Total Maximum Daily Load for PCBs in San Francisco Bay

Final Staff Report
for Proposed Basin Plan Amendment

California Regional Water Quality Control Board

San Francisco Bay Region

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1. Introduction

This Staff Report presents the supporting documentation for a proposed Basin Plan amendment that will be considered by the California Regional Water Quality Control Board, San Francisco Bay Region (Water Board) that establishes a Total Maximum Daily Load (TMDL) and implementation plan for Polychlorinated Biphenyls (PCBs), including PCBs with dioxin-like properties, for all of San Francisco Bay. The TMDL is based on attainment of a fish tissue target PCBs concentration protective of human health, wildlife, and aquatic life. This report contains the results of analyses of PCBs impairment assessments, sources and loadings, linkage analyses, load reductions, and implementation actions.

The Clean Water Act requires California to adopt and enforce water quality standards to protect San Francisco Bay. The Water Quality Control Plan for the San Francisco Bay Region (Basin Plan) delineates these standards, which include beneficial uses of waters in the Region, numeric and narrative water quality objectives to protect those uses, and provisions to enhance and protect existing water quality (antidegradation). The California Toxics Rule (CTR) is the basis for the numeric water quality criteria for PCBs in San Francisco Bay. Section 303(d) of the Clean Water Act requires states to compile a list of “impaired” water bodies that do not meet water quality standards and to establish a TMDL for the pollutant that causes impairment. The proposed TMDL and implementation plan are designed to resolve PCBs impairment in all segments of San Francisco Bay.

For the purpose of the report, all segments of San Francisco Bay include the portion of the Sacramento and San Joaquin Delta in the San Francisco Bay Region, and all portions and contiguous tidal zones of Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central Bay, Lower Bay and South Bay. Throughout this report, the terms San Francisco Bay and Bay are inclusive of all these segments.

This report provides the rationale and the technical basis for the required TMDL elements and associated implementation plan. This report meets the requirements of the California Environmental Quality Act (CEQA), including the preparation of a checklist (Appendix A) for adopting Basin Plan amendments and serves in its entirety as a substitute CEQA environmental document. It builds on earlier reports on sources and loadings (June, 2000), impairment assessment (June, 2001) and a Project Report (January 2004). It also builds on the Draft Staff Report (June 23, 2007 version) that was circulated for a 60-day public review period and testimony hearing that was held on September 12, 2007, and the Revised Draft Staff Report (December 3,, 2007 version) that was circulated for a 45-day public review. This report was developed with consideration of stakeholder input, including incorporation of comments received on the Project Report and comments received on the Draft Staff Report and Revised Draft Staff Report, and has been updated with new information.

The process for establishing a TMDL includes compiling and considering available data and information, conducting appropriate analyses relevant to defining the impairment problem, identifying sources, and allocating responsibility for actions to resolve the impairment. This report is organized into sections that reflect background information, the key elements of the TMDL process, and regulatory analyses required to adopt the amendment.

In addition, the scientific basis of the Basin Plan amendment was subjected to external scientific peer review. This step is required under §57004 of the Health and Safety Code, which specifies that an external review is required for work products that serve as the basis for a rule,

"…establishing a regulatory level, standard, or other requirements for the protection of public health or the environment." The scientific basis of the PCBs TMDL, as presented in the Staff Report, was evaluated by two peer reviewers, Prof. David O. Carpenter, M.D., and Prof. Kevin J. Farley, who concluded that the scientific basis of the proposed Basin Plan amendment is based on sound scientific knowledge, methods, and practices.

Section 2 presents the problem statement that the project is based on and defines the project, why it is necessary and its objectives. Section 3 presents information about the physical setting of San Francisco Bay, including climate, hydrology, geology and biology. Section 4 discusses the chemistry and historical use of PCBs. Section 5 provides a discussion of the water quality standards that are applicable to San Francisco Bay. Section 6 presents the results of the impairment assessment that identified adverse impacts to beneficial uses in the Bay.

Section 7 presents our understanding of the sources of loading of PCBs to the Bay. Sources and loading are identified as internal or external to the Bay. Internal sources reflect the current reservoir of PCBs found in sediments or the water column. External sources reflect loads coming into the Bay, for example, from urban runoff or wastewater treatment plants.

Section 8 presents the derivation of the numeric target. Section 9 presents the linkage analysis which describes the relationship between PCBs sources and the proposed target, and estimates the bay's capacity to assimilate PCBs while still meeting the numeric fish tissue targets. Section 10 presents the proposed TMDL and the allocations of the TMDL to external sources.

Section 11 presents the Implementation Plan which includes actions and requirements deemed necessary to implement the external source allocations and actions to manage internal sources of PCBs. It specifies monitoring activities to demonstrate attainment of allocations and the numeric target. It also presents an adaptive implementation strategy to review implementation progress and to evaluate any new information generated, which may lead to improved implementation actions, and refinement of the TMDL, the numeric target or the allocations in the future.

Section 12 presents the results of CEQA analyses including an environmental impact assessment and an evaluation of alternatives to the proposed Basin Plan amendment. Section 13, References, lists all the information sources cited and relied upon in preparation of this report.

2. Project Definition

This section presents the problem statement upon which the proposed Basin Plan amendment project is based. It also presents the project definition and objectives which form the basis of the assessment required by the CEQA.

2.1 Problem Statement

All San Francisco Bay segments were initially placed on the California 303(d) list in 1998 for total PCBs and dioxin-like PCBs due to an interim health advisory for fish consumption. The 1998 listing applies to the following Bay segments: Sacramento and San Joaquin Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central Bay, Lower Bay and South Bay. The 303(d) list was revised in 2002 to include specific locations in the Lower Bay segment. These listing were sustained on the 2006 303(d) list version (Table 1; Figure 1). This TMDL applies to all Bay segments.

As further discussed in the Impairment Assessment in Section 6, water quality objectives that are not attained include the narrative water quality objective which states that controllable water quality factors shall not cause a detrimental increase in toxic substances found in bottom sediments or aquatic life and the numeric water quality criterion of 0.00017 ug/L total PCBs in water. The existing beneficial use that is not fully supported due to elevated PCBs levels in fish is commercial and sport fishing. However, this TMDL is designed to ensure protection of all beneficial uses of the Bay including but not limited to preservation of rare and endangered species, estuarine habitat, and wildlife habitat.

Table 1-San Francisco Bay Water Segments on 2006 303(d) List for PCBs

Water Body Names	Hydrologic Unit	Total Water Body Size (acres)
Sacramento/San Joaquin Delta	207.100	41,736
Suisun Bay	207.100	27,498
Carquinez Strait	207.100	5,657
San Pablo Bay	206.100	68,349
Richardson Bay	203.130	2,439
San Francisco Bay, Central	203.120	70,992
San Francisco Bay, Lower (including)	204.100	79,293
Central Basin, San Francisco	204.400	40
Mission Creek	204.400	8.5
Oakland Inner Harbor (Fruitvale site)	204.200	0.93
Oakland Inner Harbor (Pacific Dry-Dock Yard 1 site)	204.200	1.8
San Francisco Bay, South	205.100	21,669

(2006 CWA Section 303(d) list)

2.2 Project Definition

The project is the adoption of a proposed Basin Plan Amendment to establish a TMDL and a phased implementation plan to attain PCBs water quality standards in all segments of San Francisco Bay. The Water Board is obligated under Section 303(d) of the Clean Water Act to develop a TMDL for San Francisco Bay to address PCBs impairment. The following components form the basis of the proposed regulatory provisions and define the project:

1. Numeric target for PCBs concentrations in fish tissue of 10 ug/kg.
2. Total maximum average yearly PCBs load~~s~~ to San Francisco Bay of 10 kg/year.
3. Allocation of the total maximum average yearly PCBs load among the various external PCBs sources to San Francisco Bay.
4. Plan to implement the TMDL that includes actions to reduce PCBs loads to achieve external load allocations and actions to manage internal sources of PCBs in San Francisco Bay.
5. Monitoring program to evaluate progress in meeting the numeric target and load allocations.
6. Plan and schedule for studies to improve technical understanding relevant to the PCBs TMDL and implementation plan, and for reviewing progress toward meeting targets, implementing actions and evaluating continued appropriateness and effectiveness of actions.

Figure 1-San Francisco Bay Embayments

2.3 Project Objectives

The proposed Basin Plan Amendment is intended to reduce existing and future PCBs discharges to San Francisco Bay associated with controllable water quality factors. Controllable water quality factors are those resulting from human activities that can influence water quality and be reasonably controlled through prevention, mitigation, or restoration. Specific objectives of the project are as follows:

1. Attain numeric PCB water quality criteria and the narrative bioaccumulative water quality objective established for the Bay in as short a time frame as feasible.
2. Protect beneficial uses of San Francisco Bay including but not limited to sport fishing and wildlife habitat.
3. Set target(s) to attain relevant water quality standards in all parts of the Bay.
4. Reduce loading of PCBs to the Bay from external sources and reduce uptake from sediments.
5. Continue to make use of the experience and expertise of the Water Board and its stakeholder community regarding local watersheds and PCBs sources.
6. Initiate actions to reduce PCBs discharges, while continuing to accommodate new information on PCBs fate in the environment.
7. Establish a decision-making framework where management actions evolve to adapt to future knowledge or conditions.
8. Favor actions that have a multi-contaminant benefit and promote efficiencies in water quality regulation and resource management.
9. Avoid actions that will have unreasonable costs relative to their environmental benefits.
10. Comply with the antidegradation requirements of State Board Resolution No. 68-16 and federal antidegradation regulations (40 CRF 131.12).
11. Base decisions on readily available information on ambient conditions, PCBs loads, fish consumption patterns, and PCBs fate and effects.
12. Consider site-specific factors relating to PCBs sources, ambient conditions, watershed characteristics, and response to management actions.
13. Avoid arbitrary decisions and speculation when computing loads, setting targets, setting allocations, determining implementation actions, and defining a margin of safety.
14. When selecting from a range of options, select an environmentally protective option as a means of building an implicit margin of safety into the TMDL.
15. Consider natural, seasonal, and inter-annual variability in determining the manner of implementing the load allocations.
16. Avoid imposing regulatory requirements more stringent than necessary to meet the targets designed to attain water quality standards.
17. Provide details of an implementation plan that includes: a description of the nature of actions necessary to meet allocations and targets and thereby achieve water quality standards; a schedule for actions to be taken; and a description of monitoring to be

undertaken to determine progress toward meeting allocations, targets and water quality objectives.

18. Provide interim risk management programs to protect recreational sport fishing anglers
19. Comply with the Clean Water Act requirement to adopt a TMDL for a 303 (d) listed impaired water body.

3. Setting

San Francisco Bay is located on the Central Coast of California and marks a natural topographic separation between the northern and southern coastal mountain ranges. The Bay functions as the only drainage outlet for waters of the Central Valley.

Because of its highly dynamic and complex environmental conditions, the Bay system supports an extraordinarily diverse and productive ecosystem. The basin's deepwater channels, tidelands, and marshlands provide a wide variety of habitats that have become increasingly vital to the survival of several plant and animal species. The basin sustains communities of crabs, clams, fish, birds and other aquatic life and serves as an important wintering site for migrating waterfowl.

3.1 Physical Setting

San Francisco Bay is a large coastal embayment receiving fresh water from Central Valley rivers via the Delta and from local small tributaries (Figure 2). The Bay is relatively shallow with an average depth of around 6 meters and a median depth of about 2 meters at mean lower low water (Conomos, 1979). Narrow channels 10 to 20 meters deep incise broad expanses of the Bay floor. Deeper sections of channels such as the Golden Gate (110 meters) and Carquinez Strait (27 meters) are topographic constrictions where depths are maintained by scouring from tidal currents. Due to the extent of shallow areas, seasonal winds cause significant sediment resuspension and movement in the Bay.

The Bay is subdivided in segments: Sacramento and San Joaquin Delta, Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central Bay, Lower Bay and South Bay. The northern reach of the San Francisco Bay (Suisun Bay, Carquinez Strait, and San Pablo Bay) is partially to well-mixed while the South Bay (Lower and South Bay) is a tidally oscillating lagoon. The Central Bay is most influenced by water exchange with the ocean.

3.2 Climate

The climate of San Francisco Bay plays an important role in determining the environmental conditions found in the Bay. The Bay has a Xeric (Mediterranean) moisture regime characterized by cool, dry summers and mild, wet winters. The amount and timing of precipitation, air temperature, and wind patterns influence the Bay's freshwater inflow, salinity, currents, and suspended sediment concentrations.

The sun affects the Bay by promoting photosynthesis and warming the shallow areas, which in turn influences carbon dynamics in the water column and sediments. Carbon dynamics and the formation of humic substances (natural organic matter) influence the partitioning of PCBs in aquatic environments between sediments, water, and biota.

The Bay is subjected to strong southwest summer winds. These strong winds exert stress on the water surface, which generates waves. Wind-generated waves resuspend sediments creating turbid conditions and dispersing sediments throughout the Bay, thereby affecting movement of PCBs in the Bay. Waves also tend to mix and aerate the water, which also influences carbon fluxes in the Bay.

PCBs mainly partition into the organic carbon phase such as the organic matter in sediments, or into the lipid fraction of biota. A better understanding of sediment movement and organic carbon fluxes is essential to understanding distribution and long-term fate of PCBs in the Bay. Our ability to predict the fate of PCBs on a fine scale will require improved understanding of sediment movement and carbon flux throughout the Bay.

