraulic traps on the river bottom. Since hydraulic mining was practiced throughout the

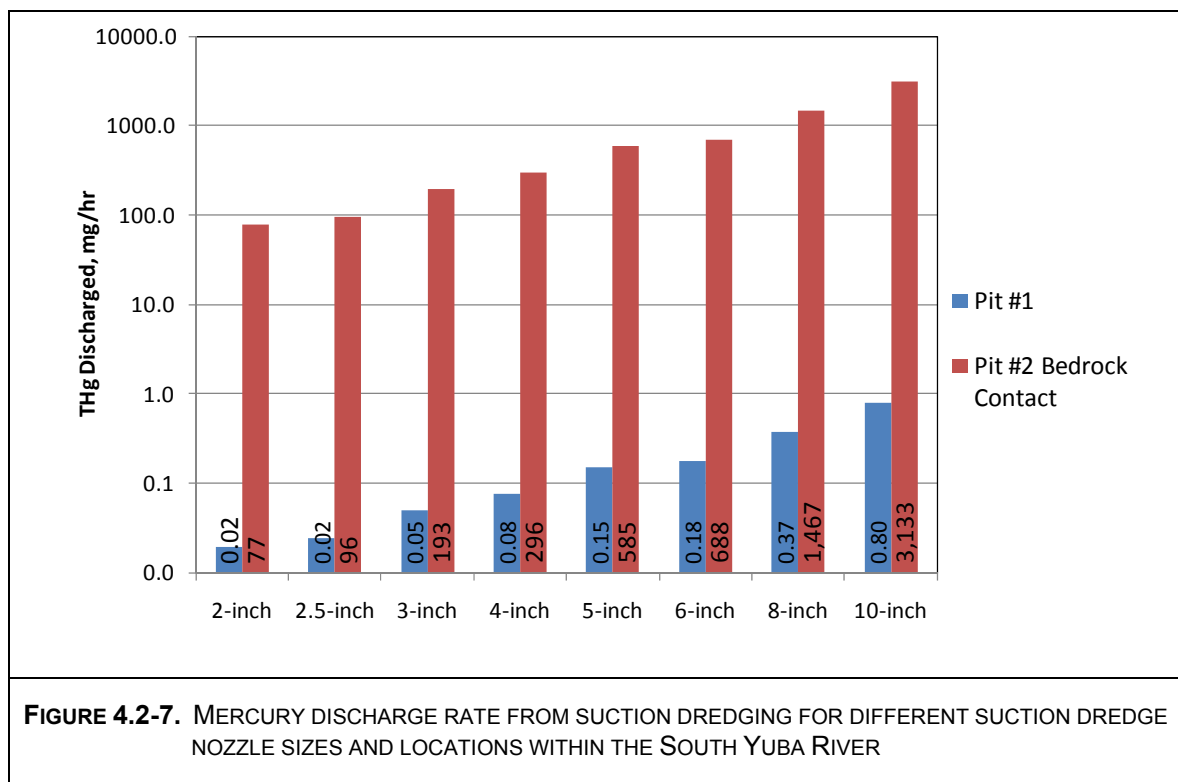
watershed, it is possible that Hg contaminated sediment layers are present throughout the lower region of the watershed (Fleck et al., 2011). The deeper sediments at these sites did not appear to be available to mobilization by storms. Indeed, Pit #2:BC sediment appears to be undisturbed since hydraulic mining days, over 100 years ago, but no attempt was made to quantitatively date the sediment. Although the extent to which these deep sediments that contain high concentrations of legacy mercury are targeted by suction dredgers is unknown, because they also contain high concentrations of legacy gold, it is reasonable to assume that these areas would be attractive to and targeted by suction dredgers.

Elemental mercury (i.e., liquid Hg(0)) has been visually documented at many locations throughout the Sierra Nevada, but generally has not been quantified. On the South Fork of the American River, near Lotus, Humphreys (2005) describes a location where elemental Hg was present and whose sediment Hg concentration (particle bound plus liquid Hg) was 1,170 mg/kg. In the Greenhorn Creek watershed, tributary to the Bear River, concentrations of elemental Hg were estimated via a field panning method at 14 locations and varied from 100 mg/kg (the estimated detection limit of the test) to 45,000 mg/kg, equivalent to 4.5% (Alpers et al., 2005). It is probable that elemental Hg is present at many additional locations throughout the California gold-country, but no systematic efforts have been made to locate these so-called “hot spots.”

Where elemental Hg is present, suction dredging has been observed to result in the “flouring” of Hg droplets—that is, the breaking up of larger liquid droplets into many very small droplets (Humphreys, 2005; Silva, 1986). Flouring results in increased surface area contact with water of Hg droplets, which may affect transformation as described in the transformation section below. However, some have noted that the equipment used in this study is no longer in production, and suggested that modern equipment may result in less flouring (McCracken, 2007), although this has not been scientifically evaluated. Furthermore, it is not clear from the study whether Hg droplets were floured prior to being dredged or were floured as a result of the dredging. Nevertheless, floured Hg was present in the discharge from the suction dredge. Consequently, it is unlikely that suction dredges would recover either floured mercury in sediment dredged, or mercury floured by the suction and turbulence of the dredge. Transport and transformation of elemental Hg is addressed below, but due to significant data gaps in our understanding of both, it is excluded from the initial quantitative assessment.

Impact of Dredging Operations Variables on Quantity of Mercury Discharged

Sediment characteristics discussed above were combined with estimates of sediment moved per hour for various nozzle sizes provided by a suction dredge manufacturer to estimate the quantity of Hg discharged per hour (See Table 3-2 in the Activity Description chapter). A 4 inch diameter nozzle size is the most typical size used by suction dredgers, based on the results of the Suction Dredger Survey. An 8 inch nozzle was chosen as it is the largest allowable nozzle in California (although analysis for a 10 inch nozzle was also conducted). This exercise was conducted for both the more typical background average Hg level sediment (Pit #1) and the worst-case hot-spot sediment (Pit #2:BC). Figure 4.2-7 shows the rate of discharge of THg in the <63 μ m portion from different size suction dredges in the two sediments. Because Pit #2:BC has both a greater percentage of <63 μ m particles and a much greater concentration of mercury associated with those particles, discharge rates from Pit #2:BC are more than 3 orders of magnitude greater than for Pit #1.



Existing Data of Total Recoverable Mercury in Suction Dredge Discharge

Very little direct data exists on the levels of THg found in suction dredge discharge. Existing data on TSS in suction dredge discharge or immediately downstream of the discharge was combined with sediment Hg levels to estimate total recoverable Hg in the discharge. Suspended sediment downstream of suction dredges has been reported as high as 340 mg/L (Thomas, 1985), but can also be as low as 1-2 mg/L (Stern, 1988). Based on the THg concentrations measured in Pit #1 and Pit #2:BC sediments, Table 4.2-4 shows estimated THg discharge that could occur from a suction dredging operation discharging suspended sediment at the 340 mg/L rate. The table shows that using a worst-case scenario of 340 mg/L TSS, total recoverable Hg is estimated to be 0.094 micrograms per liter ($\mu\text{g/L}$) with Pit #1 sediments. The same calculation at Pit #2:BC yields a total recoverable Hg concentration of 3.77 $\mu\text{g/L}$. Using a TSS of 3 mg/L, both locations yield total recoverable Hg levels below the CTR human health criterion of 0.05 $\mu\text{g/L}$. Humphreys (2005) measured suspended sediment THg concentration at 298 mg/kg but did not report the TSS concentration itself. In order for the THg concentration in this discharge to have been below 0.05 $\mu\text{g/L}$, TSS would have had to be < 1 mg/L, which is possible, but unlikely. Therefore, this discharge likely contained total recoverable Hg concentrations greater than the CTR criterion.

TABLE 4.2-4. ESTIMATED TOTAL RECOVERABLE MERCURY IN SUCTION DREDGE DISCHARGE AT PIT #1
AND PIT#2:BC SITES IN THE SOUTH YUBA RIVER

TSS (mg/L)	Pit #1 (µg/L) ^a	Pit #2:BC (µg/L) ^b
1	0.000276	0.0111
3	0.000828	0.0333
5	0.00138	0.0555
10	0.00276	0.111
50	0.0138	0.555
100	0.0276	1.11
200	0.0552	2.22
340 ^c	0.0938	3.78

Bold values indicate exceedances of CTR human health criterion of 0.05 µg/L total recoverable mercury.

^a = Assumed only < 63 µm particles discharged from suction dredge; Pit #1 < 63 µm sediment concentration = 0.276 mg/kg.

^b = Assumed only < 63 µm particles discharged from suction dredge; Pit #2:BC < 63 µm sediment concentration = 11.1 mg/kg.

^c = Highest reported suction dredge discharge/plume TSS concentration found in the literature.

Discharge of Mercury from Background Watershed Sources

In contrast to Hg discharged from suction dredging, which occurs primarily during the summer, the majority of Hg from background watershed sources is discharged during the winter wet season, when runoff conditions contribute to high flows that scour sediments laden with Hg. Figure 4.2-8 shows measured Hg and discharge on the South Yuba River at Jones Bar for water years 2001-2004. This data was used to estimate annual Hg load of inflows to Englebright Lake for water years 2001-2004, which ranged from 3.4 to 7.2 kilograms per year (kg/yr) (Alpers et al., in prep). These years, overall, had below average rainfall and runoff. Water year 2001 loads were used as representative dry year loads, while water year 2003 loads were used as normal water year loads. Conditions for these years are shown in Table 4.2-5. Loads calculated for water year 2003 were based on measurements taken during the wet season only, a period when suction dredges typically are not operated. Therefore, values for water year 2003 are an estimated minimum overall load for that year. However, because the majority of background Hg transport occurs during the wet season, this is a good estimate of the true rainfall-induced watershed load for this water year. Loads calculated for water year 2001 were based on measurements during both the wet and dry season. It should be noted that these studies were not designed to detect suspended sediment pulses from operating dredges. Sampling frequency was biased towards winter when both flows and suspended sediment loads are high but variable. Less sampling was performed during the summer when flows are low and stable and ambient turbidity/TSS loads are low.

Sampling frequency for both cited studies was no more than once a month during the summer, almost always occurred on weekday mornings, and took about an hour to perform. Such sampling would not be expected to detect pulse flows from dredges that are frequently operated on weekends. However, given this, it is possible that suction dredges were contributing to the annual Hg load calculated, but Hg levels do not appear to reflect

unusually high concentrations during the dry season. Given this, there are inherent uncertainties to the Hg loading estimates.

