
State of California
The Resources Agency
Department of Water Resources

**CONTAMINANT ACCUMULATION IN FISH,
SEDIMENTS,
AND THE AQUATIC FOOD CHAIN
-
STUDY PLAN W2, PHASE 1 DRAFT REPORT**

**Oroville Facilities Relicensing
FERC Project No. 2100**



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REPORT SUMMARY

Significant historic and current gold mining, hydropower generation, and industrial activities in the upper Feather River watershed could contribute metal and organic contaminants to project waters. Sediments laden with metals and organic contaminants could undergo biochemical conversion in the reservoirs, become available to biota, and subsequently bioaccumulate in the food web within project waters. A variety of wildlife, including threatened and endangered species, prey on fish from project waters, which also receive significant activity from sport fishermen. This study was undertaken to determine the significance of contamination in fish, crayfish, and sediments in project waters, and evaluate the effect to prey species and humans. The study was divided into two phases. Phase 1 evaluates contaminants in biota and sediments in the project area, while Phase 2 evaluates sources of contaminants, extent of downstream effects, and provides additional information within the project area. This report presents the results of the first phase of the study.

Eleven organic compounds, included two PCB aroclors, were detected in fish from the project area. The contaminants detected in fish include chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, and trans-nonachlor), dichloro-diphenyl-trichloroethane (DDT) breakdown products (DDD,op', DDD,p,p', DDE,p,p', and DDMU,p,p'), dieldrin, hexachlorobenzene, and polychlorinated biphenyl (PCB) aroclors 1254 and 1260 and congeners. The organophosphate chlorpyrifos was also detected. Only the DDT breakdown product DDE,p,p' and PCB arochlor 1254 were found in crayfish.

Metals detected in fish tissues include arsenic, cadmium, chromium, copper, nickel, lead, selenium, silver, zinc, and mercury. All the metals were also detected in crayfish, except arsenic, cadmium, nickel, and selenium which were not analyzed from these organisms.

Several of the organic and metal contaminants exceed various guidelines or criteria developed to evaluate the significance of contamination and protect wildlife or humans that may eat contaminated fish. Results from this phase of the study will be used to determine analyses required from sediment samples collected during Phase 1, and additional monitoring requirements upstream, within, and downstream from the project area for Phase 2 of the study.

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1.0 INTRODUCTION

The Environmental Work Group identified contaminant accumulation in fish, sediment, and the aquatic food chain as an issue of concern. Contamination of fish from mercury and other metals and organic contaminants is a significant issue in many areas of California, including the Feather River watershed.

Lake Oroville tributaries in the upper Feather River watershed experienced significant gold mining activity during the Gold Rush era, and continue to experience significant recreational gold mining activity. Numerous large mercury mines were developed in the Coast Range to supply mercury as an amalgam for gold extraction in the Feather River and other areas. Mercury lost to the tributaries during gold mining operations is slowly being transported downstream with sediments. Though the Gold Rush era has long since passed, significant quantities of mercury still remain in the streams tributary to Lake Oroville.

Potentially occurring anoxic conditions beneath the sediment-water interface at the bottom of project reservoirs create ideal conditions for biologically mediated liberation of methylmercury by sulfate-reducing bacteria. The redistribution of methylmercury in the water column during lake mixing in the fall and winter may facilitate bioaccumulation into the food web, including plankton, fish, and piscivorous birds and other animals, including humans.

In addition, other industrial activities in the upper Feather River watershed have contributed metal and organic contaminants, including polychlorinated biphenyls, which also have an affinity for sediments and bioaccumulate in the food web. Re-suspended sediments and recycled metals and organic contaminants in Lake Oroville can be transported downstream to other project waters, including the Diversion Pool, Thermalito Forebay and Afterbay, Oroville Wildlife Area ponds, and Feather River, where uptake and bioaccumulation in aquatic organisms can occur.

Sediments trapped behind the dam are potentially laden with metals and organic contaminants, which may bioaccumulate in the food web. Sediments carried into Lake Oroville initially deposit into the upper tributary arms. Sediment deposits are transported further into the reservoir due to natural high flow hydrologic events, reduced reservoir levels, and periodic discharge surges from upstream hydropower generation.

1.1 BACKGROUND INFORMATION

Sediments in Feather River tributaries are known to carry metal and organic contaminants. Prior to construction of Oroville Dam, sediments carried by the tributaries and the main stem of the Feather River in the reservoir footprint were transported downstream. Subsequent to completion of the dam, sediments carried by the tributaries set-

tle into the upper arms of Lake Oroville, but are reworked by stream flows as reservoir levels drop throughout the summer and are re-deposited further into the reservoir area. Thermal stratification in the reservoir during the summer can facilitate leaching of metals and organic contaminants from the sediments into the water column, where they become available for uptake by aquatic life or release downstream. In addition, sediment dwelling organisms (e.g., crayfish, insects) ingest the sediments and can absorb contaminants. Contaminants in lower trophic levels are bioaccumulated in higher trophic level organisms, and may reach levels that are deleterious to other organisms (including listed species and humans) that ingest them.

Impoundment of the reservoir created conditions in which sediments possibly laden with contaminants are trapped, which could then allow bioaccumulation of contaminants in the food web. Water with bio-available forms of metals and organic contaminants that is released from the reservoir may contribute to bioaccumulation in downstream organisms. Bioaccumulation may not have been significant downstream from the dam prior to its construction because the metals and organic contaminants were bound to the sediment particles, not readily available for uptake, and transported out of the system with higher flows.

The California Department of Water Resources and State Water Resources Control Board had conducted limited sampling for metals in some fish from the reservoir and Feather River downstream from the dam. Analyses of the few fish from Lake Oroville and the Feather River had detected mercury at concentrations that exceed current U.S. Environmental Protection Agency and California Office of Environmental Health Hazard Assessment criteria. These data are not sufficient to determine the magnitude and extent of mercury contamination in fish and other organisms, nor the source.

A variety of wildlife species prey on fish or other aquatic species from project waters. These wildlife species could suffer adverse physiological or reproductive responses from ingestion of prey species containing elevated levels of certain contaminants. Contaminants ingested by wildlife species that prey on aquatic species from project waters can also be bioaccumulated and passed on to other predatory fish and wildlife species that in turn prey on them.

In addition, some contaminants are not strong bioaccumulators (e.g., some metals such as copper and arsenic), but may be mobilized and made available to the biota under certain environmental conditions (e.g., re-suspension of sediment deposits from the arms to the main body, depressed oxygen and pH conditions, etc.) found in the reservoir. Organisms can become re-exposed to contaminants as the lake level drops and deposited sediments are re-suspended and transported further into the reservoir. The shallow, relatively warm, organic rich waters of the Thermalito Forebay and Afterbay could contribute to the methylation of mercury and dissolution of other metals and organic contaminants. Environmental conditions such as these in project water bodies

may promote mobilization of sediment bound contaminants and transport out of the "project area" where they could affect threatened and endangered species.

1.1.1 Statutory/Regulatory Requirements

Demonstration of compliance with basin plan objectives is necessary for the SWRCB to issue a water quality certification. Basin plan objectives include provisions against increases in suspended sediment discharges and deposition of material that adversely affect beneficial uses, and toxic substances that produce detrimental effects to humans, plants, animals, and aquatic life. The water quality certification is needed for license renewal with the Federal Energy Regulatory Commission.

1.1.2 Study Area

The study area is generally within the FERC project boundary, but also includes lands adjacent to the project boundary where piscivorous species may occur. The first phase of this study focused on evaluation of contaminants in project waters. Phase 2 will evaluate contamination in reservoir tributaries, additional fish species or areas within project waters, and the Feather River downstream from the project area.

1.1.2.1 Description

Water bodies sampled for Phase 1 of the study included Lake Oroville, Diversion Pool, Thermalito Forebay and Afterbay, low flow section of the Feather River, Feather River immediately downstream from the Afterbay Outlet, and two Oroville Wildlife Area ponds.

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area, Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with

two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts. The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 cfs and 5,610 cfs, respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, four miles downstream of the Oroville Dam creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cubic feet per second of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate an average of 8,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment.

There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the Oroville Wildlife Area.

The Oroville Wildlife Area comprises approximately 11,000-acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and two primitive camping areas. DFG's habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

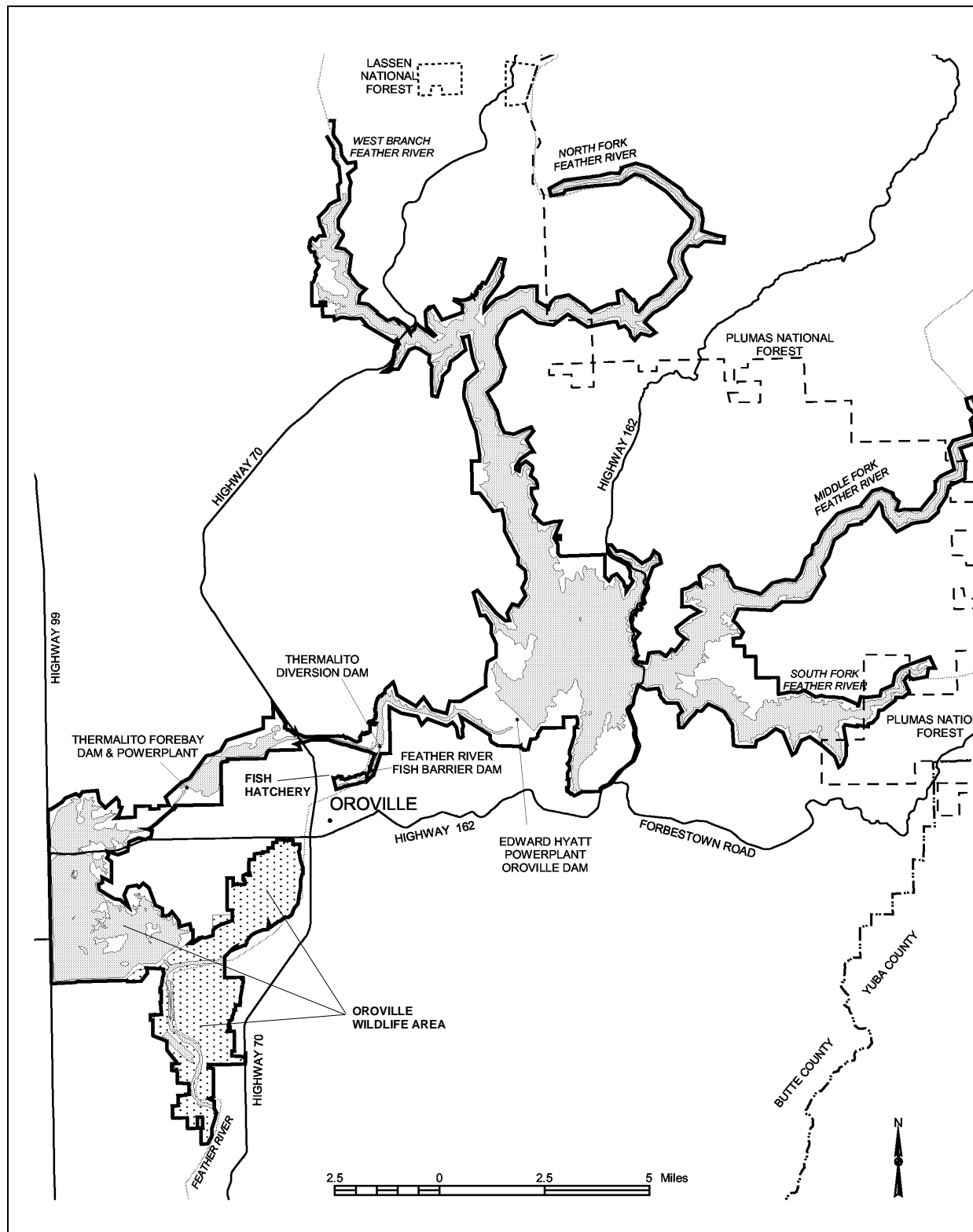


Figure 1.2-1. Oroville Facilities FERC Project Boundary

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1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet; however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

1.3.1 Downstream Operation

An August 1983 agreement between DWR and the California Department of Fish and Game entitled, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife," sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oro-

ville Facilities release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52 °F for September, 51 °F for October and November, 55 °F for December through March, 51 °F for April through May 15, 55 °F for last half of May, 56 °F for June 1-15, 60 °F for June 16 through August 15, and 58 °F for August 16-31. A temperature range of plus or minus 4 °F is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Oceanic and Atmospheric Administration Fisheries has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65 °F on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65 °F from approximately April through mid May, and 59 °F during the remainder of the growing season). There is no obligation for DWR to meet the rice water temperature goals.

However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers. Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the wa-

tershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

Information derived from this study will be used to demonstrate compliance with water quality standards and other appropriate requirements in the application for water quality certification. Information from the study is also needed to address DFG, U.S. Forest Service, U.S. Fish and Wildlife Service, and NOAA Fisheries concerns related to fish and wildlife species that feed on potentially contaminated aquatic organisms in the project area.

Analyses of fish tissue for mercury and other metals and organic contaminants are necessary to determine project effects and compliance with Basin Plan objectives. Since recreation, including fishing, is a major beneficial use at project facilities, analysis of fish tissues provides valuable information for fish consumption advisories.

Sediment analysis will help determine whether contamination of biota is attributable to contaminant sources located within the reservoir or upstream from the project area, and if contamination is local or widespread. Certain areas may be less contaminated than others and not warrant the same restrictions as other reservoir locations for consumption of fish. Identification of the location and extent of sediment contamination will be used to develop reservoir management practices (licensing conditions) designed to improve the overall water quality and natural and recreational resources of the reservoir. In addition, sediment contamination information will be used to focus efforts to reduce sediment loading for improvement of water quality in the reservoir.

3.0 STUDY OBJECTIVE(S)

The objectives of the study are to: 1) determine the magnitude and extent of bioaccumulation of metals and organic contaminants in aquatic organisms within the project area, 2) identify sources and potential pathways of contamination that contribute to bioaccumulation including contaminated sediments deposited as a result of project features, operations, and maintenance, and 3) provide information that could be used to develop potential protection, mitigation and enhancement measures.

3.1 APPLICATION OF STUDY INFORMATION

Information from the study will be used to determine compliance with basin plan objectives, which is necessary for the SWRCB to issue a water quality certification. The water quality certification is needed for license renewal with the FERC.

In addition, information from the study will be used to evaluate effects to fish and wildlife species that feed on potentially contaminated aquatic organisms in the project area, which is a concern to several agencies, including the CDFG, USFS, USFWS, and NOAA Fisheries.

OEHHA will use information developed from the study to determine whether risks to human health exist due to consumption of contaminated fish from affected waters. OEHHA may request additional studies to more accurately determine human health risks, or may decide to issue a health advisory suggesting that certain demographic groups limit consumption of fish from the affected waters.