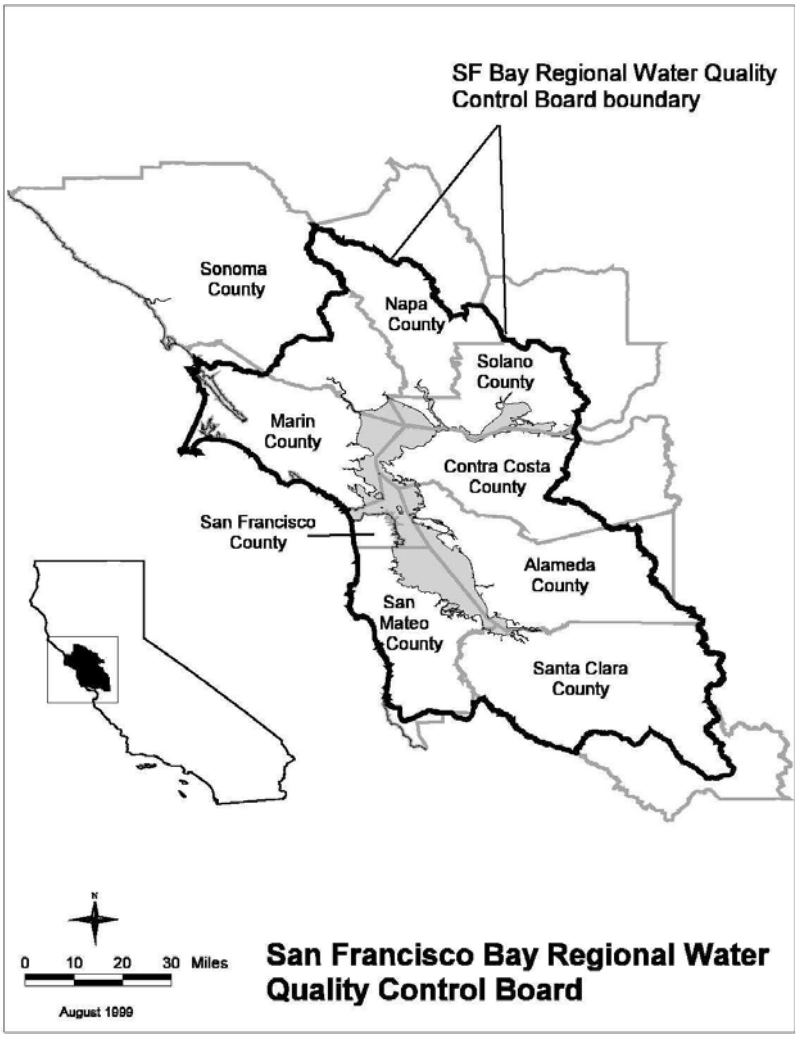

Figure 2-San Francisco Bay Region

3.3 Hydrology

Freshwater inflows, tidal mixing, and their interactions largely determine variations in the hydrology of the Bay. Hydrology has profound effects on biota that live in the Bay because it determines the salinity in different portions of the Bay.

The Bay receives 90 percent of its fresh water inflows from streams and rivers draining the Central Valley watershed and about 10 percent from local tributaries surrounding the Bay (SFEP, 1992a). The Sacramento and San Joaquin Rivers carry about 60 percent of the state runoff draining around 152,500 square kilometers (km^2) or 40 percent of California's surface area (Conomos et al., 1985). Of the fresh water flows entering the Bay from the Central Valley watershed, the Sacramento River typically accounts for 80 percent, the San Joaquin River 15 percent, and smaller rivers and streams the remainder.

The northern reach of the Bay (comprised of Suisun Bay, Carquinez Strait, and San Pablo Bay) is geographically and hydrologically distinct from the Central and South Bays. The northern reach is a partially to well-mixed waterbody (depending on the season) that is dominated by seasonally varying delta inflow. The South Bay is a tidally oscillating, lagoon-type Bay, where variations are determined by water exchange with the northern reach and the ocean. Water residence times are much longer in the South Bay than in the North Bay.

Response time of the Bay to PCBs source control will depend on the sediment hydrodynamics of the Bay, such as its rate of flushing, sediment dynamics, and the variability in inflow. The effect of these parameters over a long time scale needs to be accounted for in determining the long-term fate of PCBs in the Bay.

3.4 Geology

San Francisco Bay is located within the Coast Ranges of California. The Coast Ranges are characterized by northwest trending longitudinal mountain ranges and valleys formed by faulting and folding (Howard, 1979).

In aquatic environments, PCBs are mainly associated with sediments. Therefore, understanding past, current, and future sedimentation and sediment movement is essential for predicting the fate and transport of PCBs in the Bay.

Delta inflow from the Central Valley watershed is the major source of new sediment input into the Bay. Most new sediment (approximately 80 percent) originates in the Sacramento-San Joaquin River drainage and enters primarily as suspended load during the high winter inflows. Much of the winter sediment load from the Sacramento and San Joaquin rivers initially settles out in San Pablo Bay. During the low flow summer months, wind-generated waves and tidal currents resuspend the previously deposited sediment and redistribute it over a wider area.

The Bay's sediment mass balance was greatly altered by the advent of hydraulic mining in the Sierras in the late 1800's. The resulting large increase in sediment loads to the Bay due to hydraulic gold mining affected both the mudflat and sub-tidal areas (SFEP, 1992a). Deposition of fine sediments originally raised mud elevations several meters in Suisun Bay, and the elevation of mud migrated as a "mud wave" to San Pablo Bay and the Central Bay over the past century. During the time of highest PCBs production and use, the continual deposition of sediment buried PCBs being released into the Bay from land and maritime-based activities. Therefore, a large reservoir of PCBs was created in the Bay sediments.

Recent studies indicate that, in portions of the Bay, sediments are eroding (Jaffe et al., 1998). Sediments deposited during the period of Bay Area industrialization are now being uncovered due to a decrease of sediments entering the Bay from the Sacramento and San Joaquin rivers. This erosion could uncover contaminated sediments, resulting in increased availability of PCBs to the food web. Even if all current PCBs sources to the Bay are eliminated, exposure of historically contaminated sediment may turn out to be a significant PCBs source to organisms.

Sediment dynamics influence the distribution, transport and fate of PCBs in the Bay. Bathymetry is a factor affecting sediment dynamics. Broad shallows incised by narrow channels characterize San Pablo Bay, Suisun Bay, and the South Bay. These shallower areas are more prone to wind-generated currents and sediment resuspension and deposition than deeper areas, such as the Central Bay. Near-shore shallow areas are likely repositories of larger reservoirs of PCBs, due to their proximity to historical land-based industrial activities.

Currents created by tides, freshwater inflows, and winds cause erosion and transport of sediments in the Bay. Tidal currents are usually the dominant observed currents in the Bay. Generally, tides appear to have a significant influence on sediment resuspension during the more energetic spring tide when water column sediment concentrations naturally increase.

Strong seasonal winds create circulation and mixing patterns and add to tide- and river-induced current forces. It has been estimated that about 160 million cubic yards (mcy) of sediments are resuspended annually from shallow areas of the Bay by wind-generated waves (U.S. ACE, 1998), while 8 to 10 mcy enter the Bay from the Central Valley watershed and 4 to 8 mcy leave the Bay through the Golden Gate (Table 2). These estimates of sediment inputs have been updated (Schoellhamer et al., 2005), but these relative estimates are used to illustrate the substantial degree of sediment resuspension compared to gains and losses. These are the only estimates of sediment resuspension volumes. By comparison, between 2001 and 2005, an average of 1.8 mcy of dredged sediments was disposed in the Bay as a result of maintenance dredging activities between 2001 and 2005 (DMMO, 2006). The current estimate of the sediment budgets indicates a net loss of 2.4 mcy of sediments from the Bay (Schoellhamer et al., 2005).

Table 2-Sediment Movement in San Francisco Bay

Pathway	Sediment Volume (10^6 cu yd)
Inflow from Central Valley	6.9-8.1
Inflow from other tributaries	1.1-2.4
Outflow through the Golden Gate	4.2-8.1
Resuspension	160

(U.S. ACE, 1998)

Our understanding of sediment dynamics is based on general Bay-wide models. These models are based on Bay-wide averages and do not consider site-specific PCB-Contaminated sites in the near-shore environment.

3.5 Biology

Many species of birds, fish, and mammals regularly reside in the Bay, including a number of endangered, threatened, and rare wildlife species. The Bay supports a diversity of habitat types resulting in a diversity of wildlife species. High food productivity in different habitats types allow some species to achieve substantial numbers. Tidal salt marshes and open waters sustain aquatic plants and phytoplankton that feeds the Bay food web.

Open Waters

Open waters include various habitat types, such as subtidal waters and sloughs. Open waters support benthic and pelagic invertebrates, fish, waterbirds, and seals. Invertebrates serve as prey for large fish populations representing several different trophic levels, including Pacific herring, northern anchovy, Pacific sardine, staghorn sculpin, several species of perch, English sole, and California halibut. Many of these fish species in turn serve as prey to piscivorous birds such as the Forster's tern, California least tern, American white pelican, brown pelican, and double-crested cormorant. Waterfowl such as greater scaup, lesser scaup, canvasbacks, and surf scoters dive for bivalves, crustaceans, and other invertebrates in shallower open waters. Bird diversity in the open Bay waters is fairly low, as the species of birds that can exploit the subtidal areas are limited to those that can forage from the air (*e.g.*, terns) or under water (*e.g.,* scoters) and those that can swim.

Sloughs and channels provide important habitat for large numbers of benthic and pelagic invertebrates and fish. These organic-rich channels serve as important nurseries and feeding areas for estuarine fish. Diving ducks generally avoid the smaller tidal channels but are found in abundance, particularly during their non-breeding season, near the mouths of the larger sloughs, and in open waters. Terns often forage in the larger channels, and several species of herons and egrets forage in the shallower channels for fish. Many shorebirds feed along the exposed flats along tidal channels at low tide, as do rails and other tidal marsh birds.

The Bay’s open water provides shallow and deep-water habitat throughout San Francisco Bay. Sediments in these areas range from clays to sand. The dominant plants are phytoplankton, green algae and blue green algae (SFEP, 1992b). Extensive phytoplankton growth in the water column occurs in Suisun, San Pablo and South Bays. Open waters also provide habitat for benthic (bottom dwelling) organisms, fish, and birds. Other important habitats include mudflats, tidal and brackish marsh, and wetlands. Large numbers of benthic organisms, such as clams, worms, mussels, shrimps, and crabs, reside in these habitats. Bay-dwelling fish, such as shiner surfperch, white croaker, and jacksmelt, are known to feed on these benthic organisms (Goals Project, 2000).

The makeup of benthic communities varies highly both spatially and over time (SFEP, 1992b; Thompson et al., 2000). A better understanding of the factors controlling benthic community composition and dynamics would further our understanding of the food web in general, and the uptake and transfer of PCBs in the food web. Benthic organisms are a large part of the diet for the Bay fish species with the highest PCBs concentration (Roberts et al., 2002). Modeling of PCBs in the food web of in the Bay has been performed providing a linkage between PCBs concentrations in sediment, water and biota (Gobas and Wilcockson, 2003; Gobas and Arnot, 2005).

Mudflats

Intertidal mudflats are expanses of minimally vegetated to unvegetated mud in the lower marsh zone. Most of this habitat occurs just beyond the edge of fully vegetated wetlands, and between channels and edges of wetlands within sloughs. Shallow waters generally cover mudflats during high tide, but they are uncovered at low tide. Narrow mudflats occur along the edges of the tidal sloughs and channels, while larger mudflats occur at the mouths of sloughs and along the edge of the Bay.

Mudflats support a large community of diatoms, worms, shellfish, and algae. Organic debris from tidal marshes, phytoplankton, algae, and diatoms are responsible for the large numbers of benthic invertebrates on mudflats. Crustaceans, polychaete worms, gastropod and bivalve mollusks, and other invertebrates live on or just below the surface of the mud. During high tides, mudflats provide foraging habitat for many species of fishes and wading birds. During low tides, large numbers of shorebirds feed in the mudflats. These mudflats are a key reason for the importance of the San Francisco Bay Area to West Coast shorebird populations.

Smaller channels in brackish and salt marshes are the favored feeding areas for the state and federally endangered California clapper rail. Shorebirds, gulls, terns, American white pelicans, and ducks often use exposed mudflats as roosting or loafing areas when available, as do Pacific harbor seals. When the tides rise, most of these birds return to roosting areas in salt ponds or other alternate habitats; the seals move to open waters.

The state and federally endangered salt marsh harvest mouse, the salt marsh wandering shrew, and the California vole reside where pickleweed is present. California clapper rails nest in cordgrass, denser stands of pickleweed, and marsh gumplant, in both salt and brackish tidal marshes.

Tidal marshes are important to the aquatic components of the Bay' overall ecosystem, not just to the species that reside and/or feed there. Organic debris from tidal marshes forms much of the foundation of the Bay food web.

Brackish Marsh
Brackish marshes occur in the low-to-mid intertidal reaches of sloughs and creeks draining into the Bay. Their vegetation is subject to tidal inundation diluted by freshwater flows.

The vegetation in brackish marsh habitat is dominated by plant species adapted to intermediate (brackish) salinities, including short bulrushes such as alkali bulrush and saltmarsh bulrush. Other plants found in brackish marshes include alkali heath, cattails, spearscale, and pickleweed. Large patches of the invasive pepperweed also occur within the terraced areas in these middle reaches.

Brackish marshes support many of the wildlife species that use salt marsh and freshwater marsh habitats. Brackish marshes are particularly important for anadromous fish (migrating from saline to fresh water to spawn) and catadromous fish (migrating from fresh to saline water to spawn) and invertebrates such as shrimp.

Most terrestrial and wetland wildlife species are tolerant of a range of salinities, and are affected more by habitat structure and food availability than by salinity. Brackish marshes support most of the bird species occurring in both salt and freshwater marshes. California clapper rails occur in brackish marshes, and likely breed in these marshes. The often taller, denser vegetation in brackish marshes supports large densities of breeding song sparrows, saltmarsh common yellowthroats, and marsh wrens, and large numbers of Virginia rails and soras during migration and winter.

4. Polychlorinated Biphenyls

PCBs are a class of organic compounds produced as complex mixtures for a variety of uses, including dielectric fluids in capacitors and transformers. PCBs were manufactured commercially by the Swann Chemical Company beginning in 1929. Monsanto acquired the process in 1935 and continued PCBs production until 1977 (Erickson, 1997).