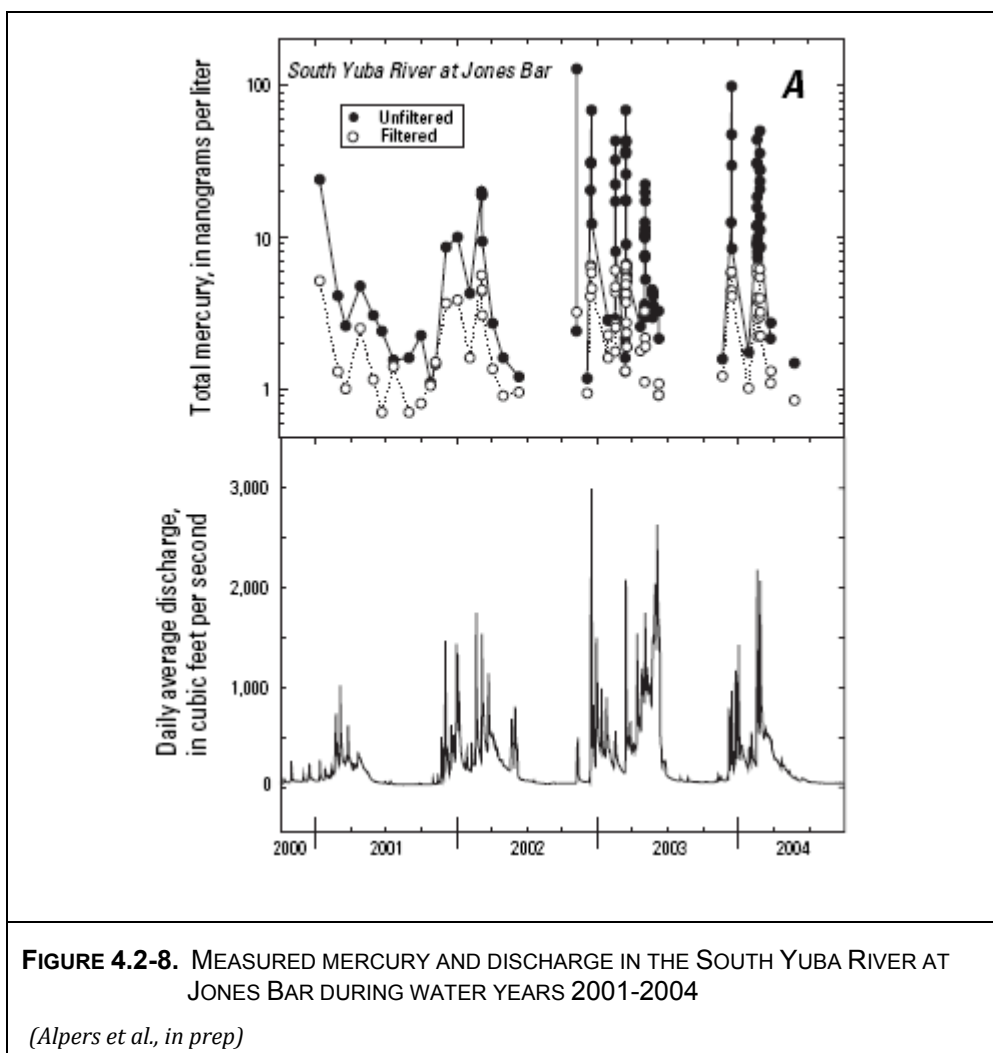


TABLE 4.2-5. BACKGROUND WATERSHED SEDIMENT CONTRIBUTION AND MERCURY DISCHARGE IN SOUTH YUBA RIVER AT JONES BAR

Water Year	Water Year Type	Percent of Average Precipitation	Sediment Discharge (tons)	THg Transported (kg)
2001	Dry	73%	730	0.53
2003	Normal	112%	7600	3.1

From Curtis et al., 2006; Alpers et al., in prep

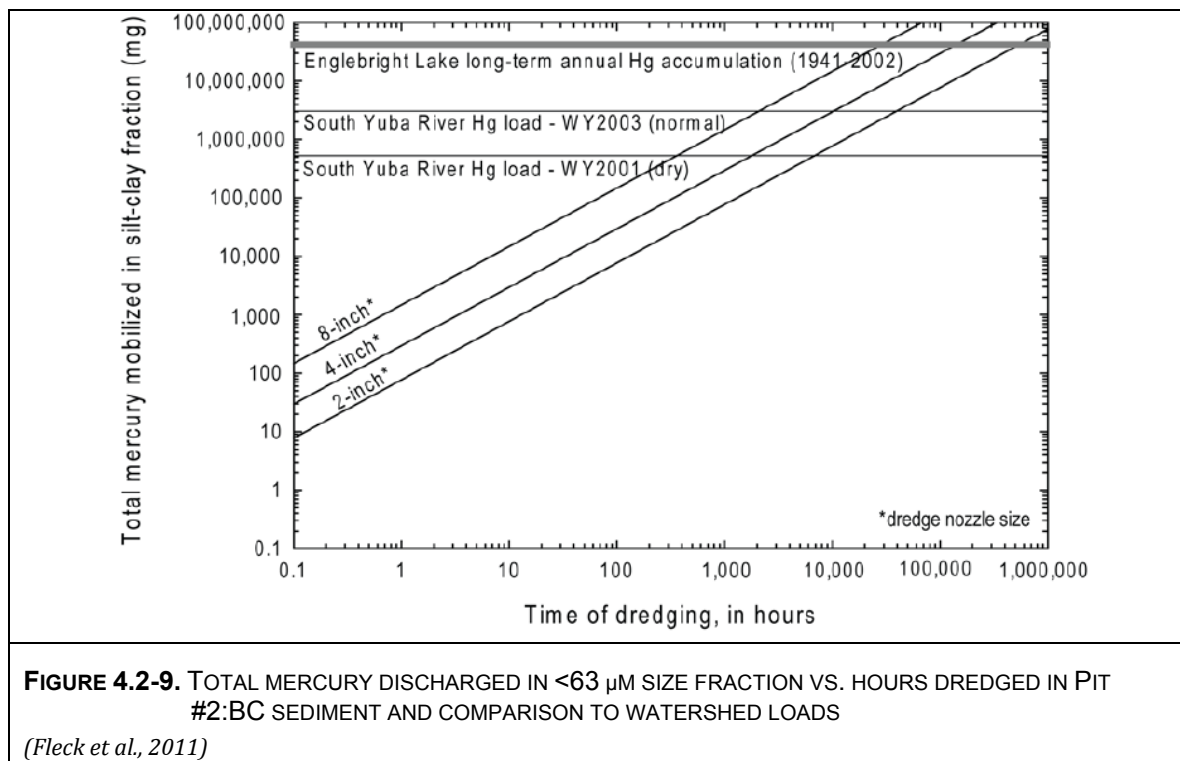
Considering the background watershed loading of Hg to the Delta, the average annual input of total Hg ranges between 220 and 403 kg/yr, and the average annual input of MeHg to the Delta is approximately 5.2 kg/yr (Wood et al., 2008). Measurements of Hg and TSS that form the basis of these estimates may have been influenced by suction dredge discharge, so

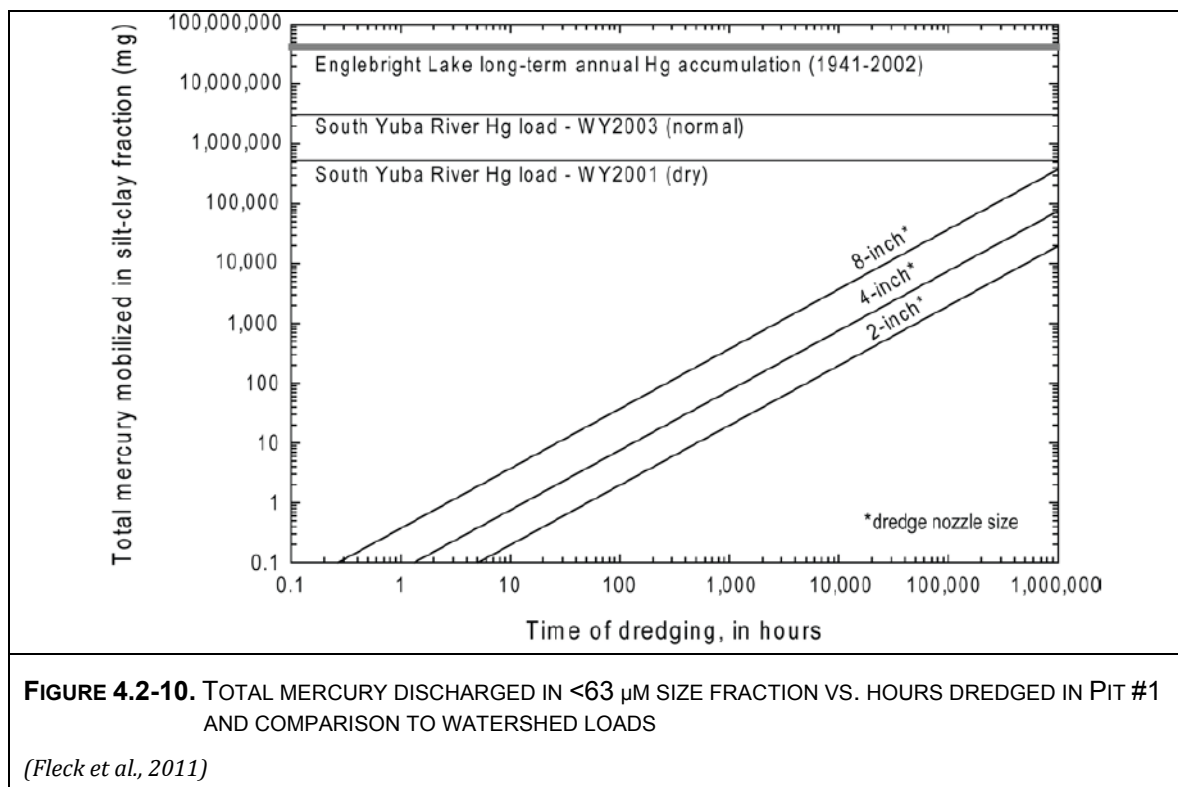
there is uncertainty over whether these are truly background measurements or a combination of background and suction dredge Hg loadings.

Figure 4.2-9 and Figure 4.2-10 show the total amount of Hg discharged with selected nozzle sizes as a function of hours dredged and a comparison to watershed loads.

Transport of Mercury Discharged from Suction Dredging and Background Watershed Sources

When sediment is discharged from suction dredging, coarser particles will settle out at a lesser distance downstream than fine particles (see also Chapter 4.1, *Hydrology and Geomorphology*). Flow velocity (which is correlated to discharge for a given river) affects both what size particles are carried by the current and how far the particles travel before they settle out of the water column. For the South Yuba River, data from bed and suspended sediments under different flow regimes indicate that fine particles $<63\ \mu\text{m}$ remain mostly suspended, and thus are transported at least as far as Englebright Lake (Curtis et al., 2006). Particles $>63\ \mu\text{m}$ do not remain suspended during summer low flows, and are thus deposited back into the river. However, these particles may be transported downstream to Englebright Lake during higher winter flows, depending on their size, the flows, and the distance to the reservoir.





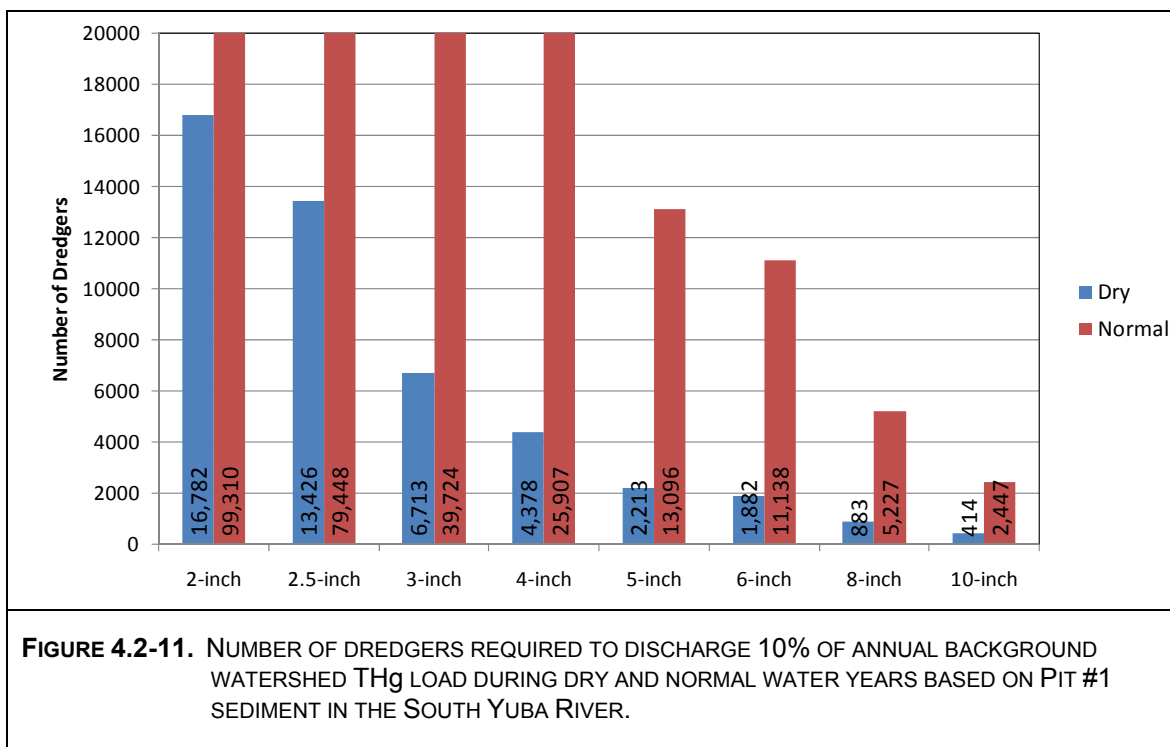
For the purposes of this assessment, it is assumed that $>63 \mu\text{m}$ particles are transported to other parts of the river, while $<63 \mu\text{m}$ particles are delivered downstream to Englebright Lake or beyond, eventually being deposited in the Delta. During water years 2001-2004, it is estimated that only 40% of total Hg inputs to Englebright Lake were deposited, while the remaining 60% was transported downstream of Englebright Dam (Alpers et al., in prep).