The study will also provide information that may be useful in determining sources of contaminants so that the role of the project in contributing to contamination may be ascertained and remedial measures developed to improve water quality.

4.0 METHODOLOGY

The study was designed to be conducted in phases. The first phase emphasized analysis of metals and organic contaminants in fish, crayfish, and sediments in the project area. The first phase collected fish tissues and sediment samples from 16 locations in the project area, while crayfish were collected from four sites. Sediment samples have been frozen for later analysis. The Environmental Work Group will use the fish tissue and water quality data from Study Plan SPW1 to select a minimum of six sites for sediment samples to be analyzed for methylmercury, total mercury, and PCBs. Additional constituents may be analyzed from these six and any or all of the other ten sediment sampling sites based upon results from fish tissue and water quality analyses. Other sediment may be collected to augment the 16 samples.

The environmental compartments analyzed in subsequent phases, if needed, will be determined in consultation with appropriate resource and health agencies and the Environmental Work Group or Task Force. Analyses in subsequent phases in tributaries to the reservoir would provide background data needed to evaluate the role of the reservoir in bioaccumulation. Subsequent analyses of sediments and additional fish in the project area would provide information to determine the extent and sources of contamination, and species affected. The extent of project related impacts to fish, crayfish, and sediments downstream from the project area would also be analyzed in subsequent phases.

4.1 STUDY DESIGN

Water bodies sampled for Phase 1 of the study include Lake Oroville, Diversion Pool, Thermalito Forebay and Afterbay, low flow section of the Feather River, Feather River immediately downstream from the Afterbay Outlet, and two Oroville Wildlife Area ponds. Tasks undertaken in Phase 1 included sample collection, laboratory analyses, and data interpretation.

Specific fish species sampled was dependent on the types resident in the water body being investigated. Collection of newly planted fish (i.e., less than one year residency) was avoided. Fish species originally targeted from each sampling site included one larger size class of a black bass and a catfish species. Attempts were made to collect ten large bass that are a 'keepable' size as defined in the fishing regulations (i.e., greater than 15 inches in total length), and five catfish from each site. However, not all sites contained the originally targeted species, nor could the desired numbers of fish be collected at each site. The Environmental Workgroup Task Force suggested, based on similar trophic activity, that pikeminnow could be substituted for the bass species, and carp could be substituted for the catfish. The Task Force also determined that sufficient fish had been collected for analysis, though the targeted number were not caught.

Fish were collected beginning in the late spring of 2002 with electroshockers, gill nets, hooks and lines, and seines. Fish were weighed and measured, wrapped in aluminum foil, and immediately frozen for transport to the laboratory.

Crayfish were also collected from several sites within the project area at approximately the same time that the fish were collected. Larger (older) crayfish were targeted. Ten crayfish of similar size from each sampled site were composited. Crayfish were collected by hand, nets, and baited traps. Crayfish were wrapped in aluminum foil and frozen for transport to the laboratory.

Sediments were collected from sites where fish were collected. Sediments were collected with a sediment core sampler in deeper waters, and with a hand corer or teflon spoons in shallower waters following methods of the U. S. Geological Survey (USGS 1994). The top six inches of sediments in ten cores were composited and subsampled into teflon bottles. Sediments collected with teflon spoons from ten areas at shallow monitoring sites were also composited and subsampled into teflon bottles. The bottles have been frozen for later analyses (Dave Crane, DFG Water Pollution Control Laboratory, pers. comm.)

All bass were individually analyzed for total mercury. Subsequently, composites according to species were made of five of the bass and the other fish species at each site for other analyses following the protocol of OEHHA. Each composite was composed of fish with no greater than 25 percent difference in fork length between the largest and smallest individual.

4.1.1 Sampling Sites

Sampling sites for fish, crayfish, and sediments were selected from each of the water bodies associated with the Oroville Facilities. Sampling sites were selected to be representative of the particular water body.

4.1.1.1 Lake Oroville

Screening for fish contamination in Lake Oroville required multiple sampling sites in each arm and the main body due to the size of the reservoir. Fish were collected from two different sampling sites in each of the North, Middle, and South Fork arms and from both the east (Bidwell Marina arm) and west (Spillway arm) sides of the main body of the reservoir (Figure 4.1-1). Bottom sediments were collected at each of these sites. In addition, bass and catfish were collected near the Lime Saddle Marina for polynuclear aromatic hydrocarbon contamination analysis, since the marina environment is the most likely site for PAH accumulation. Fish species caught at these sites included spotted bass, channel and white catfish, and carp (Table 4.1-1).

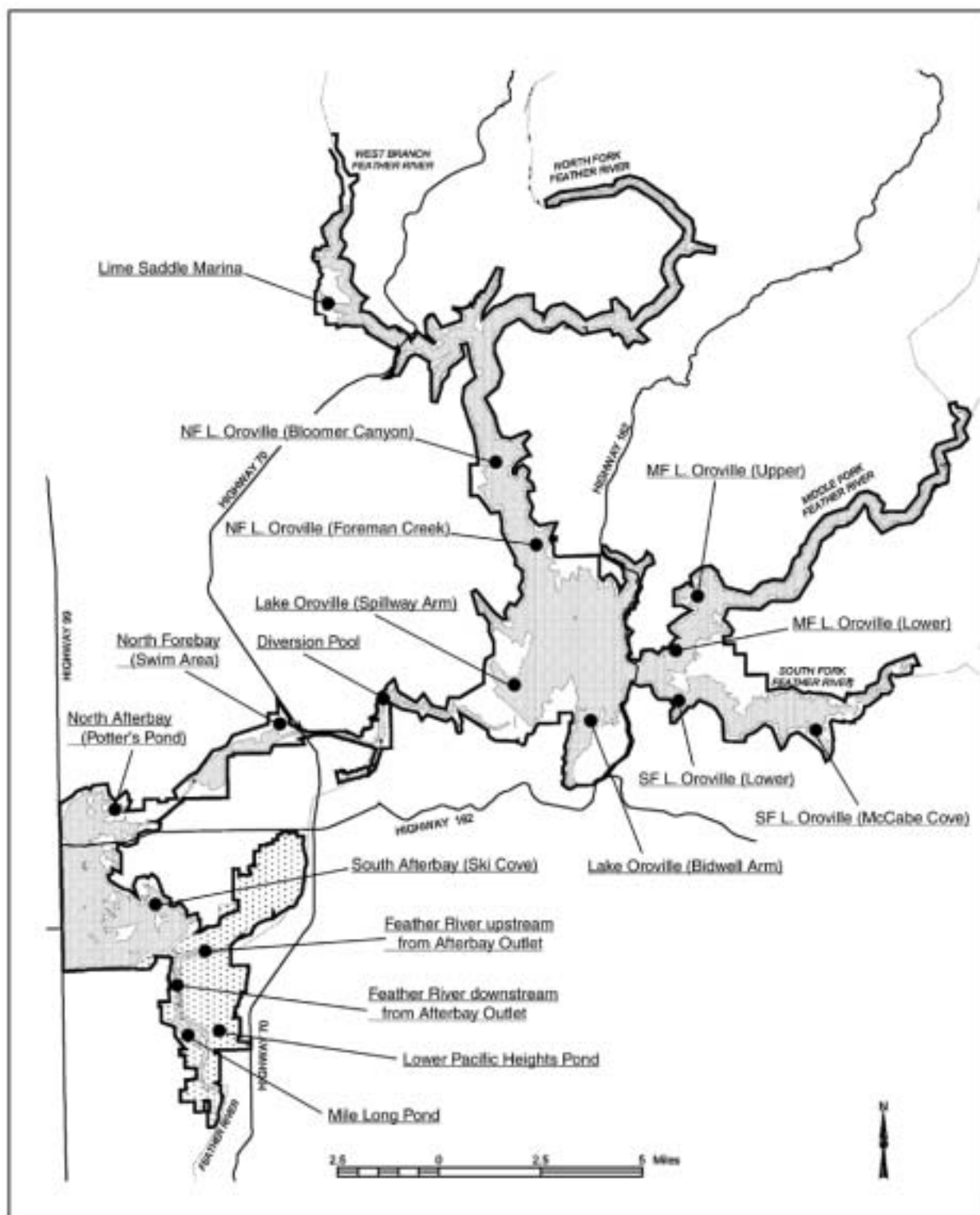


Figure 4.1-1. Fish, Sediment, and Crayfish Sampling Sites

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Table 4.1-1. Fish Collected for Contaminant Analyses from Project Waters

Sampling Location	Bass	Pikeminnow	Catfish	Carp	Crayfish
SF Lake Oroville (McCabe Cove)	9 SB		3 CHC		
SF Lake Oroville (Lower)	7 SB		5 CHC		
MF Lake Oroville (Upper)	7 SB		3 CHC		
MF Lake Oroville (Lower)	5 SB		3 CHC		
NF Lake Oroville (Bloomer Canyon)	10 SB		4 CHC	2	
NF Lake Oroville (Foreman Creek)	10 SB		5 CHC, 3 WHC		
Lime Saddle Marina (West Branch Arm)	10 SB		4 CHC		
Lake Oroville (Spillway Arm)	7 SB		4 CHC		
Lake Oroville (Bidwell Arm)	7 SB		5 CHC		
Diversion Pool					10
North Thermalito Forebay (Swim Area)		10		5	
North Thermalito Afterbay					10
North Thermalito Afterbay (Potter's Pond)	8 LM			3	
South Thermalito Afterbay	8 LM			5	10
Feather River US from Afterbay Outlet	5 LM				
Feather River DS from Afterbay Outlet	10 LM				
Feather River DS Hwy 70					10
Mile Long Pond	8 LM		4 BRB		
Lower Pacific Heights Pond			5 CHC		

SB-spotted bass, LM-largemouth bass, CHC-channel catfish, WHC-white catfish, BRB-brown bullhead

4.1.1.2 Diversion Pool

The Diversion Pool was sampled near the Diversion Dam. Though bass, catfish, carp, or pikeminnow were targeted for collection, none could be obtained. Habitat conditions in the Diversion Pool are not appropriate for the targeted species (Eric See, DWR, pers. comm.). Only crayfish were collected from this site.

4.1.1.3 Thermalito Forebay and Afterbay

Fish could not be obtained from the main Thermalito Forebay. However, collection activities in the North Forebay Recreation Area (swim area) did yield carp and pikeminnow. The Thermalito Afterbay was sampled in both the northern and southern regions, but fish could only be obtained from the south Thermalito Afterbay where largemouth bass and carp were obtained, in addition to crayfish. However, crayfish were obtained from the north Thermalito Afterbay, and largemouth bass and carp were obtained from a waterfowl brood pond, called Potter's Pond, formed in one of the fingers of the north Thermalito Afterbay.

4.1.1.4 Lower Feather River

The Feather River downstream from Oroville Dam was sampled at one site in the low flow section between the fish hatchery and Afterbay Outlet and at another site downstream from the outlet within the project boundary. Largemouth bass were collected from both sites. Crayfish were collected from the low flow section downstream from the Highway 70 bridge.

4.1.1.5 Oroville Wildlife Area

Two representative ponds were sampled in the Oroville Wildlife Area. Warmwater fish species collected from these ponds include largemouth bass and brown bullhead from Mile Long Pond, and channel catfish from the Lower Pacific Heights Pond.

4.1.2 Laboratory Analyses

Analytical procedures generally followed those used in the Toxic Substances Monitoring Program conducted by the SWRCB and DFG (SWRCB 1996). Metals, pesticides, polychlorinated biphenyls, and polynuclear aromatic hydrocarbons were analyzed from fish or crayfish tissues for this study (Table 4.1-2).

Table 4.1-2. Metals and Organic Contaminants Analyzed from Fish and Crayfish

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
Organochlorine Pesticides by EPA Method 8081A			
aldrin	1	dieldrin	1
alpha-BHC	1	endosulfan I	2
beta-BHC	2	endosulfan II	2
gamma-BHC	1	endosulfan sulfate	2
delta-BHC	1	endrin	2
alpha-chlordane	1	endrin aldehyde	2
gamma-chlordane	1	endrin ketone	2
alpha-chlordene	1	heptachlor	1
gamma-chlordene	1	heptachlor epoxide	1
chlorpyrifos	2	Kelthane (dicofol)	2
chlorthal (dacthal)	2	methoxychlor	10
2,4'-DDD	2	mirex	2
2,4'-DDE	2	nonachlor, cis	2
2,4'-DDT	2	nonachlor, trans	2
4,4'-DCBP	2	oxadiazon	2
4,4'-DDD	2	oxychlordane	2

Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
4,4'-DDE	2	tetradifon (tedion)	2
4,4'-DDT	2	toxaphene	100
4,4'-DDMU	2		
Polynuclear Aromatic Hydrocarbons by EPA Method 8270C/SIM			
acenaphthene	10	fluoranthene	10
acenaphthylene	10	fluorene	10
anthracene	10	indeno(1,2,3-cd)	10
		pyrene	
benzo(a)anthracene	10	3-methylcholanthrene	10
benzo(b, j&k)fluoranthene	10	1-methylnaphthalene	10
benzo(g,h,i)perylene	10	2-methylnaphthalene	10
benzo(a)pyrene	10	1-methylphenanthrene	70
benzo(e)pyrene	10	naphthalene	10
biphenyl	10	perylene	10
chrysene	10	phenanthrene	10
dibenzo(a,h)anthracene	10	pyrene	10
2,6- dimethylnaphthalene	10	2,3,5- trimethylnaphthalene	10
Polychlorinated Biphenyls (PCB) Congeners by GC/ECD w/congener standards			
Congener	Reporting Limit ppb (ng/g)	Congener	Reporting Limit ppb (ng/g)
8	0.6	128	0.6
15	0.6	132	0.6
18	0.6	137	0.6
27	0.6	138	0.6
28	0.6	149	0.6
29	0.6	151	0.6
31	0.6	153	0.6
44	0.6	156	0.6
49	0.6	157	0.6
52	0.6	158	0.6
66	0.6	167	0.6
70	0.6	169	0.6
74	0.6	170	0.6
77	0.6	174	0.6
81	0.6	177	0.6
87	0.6	180	0.6
95	0.6	183	0.6
97	0.6	187	0.6
99	0.6	189	0.6
101	0.6	194	0.6

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Analyte	Reporting Limit ppb (ng/g)	Analyte	Reporting Limit ppb (ng/g)
105	0.6	195	0.6
110	0.6	200	0.6
114	0.6	201	0.6
118	0.6	203	0.6
123	0.6	206	0.6
126	0.6	209	0.6
Organophosphorus Pesticides by EPA Method 8141A			
chlorpyrifos	2	parathion, ethyl	2
diazinon	20	parathion, methyl	4
Metals by EPA Method 6020 (ICPMS)			
arsenic*	0.02	mercury	0.01
cadmium	0.005	nickel	0.01
chromium	0.1	selenium*	0.02
copper	0.006	silver	0.005
lead	0.007	zinc	0.06

* analysis with methanol addition

Methylmercury is assumed to be the form of mercury available for bioaccumulation in the food web. Most mercury in fish tissues is in the methylmercury fraction. Total mercury, however, is typically analyzed from fish tissue and is assumed to represent the methylmercury content of tissues. Fish muscle tissue (filet) is typically analyzed for arsenic, cadmium, nickel, mercury, and selenium, while fish liver is analyzed for copper, zinc, chromium, lead, and silver. The laboratory performed these typical analyses, as well as analyses of all the metals from most filet samples. All organic chemicals in the fish were analyzed from filets. Whole body analyses of metals and organic chemicals were performed on the crayfish. Crayfish were shelled at the laboratory prior to analysis for methylmercury. All analyses for organic contaminants were performed at the California DFG Water Pollution Control Laboratory in Rancho Cordova, while metals analyses were performed at the DFG Moss Landing Marine Laboratories in Monterey.