In the United States, discovery of PCBs as ubiquitous environmental contaminants led to their initial regulation under the Toxic Substances Control Act (TSCA) in 1976. In 1978, Congress banned the manufacture, processing, and distribution in commerce of PCBs. Use of PCBs was restricted to totally enclosed applications, and non-totally enclosed applications were only allowed with the United States Environmental Protection Agency (U.S. EPA) exemptions. In 1979, U.S. EPA passed regulations that defined totally enclosed applications as intact, non-leaking electrical equipment. U.S. EPA banned the manufacture and distribution in commerce of materials containing any detectable PCBs in 1984 (Erickson, 1997).

Although PCBs uses have been phased out since the ban, large quantities have remained in use, and some PCBs are still in use today (Table 3). Therefore, the potential for continued PCBs release to the environment remains. It is not known how much unreported PCBs are still being used today nor how much were used in the past in a manner such that they could be currently released to the environment.

Table 3-Self Reporting of PCBs Uses in the Bay Area (1999)

Company	City	Number of Transformers	PCBs Mass (kg)
USS-POSCO Industries	Pittsburg	65	141,494
Quebecor Printing San Jose, Inc.	San Jose	5	32,094
NASA	Moffett Field	17	7,052
Gaylord Container Corp	Antioch	2	6,078
General Chemical	Pittsburg	3	4,800
Rhodia Inc.	Martinez	4	3,356
DOT Maritime Administration Suisun Bay Reserve Fleet	Benicia	3	1,048
Macaulay Foundry, Inc.	Berkeley	1	913
Stanford Linear Accelerator Center	Menlo Park	1	1

http://www.epa.gov/opptintr/pcb/xform.htm

4.1 Chemical Structure

PCBs are a family of chlorinated organic compounds formed by two benzene rings linked by a single carbon-carbon bond (Figure 3). Various degrees of substitution of chlorine atoms for hydrogen are possible on the remaining 10 benzene carbons. There are 209 possible arrangements of chlorine atoms on the biphenyl group. Each individual arrangement or compound is called a congener. Groups of congeners with the same number of chlorine atoms are called homologs. Thirteen of the 209 congeners are known to show toxic responses similar to those caused by 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), the most toxic dioxin compound (Van den Berg et al, 1998).

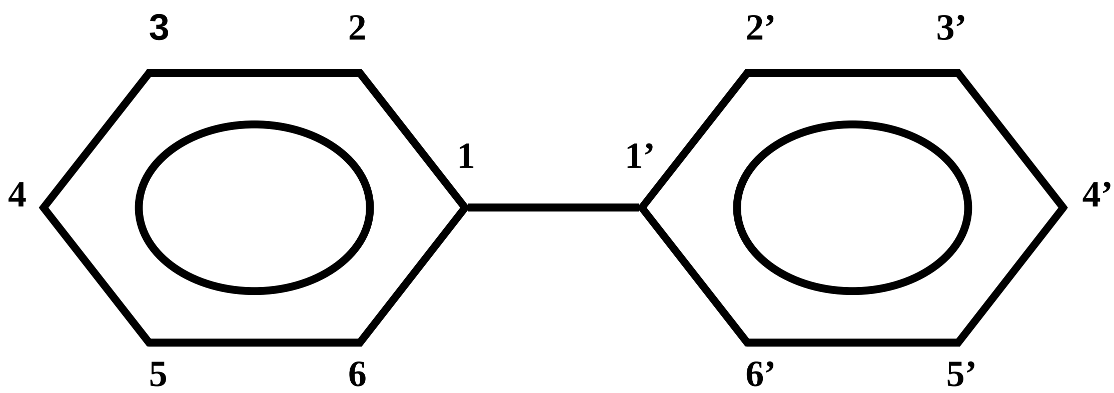

Figure 3-Structure of PCB Molecule

PCBs were mainly marketed as Aroclors in the United States. Aroclors are mixtures of congeners with varying numbers of chlorine atoms (Table 4). Aroclors were the most abundant PCBs mixtures manufactured and used in the United States. The numbering scheme for Aroclors is based on their structure and mixture: the first two digits represent the number of carbon atoms (12) while the second two numbers denote the percent chlorine by weight. Aroclor 1016 is an exception and has a chlorine weight content of 40 to 42 percent (ATSDR, 2000).

Table 4-Percentage of PCB Homolog in Aroclors

Homolog	Aroclor						
	1016	1221	1232	1242	1248	1254	1260
Biphenyl		10					
Mono-CBs	2	50	26	1	--	--	--
Di-CBs	19	35	29	13	1	--	--
Tri-CBs	57	4	24	45	21	1	--
Tetra-CBs	22	1	15	31	49	15	--
Penta-CBs	--	--	--	10	27	53	12
Hexa-CBs	--	--	--	--	2	26	42
Hepta-CBs	--	--	--	--	--	4	38
Octa-CBs	--	--	--	--	--	--	7
Nona-CBs	--	--	--	--	--	--	1
Deca-CBs	--	--	--	--	--	--	--

(ATSDR, 2000)

Although the congener compositions of manufactured Aroclors are known, the fate of the various congeners in the environment is not as well understood. Fate and stability of congeners vary with the degree and location of chlorination, making source identification of environmental PCBs difficult.

4.2 Chemical and Physical Properties

PCB congeners vary markedly in their chemical and physical properties depending on the degree and position of chlorination. Important properties such as non-flammability, low electrical conductivity, high thermal stability, and high boiling point, make PCBs highly stable and persistent in the environment. PCBs are also soluble in non-polar organic solvents and biological lipids, hence their tendency to bioaccumulate in living organisms.

PCBs are generally resistant to degradation, and are strongly resistant to acids and alkalis. PCBs have a low solubility, low volatility (small Henry's Law constant), and increasing affinity for organic matter (increasing log K_{ow}) with increasing chlorination (Table 5). Note that organic compounds with a log K_{ow} greater than 3.5 are considered to have a large potential to bioaccumulate (U.S. EPA, 1985). Biodegradation rates of PCBs also vary greatly depending on the degree and location of chlorination, and redox conditions (ATSDR, 2000).

PCB congeners exhibit of range of properties, which affect their fate and residence time in the environment. Solubility of PCBs in water generally decreases with increased chlorination (Table 5). PCBs adsorption to sediment, denoted by increasing K_{ow}, generally increases with increasing degree of chlorination (Table 6) or increasing sediment organic carbon concentration (ATDSR, 2000). PCBs in aquatic systems are therefore usually found in much greater mass in the sediments than in the water column. Increasing log K_{ow} is accompanied by an increase in the tendency to bioaccumulate in aquatic organisms. Bioconcentration factor (BCF) increases a thousand-fold when going from monochlorobiphenyl to decachlorobiphenyl. Evaporation rates decrease with increasing degree of chlorination (Table 6). In general, the lower chlorinated PCB congeners are removed faster from the aquatic environment than the more chlorinated PCBs as the lower chlorinated congeners are not sorbed as strongly to sediments and are more readily volatilized.

Table 5-Selected Properties of PCBs as Aroclors

Aroclor	Density (g/cm^3)	Solubility (mg/L)	Log K_{ow}	Henry's Law Constant ($atm\text{-}m^3/mole$)
1016	1.37	0.42	5.6	2.9×10^{-4}
1221	1.18	0.59	4.7	3.5×10^{-3}
1232	1.26	0.45	5.1	No Data
1242	1.38	0.34	5.6	5.2×10^{-4}
1248	1.44	0.06	6.2	2.8×10^{-3}
1254	1.54	0.06	6.5	2.0×10^{-3}
1260	1.62	0.08	6.8	4.6×10^{-3}
1262	1.64	0.05	No Data	No Data
1268	1.81	0.3	No Data	No Data

Kow = Octanol-water partitioning coefficient (increasing number indicates decreasing water solubility)
(ATSDR, 2000)

Table 6-Selected Properties of PCBs as Homologs

Isomer Group	Melting Point (^oC)	Vapor Pressure (Pa)	Water Solubility at 25^oC (g/m^3)	log K_{ow}	Approximate BCF in Fish	Approximate Evaporation Rate at 25^oC (g/m^2hour)
Biphenyl	71	4.9	9.3	4.3	1000	0.92
MonoCB	25-78	1.1	4	4.7	2500	0.25
DiCB	24-149	0.24	1.6	5.1	6300	0.065
TriCB	28-87	0.054	0.65	5.5	1.6×10^4	0.017
TetraCB	47-180	0.012	0.26	5.9	4.0×10^4	4.2×10^{-3}
PentaCB	76-124	2.6×10^{-3}	0.099	6.3	1.0×10^5	1.0×10^{-3}
HexaCB	77-150	5.8×10^{-4}	0.038	6.7	2.5×10^5	2.5×10^{-4}
HeptaCB	122-149	1.3×10^{-4}	0.014	7.1	6.3×10^5	6.2×10^{-5}
OctaCB	159-162	2.8×10^{-5}	5.5×10^{-3}	7.5	1.6×10^6	1.5×10^{-5}
NonaCB	183-206	6.3×10^{-6}	2.0×10^{-3}	7.9	4.0×10^5	3.5×10^{-6}
DecaCB	306	1.4×10^{-6}	7.6×10^{-4}	8.3	1.0×10^7	8.5×10^{-7}

(Erickson, 1997)

The biggest reservoir of PCBs in aquatic systems is sediments rather than the water column. As the tendency of PCBs to adsorb to sediments increases with increasing log K_{ow}, their persistence in surface waters increases. This property enhances the importance of bottom-dwelling organisms in the food-web transfer of PCBs. This is also the case for decreasing water solubility and decreasing volatility (decreasing vapor pressure). Many physical and chemical factors affect this persistence and transfer, ultimately limiting our ability to predict the fate and transport of PCBs in aquatic environments.

4.3 Production and Uses

PCBs were produced in very large quantities both within and outside the United States. Although their uses in capacitors and transformers are well known, PCBs were used in a wide variety of applications including some involving direct contact with the environment.

Production

In the United States, commercial PCBs production started in 1929 and continued until 1977 (ATSDR, 2000). The estimated total commercial production of PCBs in the United States ranged from 610 million to 635 million kilograms (kg). Most of domestic uses of PCBs were Aroclors produced in the U.S. with only 1.4 million kg of PCBs imported. U.S. production peaked in 1970 at 39 million kg.

PCBs mixtures were manufactured in other countries under many different trade names; these include Clophen (Germany), Fenclor (Italy), Kaneclor (Japan), Sovol (former USSR) and Phenoclor (France). Fenchlor DK is a product of interest as it is comprised solely of decachlorinated biphenyl (Congener #209) and was used in investment casting (Erickson, 1997).

The Monsanto Chemical Company produced approximately 99 percent of PCBs used by U.S. industry. Prior to ceasing production, up to 200,000 kgs of PCBs products per year were imported into the U.S. (ATSDR, 2000). Importation of PCBs continued after U.S. production was banned until January 1, 1979. However, U.S. EPA permitted 16 companies that filed exemption petitions to continue to import and use PCBs after the ban on importation.

Between 1957 and 1977, 52 percent of the Aroclors produced consisted of Aroclor 1242 and 13 percent were its replacement, Aroclor 1016 (Table 7). Aroclor 1016 production was started in 1970, as it was believed to be less harmful to the environment than Aroclor 1242 (Erickson, 1997). Although frequently reported in environmental samples, the more chlorinated Aroclors 1248, 1254 and 1260 comprised only 7, 16 and 11 percent of the PCBs mixtures produced. This high frequency of detection of more chlorinated PCBs may be due to the preferential loss of lower chlorinated PCB congeners from the environment.

Table 7-Relative Production of Aroclors in the United States (1957-1977)

PCBs Mixture	Percent of Production
Aroclor 1016	13
Aroclor 1221	1
Aroclor 1232	<1
Aroclor 1242	52
Aroclor 1248	7
Aroclor 1254	16
Aroclor 1260	11
Aroclor 1262	1
Aroclor 1268	<1

(U.S. EPA, 1996)

Use

PCBs mixtures were most commonly used as dielectric fluid in electrical equipment such as transformers and capacitors (EIP, 1997). PCBs uses can be divided into three different categories: completely closed systems (electrical equipment such as capacitors and transformers), nominally closed systems (e.g., vacuum pumps and hydraulic transfer systems), and open-ended applications (e.g., paints, adhesives, pesticide extenders, inks, and plasticizers). In addition, PCBs had a vast number of other uses, through their inclusion as components in products such as building materials (paints, caulks and sealants), greases, oils, carbonless copy paper, and as ballast in fluorescent lights (Table 8). For example, PCB-containing paints and building sealants were used extensively at Department of Defense (DOD) and Department of Energy (DOE) facilities (U.S. Navy, 2006a; Poland et al., 2001). PCBs have also been detected in up to half the paints and sealants of buildings constructed between 1950 and 1980 in Switzerland (Kohler et al., 2005), Sweden (Astebro et al., 2000), and Australia (CFEMU no date). Based on the results of these studies, PCBs removal programs from building materials have been implemented in these countries. PCBs have been used and are still in use in non-liquid forms in building materials (U.S. EPA, 1999a), including as aquatic paints in fish hatcheries (WDEC, 2006; Cornwall, 2005). However, the extent of PCB-containing materials use in Bay area buildings, as well as the potential of these materials to be released and transported to the Bay, has not been determined.

Prior to 1974, PCBs were used in both closed and open-ended applications. After 1974, open-ended uses of PCBs mixtures were discontinued. One exception was the use of PCBs 209 (decachlorobiphenyl) as filler for investment casting waxes. About 200 tons of PCBs were imported from France and Italy for this use in 1974. The production of PCBs-containing capacitors and transformers ended in January 1979. The life expectancy of transformers and capacitors is decades. In-place capacitors and transformers may still remain significant potential sources of PCBs to the environment. U.S. EPA maintains a database of current volumes of PCBs used in the United States. The database only contains uses that have been reported voluntarily. A query of this U.S. EPA database showed significant ongoing use, almost 200,000 kg, in the San Francisco Bay Area (Table 3).

PCBs industrial use and manufacture has created on-land and in-Bay contaminated area in the San Francisco region. Remediation and control of PCBs releases from these sites may be necessary to restore the Bay's beneficial uses. In addition, the role of widespread open-ended PCBs uses needs to be addressed to ensure that the implementation actions are successful.