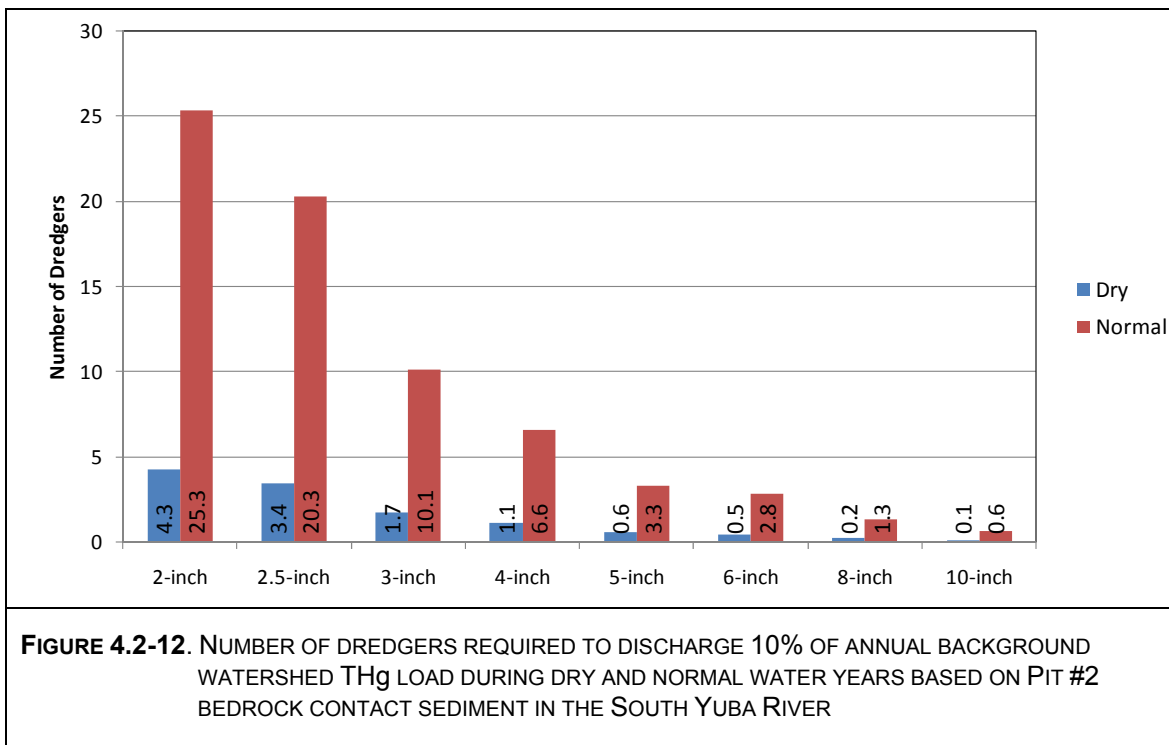
Transport of elemental Hg that is floured and discharged from suction dredging is largely unknown. Floured Hg has been observed to float initially (Humphreys, 2005). Subsequently, these Hg droplets may sink (for example, after coagulating with other particles downstream), or may continue to float until they dissolve or volatilize.

The amounts of THg discharge shown in Figure 4.2-7 were used to estimate the number of dredgers required to discharge 10% of background watershed loads. The value 10% was selected based on a professional judgment of what would be a measurable increase in background loading. The analysis does not assume that this is a threshold of significance below which effects are insubstantial, but is used as a reasonable point of reference. The average number of hours dredged per year was based on the results of a survey of suction dredgers and was 160 hours (Suction Dredger Survey results, Appendix F). Results are shown in Figures 4.2-11 and 4.2-12. Due to the lower rate of Hg discharge from Pit #1 (see Figures 4.2-7 through 4.2-9), many more dredgers would be required to reach 10% of background watershed loading than for Pit #2:BC. However, experienced suction dredgers would likely not target Pit 1 type sediment because it contained little gold, or would only dredge the material as overburden—material that must be removed to get to more prospective layers below. During a dry year, a single dredger with a 4 inch dredge in Pit #2:BC or similar sediments (e.g., the layer of sediment overlying Pit #2:BC, referred to as

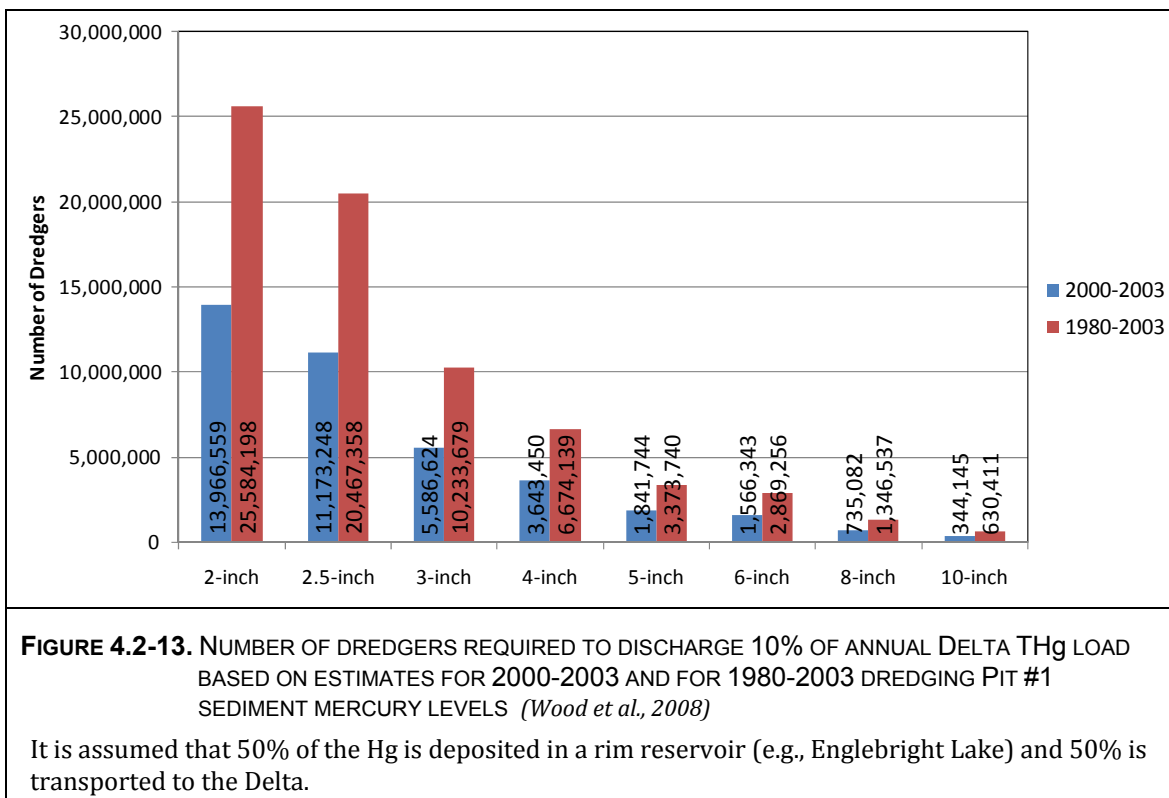
the Compact Sediment layer in Fleck, 2011, which also had elevated THg) would contribute almost 10% of the background watershed loading. More than the entire permitted population of suction dredgers (almost 4,400, versus the permitted population of approximately 3,650) would need to be operating within sediments with concentrations similar to Pit #1 to discharge 10% of the background Hg loading in a dry year using average size (4 inch) dredges. The results of the survey indicated that approximately 260 dredgers operated in the South Yuba watershed in 2008, resulting in approximately 25,000 dredging hours (Suction Dredger Survey results, Appendix F). However, there are concerns that suction dredger self survey data have been skewed by the survey respondents.

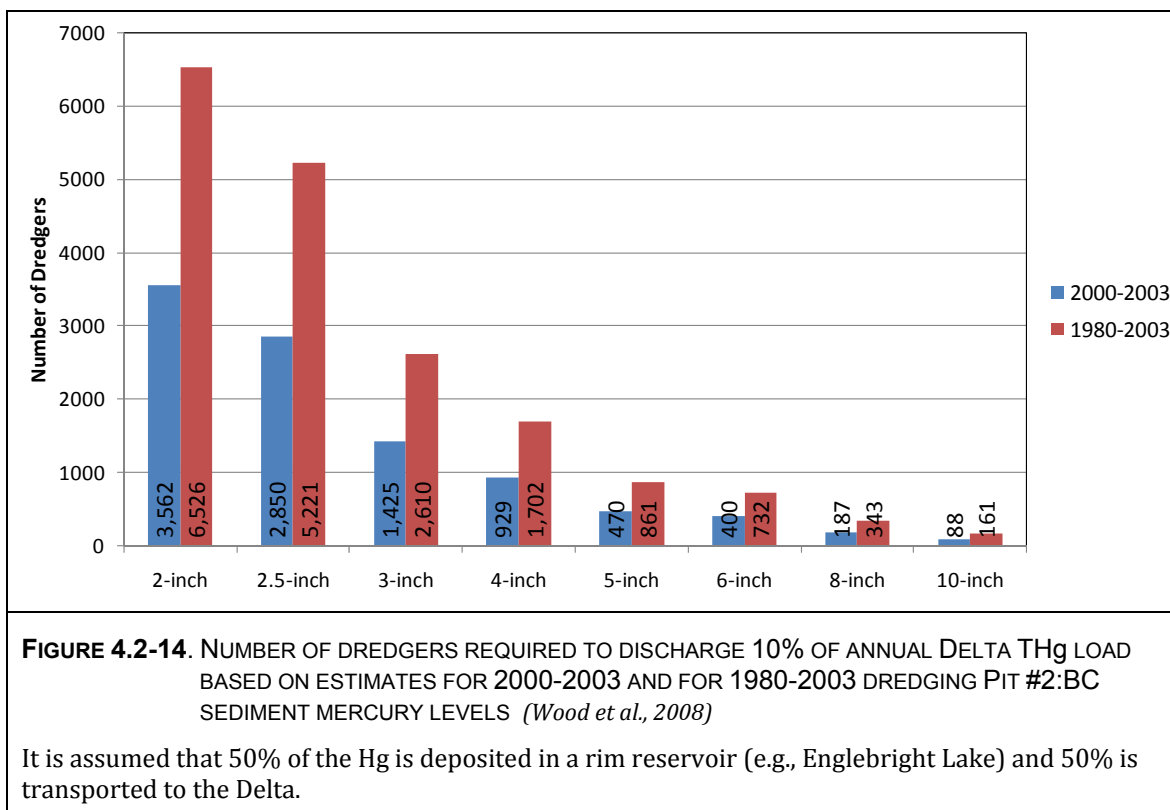
Assuming 50% of transported sediment is deposited in a reservoir between where suction dredging is occurring and downstream reaches where particle bound Hg may reach the Delta, the same calculations were conducted to determine the number of dredgers necessary to equal 10% of the existing Hg loading to the Delta, with results shown in Figures 4.2-13 and 4.2-14. Figure 4.2-13 indicates that no practical number of dredgers in Pit #1 could approach 10% of Delta Hg loading in a year, but that a realistic number of dredgers in Pit #2:BC could reach this level.