Bass obtained from each sampling site were individually analyzed for total mercury contamination. Subsequently, up to five fish from each site were composited following OE-HHA guidelines (Margie Gassel, OE-HHA, pers. comm.). The bass and catfish composites were analyzed for organic and metal contaminants. The composites of bass and catfish collected near the Lime Saddle Marina were analyzed for polynuclear aromatic hydrocarbons. The composited crayfish samples were analyzed for organic and metal contaminants.

Sediment samples from a minimum of six sites will be submitted for organic and metal contaminant analyses following review by the Environmental Work Group or Task Force

of the fish and crayfish analysis results. Sediments from these six and possibly other sites will be analyzed for mercury, PCBs, and other metal or organic contaminants identified from the fish or crayfish samples at a level of concern. The sediments will be analyzed at the DFG laboratory.

4.2 DATA INTERPRETATION

Criteria and guidance values for protection of human health and wildlife from contaminant accumulation or ingestion were researched and reviewed for those contaminants identified in the fish from this study. Criteria and guidance values reviewed include numerical criteria and guidance values of the USEPA, OEHHA, SWRCB, U.S. Food and Drug Administration, Food and Agriculture Organization of the United Nations, USFWS, Environment Canada, National Academies of Sciences and Engineering, and New York Department of Environmental Conservation. Unfortunately, few criteria or guidelines have been developed for protection of predatory wildlife species from ingestion of prey containing metal or organic contaminants, though the USFWS and USEPA are beginning efforts to evaluate toxicity data which may eventually lead to development of protective criteria (Dan Russell, Senior Environmental Contaminant Specialist, USFWS, Sacramento, pers. comm.).

4.2.1 USEPA and OEHHA

The USEPA has recommended screening values for 25 chemical contaminants that have been observed to bioaccumulate in fish tissues (Brodberg and Pollock 1999). The screening value approach is recommended by the USEPA to identify chemical contaminants in fish tissue at concentrations that may be of human health concern for frequent consumers of sport fish. Screening values are not intended to be used for issuance of health advisories, but to identify fish species and contaminants for which more intensive information is needed. The USEPA screening values were calculated for a 70 kg (155 lb.) adult with a fish consumption value of 6.5 g (0.23 oz.) per day. Screening values for use in California lakes were calculated by OEHHA according to USEPA guidance for a 70 kg adult, but using a consumption value of 21 g (0.74 oz.) per day.

As required by Section 304(a) of the Clean Water Act, the USEPA revised the water quality criteria for mercury in 2001 to reflect the latest scientific knowledge on effects to health (USEPA 2001). The USEPA determined that the major pathway for human exposure to methylmercury was through consumption of contaminated fish. Therefore, the USEPA concluded that a fish tissue residue water quality criterion for methylmercury was more appropriate than a water column based water quality criterion. The fish tissue residue criterion for protection of human health was calculated to be 0.3 mg methylmercury/kg of fish.

4.2.2 Toxic Substances Monitoring Program

The SWRCB has conducted the Toxic Substances Monitoring Program since 1976 to provide information on the occurrence of toxic substances in fish and other aquatic life. Results from the TSMP are used by the SWRCB and Regional Water Quality Control Boards in Water Quality Assessment reports to identify impaired waterbodies. The TSMP uses several “criteria” for evaluation of impairment, including the maximum tissue residue level, elevated data level, USFDA action level, NAS guideline, and median international standard.

Maximum tissue residue levels were developed by SWRCB staff from human health water quality objectives in the November 16, 1990 draft Functional Equivalent Document – Development of Water Quality Plans for Inland Surface Waters of California and Enclosed Bays and Estuaries of California, the April 9, 1991 draft Supplement to the Functional Equivalent Document, and the 1997 California Ocean Plan (SWRCB 1996). The MTRLs were calculated by multiplying the draft human health water quality criteria by the bioconcentration factor for each substance, and are an assessment tool for indicating water bodies with potential human health concerns rather than compliance or enforcement criteria. MTRLs are compared only to filet or edible tissue samples and not whole body or liver samples.

Elevated data levels are used by the SWRCB to compare results of current studies with results from previous studies. The EDL is calculated by ranking all of the results for a given chemical from the highest to the lowest concentration measured, including those records where the chemical was not detected. A cumulative distribution is constructed and percentile rankings are calculated. The 85th percentile was chosen by the SWRCB as an indication that a chemical is elevated from the median, while the 95th percentile was chosen to indicate values that are highly elevated above the mean. These measures provide a guide to determine if a chemical has been found in unusually high concentrations, and are not directly related to potentially adverse human or animal health effects.

The USFDA has established maximum concentration levels, termed action levels, for some toxic substances in human foods based on assumptions of the quantities of food consumed by humans and upon the frequency of their consumption (SWRCB 1996). The action levels are intended to protect humans from the chronic effects of toxic substances consumed in foodstuffs.

The NAS and NAE have established recommended maximum concentrations of toxic substances in freshwater fish tissues (NAS 1972). These guidelines established water quality recommendations to protect aquatic organisms as well as the predators of the organisms.

Median international standards for metals were developed from a survey by the FAO of health protection criteria used by member nations. These standards do not apply within the United States, but provide an indication of concentrations of metals that other countries have determined to be elevated in fish tissues.

4.2.3 New York Guidelines

The NYDEC developed guidelines for the protection of fish-eating wildlife. The guidelines are based on the laboratory animal toxicology database used to derive criteria for protection of human health, but were extrapolated from laboratory animals to wildlife. From all target species, the bird and mammal with the greatest ratios of daily food consumption to body weight were used to derive the wildlife criteria (Newell et al. 1987). Because several birds consume about 20 percent of their body weight per day, a generic bird, with a body weight of 1 kg (2.2 lbs.) and food consumption of 0.2 kg (7 oz.) per day, was selected. The mink, with an average body weight of 1 kg and food consumption of 0.15 kg (5.3 oz.) per day, was used to represent fish-eating mammals.

4.2.4 Canadian Tissue Residue Guidelines

Canadian tissue residue guidelines were developed by the National Guidelines and Standards Office of Environment Canada to protect wildlife that consume aquatic biota (EC 2000). The guidelines were calculated from the most sensitive of the available toxicity tests and applied to Canadian species with the largest food intake/body weight ratio, and therefore are conservative guidelines.

4.2.5 U.S. Fish and Wildlife Service

The USFWS published a series of Contaminant Hazard Reviews from 1985 to 1998. Each review evaluated hazards to fish, wildlife, and invertebrates for a specific contaminant. The reviews discuss sources and uses, chemical properties, mode of action, background concentrations, lethal and sub-lethal effects where known, and recommendations of contaminant levels in fish to protect birds and wildlife.

The USFWS also evaluated the USEPA human health criterion for mercury to determine the protectiveness for threatened and endangered wildlife in California (USFWS 2003). The USEPA in 2001 developed a recommended water criterion based on a tissue residue concentration of 0.3 mg/kg in edible portions of fish tissue to protect human health. As part of Endangered Species Act consultation for promulgation of this criterion in California, the USEPA agreed that the human health criterion should be sufficient to protect federally listed aquatic and aquatic-dependent wildlife in California. The USFWS conducted a biological evaluation of the effects of the proposed action on federally listed and proposed threatened and endangered species within California. A "wildlife value" was calculated to protect wildlife species that is analogous to the tissue residue concentration for human health protection. A wildlife value was determined for

each species of concern using body weight, total daily food ingestion rate, and a protective reference dose.

5.0 STUDY RESULTS

Eleven organic compounds and two PCB aroclors were detected in fish from Phase 1 of this study (Table 5.0-1). The contaminants detected include several organochlorines, including chlordanes (cis-chlordane, trans-chlordane, cis-nonachlor, and trans-nonachlor), dichloro-diphenyl-trichloroethane (DDT) breakdown products (DDD,op', DDD,p,p', DDE,p,p', and DDMU,p,p'), dieldrin, hexachlorobenzene, and polychlorinated biphenyl (PCB) aroclors 1254 and 1260 and congeners. The organophosphate chlorpyrifos was also detected. Only the DDT breakdown product DDE,p,p' and PCB aroclor 1254 were found in crayfish.

Metals detected in fish tissues include arsenic, cadmium, chromium, copper, nickel, lead, selenium, silver, zinc, and mercury (Table 5.0-2). The metals were also detected in crayfish, except arsenic, cadmium, nickel, and selenium which were not analyzed from these organisms.

5.1 RELATIONSHIP OF RESULTS TO CRITERIA AND GUIDELINES

Organic compounds and metals detected were compared to the guidelines and criteria to determine whether elevated or harmful levels were present in fish from project area waters.

5.1.1 Organic Contaminants

5.1.1.1 Chlordane

The chlordane compounds cis-chlordane and cis-nonachlor were detected in pikeminnow and carp from the North Forebay Recreation Area swim area, carp from the south Thermalito Afterbay, and channel catfish from the Lower Pacific Heights Pond. Trans-chlordane was detected from these same fish, except those from the south Thermalito Afterbay. Trans-nonachlor was detected in channel catfish from all sampling sites in Lake Oroville, and in carp from both North Fork Arm sampling sites. Trans-nonachlor was also detected in Sacramento sucker collected from the Diversion Pool, pikeminnow and carp from the North Thermalito Forebay swim area, carp from the south Thermalito Forebay, and channel catfish from the Lower Pacific Heights Pond. No chlordane compounds were detected in bass or crayfish species from any of the project waters.

None of the individual chlordane compounds exceeded the guidance values, which consist of elevated data levels. However, the sum of the individual chlordane compounds (i.e., total chlordane) exceeded the maximum tissue residue level at each site where any chlordane compounds were detected. No other guidelines or criteria were exceeded.

Contaminant Accumulation In Fish, Sediments, And The Aquatic Food Chain
Study Plan W2, Phase 1 Draft Report
Oroville Facilities P-2100 Relicensing

Table 5.0-1. Detected Pesticides in Fish from the Oroville Facilities (Fresh Weight ppb (ng/g))