Table 8-Selected List of PCBs Uses

Category	Use
Electrical Uses	Transformers and Capacitors
	Voltage Regulator (power lines)
	Starting Aid (single phase motors)
	Power Factor Correction (rectifier, AC induction motor, furnaces)
	Consumer Electrical Items (refrigerators, televisions, washing machines)
	Water Well Pumps
	Lamp Ballast (fluorescent, high intensity discharge)
	Switch Gear
	Manufacturing Machinery (capacitors, transformers, associated switchgear)
	PCB Contaminated Mineral Oils (transformer changeout)
Non-Electrical Uses	Printing Inks and Pastes
	Carbonless Copy Paper
	Pumps
	Hydraulic Fluids
	Heat Transfer Fluids
	Flame Retardant
	Air Compressor Lubricants
	Plasticizer in paints, resins, synthetic rubber, surface coatings, wax, sealants, waterproofing compound, glues and adhesives
	Pesticides (as extenders)
	Cutting Oil (microscope slide oil)
PCB Contaminated Solids	Wiping Rags
	Safety Equipment
	Machinery
	Soil, Gravel, Asphalt, Sediment

(EIP, 1997)

Disposal

U.S. EPA first promulgated rules in 1978 specifying that liquids containing >0.05 percent (500 mg/kg) PCBs could only be disposed of by incineration in specially permitted facilities, and all non-liquid PCBs mixtures >0.05 percent could only be disposed in specially permitted landfills. In 1979, the regulated PCBs content was lowered to 0.005 percent, or 50 mg/kg. Regulations did not apply to disposal of PCBs dielectric fluid in small capacitors (<3 lbs.) commonly found in fluorescent light ballasts due to the impracticality of regulating the one billion ballasts installed in fluorescent light fixtures throughout the U.S. Disposal and management of PCBs is further regulated under the Resource Conservation and Recovery Act (RCRA). The Clean Water Act (CWA) regulates the discharge of PCBs-laden wastewater into U.S. waters.

4.4 Quantitation

Historically, PCBs have been quantified as Aroclor mixtures by comparing environmental samples to pure unweathered Aroclor standards. This method's ability to correctly quantify PCBs has been questioned (U.S. EPA, 1996), due to the changes (weathering) Aroclor mixtures undergo in the environment. Analytical methods are now being used to quantify individual PCB congeners (Erickson, 1997). These new methods for quantifying PCB congeners in soils and tissue matrices are performed on a relatively routine basis. Low-level analysis of PCB congeners in water at detection limits that allow comparison to U.S. EPA criterion are still non-routine, can have poor precision, and are relatively expensive.

U.S. EPA established the PCBs water quality criterion for the protection of aquatic life based on the sum of Aroclors, and for the protection of human health based on total PCBs, e.g., the sum of all congeners, or isomers or homologs or Aroclor analyses (U.S. EPA, 2000b). In order to utilize all readily available data, in this report we define total PCBs as any of the following:

- Sum of Aroclors;
- Sum of the individual congeners routinely quantified by the Regional Monitoring Program (RMP) or a similar congener sum; or
- Sum of the National Oceanic and Atmospheric Administration (NOAA) 18 congeners converted to total Aroclors (NOAA, 1993). A comparison of the sum of 18 NOAA congeners converted to Aroclor with quantified sums of Aroclors shows relatively good correlation (Figure 4) in one study.

This is a broad designation of total PCBs that can introduce data comparability issues. However, for the purpose of estimating PCBs loads, sources and reservoirs, the introduced error will likely be small compared to the range of PCBs concentrations found in the Bay. PCBs concentrations in Bay sediments commonly vary by three to four orders of magnitude: Bay ambient sediments have about 4.6 micrograms per kilogram (µg/kg) PCBs, while areas considered contaminated can have PCBs concentrations ranging from 1,000-10,000 µg/kg and up. In addition, PCBs concentrations in sources, reservoirs and biota vary by several orders of magnitude in the Bay. Therefore, the use of data, obtained by different methodologies, is justifiable for the purpose of this report. Where possible, water PCBs concentrations were quantified using similar analytical methods, permitting better data comparability.

All data collected for the development of this TMDL are congener based. We recommend that ongoing PCBs data collection activities in the Bay analyze for a suite of congeners. Specifically, Regional Board staff promotes the analysis of a congener list comparable to that quantified by the RMP to facilitate data comparability for long-term trend analysis. Typically, PCBs are measured as Aroclors using U.S. EPA method 8082 or U.S. EPA method 608 for wastewater. These are routine, relatively inexpensive, methods employed by most laboratories. However, the reporting limits for sediments (about 20 µg/kg) and water (about 0.5 µg/L) with these methods are significantly greater than current ambient concentrations in the Bay and discharged wastewater. In the last few years, more laboratories have started using U.S. EPA method 1668 for the analysis of PCBs in sediment and water. Using this method, reporting limits achieved for sediment (50 ng/kg) and water (100 pg/L) have environmental significance. Therefore we use method 1668 for the monitoring of ambient conditions in San Francisco Bay.

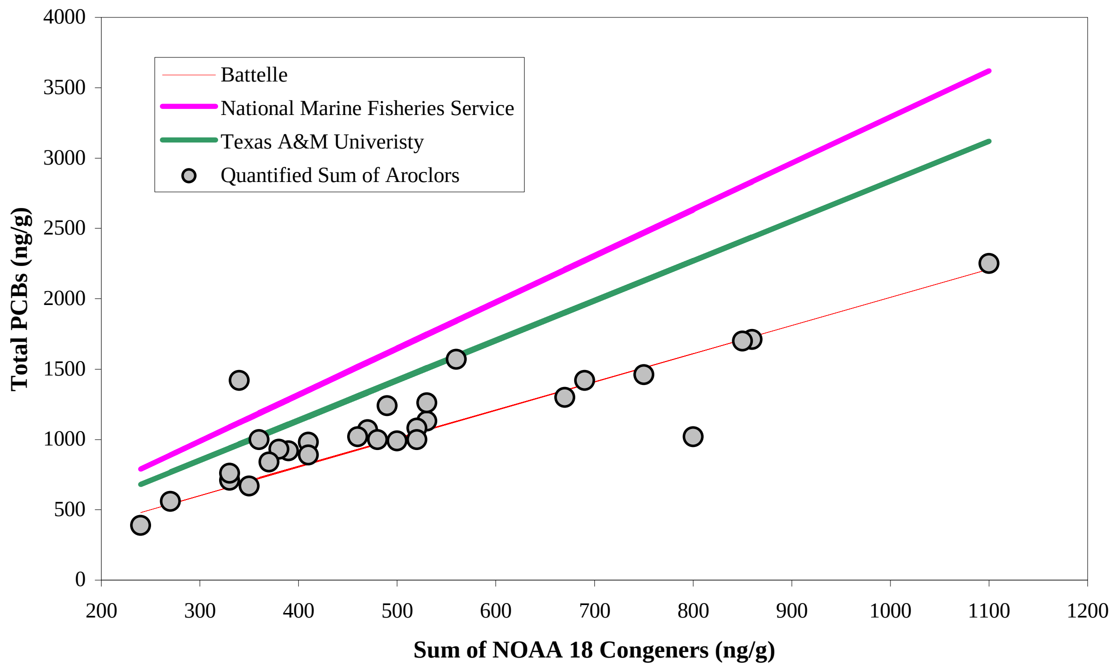

Figure 4-Correlation of PCBs Quantified as Aroclors and Aroclors Calculated from Congener Data (data from SFPUC, 2002)

Regression Line Represents each Organizations Respective Methodology for Quantifying Total Aroclors from Congener Data.

5. Applicable Water Quality Standards

Section 303(d) of the Clean Water Act requires the State of California to identify waters not meeting water quality standards. Water quality standards consist of three parts: beneficial uses, water quality objectives, and antidegradation.

> **Designated or Beneficial Use** - A specific desired use appropriate to the waterbody, termed a *designated use* (beneficial use in California). A beneficial use describes the goal of the water quality standard. It is stated in a written, qualitative form, but the description is as specific as possible.
>
> **Water Quality Criterion or Objective** - A *criterion* that can be measured to establish whether the designated use is being achieved (objective in California). A water quality criterion or objective represents the condition of the waterbody that supports a designated use. The designated or beneficial use is a description of a desired endpoint for the waterbody, and the criterion or objective is a measurable or narrative indicator that is a surrogate for determining attainment of the beneficial use.
>
> **Antidegradation Policy** - An antidegradation policy (under both Federal and California regulations) ensuring that water quality will be maintained at a level protecting beneficial uses.

The beneficial use impaired by PCBs in the Bay is described as follows:

> **Ocean, commercial, and sport fishing (COMM)**
> *Uses of water for commercial or recreational collection of fish, shellfish, or other organisms in oceans, bays, and estuaries, including, but not limited to, uses involving organisms intended for human consumption or bait purposes.*

The applicable water quality objectives include the narrative objective for bioaccumulative substances in San Francisco Bay. This narrative objective states: “Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.” This narrative water quality objective is applicable to both total PCBs and dioxin-like PCBs.

Two applicable numeric water quality standards for total PCBs are promulgated at 40 Code of Federal Regulation Section 131.38, also known as the California Toxics Rule (CTR). These standards include the saltwater criterion continuous concentration (CCC) of 30 nanograms per liter (ng/L) for the protection of aquatic life and its uses from chronic toxicity, and the human health criterion of 170 picograms per liter (pg/L) for the protection from consumption of aquatic organisms. These criteria apply to total PCBs, defined as the sum of all Aroclors, or all congeners or homologs or isomers, and were derived to protect against adverse effects due to PCBs in water. PCBs concentration in the Bay waters are generally below the CCC water quality standard, indicating that current conditions are protective of aquatic life from chronic toxicity. We therefore propose to use the more protective human health criterion as the applicable water quality standard for the PCBs TMDL. This criterion was derived to protect the general population from an increased risk of no more than one in a million. This criterion was developed using a bioconcentration factor (BCF) approach with an upper bound potency factor reflective of high risk and persistence. However, in the development of this criterion it is explicitly recognized that it is not as protective of sub-populations that consume greater quantities of fish than the general population, and that subsistence fish consumers may only be protected from an increased risk of one in ten thousand. The CTR does not promulgate a separate numeric water quality criterion for dioxin-like PCBs.

Both the narrative and numeric water quality objectives are intended to protect beneficial uses related to human health (COMM). The narrative water quality objective is also intended to protect wildlife beneficial uses of the Bay, including:

> **Estuarine habitat (EST)**
> *Uses of water that support estuarine ecosystems, including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds), and the propagation, sustenance, and migration of estuarine organisms.*
>
> **Preservation of rare and endangered species (RARE)**
> *Uses of waters that support habitats necessary for the survival and successful maintenance of plant and animal species established under state and federal law as rare, threatened or endangered.*
>
> **Wildlife habitat (WILD)**
> *Uses of water that support wildlife habitats, including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.*

6. Impairment Assessment

All segments of San Francisco Bay were placed on the 303(d) list for PCBs due to an interim health advisory for fish consumption. The advisory was based on elevated PCBs concentrations in fish tissue collected in 1994 that may cause a detrimental human health effect for people consuming fish caught in the Bay. Follow-up studies in 1997 and 2000 confirmed the presence of PCBs in Bay fish tissue at concentrations that may be harmful to fish consumers. As such, the narrative water quality objective for bioaccumulative substances that is protective of these beneficial uses is not attained. This is also deemed impairment of COMM beneficial uses with regards to commercial and sport fishing in the Bay, and of EST, RARE and WILD with regards to bioaccumulation.

Consumption of PCBs-contaminated fish is considered a primary source of human exposure in locations where fish consumption (i.e. sports and subsistence fishing) and PCBs contamination are significant. A related probable exposed population is breast-fed children whose mothers consume PCBs-contaminated fish. The evaluation of the health effects of PCBs mixtures is complicated by their complex congener composition (ATSDR, 2000). There is evidence that PCB-health risks increase with increased chlorination because more highly chlorinated PCBs are retained more efficiently in fatty tissues (U.S. EPA, 1997a). Observed effects in humans have ranged from mild reactions to serious health consequences. However, individual PCB congeners have widely varying potencies for producing a variety of adverse biological effects including hepatotoxicity, developmental toxicity, immunotoxicity, neurotoxicity, and carcinogenicity.

PCBs mixtures have been classified as probable human carcinogens (U.S. EPA, 1997a). This is based on studies that have found liver tumors in rats exposed to Aroclors 1260, 1254, 1242, and 1016. Evaluation of the animal data indicates that PCBs with 54 percent chlorine content induces a higher yield of liver tumors in rats than other PCBs mixtures (ATSDR, 2000).

The CTR numerical criterion was derived for the protection of human health from the consumption of aquatic organisms, and as such exceedances of this criterion result in the impairment of the COMM beneficial uses. However, evidence that wildlife may be affected by PCBs exists as bird egg PCBs concentrations that have been measured at levels near the effects threshold (Schwarzbach et al., 2001).

The following sections present the data used to evaluate PCBs impairment of beneficial uses of the Bay. A review of readily available PCBs concentration data for benthic organisms and fish tissue is included, as well as water column PCBs concentrations.

6.1 Benthic Organisms

Several agencies use bivalves to measure the presence of bioaccumulative substances in the water column (NOAA, 1993; Stephenson et al., 1995). Because bivalves integrate water column concentrations of bioaccumulative substances over time, they are useful in identifying geographical areas needing further investigation.

The California Department of Fish and Game (CDFG) initiated the California Mussel Watch Program to measure bioaccumulation in bivalves placed at specific locations throughout the Bay. The long-term bivalve data shows a significant decrease of PCBs concentration in mussels deployed off Point Pinole and Treasure Island between 1977 and 1992 (Stephenson et al., 1995). The bivalve deployment program was continued and expanded by the RMP. RMP data indicate a continued decrease in PCBs concentration in bivalves placed near Yerba Buena Island from 1980 to 1996 (Gunther et al., 1999).