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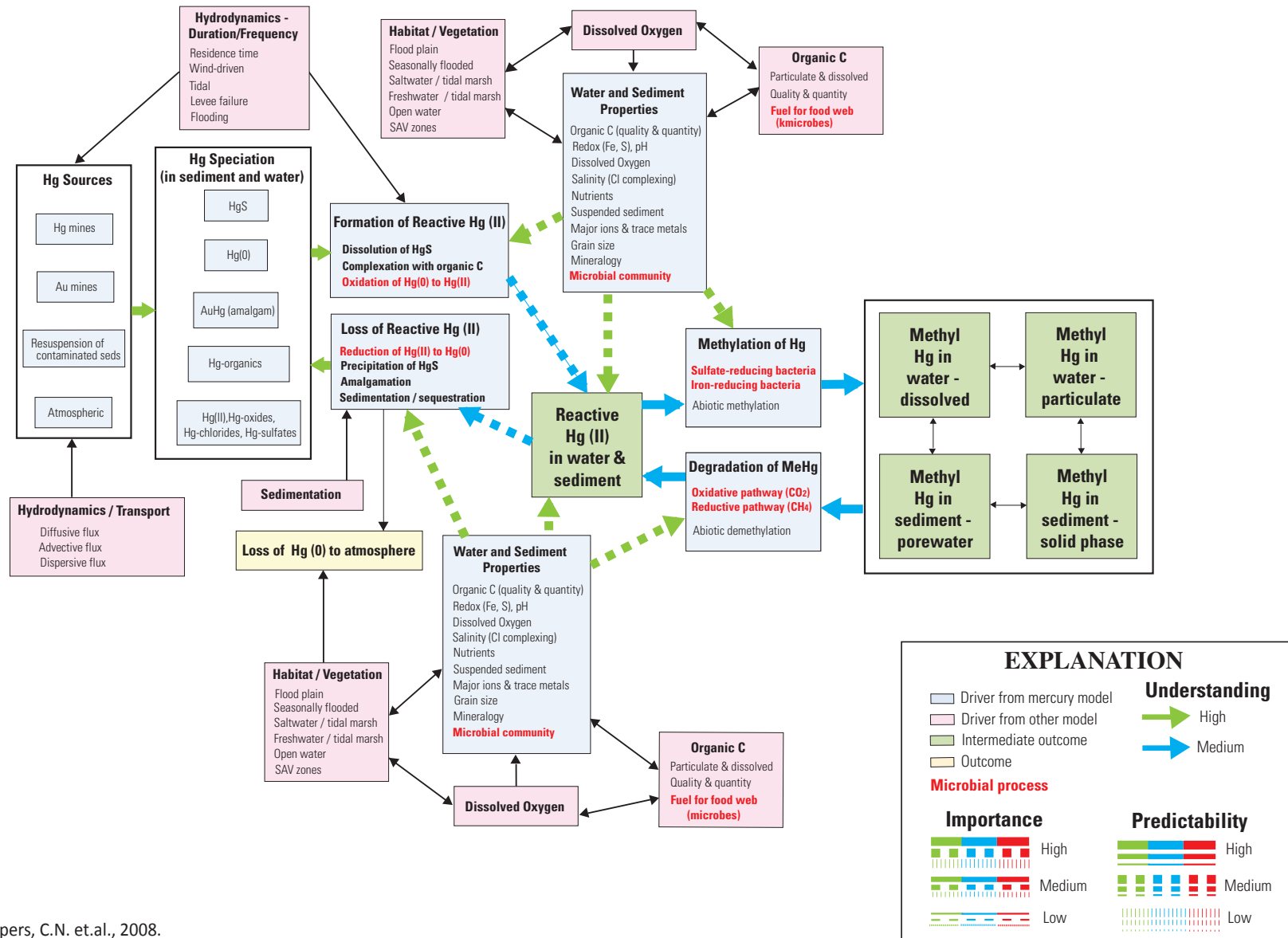


Transformation and Bioaccumulation of Mercury Discharged from Suction Dredging and Background Watershed Sources

Elemental Hg (i.e., liquid Hg(0)) was used for gold recovery in placer and hard-rock mines. Experiments with Hg droplets in water have shown that they can either dissolve, forming dissolved Hg(0), or oxidize directly to Hg(II) (Afonso de Magalhaes and Tubino, 1995; Amyot et al., 2005). The latter is enhanced in the presence of chloride, oxygen, and light; however, dissolved Hg(0) would also be subsequently available to oxidation to Hg(II). Studies have shown that Hg(II) is the form most readily converted to MeHg by microbes (Keiu, 2004; Marvin-DiPasquale et al., 2009; Marvin-DiPasquale and Cox 2007). Reactive Hg(II) (i.e., Hg(II)_R) is "an operationally defined fraction that represents the result of a 15-minute digestion with SnCl₂, a strong reducing agent that converts Hg(II) to elemental Hg(0) so that the readily available Hg(II) fraction can be measured (Marvin-DiPasquale et al., 2009; Marvin-DiPasquale and Cox, 2007). Experiments with mercury in a variety of model compounds representing a wide range of mercury species indicate that solid phase Hg(II)_R appears to be a good predictor of microbial MeHg production (Alpers et al., 2008).

Figure 4.2-15 shows a conceptual model for Hg transformation and bioaccumulation. Transformation refers to the conversion of various Hg species, including elemental Hg, into Hg(II)_R and subsequently to MeHg, and the corresponding backwards transformations. MeHg is transferred between the water-column and bed sediment hydrodynamically and between dissolved and particle-bound phases via physical-chemical partitioning. Some fraction of MeHg is taken up into the base of the food web and is then biomagnified up the food web, resulting in the highest concentrations at the top of the food web, generally in piscivorous fish, reptiles, mammals, or birds (Scudder et al., 2009). Most studies indicate

DRERIP Submodel #1 -- Mercury Methylation in the Sacramento-San Joaquin Delta



Source: Alpers, C.N. et.al., 2008.

that a majority of the Hg found in fish tissue is MeHg, in many cases the proportion is up to 95% (e.g., Bloom 1992). Numerous factors affect the multiple linkages contained within the model. Water and sediment properties that affect virtually all parts of the model include: oxidation-reduction conditions, salinity, nutrients, suspended sediment, major ions and especially levels of sulfate, trace metals, mineralogy, grain size, microbial community, organic carbon, and dissolved oxygen. Factors that affect uptake into the foodweb and subsequent bioaccumulation include: species composition, growth rate, density, food chain length, trophic transfer efficiency, exposure time, food availability and quality, predation, fecundity, habitat/vegetation, and hydrodynamics (Alpers et al., 2008).

Transformations of floured elemental Hg are essentially unknown. Increased surface area and chemical reactivity of floured Hg are likely important factors relevant to the overall environmental effects of Hg that is discharged from suction dredging activity. It is possible that floured Hg floating on the surface of water would volatilize, but if it remains a liquid droplet, either on the surface or having sunk, it would be subject to transformation. Transformation of liquid Hg(0) to dissolved Hg(II) has been shown to be proportional to surface area. The half-life of a 0.1 milliliter droplet of Hg in water subjected to dissolution alone is approximately 30 years (Amyot et al., 2005). Assuming droplets as spheres, dividing a single 0.1 mL droplet (approx. 6 mm diameter) into 10 equal smaller droplets (of approx. 2.7 mm) increases the surface area by approximately 2 times, while dividing it into 10,000 equal smaller droplets (of approx 0.27 mm) increases it by approximately 20 times. An extreme case would be the division into 10,000,000,000 equal droplets (of approx 2.7 μ m), increasing the surface area by approximately 2000 times. This size droplet was observed on amalgam surfaces from the South Yuba River via a scanning electron microscope (Fleck et al., 2011). Regarding the impact of elemental mercury on uptake of MeHg, in microcosms containing sediment, zebrafish, and Hg droplets, rapid (i.e., within 7 days) increases in dissolved and fish tissue MeHg concentration have been observed after the start of the exposure (Dominique et al., 2007).

While fish tissue levels represent Hg accumulated over time, concentrations of Hg in water are variable and affected by season and hydrologic conditions, and are, therefore, an uncertain predictor of fish tissue levels (Brigham et al., 2009). However, several studies have found significant correlations between THg and MeHg in the water column (both filtered and unfiltered) and fish tissue levels (Chasar et al., 2009; Scudder et al., 2009). Scudder et al. (2009) found significant correlations between sediment MeHg levels normalized by loss on ignition (a measure of organic matter content) and fish tissue levels. The logarithm of the bioaccumulation factor (BAF) of filtered MeHg from fish to water is approximately 6.33, while the BAF of sediment MeHg to fish is approximately 3.42 (Scudder et al., 2009). This means that at equilibrium, there is > 2,000,000 times more MeHg in fish than in the surrounding water, and > 2,000 times more MeHg in fish than in the sediment in their vicinity.

Because Pit #2:BC sediments were relatively more elevated in Hg(II)_R than THg compared to surface sediment layers, the potential environmental impact caused by mobilization of Hg(II)_R may be even greater than is suggested by THg (Fleck et al., 2011). Additionally, resuspension of Pit #1 and Pit#2:BC sediments has been demonstrated to affect Hg speciation in the sediments. After resuspension for 7 days in oxygenated water under laboratory conditions, THg concentrations exhibited an apparent decrease, while Hg(II)_R concentrations increased in both Pit #1 and Pit #2:BC sediments (Marvin-Dipasquale et al.,

2011). The authors of the study attributed decreasing THg concentrations to loss of fine particles in the supernatant following centrifugation. Because this is an artifact of the laboratory methodology, THg would not be expected to decrease after resuspension in the environment. Also possible, but deemed unlikely by the authors, was loss to volatilization and issues related to sampling bias.

Experiments at Camp Far West Reservoir, found that upstream sources of MeHg may be more significant under high-flow conditions, while sources internal to the reservoir may be more important during low-flow conditions (Kuwabara et al., 2003). Benthic fluxes of dissolved MeHg were generally negligible or positive, that is, from the sediment to the water-column, and were greater during April (when water was oxic) than November (when water was suboxic).

A fundamental difference between Hg discharged by suction dredging and that discharged from background watershed sources is that the majority of suction dredging discharge and transport occurs during the summer, while the majority of background Hg transport occurs during high winter flows. The impact of this difference is not obvious, and will likely vary from watershed to watershed. One important distinction is that higher temperatures in the summer contribute to higher methylation rates, assuming that the mercury is transported to a region where methylation could occur. However, California's water system is highly managed—factors such as increased reservoir storage during the winter have been correlated with increased food-web MeHg levels in Camp Far West Reservoir, (Stewart et al., 2008).

In-stream: As discussed above, coarse-particle (i.e., >63 μm) bound Hg in elevated concentrations discharged from suction dredging in the South Yuba River is transported to nearby other parts of the stream where it settles out and rests on the surface. Because concentrations and loads of Hg within the stream are not altered, assessment of the transformation and bioaccumulation of this Hg examines the impact of resuspension and movement of Hg at depth to Hg in the top-sediment. Recent studies indicate that following resuspension of South Yuba River sediments, both from Pit #1 and Pit #2:BC, increased methylation was not observed after deposition into South Yuba River receiving sediments, which were relatively low in organic content (Marvin-DiPasquale, 2011).

Nevertheless, invertebrate Hg data from the South Yuba River indicate that suction dredging may have been contributing to elevated tissue concentrations. Suction dredging on the South Yuba was prohibited by the Bureau of Land Management during 2008, but had been allowed in all years prior. Figures 4.2-16 through 4.2-18 show invertebrate MeHg levels analyzed at one site in Humbug Creek and several sites downstream of its confluence with the South Yuba River in 2007 and 2008. All taxa collected in 2007 had higher concentrations of MeHg than the same taxa from the same sites in 2008, with few exceptions for which concentrations were similar. Overall, levels in 2008 were statistically significantly higher than levels in 2007. Documented inter-annual variation in other watersheds is typically less than differences observed in the South Yuba River. Hydrologic conditions were very similar between these water years, and were not atypical for this region, except in April through June, when conditions were drier than normal for both years (Fleck et al., 2011). Although caution should be used in interpreting these results because only year of data is available for the no dredging condition, these are likely the only data available at this time that can be used to compare tissue Hg levels with and without the

influence of suction dredging. Fish tissue levels of Hg in the South Yuba River are relatively low (0.17 parts per million [ppm] average), owing in part to the fact that the figure is from rainbow trout, which tend to accumulate MeHg to a much lesser extent than piscivorous fish such as largemouth bass (the average Hg concentration in trout tissue from around the U.S. is about 0.11 ppm).