			chlordanes, cis	chlordanes, trans	nonachlor, cis	nonachlor, trans	chlordanes (total) (e)	chlorpyrifos	DDD, o,p'	DDD, p,p'	DDE, p,p'	DDMU, p,p'	DDT (total) (f)	dieldrin	hexachloro-benzene (HCB)	Aroclor 1254	Aroclor 1260	PCB (g)	PCB (total)(h)
Maximum Tissue Residue Levels (MTRLs) (for Filets or Edible Tissues) (a)	for Carcinogens in Inland Surface Waters						1.1						32	0.65	6			2.2	
NAS Recommended Guideline for Freshwater Fish (b)	(Whole Fish)						100						1,000	100				500	
FDA Action Level for Freshwater and Marine Fish (c)	(Edible Portion)						300						5,000	300				2,000 (i)	
OEHHA Screening values and action levels in fish tissues (d)	USEPA Value						80	30,000					300	7	70			10	
	OEHHA Value						30	10,000					100	2	20			20	
	Fish Type (h)																		
Elevated Data Levels (a)	Whole Freshwater Fish Calculated Using 1978 - 1995 Data (ppb, wet weight)	EDL 85	30.7	20	16.7	44	128.8	25.4	44	254	1,570	46.4	2,393.40	46.4	3.6	120	77.1	219.6	
		EDL 95	57.9	36	27	65.7	195.1	61.9	140	893	3,490	120	5,037.70	378.5	9.1	358.5	160	472.5	
	Freshwater Fish Filets Calculated Using 1978 - 1995 Data (ppb, wet weight)	EDL 85	12	7.4	5.4	17.2	38.8	<10.0	11	77.6	540	<5.0	667.9	9.4	<2.0	<50.0	54.2	120	
		EDL 95	36.4	21	18	44	117.8	25.7	33.6	232	1,955	36	2,424.40	32.5	5	140.5	180	350	
Median International Standards (i) (excludes liver)																			
New York DEC Fish Flesh Criteria for fish-eating wildlife							500						200	120	330			110	110
Canadian Tissue Residue Guideline:													14						
USFWS Contaminant Hazard Reviews recommendation							300 (USFWS 1990)	2,000 (USFWS 1988a)										Wildlife <100, avian <3,000 (USFWS 1986a)	Wildlife <100, avian <3,000 (USFWS 1986a)
Sample Number	Station Name	Species*	chlordanes, cis	chlordanes, trans	nonachlor, cis	nonachlor, trans	chlordanes (total) (e)	chlorpyrifos	DDD, o,p'	DDD, p,p'	DDE, p,p'	DDMU, p,p'	DDT (total) (f)	dieldrin	hexachloro-benzene	Aroclor 1254	Aroclor 1260	PCB (g)	PCB (total)(h)
2029-2034	SF Arm Lake Oroville (McCabe Cove)	SPB	ND	<RL	<RL	<RL		ND	ND	1.10	6.40	ND	7.50	<RL	<RL	16	31	47 (j,l,m)	34.991
2038,39 2242	SF Arm Lake Oroville (McCabe Cove)	CHC	<RL	<RL	<RL	2.26	2.26 (j)	ND	ND	2.59	27.8	<RL	30.39 (n)	ND	0.312	37	97 (k)	134 (j,k,l,m,o,p)	88.777
2136-2148	Lower SF Lake Oroville	CHC	<RL	<RL	<RL	2.31	2.31 (j)	ND	<RL	3.57	24.7	<RL	28.27 (n)	<RL	<RL	37	94 (k)	131 (j,k,l,m,o,p)	85.137
2139-2236	Lower SF Lake Oroville	SPB	<RL	<RL	<RL	<RL		ND	ND	<RL	5.21	ND	5.21	<RL	<RL	18	24	42 (j,l,m)	29.33
2125-2135	Upper MF Lake Oroville	CHC	<RL	<RL	<RL	1.79	1.79 (j)	ND	ND	1.37	15.9	<RL	17.27 (n)	0.522	<RL	20	27	47 (j,l,m)	29.093
2126-2132	Upper MF Lake Oroville	SPB	ND	ND	ND	<RL		ND	ND	2.16	2.16	<RL	2.16	<RL	<RL	<RL	<RL		4.664
2075-2089	Lower MF Lake Oroville	SPB	ND	<RL	ND	<RL		ND	ND	<RL	2.05	ND	2.05	<RL	<RL	10	<RL	10 (j,m)	8.655
2088-2092	Lower MF Lake Oroville	CHC	<RL	<RL	<RL	3.43	3.43 (j)	ND	ND	2.21	21.0	<RL	23.21 (n)	<RL	<RL	37	66 (k)	103 (j,l,m,p)	66.772
2045-2049	NF L. Oroville (Bloomer Cnyn)	SPB	ND	ND	ND	<RL		ND	ND	<RL	2.24	ND	2.24	<RL	ND	<RL	<RL		7.078
2188-2209	NF L. Oroville (Bloomer Cnyn)	CHC	<RL	<RL	<RL	1.72	1.72 (j)	ND	ND	1.38	15.3	ND	16.68 (n)	0.732 (j)	<RL	27	24	51 (j,l,m)	30.398
2175-2207	NF L. Oroville (Bloomer Cnyn)	CP	<RL	<RL	<RL	1.51	1.51 (j)	ND	ND	1.16	12.9	<RL	14.06 (n)	0.525	<RL	18	12	30 (j,l,m)	20.327
2150-2163	NF L. Oroville (Foreman C)	CHC	<RL	<RL	<RL	1.88	1.88 (j)	ND	ND	1.76	16.6	<RL	18.36 (n)	0.598	<RL	31	20	51 (j,l,m)	31.332
2152-2172	NF L. Oroville (Foreman C)	SPB	<RL	<RL	ND	<RL		ND	ND	<RL	2.29	ND	2.29	<RL	ND	<RL	<RL		7.299
2155-2158	NF L. Oroville (Foreman C)	WHC	<RL	<RL	ND	<RL		ND	ND	ND	3.3	ND	3.30	<RL	ND	<RL	<RL		7.473
2159-2160	NF L. Oroville (Foreman C)	CP	<RL	<RL	<RL	1.58	1.58 (j)	ND	<RL	1.37	15.2	ND	16.57 (n)	<RL	<RL	16	15	31 (j,l,m)	22.023
2064-2068	Lake Oroville Spillway arm	CHC	<RL	<RL	<RL	2.46	2.46 (j)	<RL	ND	2.72	33.7	<RL	36.42 (j)	0.775 (j)	0.710	34	32	66 (j,l,m)	42.282
2061-2073	Lake Oroville Spillway arm	SPB	ND	ND	ND	<RL		ND	ND	<RL	2.43	ND	2.43	ND	<RL	<RL	<RL		8.406
2100-2106	Lake Oroville Bidwell Arm	CHC	<RL	<RL	<RL	2.37	2.37 (j)	ND	ND	2.23	20.5	<RL	22.73 (n)	0.591	0.355	31	49	80 (j,l,m)	50.938
2105-2114	Lake Oroville Bidwell Arm	SPB	ND	<RL	ND	<RL		ND	ND	ND	<RL	ND		<RL	ND	<RL	<RL		5.596
2300-2305	Diversion Pool	SS	<RL	<RL	<RL	2.69	2.69 (j)	ND	<RL	2.13	19.2	<RL	21.33 (n)	<RL	0.832	55 (k)	34	89 (j,l,m)	66.365
5003	Diversion Pool	crayfish	ND	ND	ND	<RL		ND	ND	ND	<RL	ND		<RL	<RL	<RL	<RL		3.894
2210-2216	North Thermalito Forebay (swim area)	PM	2.27	1.09	2.61	7.04	13.01 (j)	<RL	<RL	13	86.9	4.71	104.61 (j,l,n)	1.64	1.05	180 (k)	104 (k)	284 (j,k,l,m,o,p)	186.81 (o,p)
2222-2226	North Thermalito Forebay (swim area)	CP	2.86	1.17	2.40	6.64	13.07 (j)	<RL	1.57	11.1	121	3.48	137.15 (j,l,n)	0.738 (j)	0.956	166 (k)	215 (k)	381 (j,k,l,m,o,p)	281.386 (o,p)
5000	North Afterbay	crayfish	ND	ND	ND	<RL		ND	ND	<RL	5.66	ND	5.66	ND	ND	<RL	<RL		7.272
2247-2251	South Thermalito Afterbay (Ski Cove)	LMB	ND	ND	ND	<RL		ND	ND	<RL	4.99	ND	4.99	<RL	ND	<RL	<RL		112.397 (o,p)
2011-2015	South Thermalito Afterbay (Ski Cove)	CP	1.01	<RL	1.26	4.31	6.58 (j)	<RL	1.22	6.31	214	7.82 (k)	229.35 (j,l,n)	0.751 (j)	0.457	81 (k)	68 (k)	149 (j,k,l,m,o,p)	5.59
5002	South Thermalito Afterbay (Ski Cove)	crayfish	ND	ND	ND	ND		ND	ND	ND	2.11	ND	2.11	ND	ND	<RL	<RL		5.933
2183-2232B	Potters Pond	LMB	ND	<RL	ND	<RL		ND	ND	ND	<RL	ND		<RL	ND	<RL	ND		3.365
2227-2241	Potters Pond	CP	<RL	<RL	<RL	<RL		ND	ND	<RL	23.7	ND	23.7	<RL	ND	19	17	36 (j,l,m)	22.537
2182	Potters Pond	LMB	ND	<RL	ND	<RL		ND	ND	ND	<RL	ND		<RL	ND	<RL	<RL		1.937
5001	Feather R. DS from Hwy 70 #2	crayfish	ND	ND	ND	<RL		ND	ND	ND	3.01	ND	3.01	ND	ND	ND	76 (k)	76 (j,l,m)	55.978
FR01-05	Feather R US from Afterbay Outle	LMB	<RL	<RL	ND	<RL		ND	ND	<RL	4.98	ND	4.98	<RL	ND	22	<RL	22 (j,l,m)	15.629
2308-2322	Feather R DS Afterbay Outlet	LMB	ND	ND	ND	<RL		ND	ND	<RL	6.41	ND	6.41	<RL	<RL	24	<RL	24 (j,l,m)	15.008
2311-2320	Feather R DS Afterbay Outle	LMB	ND	ND	ND	<RL		ND	ND	<RL	5.38	ND	5.38	<RL	<RL	21	<RL	21 (j,l,m)	11.228

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Table 5.0-1. Continued.

		chlordan cis	chlordan trans	nonachlor cis	nonachlor trans	chlordan (total) (e)	chlorpyrifos	DDD, o,p'	DDD, p,p'	DDE, p,p'	DDMU, p,p'	DDT (total) (f)	dieldrin	hexachloro- benzene (HCB)	Aroclor 1254	Aroclor 1260	PCB (g)	PCB (total)(h)
Maximum Tissue Residue Levels (MTRLs) (for Filets or Edible Tissues) (a)	for Carcinogens in Inland Surface Waters					1.1						32	0.65	6			2.2	
NAS Recommended Guideline for Freshwater Fish (b)	(Whole Fish)					100						1,000	100				500	
FDA Action Level for Freshwater and Marine Fish (c)	(Edible Portion)					300						5,000	300				2,000 (i)	
OEHHA Screening values and action levels in fish tissues (d)	USEPA Value					80	30,000					300	7	70			10	
	OEHHA Value					30	10,000					100	2	20			20	
	Fish Type (h)																	
Elevated Data Levels (a)	Whole Freshwater Fish Calculated Using 1978 - 1995 Data (ppb, wet weight)	EDL 85	30.7	20	16.7	44	128.8	25.4	44	254	1,570	46.4	2,393.40	46.4	3.6	120	77.1	219.6
		EDL 95	57.9	36	27	65.7	195.1	61.9	140	893	3,490	120	5,037.70	378.5	9.1	358.5	160	472.5
	Freshwater Fish Filets Calculated Using 1978 - 1995 Data (ppb, wet weight)	EDL 85	12	7.4	5.4	17.2	38.8	<10.0	11	77.6	540	<5.0	667.9	9.4	<2.0	<50.0	54.2	120
		EDL 95	36.4	21	18	44	117.8	25.7	33.6	232	1,955	36	2,424.40	32.5	5	140.5	180	350
Median International Standards (g) (excludes liver)																		
New York DEC Fish Flesh Criteria for fish-eating wildlife						500						200	120	330			110	110
Canadian Tissue Residue Guidelines												14						
USFWS Contaminant Hazard Reviews recommendation						300 (USFWS 1990)	2,000 (USFWS 1988a)										Wildlife <100, avian <3,000 (USFWS 1986a)	Wildlife <100, avian <3,000 (USFWS 1986a)

Sample Number	Station Name	Species*	chlordan cis	chlordan trans	nonachlor cis	nonachlor trans	chlordan (total) (e)	chlorpyrifos	DDD, o,p'	DDD, p,p'	DDE, p,p'	DDMU, p,p'	DDT (total) (f)	dieldrin	hexachloro- benzene	Aroclor 1254	Aroclor 1260	PCB (g)	PCB (total)(h)
2019-2025	Mile Long Pond	LMB	ND	ND	ND	ND		ND	ND	ND	ND	ND		<RL	ND	<RL	ND		2.379
2027,28 2243,44	Mile Long Pond	BRB	ND	<RL	ND	<RL		ND	ND	ND	<RL	ND		1.67 (j)	ND	<RL	<RL		2.366
2117-2123	Lower Pacific Heights Pond	CHC	1.04	<RL	1.02	3.12	5.17 (j)	4.18	ND	2.25	56.2	<RL	58.45 (j,n)	0.836 (j)	<RL	54 (k)	27	81 (j,l,m)	48.893
2117-2123 Duplicate	Lower Pacific Heights Pond	CHC	1.03	<RL	1.01	2.94	4.98 (j)	3.97	ND	2.25	53.2	<RL	55.45 (j,n)	0.627	<RL	52 (k)	27	79 (j,l,m)	46.66

- * SPB - spotted bass
CHC - channel catfish
CP - common carp
WHC - white catfish
SS - Sacramento sucker
PM - pikeminnow
LMB - largemouth bass
BRB - brown bullhead
- a. From SWRCB 1995. Toxic Substances Monitoring Program, 1994-95 Data Report. State Water Resources Control Board, Sacramento, California.
b. National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria, 1972 (Blue Book). U.S. Environmental Protection Agency, Ecological Research Series.
c. FDA 2000. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed. U.S. Food and Drug Administration. Industry Activities Staff Booklet. Washington, D.C.
d. OEHHA 1999. Prevalence of selected target chemical contaminants in sport fish from two California Lakes: Public Health Designed Screening Study. Office of Environmental Health Hazard Assessment, Sacramento, California
e. Sum of alpha and gamma chlordan, cis- and trans-nonachlor and oxychlordan
f. Sum of ortho and para DDTs, DDDs, and DDEs
g. Expressed as the sum of Aroclors
h. Expressed as sum of congeners
i. A tolerance, rather than an action level, has been established for PCBs (21CFR 109, published May 29, 1984). An action level is revoked when a regulation establishes a tolerance for the same substance and use.
j. Exceeds MTRL
k. Exceeds EDL for fish filets
l. Exceeds OEHHA screening level
m. Exceeds USEPA screening level
n. Exceeds Canadian Tissue Residue guideline
o. Exceeds New York DEC fish flesh criteria for fish-eating wildlife
p. Exceeds USFWS Contaminant Hazard Review proposed criteria in diet of wildlife (based on susceptibility of mink)

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Table 5.0-2. Metals Results for Fish Collected in 2002 from the Oroville Facilities (criteria and results in mg/kg (ppm))

			Arsenic	Cadmium	Chromium	Copper		Lead	Mercury	Nickel	Selenium	Silver	Zinc
Maximum Tissue Residue Levels (MTRLs) (for Filets or Edible Tissues) (a)	for Carcinogens in Inland Surface Waters		0.2										
	for Non-carcinogens in Inland Surface Waters			0.64					1	28			
NAS Recommended Guideline for Freshwater Fish (b)	(Whole Fish)								0.5				
FDA Action Level for Freshwater and Marine Fish (c)	(Edible Portion)								1.0 (d)				
OEHHA Screening values and action levels in fish tissues (e)	USEPA Value		3 (f)	10					0.6 (g)		50		
	OEHHA Value		1 (f)	3					0.3 (g,n)		20		
Elevated Data Levels (a)	Fish Type (h)		All	All	All	Non	Salmo	All	All	All	All	All	All
	Fish Livers	EDL 85	0.21	0.36	0.03	12	170	0.1	ID (j)	<0.10 (i)	3.32	0.26	28
		EDL 95	0.68	0.99	0.07	33	230	0.2	ID	0.2	4.74	0.76	38
	Whole Fish	EDL 85	0.41	0.12	0.23	3.3	0.2	0.11	0.21	1.4	0.02	42	
		EDL 95	0.88	0.19	0.54	4.3	0.46	0.22	0.56	1.9	0.04	49	
	Fish Filets	EDL 85	0.14	<0.01 (i)	<0.02 (i)	0.69	<0.10 (i)	0.8	<0.10 (i)	1	<0.02 (i)	21.4	
EDL 95		0.43	0.01	<0.02 (i)	0.99	<0.10	1.7	<0.10 (i)	1.8	<0.02 (i)	30.2		
Median International Standards (a)	(excludes liver)		1.5	0.3	1	20		2	0.5		2		45
Canadian Tissue Residue guidelines									0.033 (y)				
USFWS Contaminant Hazard Reviews			NA (z) (USFWS 1988b)	0.1 (USFWS 1985a)	NA (z) (USFWS 1986b)	NA (z) (USFWS 1998a)	NA (z) (USFWS 1988c)	wildlife: 1.1, avian: 0.1 (USFWS 1987)	wildlife:500; avian: 200 (USFWS1998b)	NA (z) (USFWS 1985b)	6 (USFWS 1996)	300 (z) (USFWS 1993)	
USFWS protection of threatened and endangered wildlife			0.3 (aa)										
Station Name	Species (k)	Type	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc	
SF Arm Lake Oroville (McCabe Cove)	CHC	flesh	<0.025	<0.002	0.134 (u)	0.29	<0.002	0.876 (r,s,u,w,bb,cc,dd)	<0.002	0.11	<0.002	6.78	
SF Arm Lake Oroville (McCabe Cove)	CHC	liver	0.115	0.061	0.477 (t)	4.07	0.038	0.022	0.047	1.72	0.006	18.6	
SF Arm Lake Oroville (McCabe Cove)	SPB	flesh	0.188 (u)	<0.002	0.123 (u)	0.24	<0.002	0.722 (r,s,w,bb,cc,dd)	<0.002	0.27	<0.002	5.00	
SF Arm Lake Oroville (McCabe Cove)	SPB	liver	0.378 (t)	0.775 (t,bb)	0.125 (t)	6.33	0.005	0.556	<0.002	0.77	0.005	22.1	
SF Arm Lake Oroville (Lower)	CHC	liver			0.3 (t)	2.13	0.943 (t)				0.003	19.2	
SF Arm Lake Oroville (Lower)	CHC	flesh	<0.025	<.002				1.059 (p,q,r,s,u,w,bb,cc,dd)	0.006	0.16			
SF Arm Lake Oroville (Lower)	SPB	liver			0.27 (t)	2.82	0.070				<.002	19.0	
SF Arm Lake Oroville (Lower)	SPB	flesh	0.21 (o,u)	<.002				0.677 (r,s,w,bb,cc,dd)	0.007	0.28			
Upper MF Lake Oroville	CHC	liver			0.48 (t)	2.87	2.581 (t)				<.002	18.4	
Upper MF Lake Oroville	CHC	flesh	<0.025	<.002				0.476 (s,bb,cc,dd)	<.002	0.12			
Upper MF Lake Oroville	SPB	liver			0.3 (t)	1.91	0.004				<.002	18.3	
Upper MF Lake Oroville	SPB	flesh	0.17 (u)	<.002				0.535 (s,w,bb,cc,dd)	0.024	0.3			
Lower MF Lake Oroville	CHC	flesh	<0.025	<0.002	0.076 (u)	0.38	<0.002	1.614 (p,q,r,s,u,w,bb,cc,dd)	<0.002	0.13	0.004	6.43	
Lower MF Lake Oroville	CHC	liver	0.164	0.182 (bb)	0.449 (t)	3.28	0.048	6.513	0.021	2.23	0.006	18.8	
Lower MF Lake Oroville	SPB	flesh	0.189 (u)	<0.002	0.124 (u)	0.24	<0.002	0.587 (s,w,bb,cc,dd)	0.018	0.27	<0.002	4.50	
Lower MF Lake Oroville	SPB	liver	0.482 (t)	0.066	0.057 (t)	6.11	0.009	0.591	<0.002	0.94	0.009	22.9	
NF Arm L. Oroville (Bloomer Cnyn)	CHC	liver			0.56 (t)	2.87	0.089				<.002	18.3	
NF Arm L. Oroville (Bloomer Cnyn)	CHC	flesh	0.020	0.003				0.402 (s,bb,cc,dd)	0.135 (u)	0.16			
NF Arm L. Oroville (Bloomer Cnyn)	CP	flesh	0.050	0.006				0.231 (bb,dd)	0.007	0.27			
NF Arm L. Oroville (Bloomer Cnyn)	SPB	flesh	0.242 (o,u)	<0.002	0.096 (u)	0.21	<0.002	0.394 (s,bb,cc,dd)	<0.002	0.27	<0.002	4.36	