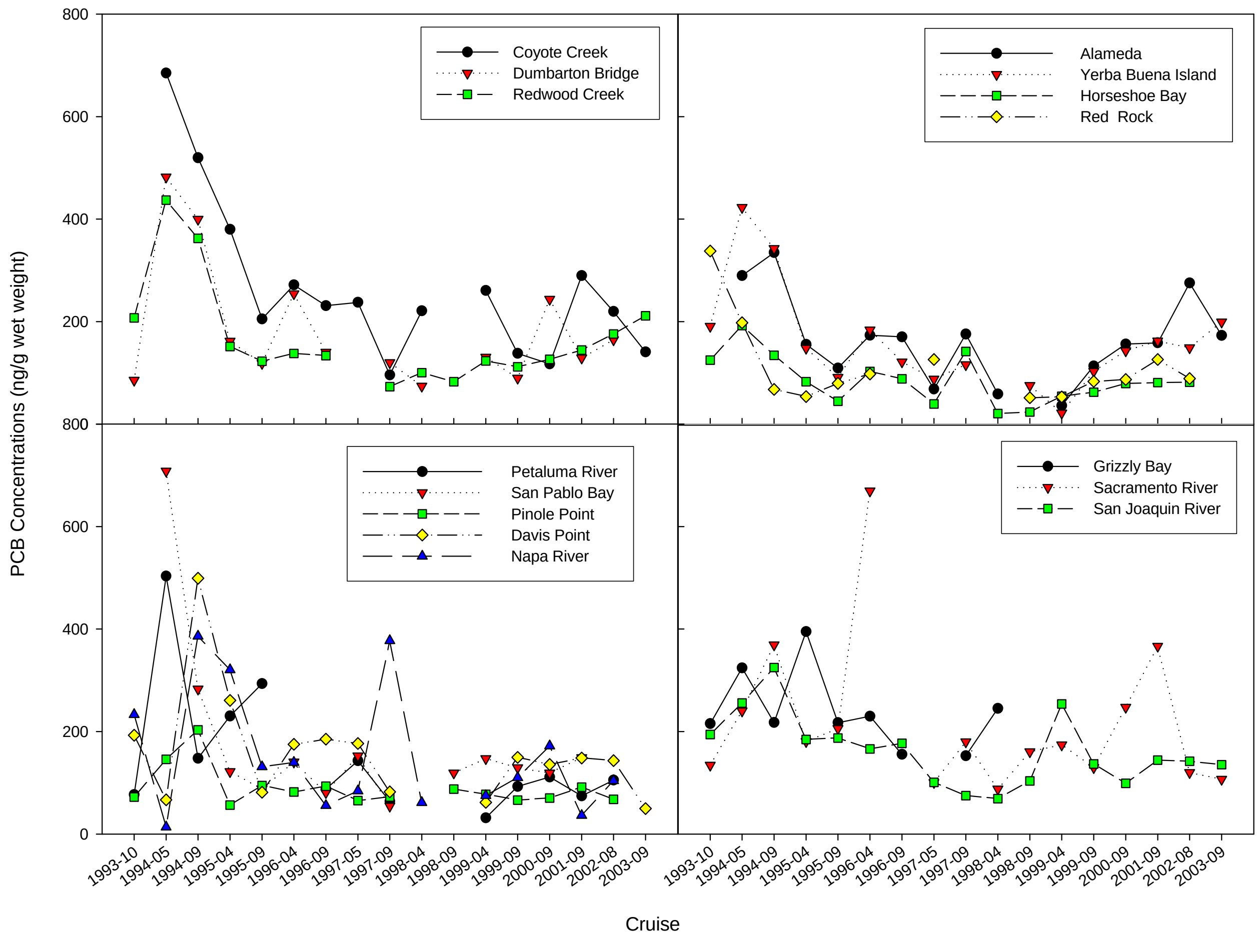

Figure 5-PCBs in Bivalves Deployed in San Francisco Bay (1993-2003)

(http://www.swrcb.ca.gov/programs/smw/index.html and http://www.sfei.org)

Over time, the frequency of deployed bivalves with tissue PCBs concentration less than the screening level of 70 nanograms per gram (ng/g) dry-weight (SFEI, 2000a) has increased (Figure 5), indicating potential improvement of the Bay relative to PCBs. Interpretation of bivalve data is limited, however, due to changing analytical procedures over time.

PCBs tissue concentrations of intertidal benthic organisms have been measured at concentrations up to 700 ng/g wet weight (PRC, 1996) near Hunter's Point Shipyard. Unfortunately, this study combined all species collected within an area and did not measure PCBs concentrations in collocated sediments. Note, however, that the maximum tissue concentration is much greater than the currently used level of concerns for fish tissue and for deployed bivalves. In a subsequent investigation at Hunter's Point Shipyard, PCBs concentrations up to 13,000 ng/g dry weight were measured in polychaete worm tissue collected in the South Basin (U.S. Navy, 2005). The biota were collected at a known PCBs-contaminated sites in the Bay where sediment PCBs concentrations are several orders of magnitude greater than those in ambient sediments.

PCBs concentrations seem to be declining over time in deployed bivalves, but are still measured at concentrations causing concern. Other benthic organisms, collected at contaminated sites, are often orders of magnitude greater than the screening level, and could be significant sources of PCBs to fish in the Bay.

6.2 Fish Tissue Studies

In 1994, fish were collected throughout the Bay and analyzed for a suite of contaminants including PCBs (SF RWQCB, 1995). All fish species collected in the 1994 study had tissue PCBs concentrations exceeding the calculated screening level of 3 ng/g wet weight (SF RWQCB, 1995). Based on these PCBs concentrations, as well as elevated concentrations of other contaminants, measured in this fish study, the Office of Environmental Health Hazard Assessment (OEHHA) issued an interim fish consumption advisory for all of San Francisco Bay (OEHHA, 1994). The OEHHA advisory is listed as interim because more information is needed about PCBs (and other contaminants) concentrations in fish in San Francisco Bay and fish PCBs concentrations that are protective of human health. Note that nationwide, there are 873 advisory listings for PCBs in surface water (U.S. EPA, 2005). OEHHA is currently reviewing this interim health advisory (OEHHA, 1999). This review includes consideration of newly collected Bay fish PCBs concentration data (SFEI, 1999a; Greenfield et al., 2003; Davis et al., 2006). OEHHA will also be considering survey results of San Francisco Bay sport fish consumers and their level of fish consumption (SFEI, 2000a).

In 1997 and 2000, the RMP collected and analyzed Bay fish for contaminant concentrations (Greenfield et al., 2003; SFEI, 1999b, Davis et al., 2006). As part of these studies, the screening level for fish tissue PCBs concentration was recalculated based on an updated cancer slope factor of 2 (U.S. EPA, 1997a); the resulting screening level was 23 ng/g wet-weight (SF RWQCB, 1995). We recalculated this screening level using local fish consumption habits (SFEI, 2000a). We used a 95th percentile upper bound estimate of the local consumption rate for fish-consuming anglers of 32 grams fish per day rather than a consumption rate for the general population of the Bay area which would be smaller. This conservative estimate constitutes, in effect, a margin of safety for the TMDL, implicitly recognizing the long-term goal of increasing the viability of fish consumption and commercial harvest from the Bay. The screening level is calculated as follows:

$$SVc = \left[\left(RL / CSF\right) * BW\right] / CR \qquad \textit{(Equation 1)}$$

where,

SVc = Screening value for a carcinogen in mg/kg
RL = Maximum acceptable risk level, 10^{-5} or one in 100,000
CSF = Oral cancer slope factor, upper bound estimate is 2 $(\text{mg/kg-day})^{-1}$
BW = Mean body weight of the population (70 kg)
CR = Fish consumption rate by all consumers based on a four-week recall, 32 g/day

The calculated screening level is 10 ng/g wet-weight. This screening level applies directly to the attainment of the COMM beneficial uses. As will be discussed in Section 9.1, this screening level is equivalent to a sediment PCBs concentration of 1 ng/g. The screening level is therefore also be protective of the EST, RARE, and WILD beneficial uses as U.S. EPA (1997b) calculated a screening level for the protection of wildlife of 160 ng/g PCBs in sediment. Using the same method and assumptions, a dioxin toxic equivalent (TEQ) screening level of 0.14 pg/g dioxin is calculated for PCBs with dioxin-like properties.

Fish tissue PCBs concentrations in all white croaker and shiner perch exceeded the screening level by an order of magnitude in the four years for which data were collected (Figure 6). Three other fish species had a high frequency of screening level exceedances: sturgeon, jacksmelt and striped bass. Two other species' contaminant concentrations had a low frequency of screening level exceedances: halibut and leopard shark. In shiner surfperch and white croaker, PCBs tissue concentrations are noticeably more elevated than in the other fish species, in large part due to the higher lipid content of these fish (SFEI, 1999b).

Regional differences in fish tissue PCBs concentrations are noticeable, especially in the 1997 data. In the 1997 data, elevated fish tissue PCBs concentrations are noticeable in the Oakland inner harbor for the three fish species shown in Figure 7: jacksmelt, surfperch and white croaker. This is not unexpected as several contaminated sites are located in the Oakland inner harbor (Batelle, 1988; BPTCP, 1998). In 2000, elevated PCBs concentrations are also noticeable for surfperch in the Oakland inner harbor as well as in San Leandro Bay, another area known to have elevated sediment PCBs concentrations (Daum et al., 2000). Elevated fish tissue concentrations in certain locations may reflect a localized diet of benthic organisms residing in contaminated sediments.

PCBs concentrations in white croaker tissue collected in the Oakland Inner Harbor showed a seasonal trend (Figure 8) with higher concentrations in summer and fall and lower concentrations in winter and spring (Greenfield et al., 2003). The trend was correlated with lipid content of the white croaker, and a relation of PCBs concentrations with reproductive activity has been hypothesized (Greenfield et al., 2003). Based on these results, we consider that relying on white croaker PCBs data collected in summer is adequate for long-term trend monitoring as it reflects the season with the higher PCBs concentrations in fish. This seasonal trend will need to be verified for other fish species of concern.

Long-term trends indicate that PCBs tissue concentrations have decreased in shiner surfperch since 1965 (Risebrough, 1995). Unfortunately, data limitations make it difficult to resolve more recent trends of fish tissue PCBs concentrations. For white sturgeon, there does not appear to be a decrease in PCBs concentrations over the last 20 years (Greenfield et al., 2003).

A possible approach for estimating the risk from environmental exposure to PCBs is to use the toxic equivalency factor (TEF) method (ATSDR, 2000). This approach looks at the potency of PCBs mixtures by comparing the toxicity of a individual dioxin-like PCB congener relative to that of 2,3,7,8-tetrachlorodibenzop-dioxin (2,3,7,8-TCDD), the most toxic and studied of the dioxins. Toxicity is calculated as the ratio of the individual PCB congener to that of 2,3,7,8 TCDD that is given a toxicity of 1 (Ahlborg et al., 1994). The contribution of each congener to dioxin-like toxicity (Table 9) is calculated by multiplying their environmental concentrations by its toxic equivalent factor (TEF) and summing to get a dioxin toxic equivalent (TEQ).

A fish tissue screening value for TEQ of 0.14 pg/g was calculated using the same methodology as that for total PCBs. That is, we used the same equation with the same values for risk level, body weight, and fish consumption rates. However, we used a cancer slope factor of 156,000, specific to dioxin-like PCBs (U.S. EPA, 2000d). In some cases, the TEQ was calculated using only three PCB congeners, numbers 77, 126 and 169. However the TEQ from these three congeners usually comprises more than 80 percent of the TEQ from all PCB congeners with dioxin like toxicity. The screening value is exceeded in shiner surfperch, striped bass and white croaker (Figure 9).

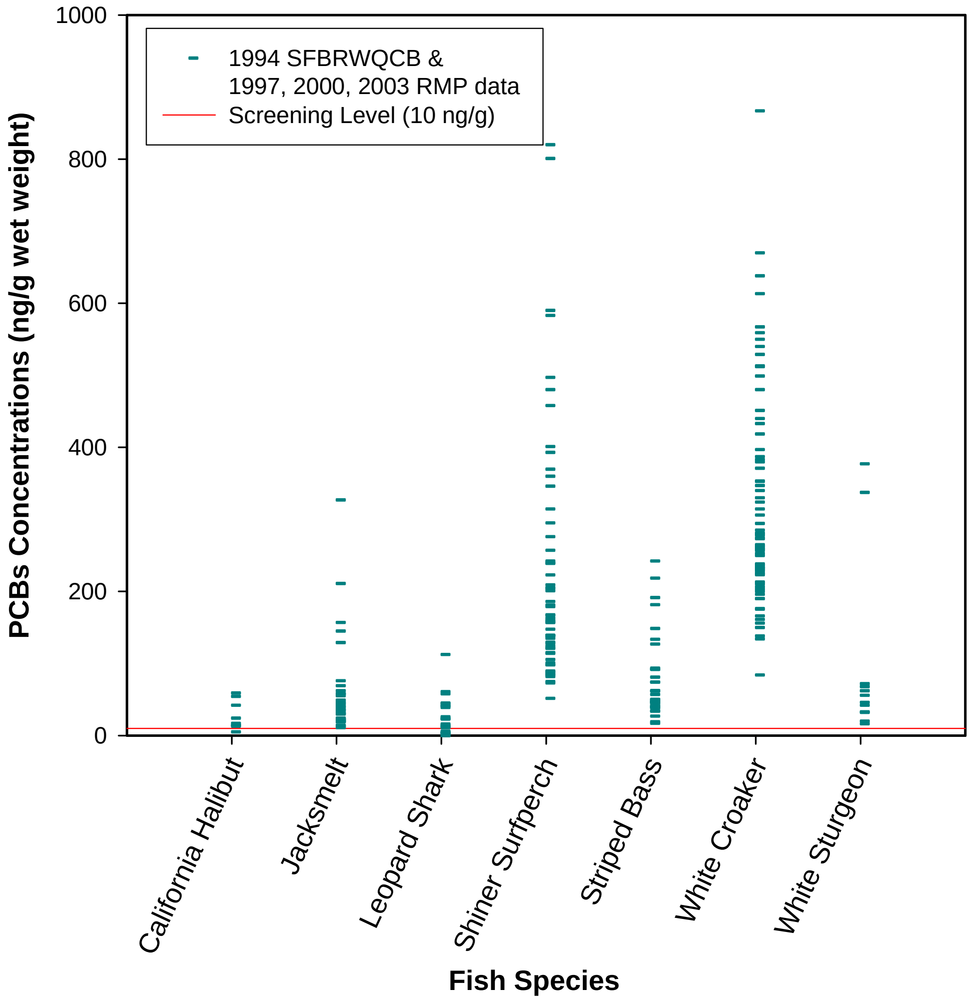

Figure 6-PCBs Concentrations in San Francisco Bay Fish. (Source www.sfei.org)