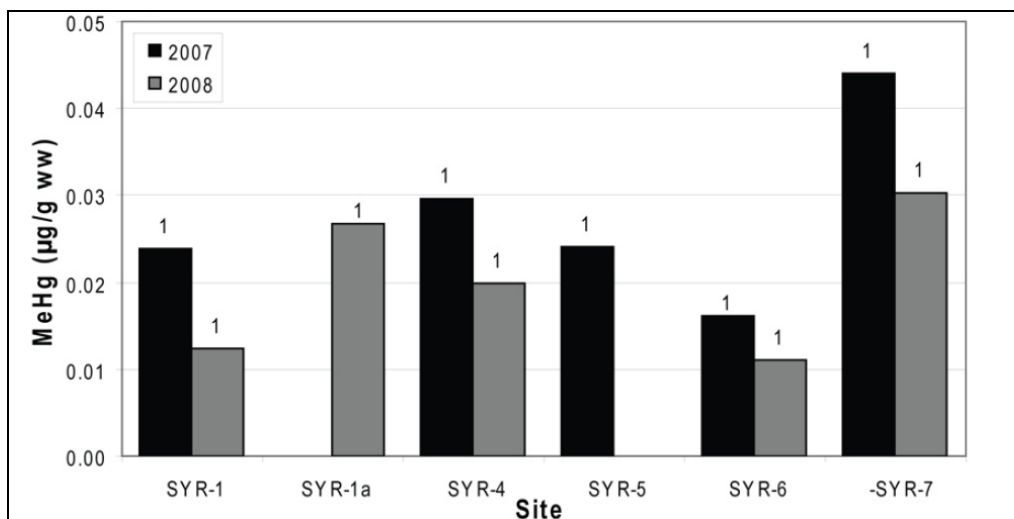


FIGURE 4.2-16. METHYLMERCURY (MeHg, $\mu\text{g/g ww}$ [WET WEIGHT]) CONCENTRATIONS IN INDIVIDUAL COMPOSITE SAMPLES OF LARVAL CADDISFLIES (ORDER TRICHOPTERA, FAMILY HYDROPSYCHIDAE) COLLECTED FROM THE HUMBAG CREEK/SOUTH YUBA STUDY AREA IN SEPTEMBER 2007 AND SEPTEMBER 2008

(Fleck et al., 2011)

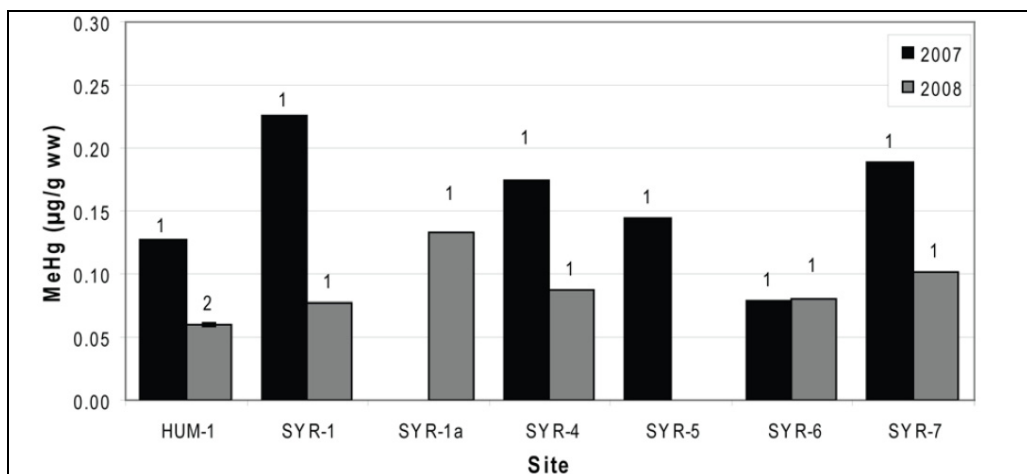
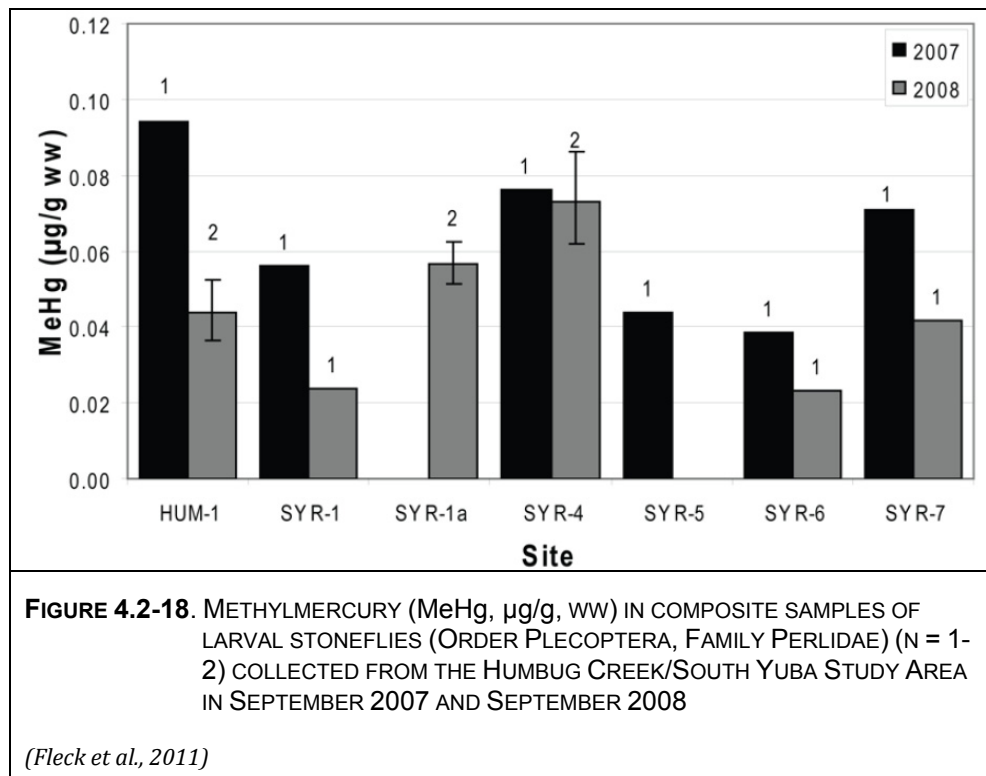


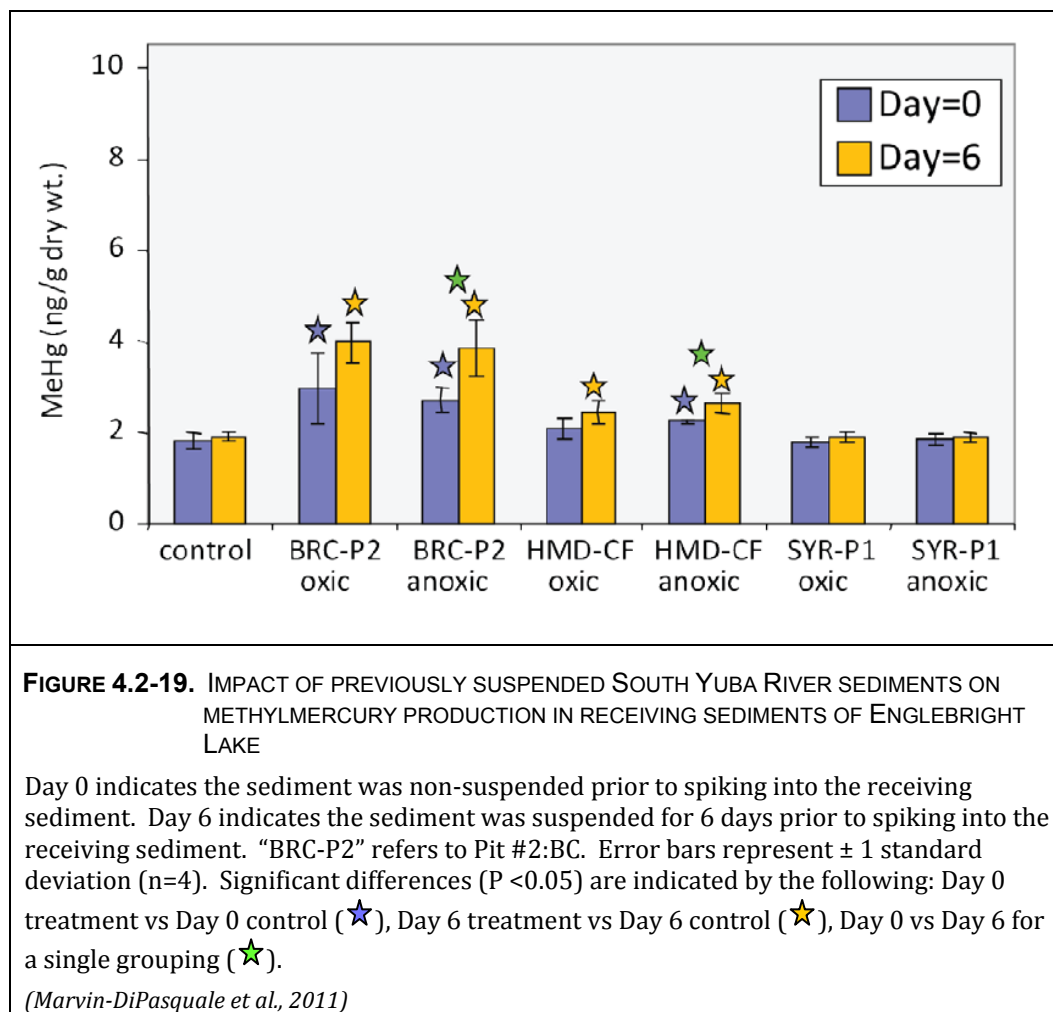
FIGURE 4.2-17. METHYLMERCURY (MeHg, $\mu\text{g/g ww}$) IN COMPOSITE SAMPLES OF WATER STRIDERS (ORDER HEMIPTERA, FAMILY GERRIDAE) (N = 1-2) COLLECTED FROM THE HUMBAG CREEK/SOUTH YUBA STUDY AREA IN SEPTEMBER 2007 AND SEPTEMBER 2008

(Fleck et al., 2011)



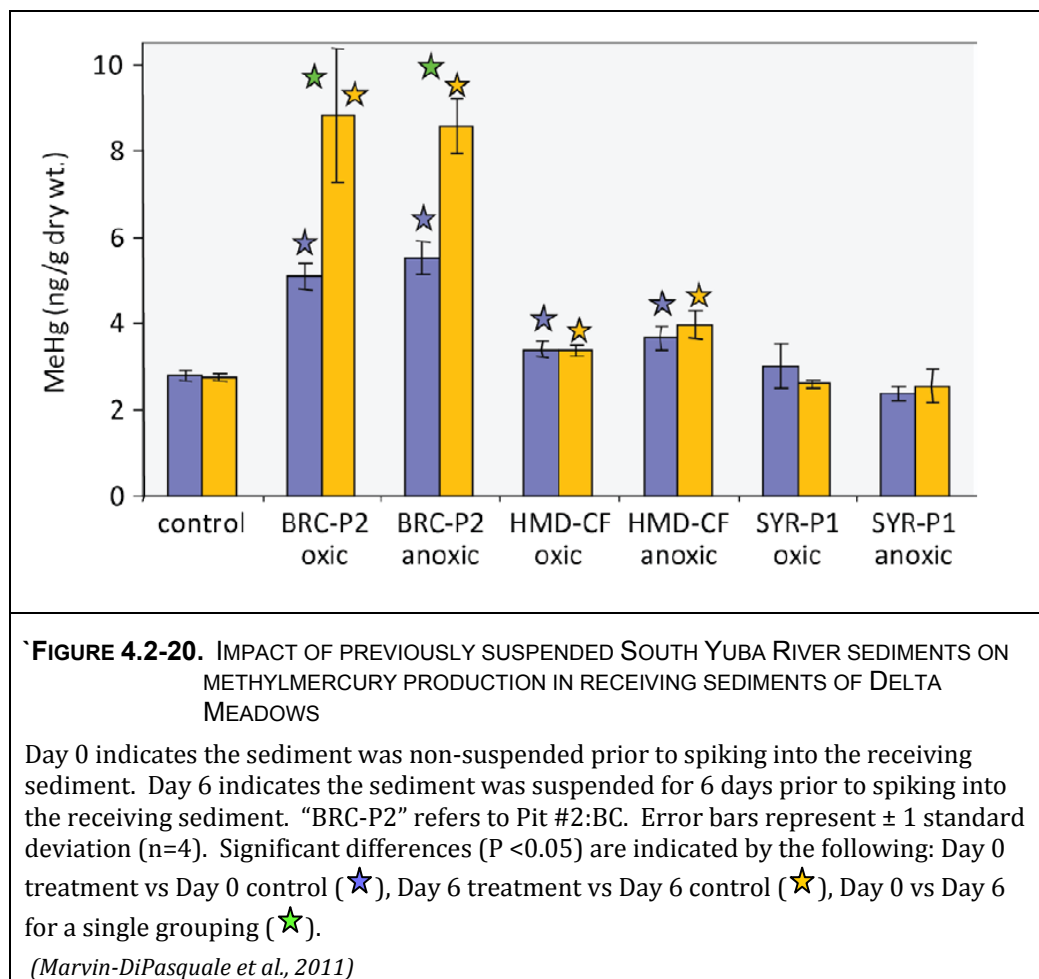
Englebright Lake: As discussed above, fine-particle bound Hg in elevated concentrations discharged from suction dredging in the South Yuba River may settle into bed-sediments of Englebright Lake. Mercury methylation potential is high (about 1% per day) in shallow sediments (4-12 centimeter) of Englebright Lake, and quite low (usually non-detectable) in deeper sediments (Alpers et al., 2006) and, therefore, increased concentrations of Hg in top-sediment of Englebright Lake would be expected to increase MeHg concentrations within the sediment. The sedimentation rate in Englebright Lake is quite high, on the order of 0.1 meters per year. Therefore, it is reasonable to conclude that much of the MeHg produced within the sediments of Englebright Lake is from Hg (whether from background sources or discharge from suction dredging) that has been deposited in the reservoir recently (i.e., within the previous few years). Therefore, it is expected that sediment-associated Hg discharged from suction dredging and transported downstream to Englebright Lake contributes to levels of MeHg found in surface sediments. Elevated fish tissue Hg concentrations in Englebright Lake (0.66 ppm in Smallmouth Bass) are driven by MeHg in the lake's sediment and water column, which in turn are affected by discharge and transport of Hg from suction dredging in addition to background watershed sources.