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Table 5.0-2. Continued.

			Arsenic	Cadmium	Chromium	Copper		Lead	Mercury	Nickel	Selenium	Silver	Zinc
Maximum Tissue Residue Levels (MTRLs) (for Filets or Edible Tissues) (a)	for Carcinogens in Inland Surface Waters		0.2										
	for Non-carcinogens in Inland Surface Waters			0.64					1	28			
NAS Recommended Guideline for Freshwater Fish (b)	(Whole Fish)								0.5				
FDA Action Level for Freshwater and Marine Fish (c)	(Edible Portion)								1.0 (d)				
OEHHA Screening values and action levels in fish tissues (e)	USEPA Value		3 (f)	10					0.6 (g)		50		
	OEHHA Value		1 (f)	3					0.3 (g,n)		20		
Elevated Data Levels (a)	Fish Type (h)		All	All	All	Non	Salmo	All	All	All	All	All	All
	Fish Livers	EDL 85	0.21	0.36	0.03	12	170	0.1	ID (j)	<0.10 (i)	3.32	0.26	28
		EDL 95	0.68	0.99	0.07	33	230	0.2	ID	0.2	4.74	0.76	38
	Whole Fish	EDL 85	0.41	0.12	0.23	3.3	0.2	0.11	0.21	1.4	0.02	42	
		EDL 95	0.88	0.19	0.54	4.3	0.46	0.22	0.56	1.9	0.04	49	
	Fish Filets	EDL 85	0.14	<0.01 (i)	<0.02 (i)	0.69	<0.10 (i)	0.8	<0.10 (i)	1	<0.02 (i)	21.4	
		EDL 95	0.43	0.01	<0.02 (i)	0.99	<0.10	1.7	<0.10 (i)	1.8	<0.02 (i)	30.2	
Median International Standards (a)	(excludes liver)		1.5	0.3	1	20	2	0.5		2		45	
Canadian Tissue Residue guidelines								0.033 (y)					
USFWS Contaminant Hazard Reviews			NA (z) (USFWS 1988b)	0.1 (USFWS 1985a)	NA (z) (USFWS 1986b)	NA (z) (USFWS 1998a)	NA (z) (USFWS 1988c)	wildlife: 1.1, avian: 0.1 (USFWS 1987)	wildlife:500; avian: 200 (USFWS1998b)	NA (z) (USFWS 1985b)	6 (USFWS 1996)	300 (z) (USFWS 1993)	
USFWS protection of threatened and endangered wildlife								0.3 (aa)					
Station Name	Species (k)	Type	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc	
NF Arm L. Oroville (Foreman C)	CHC	liver			0.48 (t)	2.73	0.015				<.002	20.7	
NF Arm L. Oroville (Foreman C)	CHC	flesh	0.030	<.002				0.343 (s,bb,cc,dd)	<.002	0.18			
NF Arm L. Oroville (Foreman C)	CP	flesh	0.110	0.005				0.721 (r,s,w,bb,cc,dd)	0.007	0.45			
NF Arm L. Oroville (Foreman C)	SPB	liver			0.26 (t)	1.91	<.002				<.002	18.4	
NF Arm L. Oroville (Foreman C)	SPB	flesh	0.100	<.002				0.143 (bb,dd)	<.002	0.13			
NF Arm L. Oroville (Foreman C)	WHC	liver			0.63 (t)	1.85	0.005				<.002	19.3	
NF Arm L. Oroville (Foreman C)	WHC	flesh	0.030	<.002				0.38 (s,bb,cc,dd)	<.002	0.15			
Lake Oroville Spillway arm	CHC	flesh	0.029	<.002	0.175 (u)	0.10	<.002	0.154 (bb,dd)	<.002	0.06	<.002	4.14	
Lake Oroville Spillway arm	SPB	flesh	0.228 (o,u)	<.002	0.073 (u)	0.24	<.002	0.469 (s,bb,cc,dd)	<.002	0.26	<.002	4.68	
Lake Oroville Spillway arm	SPB	liver	0.772 (t)	0.087	0.169 (t)	4.39	0.006	0.299	<.002	1.10	<.002	22.3	
Lake Oroville Bidwell Arm	CHC	flesh	<.025	<.002	0.094 (u)	0.23	<.002	0.973 (r,s,u,w,bb,cc,dd)	<.002	0.13	<.002	6.28	
Lake Oroville Bidwell Arm	CHC	liver	0.108	0.096	0.296 (t)	3.99	0.219 (t)	2.025	<.002	1.45	0.002	20.4	
Lake Oroville Bidwell Arm	SPB	flesh	0.159 (u)	<.002	0.141 (u)	0.21	<.002	0.432 (s,bb,cc,dd)	<.002	0.27	<.002	4.85	
Lake Oroville Bidwell Arm	SPB	liver	0.673 (t)	0.19 (bb)	0.024	8.36	0.012	0.845	<.002	1.03	0.013	25.9	
North Forebay (Swim Area)	CP	flesh	0.060	<.002				0.146 (bb,dd)	<.002	0.27			
North Forebay (Swim Area)	PM	flesh	0.25 (o,u)	<.002				0.543 (s,w,bb,cc,dd)	<.002	0.17			
South Thermalito Afterbay (Ski Cove)	LMB	flesh	0.080	<.002	0.077 (u)	0.19	<.002	0.475 (s,bb,cc,dd)	0.031	0.23	<.002	4.78	
South Thermalito Afterbay (Ski Cove)	LMB	liver	0.291 (t)	0.293 (bb)	0.074 (t)	29.5 (t)	<.002	0.399	0.025	0.90	0.018	29.6 (t)	
South Thermalito Afterbay (Ski Cove)	CP	flesh	0.126	0.007				0.234 (bb,dd)	0.014	0.18			

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Table 5.0-2. Continued.

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		Arsenic	Cadmium	Chromium	Copper		Lead	Mercury	Nickel	Selenium	Silver	Zinc
Maximum Tissue Residue Levels (MTRLs) (for Filets or Edible Tissues) (a)	for Carcinogens in Inland Surface Waters	0.2										
	for Non-carcinogens in Inland Surface Waters		0.64					1	28			
NAS Recommended Guideline for Freshwater Fish (b)	(Whole Fish)							0.5				
FDA Action Level for Freshwater and Marine Fish (c)	(Edible Portion)							1.0 (d)				
OEHHA Screening values and action levels in fish tissues (e)	USEPA Value	3 (f)	10					0.6 (g)		50		
	OEHHA Value	1 (f)	3					0.3 (g,n)		20		
Elevated Data Levels (a)	Fish Type (h)	All	All	All	Non	Salmo	All	All	All	All	All	All
	Fish Livers											
	EDL 85	0.21	0.36	0.03	12	170	0.1	ID (j)	<0.10 (i)	3.32	0.26	28
	EDL 95	0.68	0.99	0.07	33	230	0.2	ID	0.2	4.74	0.76	38
	Whole Fish											
	EDL 85	0.41	0.12	0.23	3.3	0.2	0.11	0.21	1.4	0.02	42	
	EDL 95	0.88	0.19	0.54	4.3	0.46	0.22	0.56	1.9	0.04	49	
	Fish Filets											
	EDL 85	0.14	<0.01 (i)	<0.02 (i)	0.69	<0.10 (i)	0.8	<0.10 (i)	1	<0.02 (i)	21.4	
	EDL 95	0.43	0.01	<0.02 (i)	0.99	<0.10	1.7	<0.10 (i)	1.8	<0.02 (i)	30.2	
Median International Standards (a)	(excludes liver)	1.5	0.3	1	20		2	0.5		2		45
Canadian Tissue Residue guidelines								0.033 (y)				
USFWS Contaminant Hazard Reviews		NA (z) (USFWS 1988b)	0.1 (USFWS 1985a)	NA (z) (USFWS 1986b)	NA (z) (USFWS 1998a)	NA (z) (USFWS 1988c)	wildlife: 1.1, avian: 0.1 (USFWS 1987)	wildlife:500; avian: 200 (USFWS1998b)	NA (z) (USFWS 1985b)	6 (USFWS 1996)	300 (z) (USFWS 1993)	
USFWS protection of threatened and endangered wildlife							0.3 (aa)					
Station Name	Species (k)	Type	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Feather R US from Afterbay Outlet	LMB	flesh	0.039	<0.002	0.09 (u)	0.26	<0.002	0.475 (s,bb,cc,dd)	0.016	0.16	<0.002	4.45
Feather R US from Afterbay Outlet	LMB	liver	0.113	0.058	0.109 (t)	1.68	0.003	0.215	0.022	0.63	<0.002	17.4
Feather R DS from Afterbay Outlet	LMB	liver			0.22 (t)	9.23	<0.002				<0.002	18.0
Feather R DS from Afterbay Outlet	LMB	flesh	0.050	<.002				0.542 (s,w,bb,cc,dd)	<.002	0.20		
Mile Long Pond	BRB	flesh	<0.025	<0.002	0.126 (u)	0.32	<0.002	0.062	0.004	0.04	<0.002	3.85
Mile Long Pond	BRB	liver	<0.025	<0.002	0.111 (t)	2.08	0.008	0.005	0.14 (t)	0.16	0.005	9.23
Potters Pond	CP	flesh	0.060	0.004				0.133 (bb,dd)	0.009	0.18		
Potters Pond	LMB	liver			0.19 (t)	3.53	0.008				<.002	19.0
Potters Pond	LMB	liver			0.23 (t)	3.47	0.004				<.002	18.2
Potters Pond	LMB	flesh	<0.025	<.002				0.26 (bb,dd)	0.123 (u)	0.12		
Lower Pacific Heights Pond	CHC	liver			0.06 (t)	2.05	0.034				0.003	21.0
Lower Pacific Heights Pond	CHC	flesh	<0.025	<.002				0.355 (s,bb,cc,dd)	0.006	0.10		
Diversion Pool	crayfish (l)	crayfish			0.25 (v)	20.3 (v,w)	0.012	32.5 (p,x,q,r,s,v,w,bb,cc,dd)			0.006	19.7
N. Afterbay	crayfish (l)	crayfish			0.25 (v)	34.3 (v,w)	0.023	2.0/24.9 (p,x,q,r,s,v,w,bb,cc,dd)			0.011	19.8
S. Afterbay	crayfish (l)	crayfish			0.32 (v)	27.6 (v,w)	0.035	26.3 (p,x,q,r,s,v,w,bb,cc,dd)			0.010	23.0
Feather R DS Hwy 70	crayfish (l)	crayfish			0.26 (v)	22.2 (v,w)	0.025	41.6 (p,x,q,r,s,v,w,bb,cc,dd)			0.016	22.5

Table 5.0-2. Continued

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Contaminant Accumulation In Fish, Sediments, And The Aquatic Food Chain

Study Plan W2, Phase 1 Draft Report

Oroville Facilities P-2100 Relicensing

- a. From SWRCB 1995. Toxic Substances Monitoring Program, 1994-95 Data Report. State Water Resources Control Board, Sacramento, California.
- b. National Academy of Sciences-National Academy of Engineering. 1973. Water Quality Criteria, 1972 (Blue Book). U.S. Environmental Protection Agency, Ecological Research Series.
- c. FDA 2000. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed. U.S. Food and Drug Administration. Industry Activities Staff Booklet. Washington, D.C.
- d. as methyl mercury.
- e. OEHHA 1999. Prevalence of selected target chemical contaminants in sport fish from two California Lakes: Public Health Designed Screening Study. Office of Environmental Health Hazard Assessment, Sacramento, California
- f. measured as total arsenic
- g. measured as total mercury
- h. Non = Includes all non-salmonid species. Salmo = Family Salmonidae (trouts). All = All fish species.
- i. < = EDL lies below the indicated detection limit.
- j. ID = Insufficient data to calculate the EDL.
- k. CHC - channel catfish, SPB - spotted bass, CP - carp, WHC - white catfish, PM - pikeminnow, LMB - largemouth bass, BRB - brown bullhead
- l. Analyzed as composites
- m. Duplicate
- n. As methylmercury; from USEPA 2001. Water Quality Criterion for the Protection of Human Health:Methylmercury. EPA-823-R-01-001.
- o. Exceeds MTRL for carcinogens
- p. Exceeds MTRL for non-carcinogens
- q. Exceeds FDA action level
- r. Exceeds USEPA screening level
- s. Exceeds OEHHA screening level
- t. Exceeds EDL for fish livers
- u. Exceeds EDL for fish filets
- v. Exceeds EDL for whole fish
- w. Exceeds MIS
- x. Exceeds NAS guideline
- y. As methylmercury
- z. No criteria proposed
- aa. USFWS 2003. Evaluation of the Clean Water Act Section 304(a) Human Health Criterion for Methylmercury: Protectiveness for Threatened and Endangered Wildlife in California. U.S. Fish and Wildlife Service. Sacramento, California.
- bb. Exceeds recommended limit in USFWS Contaminant Hazard Review
- cc. Exceeds recommendation of USFWS Evaluation of CWA Section 304(a) for Methylmercury
- dd. Exceeds Canadian Tissue Guideline

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

5.1.1.2 Chlorpyrifos

Chlorpyrifos was detected only in fish from the Lower Pacific Heights Pond. The concentration of chlorpyrifos in the channel catfish collected from this site did not exceed the levels of any guidelines or criteria.