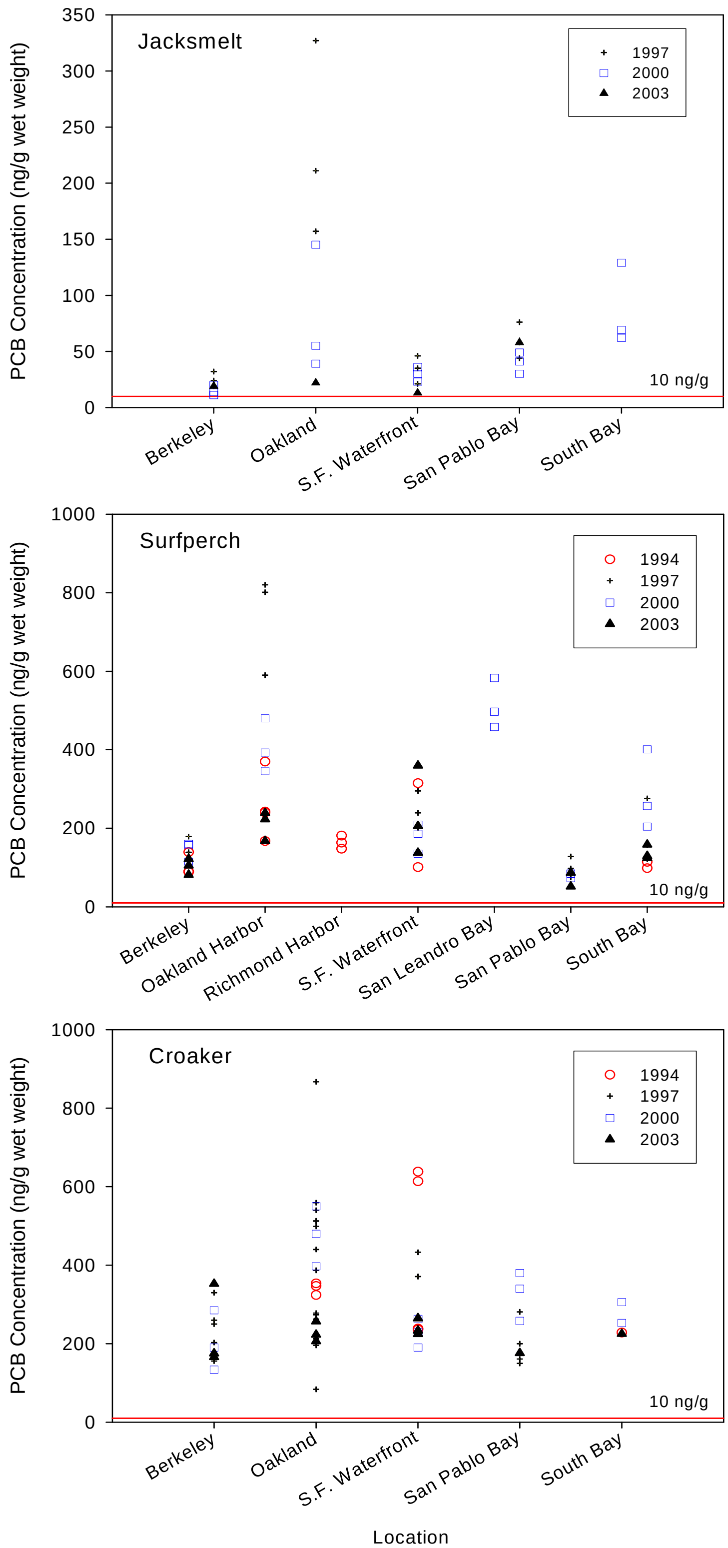

Figure 7-PCBs Concentrations in Selected San Francisco Bay Fish Tissues (1994, 1997, 2000 and 2003). Screening Level is 10 ng/g Wet weight. (Source www.sfei.org)

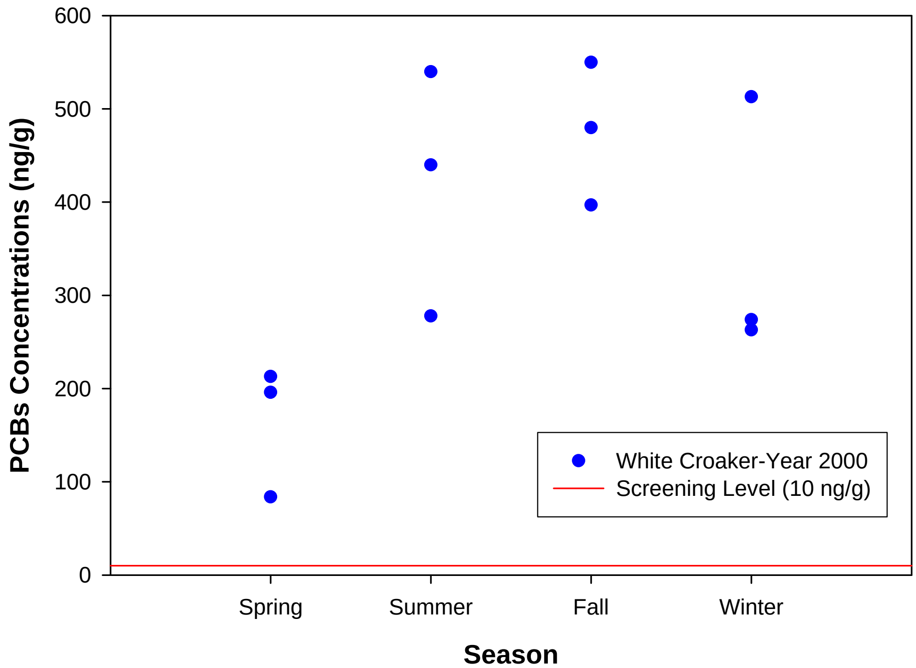

Figure 8-Seasonal Variation of PCBs Concentrations in White Croaker Adapted from Greenfield et al. (2005)

Table 9-PCB Dioxin Toxic Equivalent Factors (Van den Berg, 1998)

IUPAC	NAME	TEF
PCB-77	3,3',4,4'-Tetrachlorobiphenyl	**0.0001**
PCB-81	3,4,4',5-Tetrachlorobiphenyl	**0.0001**
PCB-105	2,3,3',4,4'-Pentachlorobiphenyl	**0.0001**
PCB-114	2,3,4,4',5-Pentachlorobiphenyl	**0.0005**
PCB-118	2,3',4,4',5-Pentachlorobiphenyl	**0.0001**
PCB-123	2,3',4,4',5'-Pentachlorobiphenyl	**0.0001**
PCB-126	3,3',4,4',5-Pentachlorobiphenyl	**0.1**
PCB-156	2,3,3',4,4',5-Hexachlorobiphenyl	**0.0005**
PCB-157	2,3,3',4,4',5'-Hexachlorobiphenyl	**0.0005**
PCB-167	2,3',4,4',5,5'-Hexachlorobiphenyl	**0.00001**
PCB-169	3,3',4,4',5,5'-Hexachlorobiphenyl	**0.01**
PCB-170	2,2’,3,3’,4,4’,5-Heptachlorobiphenyl	**0.0001**
PCB-180	2,2’,3,4,4’,5,5’-Heptachlorobiphenyl	**0.00001**
PCB-189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	**0.0001**

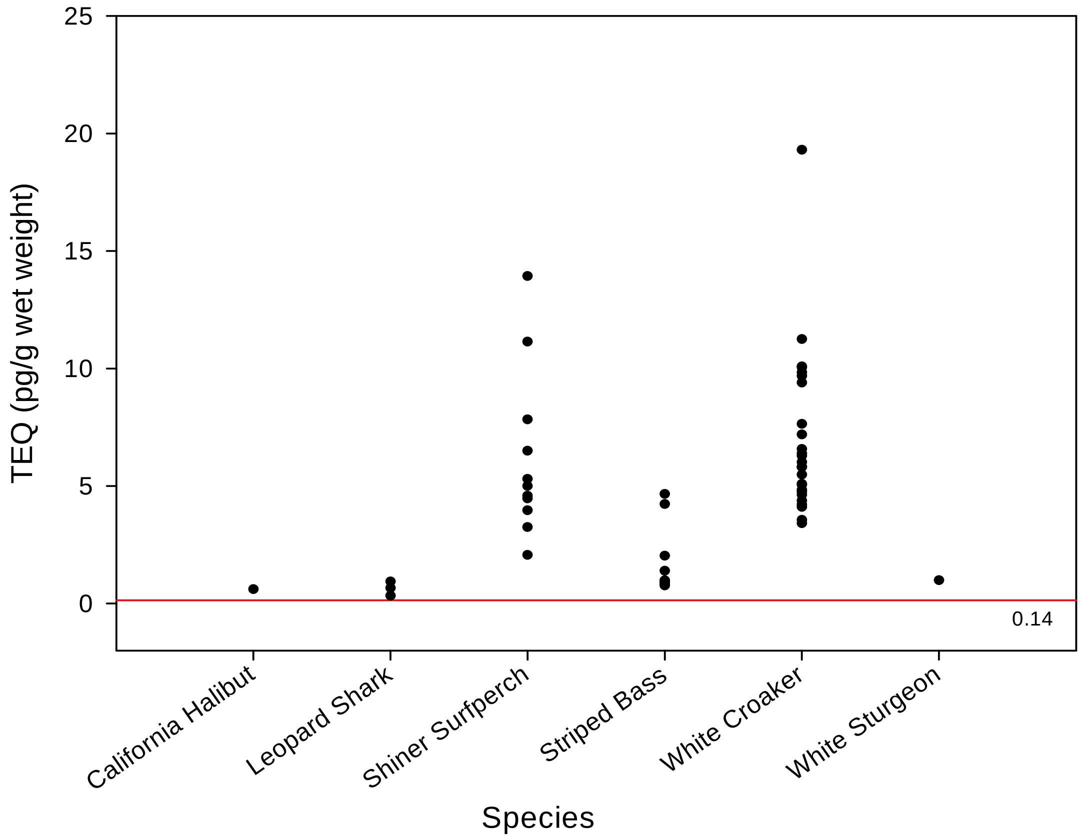

Figure 9- PCB Dioxin Toxic Equivalent (pg/g) in Selected San Francisco Bay Fish (1994, 1997, 2000) (source www.sfei.org)

6.3 Aqueous PCBs concentrations

As previously discussed, U.S. EPA has promulgated a water quality criterion for total PCBs of 170 pg/L (U.S. EPA, 2000b). Over a nine-year period of monitoring at San Francisco Bay monitoring stations (Figure 10), the PCBs water quality criterion was almost always exceeded (Figure 11; Figure 12). In the South Bay and the mouth of the Petaluma River, the water quality criterion was exceeded in 100 percent of the samples. Samples from all other in-Bay RMP sampling locations exceeded the criterion nearly 100 percent of the time. There are no apparent increasing or decreasing trends in water column PCBs concentrations over this time period, so the Bay can be considered at steady state with respect to PCBs concentrations.

The San Joaquin and Sacramento River monitoring stations did not exceed the criterion as often than those in-Bay locations. The criterion was exceeded fewer than 50 percent of the time at only one monitoring station: the Golden Gate located outside the Bay. Elevated in-Bay water column PCBs concentrations can therefore be attributed to Bay Area sources, whether from ongoing discharge of PCBs to the Bay or remobilization of PCBs already in Bay sediments.

There is a high frequency of water column exceedances of the PCBs water quality criterion. Yet, as was discussed in sections 6.1 and 6.2, benthic organisms and fish have elevated PCBs in areas where sediments also have elevated PCBs concentrations. In order to lower the fish tissue PCBs concentrations to the screening level, the TMDL focuses on PCBs in sediments.