Recent experiments have shown that sediments from Pit #2:BC increased methylation relative to the control sediment when spiked into Englebright Lake receiving sediment. Being suspended for a period of 6 days, and then spiked into Englebright Lake receiving sediments at a ratio of 1:50, doubled MeHg production in the Englebright sediment when compared to the control, which was unspiked Englebright sediment (Figure 4.2-19; Marvin-DiPasquale, 2011). The same experiments using sediment from Pit #1 showed no impact on MeHg concentrations in Englebright Lake.



Delta: Several studies have documented a significant positive correlation in the Delta between THg and MeHg (Heim, 2003; Slotton, 2003). The relationships are stronger when only one type of habitat is considered. Experiments have shown that sediments from Pit #2:BC doubled methylation relative to the control sediment when spiked into Delta receiving sediments, and after being suspended for a period of 6 days and then spiked into Delta receiving sediments, tripled MeHg production within the sediment (Figure 4.2-20). It is widely known that wetlands (i.e., land with permanently saturated soil and shallow water and favorable redox conditions) are environments favorable to methylation, and the Delta was used in these experiments as a surrogate for wetland environments. The same experiments using sediment from Pit #1 showed no impact on MeHg concentrations in Delta sediments.

Of the fish tissue levels for the protection of human health shown in Table 4.2-2, values derived using the U.S. EPA 2001 methodology based on mean and 95th percentile consumption rates in California of 0.17 and 0.06 mg/kg, respectively, are the most appropriate values to use for this assessment. Consideration is also given to criteria for protection of fish-eating mammals and birds, which are 0.1 and 0.02 mg/kg, respectively.



Evidence from laboratory experiments has shown that selenium may be able to moderate the toxic effects of Hg when present at a molar ratio greater than around 1:1 (Ganter, 1972), and that most fish in the United States contain high enough levels of selenium to make this a possibility (Peterson et al., 2009). However, epidemiological support for this phenomenon is lacking, and the limited evidence gives mixed results (Watanabe, 2002). It is, therefore, unclear how experimental evidence translates into low dose, chronic risk assessments which are conducted to derive criteria. Consequently, derived criteria do not incorporate the possibility of toxicity moderation via selenium.

Fish and other aquatic life may themselves be affected by Hg. The known acute and chronic LC50s for Hg exposure (inorganic or methyl) in water are much higher than environmental concentrations. Criteria have not been developed for the protection of aquatic life in the United States. The Canadian Water Quality Guideline (CWQG) to protect freshwater life is 26 nanograms per liter (ng/L) inorganic Hg. For MeHg, the interim CWQG is 4 ng/L (Environment Canada, 2005). Effects on fish that may occur at environmentally relevant concentrations include adverse effects on feeding behavior (0.27 mg/kg in tissue as eggs) (Fjeld et al. 1998), reduced egg survival/hatching success (exposure to 100 ng/L and 1.05 mg/kg sediment THg) (USFWS 2003), male mortality (dietary source resulting in 0.5 mg/kg MeHg in tissue) (Matta et al., 2001), impaired sexual development or immune function

(0.254 mg/kg MeHg in tissue) (Friedmann et al., 1996), and changes in gene expression associated with endocrine disruption (0.87 mg/kg MeHg in diet) (Klaper et al., 2006).

From Table 4.2-3, it is evident that numerous water bodies throughout the state contain fish with tissue mercury concentrations that exceed human health criteria (> 0.06 - 0.3 mg/kg; see Table 4.2-2), criteria for the protection of mammalian and avian wildlife (> 0.1 and 0.02 mg/kg, respectively; see Table 4.2-2), and thresholds at which adverse impacts to fish have been documented (> 0.254 mg/kg; see above paragraph).

Hg concentrations in water to be used for potable uses are usually well below the maximum contaminant level (MCL) of $2\text{ }\mu\text{g/L}$, which reflects the allowable concentration over a long-term (i.e., lifetime) exposure of an individual who consumes water containing Hg. The assessment of potential Hg discharges from Pit #1 and Pit #2:BC from the South Yuba River could result in a dredging plume concentration exceeding the CTR human health criteria upon leaving the dredge. There has been no work done to determine how far CTR and human health criteria exceedences would extend down stream of a dredge dredging Pit #2 type sediment.. Given that the discharge of Hg would be associated with TSS, and TSS plumes would undergo substantial attenuation due to sediment settling and dilution downstream, Hg concentrations would decrease downstream of the dredging. Exposure of drinking water sources to Hg from dredging activity would be low because dredging activity is anticipated to be largely dispersed, intermittent, and temporary. Consequently, the potential exposure of drinking water supplies diverted downstream from dredging areas to Hg levels exceeding the state drinking water MCL of $2\text{ }\mu\text{g/L}$ would be expected to be infrequent and intermittent. Thus, the Program would not cause substantial, or likely even measurable, increased risk to human health through consumption of Hg in drinking water supplies.

Geographic Translation

Although the South Yuba River, Englebright Lake, and the Sacramento-San Joaquin Delta were assessed specifically due to the availability of data at these sites, findings can be translated to other watersheds and geographic regions based on characteristics common to these areas and assessed areas.

As shown in Figure 4.2-2, historic gold mines are located throughout California, and suction dredgers target areas where gold has been located. Elemental Hg was used in both placer and hard-rock gold mining, and, therefore, is found throughout historic gold-mining regions. This causes background sediment Hg concentrations to be high throughout gold-mining regions, as well causing an increased probability of Hg hot-spots. Although hydraulic mining was most extensively practiced in the South Yuba watershed, it also was practiced in other watersheds of the Yuba, as well as watersheds of the Feather, American, Bear, Cosumnes, and Tuolumne Rivers. Additional sediment characterization from areas most likely to be targeted by suction dredgers would further clarify risk of dredging actions exacerbating existing Hg problems. Fish tissue data suggest that Hg in tissue will be high throughout historic gold-mining regions, and most sites are on the CWA Section 303(d) listed for Hg already. Fish tissue concentrations are above thresholds of concern throughout historic gold-mining regions (see Table 4.2-3). Therefore, any impact of suction dredging on Hg loading and MeHg concentrations in downstream environments might further exacerbate the existing Hg impairments.

Assessing risk on a site-specific basis across the state would be possible following site-specific characterization of: 1) sediment Hg levels, 2) estimates of watershed load, 3) impact on methylation experiments, and 4) impact on reactivity of resuspension experiments. Suction dredging will likely not pose substantial risk at every location it is practiced, but substantially increased risk from dredging discharges and associated Hg resuspension will likely be common across the state.

Summary of Findings

Suction dredging operators may target deep sediments (i.e., those too deep to be available to scour under winter flows), and thus mobilize sediment that may not be mobilized by typical winter high-flow events. Sediments in the historic gold-bearing and gold-mining areas of California that would be targeted by suction dredgers also may be elevated in Hg compared to sediments in other non-mining areas. The discharge of sediment with high THg concentrations will result in increased THg concentrations in upper sediments of downstream water bodies, particularly in lower elevation zones of natural sediment deposition (e.g., low-gradient floodplains), including reservoirs where present. A substantial fraction of the fine sediment also may pass through lower elevation reservoirs and thus be transported to lower elevation locations, such as the Sacramento-San Joaquin Delta, where Hg methylation and uptake may occur.

The fate and transport assessment conducted herein, based on recent intensive field studies of sites in the Yuba River system conducted by USGS scientists, indicates that the discharge and transport of THg loads from suction dredging of areas containing sediments highly elevated in Hg and elemental Hg is substantial relative to background watershed loadings, especially in below average runoff water years. For example, within areas of highly elevated sediment Hg concentrations, a single suction dredge operator using an average size (4 inch) dredge could discharge approximately 10% of the entire watershed Hg loading during a dry year during an average suction dredging time of 160 hours. By inference, the analysis indicates that larger capacity dredges or multiple dredges operating in similar sediments with highly elevated sediment Hg concentrations could potentially contribute a much larger proportion of the watershed load than 10%. The value 10% was selected based on a professional judgment of what would be a measurable increase in background loading. The analysis does not assume that this is a threshold of significance below which effects are insubstantial, but is used as a reasonable point of reference. The relative proportion of THg loading from suction dredging activity, compared to background watershed loading, is directly dependent on the dredge size, duration of operations during the year, and sediment characteristics and concentrations. The loading assessment indicates that dredging in areas with average sediment Hg concentrations and no elemental Hg is unlikely to result in a substantial contribution to the overall watershed loading. For example, when dredging in sediments with average Hg concentrations, more than the entire permitted population of suction dredgers would need to be operating within the watershed to discharge 10% of the background Hg loading in a dry year using average size (4 inch) dredges. Additionally, suction dredging discharge and transport of THg occurs primarily in the summer rather than the winter, when most background Hg is transported to reservoirs. While the precise implications of this are not known, it is known that methylation is generally more pronounced at higher temperatures and lower oxygen environments, both of which are more likely under summer conditions than winter conditions.

1 Additionally, while many unknowns surround the flouting of elemental Hg, the increased
2 surface area and increased potential for downstream transport will likely enhance
3 reactivity and transport to areas favorable to methylation (i.e., downstream reservoirs and
4 wetlands). Moreover, resuspension of sediments containing Hg in oxygenated environments
5 has been shown to increase levels of Hg(II)_R, which has been shown to be directly related to
6 methylation rate. The only available data comparing tissue Hg levels under the influence of
7 suction dredging and when no suction dredging was occurring indicate a decrease in tissue
8 Hg concentration under the no dredging condition that may not be attributable to inter-
9 annual variability or hydrologic conditions alone. Overall, available data show that suction
10 dredging of sediments with elevated THg concentrations and deposits of elemental Hg can
11 be a principal source of concern for producing higher THg concentrations in downstream
12 deposition zone sediments than would otherwise occur from discharges only of natural
13 watershed loading events. Moreover, such mobilized sediment containing high THg and
14 Hg(II)_R concentrations results in increased MeHg production in reservoirs or the Delta
15 where these Hg-laden sediments are deposited. On the contrary, mobilized sediment
16 containing average sediment Hg concentrations has been shown to have no effect on
17 measurable effect on MeHg production in a downstream reservoir or the Delta.

18 Finally, the Office of Environmental Health Hazard Assessment has documented and issued
19 consumer fish consumption advisories due to elevated levels of Hg in fish tissue for
20 numerous areas of California that were historically affected by Hg ore mining, and in some
21 of the areas where gold mining occurred and elemental Hg was used extensively.
22 Concentrations of Hg in fish tissue in these areas are also above criteria developed for the
23 protection of mammalian and avian wildlife, and occasionally exceed levels that have been
24 found to adversely affect fish health or reproduction. Fish tissue Hg levels have been
25 correlated to MeHg levels in sediment, which in turn have been correlated with THg levels
26 in sediment.