5.1.1.3 DDT Isomers

DDT isomers were detected in fish from all sites except Mile Long Pond, and in all species collected except spotted bass from the Bidwell Arm of Lake Oroville, crayfish from the Diversion Pool, and largemouth bass from Potters Pond, though other species collected from these waters contained detectable levels.

Criteria or guidelines for DDT isomers consist of EDLs, which were not exceeded. Total DDT, which is the sum of the ortho and para isomers, exceeded the MTRL and Canadian tissue residue guidelines in channel catfish from Lake Oroville collected near the spillway and the Lower Pacific Heights Pond. The MTRL and Canadian tissue residue guidelines and OEHHA screening value were exceeded in pikeminnow and carp from the North Thermalito Forebay swim area and carp from the south Thermalito Afterbay. The bass and crayfish species from these same waters contained only a fraction of the level of DDT isomers that were identified in the catfish, pikeminnow, and carp.

5.1.1.4 Dieldrin

Dieldrin was detected in channel catfish, carp, pikeminnow, or brown bullhead from all of the Lake Oroville sampling sites (except those in the South Fork Arm), the North Thermalito Forebay swim area, south Thermalito Afterbay, and Mile Long and Lower Pacific Heights ponds. Dieldrin was not detected in any bass or crayfish species.

The MTRL guideline for dieldrin was exceeded in channel catfish from Lake Oroville in the Bloomer Canyon area of the North Fork Arm and near the spillway, and from the Lower Pacific Heights Pond. Dieldrin also exceeded this guideline in carp collected from the North Thermalito Forebay swim area and south Thermalito Afterbay. Brown bullhead from Mile Long Pond also had dieldrin levels that exceeded the MTRL.

5.1.1.4. Hexachlorobenzene

Hexachlorobenzene was detected in channel catfish from Lake Oroville from the South Fork Arm near McCabe Cove and from the main body near the spillway as well as the Bidwell arm. Sacramento sucker from the Diversion Pool, pikeminnow and carp from the North Thermalito Forebay swim area, and carp from the south Thermalito Afterbay also contained detectable levels of hexachlorobenzene, but none was detected in any bass or crayfish species.

None of the fish contained hexachlorobenzene at levels that exceeded any guidance values or criteria.

5.1.1.5 PCB

PCBs were detected in all fish and crayfish species from all water bodies that were sampled, while PCB Aroclors were detected in at least some fish in all water bodies (except Mile Long Pond) and in crayfish in the Feather River downstream from the Highway 70 bridge. The EDL for Aroclor 1254 was exceeded in Sacramento sucker collected from the Diversion Pool, pikeminnow and carp from the North Thermalito Forebay swim area, carp from the south Thermalito Afterbay, crayfish from the Feather River downstream from the Highway 70 bridge, and channel catfish from the Lower Pacific Heights Pond. The EDL for Aroclor 1260 was exceeded in channel catfish from both South Fork Arm collection sites and the lower Middle Fork Arm of Lake Oroville, pikeminnow and carp from the North Thermalito Forebay swim area, and carp from the south Thermalito Afterbay.

Bass contained PCBs at much lower levels than found in other fish species. However, spotted bass collected from both South Fork arms of Lake Oroville and largemouth bass collected from the Feather River both upstream and downstream from the Afterbay Outlet to the river contained total PCBs (as the sum of Aroclors) that exceeded the MTRL and screening values of the USEPA and OEHHA, while spotted bass from the lower Middle Fork Arm of Lake Oroville contained total PCBs that exceeded the MTRL and were at the same concentration as the USEPA screening value. Total PCBs (as the sum of Aroclors) exceeded the MTRL and USEPA and OEHHA screening values in channel catfish from all sites where this species was collected, which included all the Lake Oroville sampling sites and Lower Pacific Heights Pond. In addition, channel catfish from the lower Middle Fork Arm of Lake Oroville exceeded the USFWS contaminant hazard recommendation for wildlife (USFWS 1986a), while those from both South Fork Arm collection sites also exceeded the EDL, New York criteria for fish-eating wildlife, and USFWS contaminant hazard recommendation for wildlife. Both pikeminnow and carp collected from the North Thermalito Forebay swim area exceeded the MTRL, EDL, USEPA and OEHHA screening values, New York criteria for fish-eating wildlife, and USFWS contaminant hazard recommendation for wildlife. Carp collected from both North Fork arms of Lake Oroville, south Thermalito Afterbay, and Potters Pond, Sacramento sucker collected from the Diversion Pool, and crayfish collected downstream from the Highway 70 bridge exceeded the MTRL and USEPA and OEHHA screening values for total PCBs as the sum of Aroclors. In addition, the EDL, New York criteria for fish-eating wildlife, and USFWS contaminant hazard recommendation for wildlife were exceeded in carp collected from the south Thermalito Afterbay.

5.1.2 Metal Contaminants

5.1.2.1 Arsenic

The MTRL for arsenic was exceeded in spotted bass from the lower South Fork Arm, Bloomer Canyon area of the North Fork Arm, and spillway arm of Lake Oroville, and in pikeminnow from the North Thermalito Forebay swim area. Arsenic was detected at levels that exceeded the EDL for filets in spotted bass from all of the Lake Oroville sampling areas, except the Foreman Creek area of the North Fork Arm, and in pikeminnow from the North Thermalito Forebay swim area. The EDL for liver was exceeded in spotted bass from the McCabe Cove area in the South Fork Arm, lower Middle Fork Arm, spillway arm, and Bidwell arm of Lake Oroville, and in largemouth bass from the south Thermalito Afterbay ski cove. Channel and white catfish and carp contained the lowest arsenic levels in tissues.

Arsenic is a relatively common element that occurs in air, water, soil, and all living tissues (USFWS 1988b). While arsenic is carcinogenic in humans, evidence of arsenic-induced carcinogenicity in other mammals is scarce. Evidence also indicates that arsenic is nutritionally essential or beneficial. Arsenic deficiency effects, such as poor growth, reduced survival, and inhibited reproduction, has been observed in mammals fed diets containing less than 0.05 mg arsenic/kg, but not in those fed diets with 0.35 mg/kg. In addition, while arsenic may be bioconcentrated by organisms, it is not biomagnified in the food chain. Criteria for the protection of wildlife have not been developed (EC 2000, Newell et al. 1987, USFWS 1988b).

Arsenic detected in fish from the South and North Fork arms and spillway area of Lake Oroville, and the North Thermalito Forebay are considered to be at levels that may pose a potential human health concern (SWRCB 1996), but did not exceed any compliance or enforcement criteria. Arsenic was present in fish from most lake sampling sites that exceeded the 85th percentile EDL, which indicates that this element is elevated from the median found in other water bodies sampled by the TSMP, but these concentrations are not directly related to potentially adverse human or animal health effects. Arsenic levels in fish filets were less than levels found to be nutritionally beneficial in mammals, which suggests that arsenic levels in fish from project area waters may not pose undue risk to wildlife. Arsenic levels in liver from some fish were elevated from the median found in other water bodies sampled by the TSMP and greater than levels found to be nutritionally beneficial. However, liver represents only a small portion of the whole fish that wildlife would consume, and thus would not be expected to be of concern.

5.1.2.2 Cadmium

Cadmium was detected in liver in spotted bass from the McCabe Cove area of the South Fork Arm of Lake Oroville that exceeded the EDL. The USFWS recommended

that wildlife dietary levels exceeding 0.1 mg of cadmium/kg fresh weight of prey on a sustained basis should be viewed with caution (USFWS 1985a).

Cadmium is a relatively rare heavy metal. No evidence is available to indicate that cadmium is biologically essential, but cadmium is a known teratogen and carcinogen, a probable mutagen, and has been implicated as causing severe deleterious effects to fish and wildlife (USFWS 1985a). Freshwater aquatic organisms can accumulate measurable amounts of cadmium from water containing low levels of cadmium.

Cadmium levels in fish flesh tissue from all sampling sites were always at low levels, either below or near detection levels. However, cadmium levels in liver from spotted bass from the McCabe Cove area and Bidwell Arm, and in channel catfish from the lower Middle Fork Arm of Lake Oroville exceeded the USFWS (1985a) recommendation for cadmium levels in prey species for protection of wildlife. The recommended level for wildlife protection was also exceeded in liver in largemouth bass from the Thermalito Afterbay near the ski cove. Since liver represents only a small portion of a fish, the amount of cadmium that wildlife would ingest from eating fish from project waters should be well below the level recommended by the USFWS for their protection.

5.1.2.3 Chromium

The EDL for fish filets is less than the 0.02 detection level for chromium. All fish filets and livers from all sampling sites, except liver from spotted bass from the Bidwell Arm of Lake Oroville, exceeded EDLs. The EDL for chromium in whole fish was exceeded in crayfish from each of the four sites sampled.

Chromium is an essential trace element in humans and some species of laboratory animals, but data are incomplete to determine chromium needs of other species (USFWS 1986b). At high environmental concentrations, chromium is a mutagen, teratogen, and carcinogen. Biomagnification has not been observed in the food web, and highest concentrations are usually observed at the lowest trophic levels. One of the difficulties in establishing criteria for the protection of wildlife is that sensitivity to chromium varies widely, even amongst closely related species. Adverse effects to sensitive species of wildlife have been documented at chromium levels of 5 to 10 mg/kg of diet.

No guidelines or recommendations are available for levels of chromium to protect wildlife (EC 2000, Newell et al. 1987, USFWS 1986b). However, chromium levels detected in fish from project area waters were only a fraction of the levels identified as harmful to sensitive species of wildlife. Therefore, adverse effects to wildlife from chromium levels in fish from project area waters is not expected to result in deleterious effects.

5.1.2.4 Copper

Copper levels in fish only exceeded the EDL for liver from largemouth bass collected from the ski cove area of the Thermalito Afterbay. Copper concentrations in crayfish from all four sampling sites exceeded the EDL for whole fish as well as the median international standard.

Copper is abundant in the environment and essential for normal growth and metabolism of all living organisms (USFWS 1998a). Copper is amongst the most toxic of the heavy metals in freshwater biota, and often accumulates to levels causing harm that are just above those required for growth and reproduction. Birds and mammals, in comparison to lower forms, are relatively resistant to copper. Bioavailability and toxicity of copper to aquatic organisms is dependent upon the total copper concentration and speciation. Toxicity to aquatic life is related primarily to the dissolved cupric ion and possibly hydroxy complexes. Cupric ion accounts for less than a percent of the dissolved copper in fresh water. Numerous and disparate copper criteria have been proposed for protecting the health of agricultural crops, aquatic life, terrestrial invertebrates, poultry, laboratory white rats, and humans, but no copper criteria are available for protection of avian and mammalian wildlife.

Exceedence of the EDL in the fish and crayfish indicates that copper levels are higher than the median found in other water bodies, but is not directly related to potentially adverse human or animal health. The levels of copper found in crayfish are higher than levels that other countries have determined to be elevated in fish tissues, but this standard does not apply within the United States.

5.1.2.5 Lead

Lead was generally not detected or detected only at low levels. However, liver samples from channel catfish collected from the lower South Fork, upper Middle Fork, and Bidwell arms of Lake Oroville exceeded the EDL for lead.

Lead is neither essential nor beneficial to living organisms, and may adversely affect survival, growth, reproduction, development, behavior, learning, and metabolism (USFWS 1988c). Food web biomagnification of lead is negligible, and younger organisms are more susceptible than older individuals. Guidelines for protection of wildlife from lead levels contained in prey have not been developed (EC 2000, Newell et al. 1987, USFWS 1988c), though reduced survival has been documented in sensitive species of birds at doses of 50 to 75 mg of lead/kg of body weight. Data are unavailable for toxic and sublethal effects of lead to mammalian wildlife.

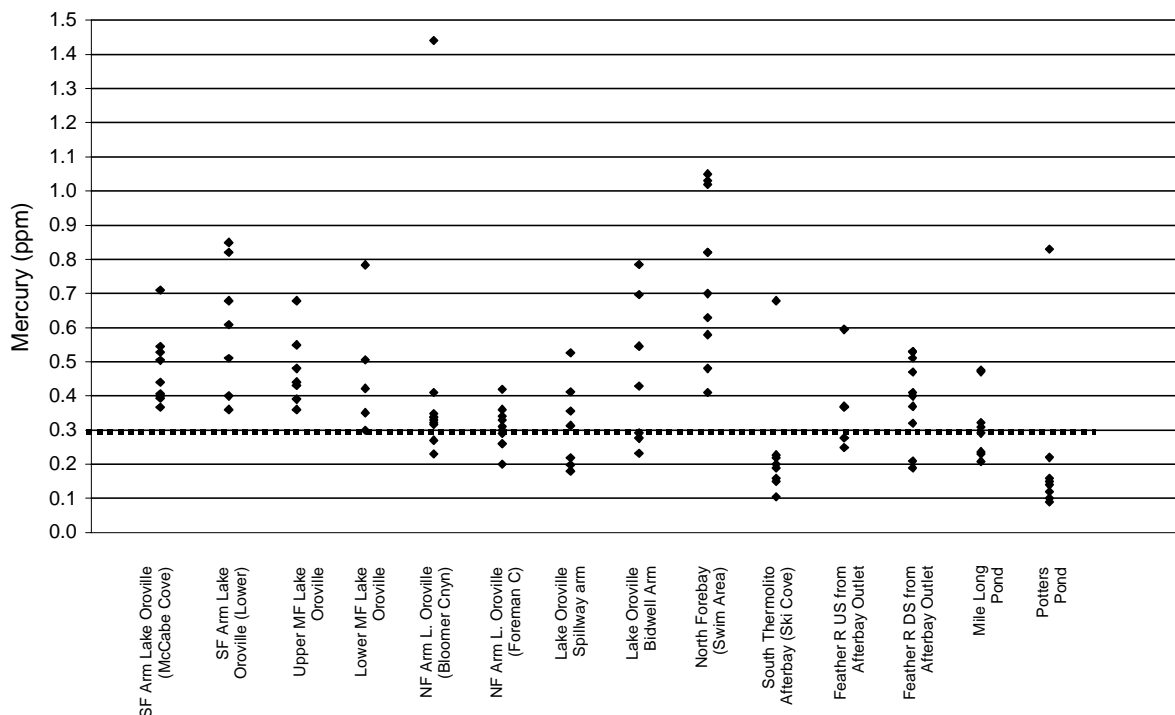
5.1.2.6 Mercury

Fish composites exceeded the OEHHA screening value or USEPA criterion for protection of human health for mercury in filets from every sampling site except Mile Long and Potter's ponds. Highest levels of mercury in fish filets, which exceeded the MTRL, were found in the lower South Fork and Middle Fork arms of Lake Oroville. The EDL was exceeded in fish from both sampling sites in the South Fork, lower Middle Fork, and Bidwell arms of Lake Oroville, while the MIS was exceeded in both of the South Fork and Middle Fork, the Foreman Creek area of the North Fork, and the Bidwell arms of Lake Oroville, the North Thermalito Forebay swim area, and the Feather River downstream from the Afterbay Outlet. Both the Canadian tissue (EC 2000) and USFWS (1987) guidelines for protection of wildlife from ingesting contaminated prey were exceeded at all stations except Mile Long Pong. The USFWS recommendation for protection of wildlife from methylmercury ingested from prey (USFWS 2003) was exceeded in fish from all sampling sites except Mile Long and Potter's ponds. Mercury levels in all the crayfish composites exceeded all the applicable guidelines and criteria, including the MTRL, NAS guideline, FDA action level, USEPA and OEHHA screening values, EDL, MIS, Canadian tissue residue guideline, and wildlife and avian protection recommendations of the USFWS.