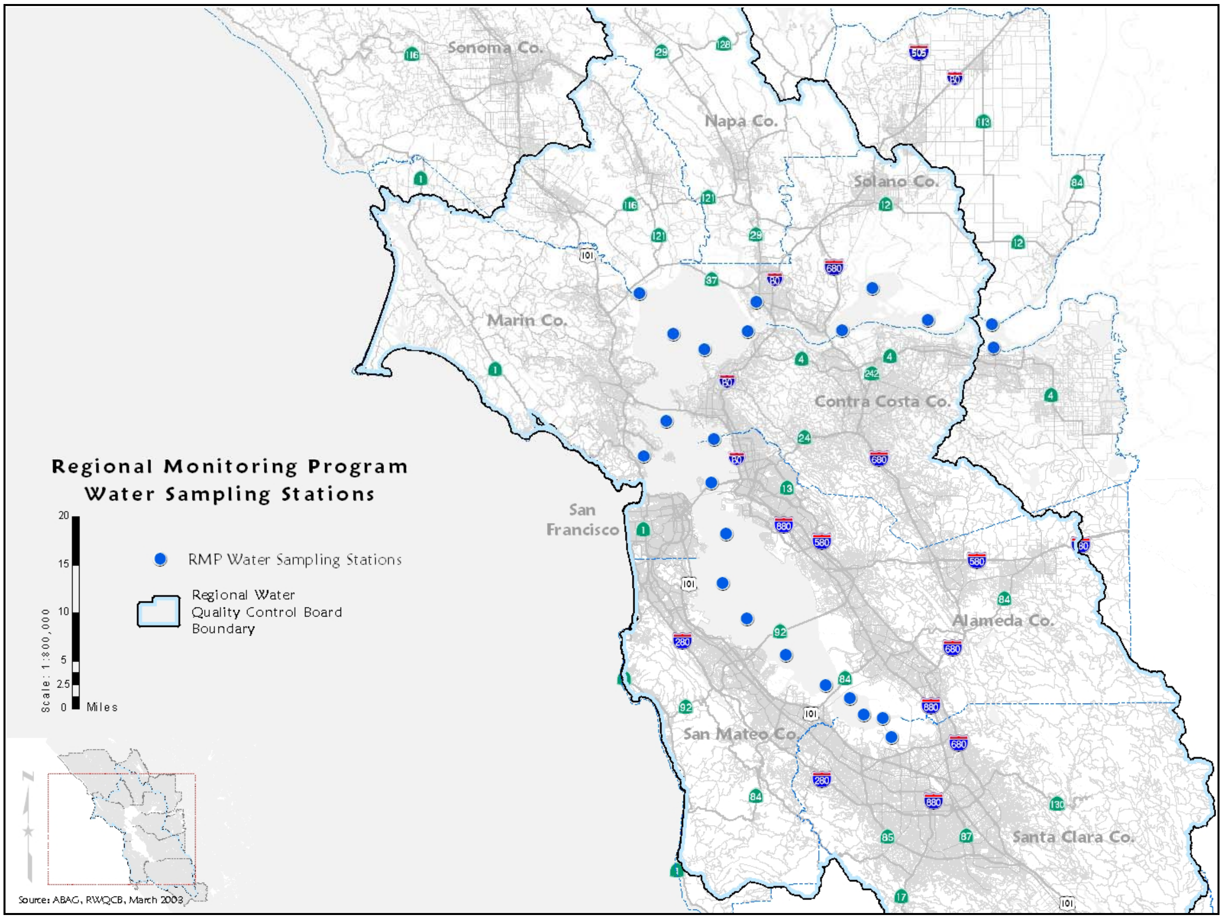

Figure 10-Regional Monitoring Program Sampling Stations (1993-2001)

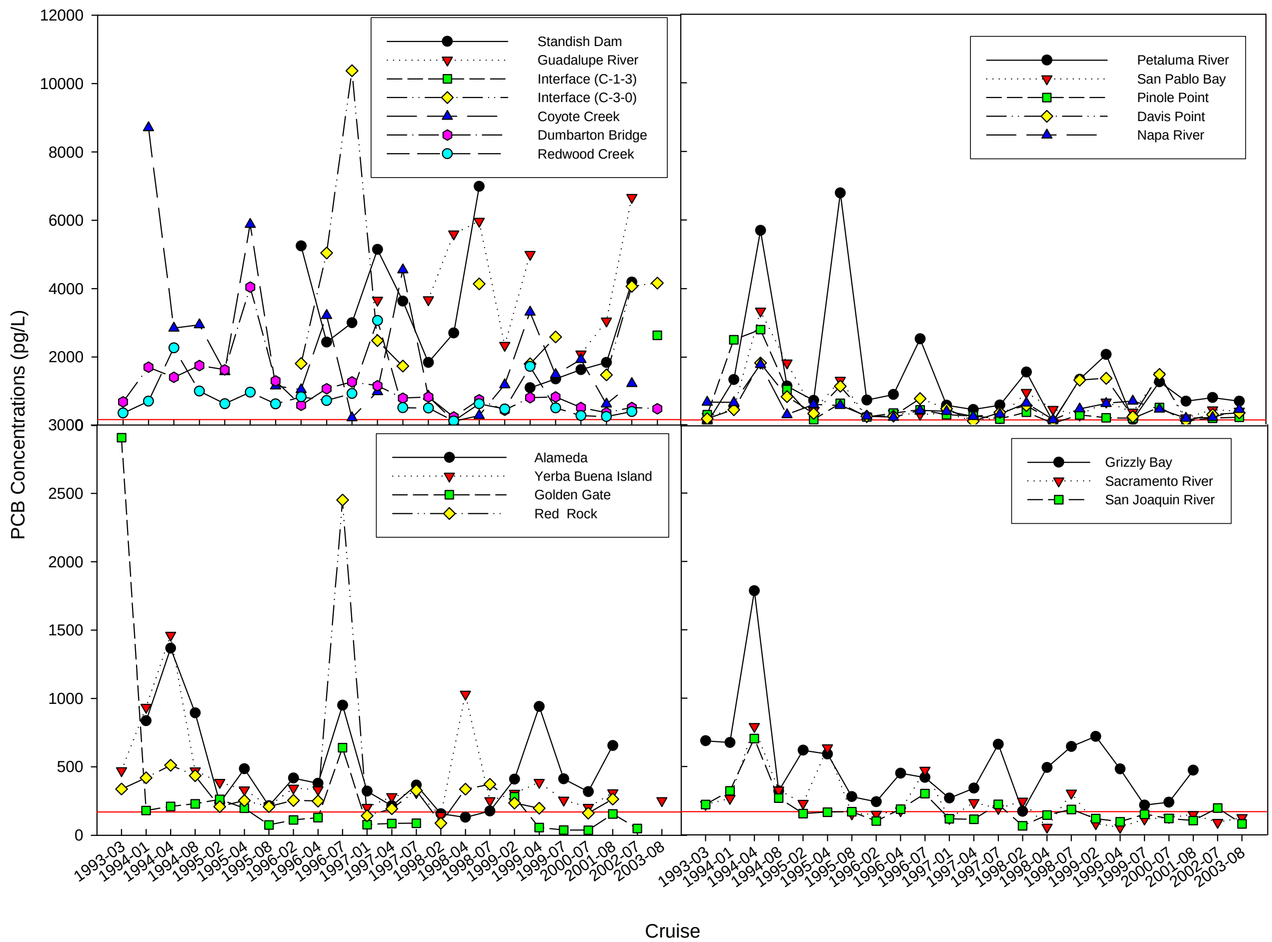

Figure 11-Water Column PCBs Concentrations in San Francisco Bay Fixed Stations (1993-2003)

Red line is the applicable water quality standard of 170 pg/L (based on data from http://www.sfei.org)

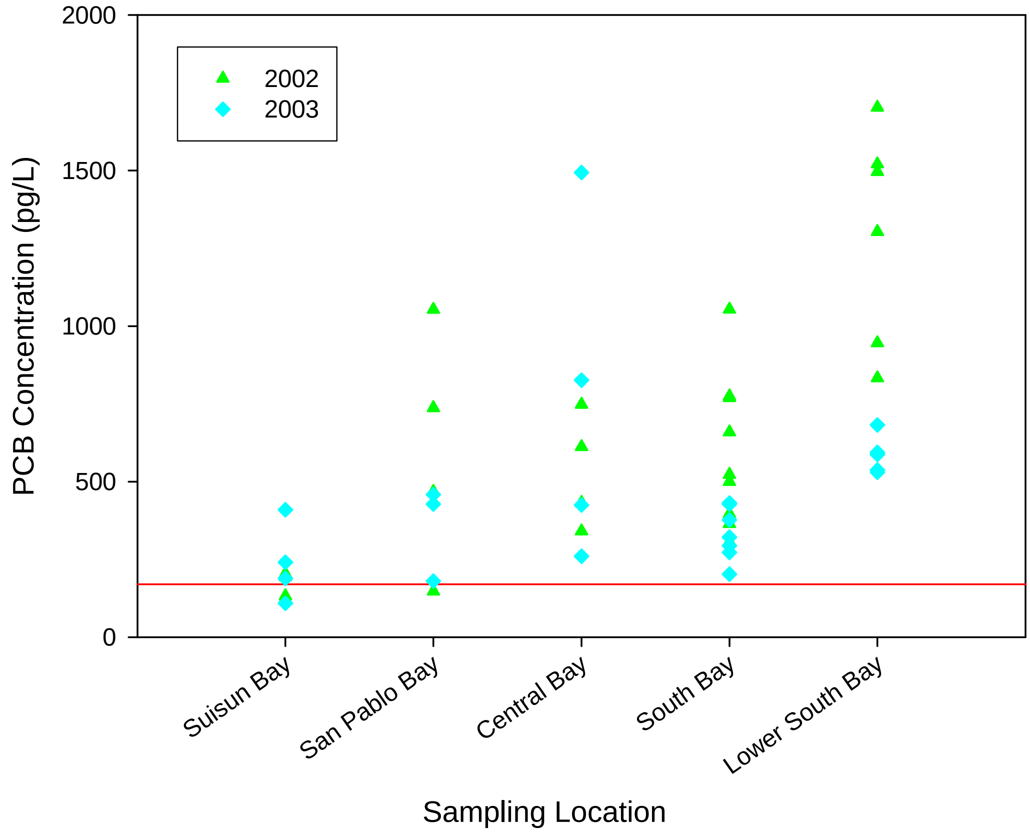

Figure 12-Water Column PCBs Concentrations in San Francisco Bay-Random Design
Red line is the applicable water quality objective of 170 pg/L.

7. Reservoirs, Sources and Loads, and Movement of PCBs

Since the onset of production in 1929, PCBs have been introduced to the environment through land disposal (legal and illegal), accidental spills and leaks, incineration of PCBs or other organic materials in the presence of chlorine, pesticide applications, surface coatings such as paints and caulks, and wastewater discharge. Diffusion of PCBs from localized areas with high PCBs concentrations has resulted in widespread low-level background concentrations across the globe (Erickson, 1997).

In the following sections, we present our understanding of PCBs distribution in the Bay, along with estimates of sources and loads. We have assessed current PCBs mass in the water column and sediments, as well as the loads from direct atmospheric deposition, Central Valley watershed inputs, municipal and industrial wastewaters, and stormwater runoff to the Bay. We also present our understanding of in-Bay PCB-contaminated sites, but can not estimate their role as sources to the water column and biota.

7.1 Environmental Reservoirs

Due to potentially large historical releases of PCBs to the Bay, an estimate of PCBs reservoirs is needed to put current PCBs loads in perspective. Two environmental reservoirs of PCBs exist in the Bay: the water column and the sediments. As discussed below, the mass of PCBs in sediments is much greater than in the water column. However, it is important to note that a numeric criterion exists for water but not for sediments. This is important since the potential for sediments to be resuspended and supply PCBs to the water column is significant, as well as the ability for sediment to supply PCBs directly to biota.

Water Column

SFEI (2007) calculated a Bay-wide PCBs concentration of 430 pg/L from RMP data collected between 2002 and 2006. Based on this water column concentration and a water volume of 5,500 million m^3 for the Bay, they estimate a PCBs mass of 2.4 kg in the water column (SFEI, 2007).

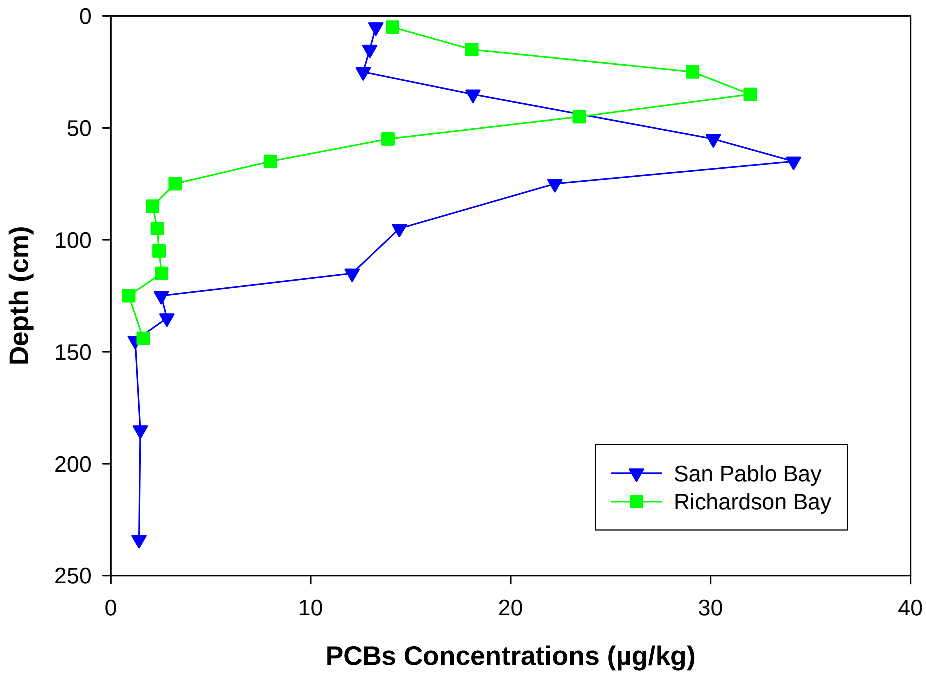

Figure 13-PCBs Concentrations with Depth in Sediments from Two North Bay Locations (USGS, 1999)

Sediments

For the purposes of this report, we separated Bay sediments into two categories: ambient and contaminated. Sediments considered ambient are from locations distant from known sources of contamination and have PCBs concentrations that cannot be statistically differentiated from other sediments collected in similar environments. Sediments considered representative of contamination are usually located near-shore, close to potential sources of contamination and have concentrations often several orders of magnitude greater than ambient sediments.

In 1992, the United States Geological Survey (USGS) collected ambient sediment cores in Richardson Bay and San Pablo Bay (Fuller et al., 1999). Radioisotopes were used to determine deposition chronologies of the sediments, which were compared to the chemical concentrations as a function of depth. PCBs concentrations were relatively constant to a depth of 25 to 50 centimeters (cm), corresponding to deposition since the early 1980s. A sharp increase in PCBs concentrations was observed below those depths, with maximum concentrations corresponding to deposition in the 1970s (Figure 13).

Total masses of PCBs per unit area for the entire depth of the cores were calculated to be 1,400 nanograms per square centimeter (ng/cm^2) and 4,100 ng/cm^2 for Richardson Bay and San Pablo Bay respectively (Venkatesan et al., 1999). Extrapolating the core results to the entire Bay, we estimate based on an estimated surface area of 1,285 km^2 that the total PCBs mass in ambient sediments ranges from 18,000 to 52,000 kg (Table 10). This range is based on the results from sediment cores collected far from known on-land PCBs use areas, and may under-represent total PCBs in the Bay. Yet, sediments represent a PCBs reservoir four to five orders of magnitude larger than the 2.4 kg in the water column.