27 Based on the information discussed above, suction dredging has the potential to contribute
28 substantially to: (1) watershed Hg loading to downstream reaches within the same water
29 body and to downstream water bodies, (2) MeHg formation in the downstream
30 reaches/water bodies, and (3) bioaccumulation in aquatic organisms in these downstream
31 reaches/water bodies. Available evidence suggests that these processes associated with
32 suction dredging in the Sierra foothills, for example, may increase Hg levels in
33 reaches/water bodies downstream of suction dredging areas by frequency, magnitude, and
34 geographic extent such that MeHg body burdens in aquatic organisms may be measurably
35 increased, thereby substantially increasing the health risks to wildlife (including fish) or
36 humans consuming these organisms. Therefore, this impact is considered a potentially
37 significant impact.

38 Potential mitigation measures to reduce the impact would necessarily involve actions to
39 avoid or limit THg discharge from areas containing elevated sediment Hg and/or elemental
40 Hg from suction dredging activities under the Program. Such discharge limiting actions
41 could include the following:

- 42 ■ Identify river watersheds or sub-watersheds where sediment Hg levels are
43 elevated above regional background levels or where elemental Hg deposits exist
44 and establish closure areas to avoid suction dredging within these areas. No
45 such data currently exist to comprehensively identify Hg "hot-spots"; however,
46 data, especially from Sierra Nevada watersheds impacted by mining, suggest

that sediment mercury levels at these sites are elevated above background levels. Hence, this action could involve a phased study to identify the presence of such areas based on intrinsic properties including proximity to mines, hydraulic and channel features, and other factors.

- Limit the allowable suction dredge nozzle size and/or allowable seasonal duration of dredging activity within water bodies known to contain sediment elevated in Hg or that contain elemental Hg deposits. Although smaller nozzle sizes would still cause mercury releases when dredging mercury enriched sediment, the amount of mercury discharged would be lower than with larger nozzle sizes.
- Implement a special individual permit system for suction dredge operators for areas where Hg “hot-spots” exist. The permit system would be designed to require assessment of the area prior to initiation of dredging activity and issuance of terms and conditions to ensure that Hg hot-spots are identified and avoided or other provisions are implemented to ensure that the dredging activity does not result in substantial discharge of Hg downstream from the site.

Implementation of such mitigation actions, implementation procedures, monitoring, and enforcement may reduce potential impacts. However, because not all locations of elemental mercury deposits are known, the feasibility with which sites containing elemental mercury could be identified at a level of certainty that is sufficient to develop appropriate closure areas or other restrictions for allowable dredging activities, is uncertain at this time. Moreover, at this time the Program allows for suction dredging activities to occur on a statewide basis within areas known to contain historic gold mining sites and sediments contaminated with elemental mercury. Thus, a comprehensive set of actions to mitigate the potential impact through avoidance or minimization of mercury discharges has not been determined at this time, nor is its likely effectiveness known. It should be noted that a program of feasible and adequate mitigation actions may be developed that includes the phased implementation of actions in combination with adaptive monitoring and evaluation measures. This impact would remain potentially significant until such time that a sufficient and feasible mitigation program is developed but there is no guarantee that this type of mitigation is practicable. This impact is considered significant and unavoidable.

Impact WQ-5. Effects of Resuspension and Discharge of Other Trace Metals from Suction Dredging (Significant and Unavoidable)

Implementation of suction dredging under the Program may result in dredging activity occurring in areas within California where the sediments could contain relatively elevated concentrations of trace metals other than Hg (e.g., copper, lead, zinc). Historic copper, lead, and silver mines are located throughout the Sierra Nevada, and copper, lead, silver, and zinc mines are located in the Klamath-Trinity Mountains. Trace metals levels in sediments in Sierra streams have not been thoroughly evaluated, with the exception that specific mining cleanup projects may have site-specific data (e.g., Iron Mountain Mine, located adjacent to Spring Creek and other tributaries to the Sacramento River near Redding). As identified in Table 4.2-1 above, the RWQCBs have identified numerous stream segments on the 303(d) list of impaired water bodies for various trace metals. Many 303(d) listed water bodies are lower elevation bays and enclosed estuaries where the historical industrial sources are the cause for listing. However, the upper Sacramento River watershed includes several 303(d) listed streams near well-known mining areas which are affected by acid mine drainage

1 producing substantial discharges primarily of cadmium, copper, and zinc. At such sites,
2 metals levels tend to be elevated in sediments, sediment pore water, and the water column.

3 Aquatic life beneficial uses are the most sensitive beneficial uses to ambient water body
4 concentrations of most trace metals. However, as evidenced by primary or secondary
5 drinking water MCLs, the municipal and domestic water supply beneficial use may be more
6 sensitive to some constituents (e.g., arsenic, iron, and manganese).

7 As noted in the discussion above for Impact WQ-3 (Turbidity/TSS), suction dredging: (a) is
8 intermittent in nature, (b) is generally widely dispersed geographically across the state,
9 typically occurs in undeveloped upper watershed areas, and (c) generally produces small
10 discharge volumes, relative to the total discharge of the water body in which dredging
11 occurs and relative to downstream larger order streams and rivers where drinking water
12 diversions exist. Consequently, dissolved trace metals or that fraction of the total metal
13 mobilized that is adsorbed to sediment particles <63 µm that stay suspended for long
14 periods of time tend to be rapidly diluted, both within the immediate water body and are
15 further diluted in downstream waters bodies. Moreover, the remainder of the total
16 recoverable trace metal fraction that is mobilized by suction dredging (i.e., fraction
17 adsorbed to larger sediment particles) generally settles out within a few hundred meters of
18 the dredging site. The result is that trace metals concentrations that may be elevated in the
19 dredging discharge tend to return to background levels within close proximity to the
20 dredge.

21 Although relatively little study of trace metal (other than mercury) mobilization and
22 transport related to suction dredging has occurred, a few studies have been identified.
23 Johnson and Peterschmidt (2005) identified a maximum copper concentration of 9.3 µg/L
24 in suction dredge effluent in a study on the Similkameen River in Washington State. Zinc
25 and lead were both significantly below their respective acute criteria. In a study of dredging
26 in the Fortymile River of Alaska, the maximum near-field copper concentration was
27 20 µg/L, and the maximum zinc concentration was 43 µg/L (Royer et al., 1999). In both
28 studies, concentrations returned to ambient background levels within a short distance from
29 the dredging site.

30 Based on the above discussion and studies cited, it is not expected that suction dredging
31 under the Program would cause more frequent exceedance of CTR criteria for the
32 protection of the municipal and domestic water supply use or state drinking water MCLs at
33 frequency, magnitude, or geographic extent that would result in adverse effects on the
34 municipal and domestic supply beneficial use, or any of the other non aquatic life beneficial
35 uses. Therefore, the remainder of this assessment will focus on determining whether
36 suction dredging under the Program would adversely affect aquatic life beneficial uses.

37 The bioavailability (i.e., the ability for a metal to be taken into the body of an aquatic
38 organism) and thus toxicity of arsenic, cadmium, chromium, copper, lead, nickel, silver, and
39 zinc are affected by the total hardness of the water and concentrations of other water
40 quality parameters, such as dissolved organic carbon, specific cations and anions, and pH
41 where exposure occurs. Consequently, the CTR criteria for these metals include either
42 includes a "water-effect ratio," that is hardness based, or both. The water-effect ratio
43 component of the CTR criteria equations for these metals accounts for the effect of all water
44 quality characteristics other than hardness on the metal's bioavailability and thus toxicity.

This is important to consider in this assessment because metals that are bound to sediment particles are not bioavailable to fish and benthic macroinvertebrates and thus are not in a form that can cause toxicity to aquatic life. Moreover, the dissolved fraction of metals measured is not all bioavailable for uptake by organisms. The amount of the dissolved fraction that is bioavailable depends on the water chemistry characteristics identified above.

This assessment considered the potential discharge of trace metals from suction dredging using a fate and transport methodology similar to that used for the assessment of mercury. Sediment core data from Englebright Lake in the Yuba River watershed, and from the lower Sacramento River between Redding and Freeport, were used as assumed average stream sediment concentrations and coupled with actual TSS data from suction dredge discharges to estimate total recoverable concentrations of arsenic, copper, silver, zinc, lead, chromium, nickel, and cadmium in a dredge's discharge plume. These estimates assume that 100% of the metal concentration is adsorbed to sediment for the purpose of calculating the estimated discharge concentrations. In reality, it is expected that most of the discharged metals concentration would indeed be sediment bound, but some fraction would be in the dissolved form, and a portion of the dissolved fraction would actually be bioavailable for uptake by organisms. The estimated discharge total recoverable metal concentrations were then compared to CTR acute (criteria maximum concentration [CMC]) and chronic (criteria chronic concentration [CCC]) criteria, based on moderate Sierra stream hardness of 40 mg/L as CaCO₃, with results shown in Table 4.2-6.

TABLE 4.2-6. SEDIMENT CONCENTRATIONS OF TRACE METALS IN SIERRA NEVADA STREAMS AND ESTIMATED TOTAL RECOVERABLE CONCENTRATIONS IN SUCTION DREDGE DISCHARGE PLUMES UNDER ASSUMED MINIMUM AND MAXIMUM TOTAL SUSPENDED SOLIDS CONCENTRATIONS

Metal	Concentration ⁽¹⁾ (mg/kg)	TEC ⁽²⁾ (mg/kg)	PEC ⁽²⁾ (mg/kg)	Total Recoverable Metal, µg/L; 3 mg/L TSS	Total Recoverable Metal, µg/L; 340 mg/L TSS	CTR CMC, µg/L ⁽³⁾	CTR CCC, µg/L ⁽⁴⁾
Arsenic	20.0	9.79	33	0.06	6.80	N/A	N/A
Copper	78.3	31.6	149	0.24	26.63	5.9	4.26
Silver	N/A	N/A	N/A	N/A	N/A	0.783	N/A
Zinc	134.5	121	459	0.40	45.73	55.1	55.1
Lead	17.4	35.8	128	0.052	5.93	25.43	0.99
Chromium	177.2	43.4	111	0.53	60.26	854	34.9
Nickel	96.1	22.7	48.6	0.29	32.68	220.4	24.0
Cadmium	0.6	0.99	4.98	0.0017	0.19	0.84	0.14

N/A = Not applicable; TSS = Total suspended solids; values in bold represent exceedances of TECs or CTR CMCs/CCCs.

¹ – Average of values measured in the Sacramento River (at Colusa, Verona, and Freeport [Alpers et al., 2000]), shallow cores in Englebright Lake (Sites 1, 4, and 7 [Alpers et al., 2006]), and fine grained sediments at Daguerre Point Dam (Alpers et al., 2006).

² – TEC = Threshold Effect Concentration (concentration below which harmful effects are unlikely to be observed); PEC = Probable Effect Concentration (concentration above which harmful effects are likely to be observed [MacDonald 2000]).

³ – CTR CMC = California Toxics Rule Criteria Maximum Concentration; assumed hardness of 40 mg/L as CaCO₃.

⁴ – CTR CCC = California Toxics Rule Criteria Continuous Concentration; assumed hardness of 40 mg/L as CaCO₃.

At the maximum anticipated TSS concentrations associated with suction dredging (i.e., 340 mg/L; Thomas, 1985), a number of CTR total recoverable criteria could potentially be

exceeded within the discharge plume. As stated above, settling of coarse suspended solids in combination with dilution from background streamflow would be expected to result in rapid attenuation of trace metal concentrations, which would be expected to return to background or near-background levels within a short distance downstream of the dredging site. Assuming that trace metals discharged from suction dredging are mostly associated with sediment, and that sediment levels in most areas dredged are relatively similar to areas elsewhere in the watershed (other than “hot-spot” areas), then the increased downstream loading of particulate-derived metals should not affect downstream sediment concentrations significantly.