Analyses of mercury from individual fish show the OEHHA screening value and USEPA criterion for protection of human health was exceeded at most sampling sites, as was the recommendation of the USFWS for protection of threatened and endangered wildlife (Figure 5.1.2-1). Most fish from the Thermalito Afterbay, which was sampled in the area of the ski cove and Potter's Pond, had levels of mercury that were less than the screening value, health criterion, and protection guideline.

Mercury has no known beneficial biological function, and can be bioconcentrated in organisms and biomagnified through the food web (USFWS 1987). Mercury is a mutagen, teratogen, and carcinogen, and causes embryocidal, cytochemical, and histopathological effects. Earlier studies have indicated that total mercury concentrations in prey items for the protection of sensitive species of mammals and birds that regularly consume fish and other aquatic organisms should not exceed 0.1 mg/kg fresh weight for birds and 1.1 mg/kg for small mammals. Criteria for methylmercury in fish of 0.3 mg/kg have been developed for protection of human health (USEPA 2001). The USEPA, in consultation with the USFWS, concluded that this criterion should also be protective of federally listed aquatic and aquatic dependent wildlife species in California (USFWS 2003). However, evaluation of this criterion indicates that certain species may be protected, depending upon which trophic level analysis approach is used, but that others are still susceptible to adverse effects at concentrations of mercury less than the criterion.

Figure 5.1.2-1. Mercury levels in individual fish from project waters (species included spotted bass from Lake Oroville, pikeminnow from the Thermalito Forebay, and large-mouth bass from the Thermalito Afterbay, Feather River, and ponds)



5.1.2.7 Nickel

Nickel was either not detected or detected at low levels in fish tissues, except in filets from channel catfish from the Bloomer Canyon area of the North Fork Arm of Lake Oroville and largemouth bass from the Potter's Pond brood pond in the north Thermalito Afterbay, and in liver from brown bullhead collected from Mile Long Pond. The nickel levels detected in these fish exceeded the EDL.

Nickel is abundant in the environment, and is essential for the normal growth of many species (USFWS 1998b). At high levels, nickel may be carcinogenic. Bird diets should contain at least 50 mg/kg of ration to prevent nickel deficiency but less than 200 mg/kg of ration for young birds and 800 mg/kg of ration for adults to prevent adverse effects on growth and survival. Most species of mammals evaluated had normal growth and survival during chronic exposure in diets containing 0.8 to 40 mg/kg. Sensitive species of wildlife sometimes exhibited reduced growth and survival when fed diets containing 500 to 2,500 mg of nickel/kg ration. However, further research is needed to clarify the role of nickel in mammalian nutrition and health effects. Nickel levels detected in fish from

project waters were well below levels recommended for protection from ingestion of prey by avian species and levels found to be acceptable in mammals (USFWS 1998b).

5.1.2.8 Selenium and Silver

Selenium was detected in fish at low levels, while silver was either not detected or detected only at low concentrations.

Neither selenium nor silver exceeded any of the guidelines or criteria, including those developed to protect avian and wildlife predators from prey containing elevated levels of silver (USFWS 1996); predator protection guidelines have not been developed for selenium (EC 2000, Newell et al. 1987, USFWS 1985b).

5.1.2.9 Zinc

Zinc was detected in all fish samples, but only the EDL was exceeded for liver in largemouth bass from the Thermalito Afterbay ski cove.

Zinc is naturally present in the environment, but often is found at elevated levels due to anthropogenic sources (USFWS 1993). Zinc deficiency occurs in many species of plants and animals, which has severe adverse effects on all stages of growth, development, reproduction, and survival. Avian diets should contain at least 25 mg of zinc/kg of ration to prevent zinc deficiency but less than 178 mg/kg of ration to prevent marginal sublethal effects. Mammals are comparatively resistant to zinc as evidenced by tolerance to extended periods on diets containing over 100 times the minimum daily zinc requirement. The most sensitive species of mammals were adversely affected at dietary concentrations of 90 to 300 mg of zinc/kg ration.

Zinc levels found in fish were well below the guideline suggested for protection of wildlife from ingestion of prey containing zinc (USFWS 1993).

5.2 COMPARISON OF FISH TISSUE TO WATER QUALITY RESULTS

Contaminants can bioaccumulate in the aquatic food web through both water-borne and sediment-borne sources. Sediments collected for Phase 1 have not yet been analyzed for contaminants. Results from fish tissue analyses were compared to concentrations of organic compounds and metals that have been found in project area waters in Study Plan SPW1 to evaluate water-borne contaminants as a source to the food web.

Water samples for organic and metal contaminant analyses were collected from project area waters near many of the locations that were sampled for fish tissue analyses. Water quality monitoring sites that correspond to fish sampling sites include the North Fork Arm near Bloomer Canyon, upper Middle Fork Arm, South Fork Arm near McCabe

Cove, and near the dam of Lake Oroville. Water samples for organic and metal contaminant analyses were also collected from the Diversion Pool, north Thermalito Forebay, north and south Thermalito Afterbay, Feather River upstream and downstream from the Afterbay Outlet, and Mile Long and Lower Pacific Heights ponds.

5.2.1 Organic Contaminants

Samples for organic analyses were collected in November 2002, and February and November 2003. Sample analyses were conducted by the DWR Bryte Chemical Laboratory in Sacramento.

Organic contaminants were not reported from any of the sampled waters at levels that exceeded the detection level.

Though potential organic contaminants were not detected in the water samples, water could still be a source of some contamination of food web organisms. Phytoplankton can accumulate low concentrations of contaminants from the surrounding water. As these organisms are eaten by other species, the low levels of contaminants assimilated by phytoplankton can bioaccumulate in the food web. Over time, sufficient bioaccumulation can occur in higher trophic levels so that even negligible concentrations of contaminants in water can become detectable in higher trophic level organisms.

5.2.2 Metal Contaminants

Metals analyses have been conducted monthly since initiation of monitoring for SPW1 in March 2002. Metals were analyzed by Frontier Geosciences in Washington and Bryte Chemical Laboratory in Sacramento.

While some metals were detected from each of the project area waters that were sampled, only arsenic, cadmium, copper, and lead were at levels in at least some of the water bodies that exceeded water quality criteria for the protection of human health or aquatic life (Appendix A).

5.2.2.1 Arsenic

Arsenic exceeded the OEHHA cancer potency factor for drinking water (CVRWQCB 2003) and USEPA (1999) water quality criteria for protection of human health through ingestion of water as well as aquatic organisms in every water sample that was collected. The highest arsenic level reported in water was 2.81 ug/L from the Lower Pacific Heights Pond, which is well below the 150 ug/L chronic criterion of the California Toxics Rule for the protection of freshwater aquatic life (CVRWQCB 2003). Arsenic in some project area waters apparently is bioaccumulating in some fish, but not to particularly elevated levels.

5.2.2.2 Cadmium

Cadmium was generally not detected or detected only at very low levels in all project area waters. However, several water bodies exhibited elevated cadmium levels in single samples. The public health goal and California Toxics Rule criterion to protect freshwater aquatic life for total recoverable cadmium (SWRCB 2003) were exceeded in one bottom sample from the Middle Fork Arm of Lake Oroville, north Thermalito Forebay, and south Thermalito Afterbay. The public health goal was also exceeded in a bottom water sample from the Diversion Pool as well as a water sample from the Feather River downstream from the Afterbay Outlet. All other analyses from each of these sites reported cadmium at non-detectable levels or levels just above the detection limit, which is well below any criterion. Cadmium was either not detected or reported at low levels in fish flesh from project area waters, except in liver from some fish collected from the Middle and South forks and Bidwell arm of Lake Oroville and the south Thermalito Afterbay, in which the recommended limit in fish tissue was exceeded. Though generally reported at very low levels in water samples, cadmium apparently is bioaccumulating in fish livers, but not to a significant amount in fish flesh. Since fish livers represent only a small portion of a fish that a predator would eat, adverse effects to wildlife from eating fish from project area waters should not pose any undue risk.

5.2.2.2 Chromium

Reported levels of chromium did not exceed any water quality criteria in project area waters. Chromium concentrations in project area waters were either below detection limits or at low levels. Since chromium does not biomagnify in the food web, adverse effects to food web organisms are not anticipated from those levels identified in project area waters.

5.2.2.4 Copper

Copper was usually reported at low levels from project area waters, but was sometimes reported at levels that exceeded the California Toxics Rule criterion to protect freshwater aquatic life in bottom water samples collected from the North, Middle, and South Fork arms of Lake Oroville, Diversion Pool, north Thermalito Forebay, and north and south Thermalito Afterbay, and mid-depth samples from Lake Oroville near the dam. The public health goal, maximum contaminant level for drinking water, agricultural goal, and California Toxics Rule for protection of human health were also exceeded in some water samples from the north Thermalito Forebay, while the public health and agricultural goal were exceeded in a bottom water sample from the South Fork Arm of Lake Oroville. Though significant concentrations of copper were reported in some water samples from many project area waters, levels in fish tissue were higher than fish from most other water bodies sampled by the TSMP only from the south Thermalito Afterbay, which may indicate that most copper found from project area waters is not in a bioavailable form.

5.2.2.5 Lead

Lead also was usually reported at low levels in water samples from project area waters. However, total recoverable lead levels exceeded the California Toxic Rule for protection of aquatic life in a bottom water sample from the Middle Fork Arm of Lake Oroville and north Thermalito Forebay, and a surface water sample from the south Thermalito Afterbay. Lead was not detected in fish at significant levels, except in liver samples from channel catfish at higher levels than most other lakes sampled by the TSMP. Generally low levels of lead in water, insignificant concentrations of lead in fish tissue, and reported negligible food web biomagnification indicate that lead is not a critical contaminant in project area waters.

5.2.2.6 Mercury

While total mercury and methylmercury levels in project area waters did not exceed any criteria, significant contamination in fish was identified. Mercury was reported in fish at levels that exceed criteria to protect human health as well as wildlife. Though levels in project area waters are low, biomagnification apparently has resulted in significant mercury concentrations in fish from all project area waters.

5.2.2.7 Nickel

Though nickel was detected from all water quality monitoring sites, no criteria were exceeded. Nickel levels in fish tissue were also generally at non-detectable or low levels, and was only elevated in a few fish compared to fish from other studies conducted by the TSMP but were still well below levels recommended for protection of predators. Nickel, therefore, is not considered to be a significant contaminant in project area waters.

5.2.2.8 Selenium, Silver, and Zinc

Selenium, silver, and zinc were all present in project area waters at low levels, and did not exceed any water quality criteria. Other than the south Thermalito Afterbay from which largemouth bass liver was at higher levels than found in other water bodies evaluated by the TSMP, these three metals also did not exceed any guidance values or criteria for the protection of human health or wildlife species. The low levels of selenium, silver, and zinc present in project area waters do not appear to be causing any adverse effects to the food web.

6.0 ANALYSES

The purpose of Phase 1 is to determine the magnitude and extent of bioaccumulation of metals and organic contaminants in aquatic organisms within the project area, and to determine the sources and potential pathways of contamination that contribute to bioaccumulation including contaminated sediments deposited as a result of project features, operations, and maintenance. A second phase is to be initiated if significant contamination is found in the biota. The purpose of Phase 2 is to determine the role of project waters in bioaccumulation by assessing contaminants in tributaries to the project, determine the distribution of contamination in project waters and extent of species affected, including other sport species (such as salmon, trout, and sunfish) and prey species eaten by other fish and wildlife (such as delta smelt, threadfin shad, and crayfish), and determine the extent of contamination in the river downstream from the project. This information could be used to develop potential protection, mitigation and enhancement measures.

Subsequent to receiving fish tissue analyses data from the DFG laboratory for mercury levels in some of the fish sampled for Phase 1, a Task Force composed of representatives from the SWRCB, NOAA Fisheries, DWR, and OEHHA met to determine the sampling regime for Phase 2. Recommendations were made to collect trout and bass species from the major tributaries to Lake Oroville, additional collection of bass and coho salmon, catfish, and sunfish from the three arms and main body of Lake Oroville, and bass and carp from the Thermalito Afterbay and Mile Long Pond. However, it was recognized that additional sampling may be necessary following receipt of the complete mercury, other metal, and organic contaminant data from the DFG laboratories. In addition, sediment samples collected as part of the Phase 1 study were preserved, pending analysis of the fish tissue samples, to determine for which parameters and from which locations sediments should be analyzed.

Therefore, following review of this report, the Task Force will convene to determine whether additional fish or locations should be sampled for Phase 2, and which sediment samples should be analyzed for which parameters. Subsequently, the data from Phase 1 and Phase 2 will be analyzed to describe existing conditions upstream from the project, within the project area, and downstream from the project, and evaluate project related effects to metal and organic compound contamination in fish.

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8.0 APPENDICES

Appendix A. Summary of Total and Dissolved Metals Results from Project Area Waters

Lake Oroville North Fork - Surface (A5R93761296)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.721	0.649	0.003	0.002	0.6	0.21	1.49	1.07	0.042	<0.015	0.00111	0.000013	1.37	0.88	0.08	0.08			0.41	0.22
Minimum detected	0.3	0.226	<0.008	<0.008	<0.07	<0.07	0.67	0.53	<0.015	<0.015	<.00015	<.000025	<0.04	<0.04	<0.30	<0.30			0.07	<0.10
Number of samples	12	12	12	12	12	12	12	12	12	12	14	14	12	12	12	12	0	0	12	12
Number of samples exceeding criteria or objectives																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Lake Oroville North Fork - Bottom (A5R93761296)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.812	0.703	0.064	0.096	3.05	0.24	5.39	5.47	0.338	0.073	0.00154	0.00003	3.94	1.4	0.13	0.11			8.43	5.61
Minimum detected	0.375	0.0442	<0.008	<0.008	0.2	<0.07	0.43	0.4	<0.015	<0.015	0.00033	<.000025	0.62	0.15	<0.30	<0.30			0.19	0.11
Number of samples	12	12	12	12	12	12	12	12	12	12	13	13	12	12	12	12			12	12
Number of samples exceeding criteria or objectives																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	1 ⁹	0	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Contaminant Accumulation In Fish, Sediments, And The Aquatic Food Chain
Study Plan W2, Phase 1 Draft Report
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Appendix A. Continued.

Lake Oroville Middle Fork- Surface (A5R93351272)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.868	0.925	0.002	0.001	0.63	0.25	1.24	0.97	0.373	0.039	0.00096	0.00002	1.17	0.74	<0.30	0.1			1.18	0.4
Minimum detected	0.244	0.257	<0.001	<0.001	<0.07	<0.07	0.42	0.37	<0.007	<0.007	<0.00015	<0.00007	<0.04	<0.04	<0.30	<0.30			<0.10	<0.10
Number of samples	13	13	13	13	13	13	13	13	13	13	15	15	13	13	13	13	0	0	13	13
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Lake Oroville Middle Fork - Bottom (A5R93351272)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	2.03	1.27	1.408	0.054	2.98	0.35	6.18	4.29	1.721	0.318	0.00349	0.000056	5.05	1.24	0.13	0.09			3.61	1.94
Minimum detected	0.361	0.293	<0.008	<0.008	<0.07	<0.07	0.4	0.41	<0.15	<0.15	0.00034	<0.000025	0.07	0.15	<0.09	<0.09			0.11	<0.10
Number of samples	13	13	13	13	13	13	13	13	13	13	15	15	13	13	13	13	0	0	13	13
Number of samples exceeding																				
Public Health Goal ¹	-	-	1	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	1	0	-	0	1 ⁹	0	1 ⁹	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Contaminant Accumulation In Fish, Sediments, And The Aquatic Food Chain
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Appendix A. Continued.

Lake Oroville South Fork - Surface (A5R93221226)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.533	0.604	0.002	0.003	1.29	0.26	1.5	0.78	0.407	0.019	0.00306	0.000025	1.81	0.73	<0.30	<0.30			1.97	0.35
Minimum detected	0.263	0.234	<0.008	<0.008	<0.07	<0.07	0.44	0.34	<0.015	<0.015	<.000025	<.000025	<0.04	<0.04	<0.30	<0.30			<0.05	<0.10
Number of samples	13	13	13	13	13	13	13	13	13	13	15	15	13	13	13	13	0	0	13	13
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Lake Oroville South Fork - Bottom (A5R93221226)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.583	0.536	0.008	0.004	1.99	0.027	222	11.7	0.349	0.022	0.0026	.000046	3	0.85	<0.30	<0.30			2.4	0.42
Minimum detected	0.312	0.283	<0.008	.002	<0.07	<0.07	0.62	0.35	<0.008	<0.008	.00011	<0.000025	0.48	<0.00	<0.30	<0.30			0.13	<0.10
Number of samples	13	13	13	13	13	13	13	13	13	13	15	15	13	13	13	13	13	13	13	13
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	1	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	1	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	5 ⁹ , 5 ¹⁰	2 ⁹ , 2 ¹⁰	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Appendix A. Continued.

Lake Oroville At Dam - Surface (A5R93251286)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.778	0.734	0.002	0.003	0.44	0.2	1.39	1.03	0.043	0.005	0.008	0.000015	1.18	0.89	0.14	0.07			0.31	0.52
Minimum detected	0.322	0.332	<0.008	<0.008	<0.07	<0.07	0.64	0.45	<0.015	<0.015	<.000025	<.000025	<0.04	<0.04	<0.30	<0.30			0.09	<0.10
Number of samples	12	12	12	12	12	12	12	12	12	12	14	14	12	12	12	12	0	0	12	12
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Lake Oroville At Dam - Mid-depth (A5R93251286)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.689	0.703	0.004	0.009	0.36	0.18	51.8	13.9	0.042	0.038	.00081	.000019	1.02	1.05	0.09	0.08			0.45	0.85
Minimum detected	0.376	0.345	<0.008	<0.008	<0.07	<0.07	0.82	0.6	<0.015	<0.015	<.00015	<.000025	0.05	<0.04	<0.30	<0.30			0.12	<0.10
Number of samples	11	11	11	11	11	11	11	9	11	11	13	13	11	11	11	11	0	0	11	11
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	0	0	3 ⁹ , 3 ¹⁰	1 ⁹ , 1 ¹⁰	0	-	-	-	-	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Appendix A. Continued.

Diversion Pool US Dam - Surface (A5R93191326)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.834	0.72	0.002	0.002	0.77	0.34	1.84	1.22	0.128	<0.015	0.00302	.000003	1.51	0.9	0.12	0.11			1.59	0.31
Minimum detected	0.364	0.316	<0.008	<0.008	0.09	<0.07	0.63	0.5	<0.015	<0.015	.0002	<.000025	0.5	0.35	<0.30	<0.30			0.06	<0.10
Number of samples	14	14	14	14	14	14	14	14	14	14	16	16	14	14	14	14	0	0	14	14
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	0	0	0	0	0	0	-	-	0	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Diversion Pool US Dam - Bottom (A5R93191326)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.857	0.75	0.085	0.131	0.54	0.43	94	84.5	0.075	0.002	.00184	.000034	1.35	1.02	0.34	0.64			0.52	0.29
Minimum detected	0.335	0.341	<0.008	<0.008	0.14	<0.07	0.67	0.52	<0.015	<0.015	<0.00015	<.000025	0.52	0.33	<0.30	<0.30			0.017	<0.10
Number of samples	14	14	14	14	14	14	14	12	14	14	16	16	14	14	14	14	0	0	14	14
Number of samples exceeding																				
Public Health Goal ¹	-	-	1	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	0	0	4 ⁹ , 4 ¹⁰	3 ⁹ , 3 ¹⁰	0	0	-	-	0	-	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Appendix A. Continued.

Thermalito Forebay, North - Surface (A5R93161366)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.815	0.689	0.003	0.003	0.48	0.41	1.43	1.02	0.85	<0.015	0.00191	.000055	1.18	.87	0.13	0.08			0.63	0.42
Minimum detected	0.349	0.0454	<0.008	<0.008	<0.07	<0.07	0.6	0.45	<0.015	<0.015	<.00015	<.000025	0.5	0.34	<0.30	<0.30			0.07	<0.10
Number of samples	14	14	14	14	14	14	14	14	14	14	16	16	14	14	14	14	0	0	14	14
Number of samples exceeding																				
Public Health Goa ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Thermalito Forebay, North - Bottom (A5R93161366)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.791	0.707	3.93	0.245	0.52	0.43	1330	144	0.732	0.191	0.00191	.000024	3.6	1.88	0.07	<0.30			1.31	1.13
Minimum detected	0.354	0.321	<0.008	<0.008	0.05	<0.01	0.71	0.53	<0.015	<0.015	.00026	<.000025	0.52	0.33	<0.30	<0.30			0.16	0.13
Number of samples	14	14	14	14	14	14	14	13	14	14	16	16	14	14	14	14	0	0	14	14
Number of samples exceeding																				
Public Health Goa ¹	-	-	1	-	-	-	2	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	1	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	1	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	1	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	1	0	-	0	4 ⁹ , 4 ¹⁰	1 ⁹ , 1 ¹⁰	1 ⁹	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Thermalito Afterbay, North - Surface (A5R93011411)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.791	0.616	0.002	0.001	0.45	0.39	1.31	0.92	0.085	.001	0.00141	.000031	1.23	0.84	0.11	0.15			0.6	0.34
Minimum detected	0.343	0.415	<0.008	<0.008	<0.07	<0.07	0.58	0.46	<0.015	<0.015	<.00015	<.000025	0.48	0.33	<0.30	<0.30			<0.10	<0.10
Number of samples	14	14	14	14	14	14	14	14	14	14	16	16	14	14	14	14			14	14
Number of samples exceeding																				
Public Health Goa ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goa ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Thermalito Afterbay, North - Bottom (A5R93011411)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.773	0.654	0.009	0.003	0.98	0.32	131	2.45	0.399	0.038	0.00268	.000051	1.6	0.87	0.09	0.1			2.21	17.3
Minimum detected	0.336	0.0421	<0.008	<0.008	<0.07	<0.07	0.69	0.43	<0.015	<0.015	.00033	<0.000025	0.58	0.37	<0.30	<0.30			0.07	<0.10
Number of samples	14	14	14	14	14	14	14	14	14	14	16	16	14	14	14	14			14	13
Number of samples exceeding																				
Public Health Goa ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goa ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	3 ⁹ , 3 ¹⁰	0	0	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Appendix A. Continued.

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Appendix A. Continued.

Thermalito Afterbay, South - Surface (A5R92921412)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.707	0.62	0.003	0.003	1.54	5	1.29	0.95	1.54	0.037	.00174	.000133	2.08	0.84	0.08	0.1			0.53	0.39
Minimum detected	0.315	0.325	<0.008	<0.008	<0.07	<0.07	0.59	0.44	<0.015	<0.015	.00018	<.000025	0.47	0.34	<0.30	<0.30			0.1	<0.10
Number of samples	14	14	14	14	14	14	14	14	14	14	16	16	14	14	14	14	0	0	14	14
Number of samples exceeding																				
Public Health Goa ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	1 ⁹	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

Thermalito Afterbay, South - Bottom (A5R92921412)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.768	0.58	5.77	7.97	1.43	0.38	1700	2.04	0.278	0.006	.0366	.00141	2.09	1.86	0.09	0.19			1.64	.83
Minimum detected	0.33	0.295	<0.008	<0.008	<0.07	<0.07	0.63	0.52	<0.015	<0.015	.00024	<.000025	0.49	0.35	<0.30	<0.30			0.17	0.12
Number of samples	14	14	14	14	14	14	13	11	14	14	16	16	14	14	14	14			14	14
Number of samples exceeding																				
Public Health Goa ¹	-	-	1	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	1	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	1	1	-	0	2 ⁹ , 2 ¹⁰	0	0	0	-	-	-	0	-	-	-	-	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	-	-	0	-

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Appendix A. Continued.

Feather R US Afterbay Outlet (A5-1695.50)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.727	0.631	0.633	0.003	0.99	0.72	67.5	1.24	0.11	0.03	0.00253	0.00021	1.29	0.91	0.13	0.11	<0.273	<0.025	0.78	1.11
Minimum detected	0.305	0.350	<0.002	0.001	<0.06	<0.02	0.60	0.49	<0.011	<0.005	0.00032	0.000039	0.35	0.26	<0.04	<0.04	<0.273	<0.025	0.12	0.10
Number of samples	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	1	1	16	16
Number of samples exceeding																				
Public Health Goa ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Human	0	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁶ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	0	0	0	0
NTR ⁷	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁸ Human	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁹ Aquatic Life	-	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ¹⁰	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	0	-	0	-

Feather R DS Afterbay Outlet (A5-1687.70)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum detected	0.633	0.597	0.074	0.008	0.99	0.65	1.47	1.05	0.157	0.032	0.00201	0.000077	1.34	0.93	0.09	0.10	<0.273	<0.025	1.47	0.61
Minimum detected	0.383	0.312	<0.002	0.001	<0.07	0.03	0.67	0.5	0.018	<0.007	0.00038	0.000025	0.44	0.27	<0.04	<0.07	<0.273	<0.025	0.18	<0.10
Number of samples	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	1	1	16	16
Number of samples exceeding																				
Public Health Goa ¹	-	-	1	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Facto ⁴	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Human	0	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁶ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	0	0	0	0
NTR ⁷	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁸ Human	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁹ Aquatic Life	-	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ¹⁰	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	0	-	0	-

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Contaminant Accumulation In Fish, Sediments, And The Aquatic Food Chain
Study Plan W2, Phase 1 Draft Report
Oroville Facilities P-2100 Relicensing

Appendix A. Continued.

Mile Long Pond (A5L92541377)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum concentration	0.77	0.75	<0.004	<0.004	1.46	0.31	0.56	0.64	0.047	0.007	0.0014	0.00006	0.7	1.41	<0.30	<0.30	<0.203	<0.011	0.48	0.89
Minimum concentration	0.18	0.17	<0.004	<0.004	<0.07	<0.07	0.09	0.07	<0.01	<0.01	0.0002	<0.00002	<0.04	<0.04	<0.30	<0.30	<0.106	<0.001	<0.1	<0.1
Number of samples	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	3	3	14	14
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	0	0	0	0
NTR ⁶	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷ Humans	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁷ Aquatic Life	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ⁸	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	0	-	0	-

Lower Pacific Heights Pond (A5L92551372)

	Arsenic		Cadmium		Chromium		Copper		Lead		Mercury	Methyl Mercury	Nickel		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D
Maximum concentration	2.81	2.84	0.007	0.005	4.17	0.87	2.43	1.54	0.273	<0.01	0.0048	0.00018	2.1	1.44	0.14	0.19	<0.203	<0.011	0.81	0.61
Minimum concentration	0.09	0.07	<0.004	<0.003	<0.07	<0.07	0.48	0.40	<0.01	<0.01	0.0004	<0.00002	0.4	0.2	<0.04	<0.04	<0.106	<0.001	0.1	<0.1
Number of samples	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	3	3	14	14
Number of samples exceeding																				
Public Health Goal ¹	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL ²	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL ²	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal ³	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor ⁴	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR ⁵ Humans	-	-	-	-	-	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-
CTR ⁵ Aquatic Life	-	0	0	0	-	0	0	0	0	0	-	-	-	0	-	-	0	0	0	0
NTR ⁷	-	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC ⁷	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC ⁹	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose ¹⁰	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	-	0	-	0	-

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Appendix A. Continued.

Footnotes

1. California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, Public Health Goals for Chemicals in Drinking Water
2. California Department of Health Services, California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring
3. Food and Agriculture Organization of the United Nations, 1985. Water Quality for Agriculture.
4. Cal/EPA, Office of Environmental Health Hazard Assessment, Cal/EPA Toxicity Criteria Database
5. California State Water Resources Control Board, Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (2 March 2003)
6. U.S. Environmental Protection Agency, Federal Register, Volume 64, No. 216 (Tuesday, 9 November 1999) [National Toxics Rule revisions]
7. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] plus updates (various dates)
8. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS] database
9. Chronic (4 day average)
10. Acute (1 hr average)

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