In the scenario described above, most of the trace metal mobilized by the dredging activity, and measured as part of the total recoverable metals measurement, is expected to be bound to sediment particles. Sediment bound metal is not bioavailable to aquatic life and thus would not pose a risk of toxicity to fish or invertebrates passing through the discharge plume. In reality, one would expect some fraction of the total recoverable measurement of elevated metal concentration in the plume to be in a dissolved or ionic form that would be bioavailable to organisms. However, the concentration of metal in a bioavailable form is expected to be substantially lower than the full total recoverable concentrations shown in Table 4.2-6. At a typical dredging site (having sediment trace metal concentrations similar to those identified herein for the Yuba and Sacramento river sites and used in the Table 4.2-6 calculations), the dredging activity is not expected to increase the bioavailable concentration of any of the eight metals discussed to levels that would be toxic to aquatic life, on an acute or chronic basis. Moreover, the bioavailable fraction of metal, which could have been elevated by the dredging activity, will rapidly become diluted with increasing distance downstream from the dredging site, and is expected to rapidly return to background levels at most sites as shown in the studies cited above.

With regards to aquatic life exposure, because of the noise and activity around a site of active dredging, relatively few fish (within the river reach) would be expected to be exposed to the plume. Those invertebrates that may be disturbed and end up drifting through the plume would generally be exposed to elevated plume concentrations for only minutes before drifting beyond the plume itself. Likewise, fish feeding within the plume (on displaced and drifting invertebrates) or moving through the plume would be exposed to elevated metals levels for short periods of time, and would not be exposed to such conditions for four continuous days, which is the exposure period associated with the chronic (CCC) CTR criteria. Hence, based on the expected speciation (i.e., form) of total recoverable metal within the discharge plume and the exposure times of aquatic organisms to the plume itself, toxicity to aquatic organisms, even those temporarily feeding within or moving through the plume, is not expected to occur. This finding is consistent with the available scientific literature, which does not document toxicity to aquatic organisms associated with suction dredging.

Because there are specific sites in California where cadmium, copper, and zinc, for example, are highly elevated where historic mining activities occurred, it is reasonable to assume that localized hot-spots containing high sediment concentrations of metal ores exist. At such sites, sediment-bound metal concentrations and sediment pore water metal concentrations are likely to be substantially higher than at typical or “normal” sites assessed above. Such sites may also have problems associated with acid mine drainage. Such sites (e.g., Spring

Creek near the Iron Mountain Mine near Redding) tend to be identified on the state's 303(d) list due to their current, substantial impairments.

Consistent with the above discussion for typical (i.e., non-hot-spot) sites, suction dredging in metal hot-spot/acid mine drainage sites would tend to remobilize sediment-bound metals, which would rapidly re-settle to the creek bed within a short distance downstream of the site. However, hot-spot sites with known acid mine drainage issues (and associated low pH waters) would be expected to have very elevated levels of dissolved metals in both the water column and in the sediment pore water as well. Remobilization of highly elevated dissolved and bioavailable metal concentrations in low pH waters could have more far-reaching effects because once remobilized, the elevated concentrations of dissolved and bioavailable metals could move much farther downstream than the sediment-bound fraction. This would potentially discharge elevated concentrations of metals into downstream reaches or other downstream water bodies, thereby substantially elevating dissolved and bioavailable concentrations of various trace metals at distant downstream sites. At the example Spring Creek site, this could result in increased loading of dissolved and bioavailable trace metals to the Sacramento River, relative to the baseline condition of not dredging at this hot-spot site. Although adequate data are not available to perform a definitive, quantitative assessment of potential metal-related impacts to aquatic life and other beneficial uses within the hot-spot water body and at downstream locations due to suction dredging, this dredging scenario has the potential to adversely affect one or more beneficial uses within the hot-spot water body itself and at downstream water body locations.

Based on the information presented and discussed above, suction dredging under the Program at typical sites would not be expected to increase levels of trace metals assessed herein in any water body such that the water body would exceed state or federal water quality criteria by frequency, magnitude, or geographic extent that would result in adverse effects on one or more beneficial uses. In addition, suction dredging would not result in substantial, long-term degradation of trace metal conditions that would cause substantial adverse effects to one or more beneficial uses of a water body. Finally, because trace metals addressed in this assessment are not bioaccumulative constituents, the potential to mobilize the trace metals discussed herein would not substantially increase the health risks to wildlife (including fish) or humans consuming these organisms through bioaccumulative pathways.

Conversely, suction dredging at known trace metal hot-spots having acid mine drainage issues and associated low pH levels and high sediment and pore water metal concentrations, including high dissolved and bioavailable forms of metals, has the potential to increase levels of one or more trace metal in water body reaches such that the water body reach would exceed CTR metals criteria by frequency, magnitude, and geographic extent that could result in adverse effects to one or more beneficial uses, relative to baseline conditions. Therefore, this impact is considered to be potentially significant.

Potential mitigation measures to reduce the impact would necessarily involve identifying known trace metal hot-spots associated with past mining operations (e.g., problematic sites with acid mine drainage) and stating in the Regulations Program that these identified sites are closed to suction dredging.

Implementation of such mitigation actions may reduce potential impacts. However, because not all locations of such contamination are known, the feasibility with which contaminated sites could be identified at a level of certainty that is sufficient to develop appropriate closure areas or other restrictions for allowable dredging activities is uncertain at this time. Thus, a comprehensive set of actions to mitigate the potential impact through closures or minimization of discharges has not been determined at this time, nor is its likely effectiveness known. It should be noted that a program of feasible and adequate mitigation actions may be developed that includes the phased implementation of actions in combination with adaptive monitoring and evaluation measures. This impact would remain potentially significant until such time that a sufficient and feasible mitigation program is developed but there is no guarantee that this type of mitigation is practicable. This impact is considered significant and unavoidable.

***Impact WQ-6. Effects of Trace Organic Compounds Discharged from Suction Dredging
(Less than Significant)***

Implementation of suction dredging under the Program may result in dredging activity occurring in sediments that could potentially contain elevated concentrations of trace organic compounds such as the now-banned and persistent legacy chlorinated hydrocarbon pesticides (e.g., DDT, dieldrin, and chlordane). Legacy pesticides can be transported to remote or high altitude waterways atmospherically. However, trace organic compounds have rarely been observed above public health thresholds in fish in upper elevation watersheds where suction dredging generally occurs (Davis et al., 2009). PCBs also are transported atmospherically, and are more commonly found above threshold values in fish (Davis et al., 2009; Ohyama et al., 2004). As noted in the Literature Review (Appendix D), characteristics of trace organic compounds in aquatic sediments have not been thoroughly evaluated throughout California. Moreover, no studies have been undertaken to determine whether suction dredging releases these chemicals, and, if so, what the fate, transport, and effects of the chemicals are downstream. The lowest applicable CTR criteria, either for aquatic life protection or human health protection, differs among the different chlorinated hydrocarbon pesticides. Regardless, where CTR criteria exist for the protection of human health via consumption of water and organisms and organisms only (i.e., municipal and domestic supply and recreation uses) and aquatic life beneficial uses, the criteria for protection of human health tend to be lower (e.g., see CTR criteria for 4,4'-DDT, Aldrin, Dieldrin, Heptachlor, PCBs). However, for some compounds (e.g., Endrin, alpha-Endosulfan, beta-Endosulfan), the CTR aquatic life criteria are lower than the human health criteria.

There are several characteristics of trace organic compounds that reduce the potential for there to be adverse effects to beneficial uses associated with their resuspension caused by suction dredging. First, legacy chlorinated hydrocarbon pesticides in particular have a high affinity for binding to sediment; thus, resuspension is unlikely to result in substantial release of bioavailable compound to the water column.

Second, these trace organic compounds were generally not widely used in the rural areas where suction dredging activity typically occurs; thus, there is unlikely to be "hot spot" areas for these compounds where dredging occurs. Based on these considerations, the vast majority of trace organic compounds mobilized by suction dredging would be adsorbed to sediments, most of which would rapidly re-settle to the stream bed within close proximity to the dredging site. Aquatic life exposed to the dredging plume would not experience

toxicity because the sediment-adsorbed compounds would not be bioavailable for uptake by organisms. Trace organics adsorbed to fine sediments (e.g., <63 µm) that are transported further downstream also would remain biologically unavailable to aquatic life and would eventually settle back to the substrate in downstream water bodies. Drinking water intakes that may divert such re-suspended fine sediments would remove the vast majority of it in the filtration process.

Third, suction dredging activities target areas with relatively active stream flow conditions. Consequently, to the degree that a portion of re-suspended trace organics would be present in the water column in bioavailable forms, their concentrations would not be expected to be at levels that would cause toxicity to aquatic life at the site or immediately downstream of the site. This is due to both expected levels of bioavailable concentrations of these compounds being relatively low and the limited duration of exposure to the dredging plume areas that organisms would experience. Invertebrates displaced by dredging or fish passing through the plume would generally be exposed to the plume for a matter of minutes. This is consistent with findings from the literature review, which did not produce any scientific literature that suction dredging results in toxic conditions for fish or other aquatic organisms. Moreover, concentrations of bioavailable organics would be rapidly attenuated by dilution with increasing distance downstream. Thus, dredging discharges would not be expected to cause measurable increases in the bioconcentration or biomagnifications of these compounds in populations of organisms in downstream reaches and downstream water bodies, relative to the baseline conditions where dredging was not occurring.

Finally, because sediment mobilization associated with suction dredging is not expected to re-mobilize high concentrations of trace organics (but rather mobilize sediments having “typical” levels of these compounds adsorbed to the sediments), its re-deposition downstream should not substantially alter downstream sediment concentrations of these compounds.

Based on the information presented and discussed above, suction dredging under the Program would not be expected to increase levels of trace organics in any water body such that the water body would exceed state or federal water quality criteria by frequency, magnitude, or geographic extent that would result in adverse effects on one or more beneficial uses. In addition, suction dredging would not result in substantial, long-term degradation of trace organic conditions that would cause substantial adverse effects to one or more beneficial uses of a water body. Finally, suction dredging is not expected to mobilize trace organics in a manner or to an extent that would increase levels of any bioaccumulative trace organic in a water body by frequency and magnitude such that body burdens in populations of aquatic organisms would be expected to measurably increase, thereby substantially increasing the health risks to wildlife (including fish) or humans consuming these organisms. Therefore, this impact is considered to be less than significant.

Activities Requiring Fish and Game Code Section 1602 Notification

Activities requiring notification under Fish and Game Code section 1602 are likely to result in additional site disturbances, increasing the potential to cause additional adverse water quality effects. Larger nozzle sizes and power winching would increase the amount of substrate movement capability, while dredging in lakes would potential affect sediment substrates with properties (e.g., percent fine-grained materials, organic matter content,

chemical composition, etc.) that may substantially differ than the predominant mineral and dense riverine sediments assessed herein. Suction dredging in lakes also would potentially increase the available area and amount of dredging within the state beyond those anticipated under the proposed regulations. Diverting stream flows at suction dredging sites would have the potential to increase channel sediment disturbance and alter the dilution and assimilative capacity of discharge plumes associated with dredging-related activity.

Activities subject to Fish and Game Code section 1602 notification have the potential to increase the discharge of sediment and magnitude and duration of turbidity/TSS plumes downstream of the dredging activity than the conditions assessed for the proposed regulations. Additionally, turbidity/TSS plumes and effects to aquatic organisms in calm lake or reservoir water bodies could differ substantially compared to the conditions assessed herein. Consequently, additional environmental assessment of turbidity/TSS discharges may be necessary to determine if the activity would result in a significant impact requiring implementation of mitigation. The extent of the necessary analyses would be determined by the CDFG on a case-by-case basis, and the detailed assessment would be evaluated in a CEQA analysis.

The additional activities that would be subject to Fish and Game Code section 1602 notification would not be anticipated to result in additional or substantially changed effects associated with encampment activities (Impact WQ-1), discharges of oil and gasoline (Impact WQ-2), or discharges of organic compounds (Impact WQ-6), which were all determined to be less-than-significant impacts under the proposed regulations not requiring Fish and Game Code section 1602 notification. Additional sediment disturbance associated with increased dredging nozzle size, diversion of streamflow, and allowance of dredging in lakes/reservoirs could increase the discharge of mercury (Impact WQ-4) and other trace metals (Impact WQ-5), as assessed above. Though the impacts of discharges of mercury and other trace metals have been found to be significant and unavoidable, activities requiring notification under Fish and Game Code section 1602 may contribute to additional adverse effects; the extent of which, would be evaluated in a CEQA analysis.