Table 10-Estimated Total PCBs Mass in Bay Sediments Based on USGS Core Data

Location	Depth (m)	Total PCBs (ng/cm2)	Total PCBs in Estuary (kg)
Richardson Bay	0.75	1,391	18,000
San Pablo Bay	1.25	4,069	52,000

Alternatively, the total mass of PCBs in ambient sediments can be estimated using the mean concentration of PCBs in sediments of 4.6 μg/kg (SFEI, 2007). Again using an area of 1,285 km^2 for the Bay and a depth of 1 meter to cover the depth to which PCBs are usually found. Assuming that Bay sediments are 55 percent solid by weight (range from 40 to 80%), we can estimate total PCBs in sediments. Sediment volumes are converted to sediment dry mass as follows:

$$M_s = \frac{(x\rho_w)}{\left[1 + x\left(\rho_w / \rho_s - 1\right)\right]} V_t \qquad \textit{(Equation 2)}$$

where,

M_s = the dry mass of sediments in kg,
x = the percent solid per unit mass sediment,
ρ_w = the density of water (1kg/L),
ρ_s = the particle density of sediments (2.65 kg/L for aluminosilicates),
and V_t = the volume of sediments.

The dry mass of sediment is then converted to PCBs mass for a range of sediment PCBs concentrations. This gives an estimate of 4,300 kg of total PCBs in ambient sediments of the Bay (Table 11), which is lower than the results based on the USGS cores (Table 10).

There are specific in-Bay locations where sediment PCBs concentrations are much higher than in the rest of the Bay (BPTCP, 1998) that we refer to as PCBs-contaminated sites. Data were collected at these sites (Table 12, Figure 14) to satisfy different regulatory requirements, and are therefore not readily comparable. For example, sampling densities and methods often vary between regulatory programs. Several of the sites (e.g. Cerrito Creek) were identified under the Bay Protection and Toxic Clean-up Program (BPTCP) and the sampling consists of one or a few surface grab samples. The Vallejo Ferry terminal site was identified during sampling and analysis for a dredging project and corresponds to one composite sample collected from several deep cores. Hunters Point Shipyard and Seaplane Lagoon at the Alameda Naval Air Station are Superfund sites regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). They have a much higher sampling density than most other sediment sites in the Bay. Other sites were investigated as part of scientific studies, such as in San Leandro Bay, or remedial investigations of on-land contaminated sites, such as the Emeryville crescent. At the Oyster Point site, remedial actions have already been undertaken. Regardless of the differences in methodology used for collecting these data, the listed sites have sediment PCBs concentrations several orders of magnitude greater than those considered ambient. These highly elevated PCBs concentrations could be contributing significant PCBs mass to the Bay's biota. PCBs concentrations in sediment dwelling biota can be correlated to PCBs concentrations in sediments (Figure 15). Potential contribution of PCBs to biota from these contaminated sediments needs to be further evaluated, and likely needs to be reduced to lower the fish tissue PCBs concentrations.

Table 11-Estimated Total PCBs Mass in Bay Sediments Based on Ambient PCBs Concentrations

Sediment PCB Concentrations (µg/kg)	SurfaceArea (km^2)	Depth (m)	Total PCBs (kg)
4.6	1,285	1	4,300
11	1,285	1	12,000
22	1,285	1	24,000
35	1,285	1	38,000

Table 12-PCBs-Contaminated Sites in the Bay

Bay Segment	Location	Maximum Sediment PCBs concentrations (µg/kg)	References
Suisun Bay	Peyton Slough	>200	BPTCP (1998)
San Pablo Bay	Vallejo Ferry Terminal	>1,000	MEC (1996), Regional Board File No.2128.03
Central Bay	Richmond Harbor/Potrero Point	>10,000	Hart Crowser (1993), BPTCP (1998), Battelle (1994)
	Stege Marsh	>1,000,000	BPTCP (1998), PERL(1999), URS (2000a), URS (2002a)
	Richardson Bay	>200	EDAW (1997); ABT (1998)
	Cerrito Creek	>200	BPTCP (1998)
	Cordonices Creek	>200	BPTCP (1998)
	Emeryville Crescent	>1,000	TetraTech (1993)
	Oakland Army Base	>1,000	Arcadis (2004)
	Oakland Harbor	>200	Battelle (1988), BPTCP (1998), EVS et al. (1998)
	San Leandro Bay	>1,000	BPTCP (1998), Daum et al., (2000), Regional board File No. 2199.9018A
	Alameda Naval Air Station Seaplane Lagoon	>1,000	BPTCP (1998), US Navy (1999), Battelle et al. (2001) Battelle 2005)
	Islais Creek	>200	BPTCP (1998), SFPUC (2002)
	Mission Creek	>200	BPTCP (1998), SFPUC (2002)
	Yosemite Creek Hunters Point Shipyard	>10,000	BPTCP (1998), SFPUC (2002), PRC (1996) Navy (2004), Battelle et al. (2004)
	Oyster Point	>1,000	MEC (1990), Treadwell and Rollo (1995), URS (2000b)
	San Francisco Airport	>1,000	BPTCP (1998), URS (1999)
South Bay	Redwood City Harbor	>1,000	MEC (1997), ABT (1997)
Lower South Bay	Moffett Federal Airfield NASA Ames	>10,000	PRC and Montgomery Watson (1997)
	Guadalupe Slough San Jose	>200	ESA (1988)

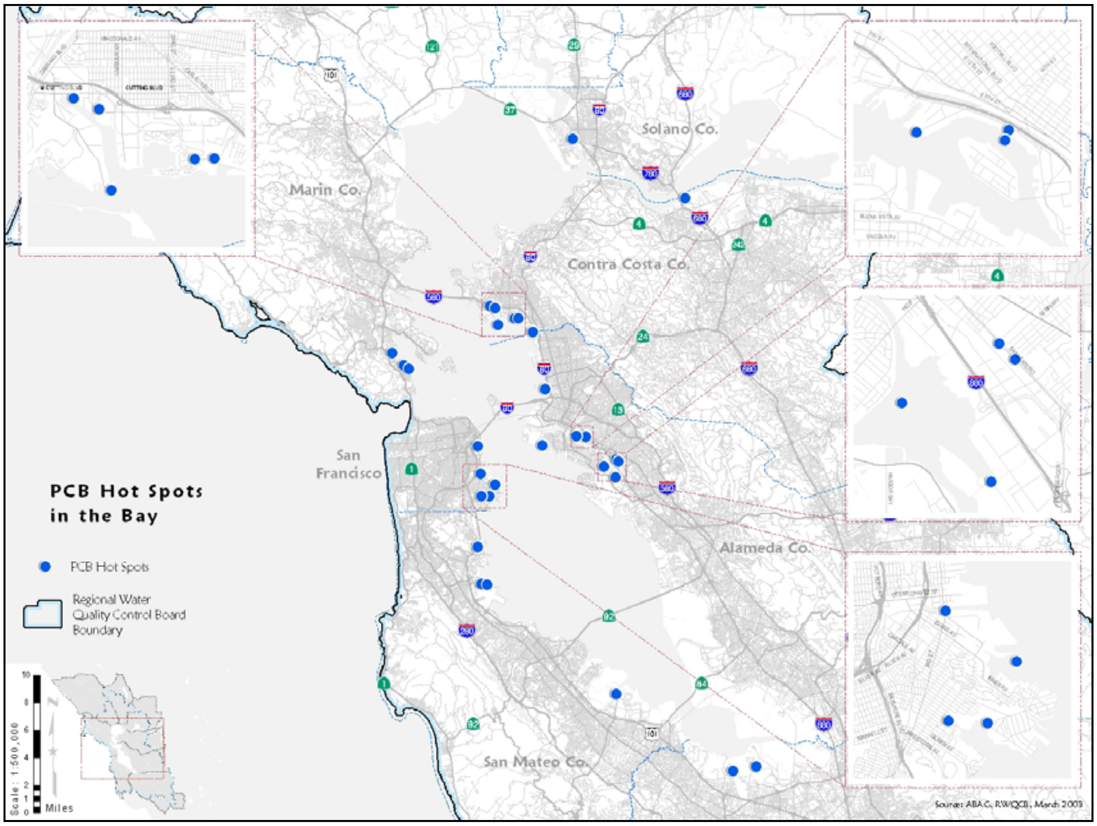

Figure 14-PCBs-Contaminated Sites in the Bay

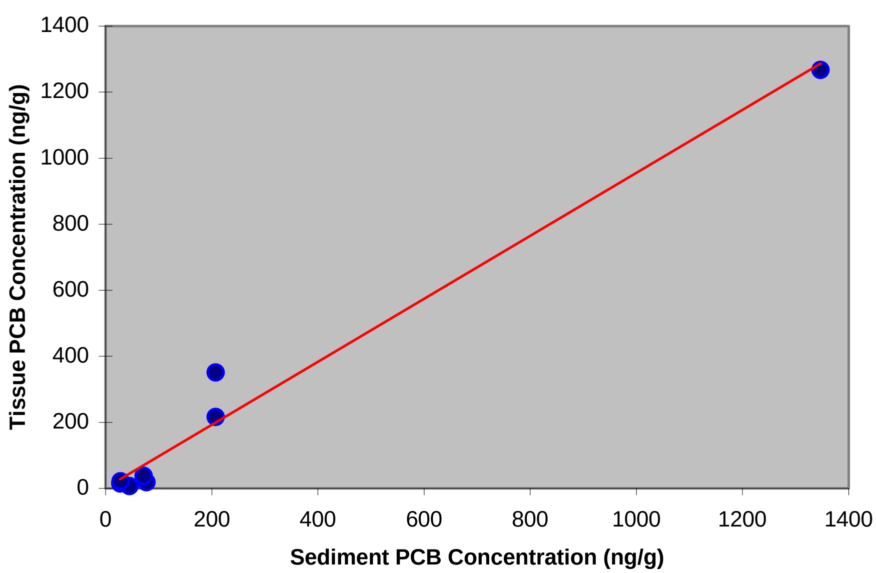

Figure 15-PCBs Concentrations in Sediment and Bent-Nosed Clam (Macoma nasuta) Tissue Following Bioaccumulation Testing, Seaplane Lagoon, Alameda NAS

7.2 External Sources

As previously discussed, sediments are the largest PCBs reservoir in the Bay and may contribute significant PCBs mass to biota. However, these sediments correspond to only one pathway of PCBs loadings to the Bay. As part of developing this TMDL, all known and potential sources and loads of PCBs to the Bay must be considered. In this section, we present our current understanding of sources and estimates of the loads from the following sources:

- Direct atmospheric deposition
- Central Valley watershed (Sacramento and San Joaquin Rivers)
- Municipal and industrial wastewater discharges
- Runoff and local tributaries

Direct Atmospheric Deposition

PCBs have been detected in remote regions of the world, far from known areas of PCBs use, indicating that atmospheric movement and deposition of PCBs can be significant sources of PCBs to surface waters (Erickson, 1997). Conversely, PCBs can also be lost from surface waters to the atmosphere by volatilization. In some instances, loss of PCBs to the atmosphere can account for the largest removal of PCBs from surface water (Jeremiason et al., 1994).

Deposition of PCBs from the atmosphere occurs either directly to surface waters, or indirectly in the watershed. PCBs deposited in the watershed may then be transported to the Bay via stormwater runoff discharges. The San Francisco Estuary Institute (SFEI) has completed a study of the direct deposition of PCBs to the Bay from the atmosphere (SFEI, 2005; Tsai et al., 2002). Indirect contributions of PCBs to the Bay from the atmosphere were not quantified, but are included in the loadings estimates for urban and non-urban stormwater runoff. Direct PCBs loads to the Bay are estimated to be 0.5 kg/yr (SFEI, 2007), but loss to the atmosphere is estimated at 7.4 kg/yr resulting in a net loss (Table 13). However, PCBs loss from the Bay to the atmosphere is accounted for in the mass budget model and is quantified in the prediction of attainment of the target.

Table 13-Estimated PCBs Mass Associated with Dredge Material Disposal (2001-2005)

Disposal Site	Total Volume 2001-2005 (cu yd)	Average Volume (cu yd/yr)	Average Annual Estimated PCB Mass (kg/yr)
In-Bay Disposal	8,900,000	1,800,000	4.6
Ocean (SF-DODS) Disposal	3,800,000	760,000	-2.0
Upland/Wetland Reuse	8,100,000	1,600,000	-4.1
Net Loss			-6.1

These load estimates are small compared to load estimates for water bodies elsewhere in the United States and may need to be revised. However, it is very likely that loads to the Bay currently are, and have always been, much lower than loads to eastern United States water bodies due to regional wind patterns that typically come from the ocean pushing locally generated airborne PCBs inland and the fact that there have been historically lower uses of PCBs in the Bay area. Finally, it is recognized that water-atmosphere transfers have greatly declined over the last three decades.

Central Valley Watershed

PCBs concentrations in the Sacramento and San Joaquin rivers have been monitored by the RMP for over ten years. Based on the concentrations measured by the RMP, we had previously estimated that about 40 kg of PCBs entered the Bay each year from the Central Valley. More recently, PCBs loads entering the Bay from the Central Valley have been estimated for the years 2002 and 2003 (Leatherbarrow et al., 2005). Annual loads of PCBs were estimated at 6.0 ± 2.0 and 23 ± 18 kg for years 2002 and 2003, respectively. The load estimates are based on measured flow-weighted mean PCBs concentrations ranging from 200 to 6,700 pg/L with a median concentration of 600 pg/L. SFEI calculated annual PCBs mass loadings using Central Valley water discharge data at Mallard Island from the Department of Water Resources (Interagency Ecological Program) using a mass balance approach and the DAYFLOW model (SFEI, 2007). These annual load estimates may be at the lower end of the range of annual loads as these years were drier years with lower sediment inflow from the Central Valley (Leatherbarrow et al., 2005). For the TMDL, we are using the SFEI derived average load of 11 kg/yr, derived from five years of data, as the loading to the Bay from the Central Valley (SFEI, 2007).

Municipal and Industrial Wastewater Dischargers

There are a number of municipal and industrial wastewater discharges into San Francisco Bay (Figure 16 and Figure 17). Municipal wastewater discharges are located throughout the Bay (Figure 16), while the major industrial wastewater discharges take place in the north Bay segments (Figure 17) where ambient PCBs water concentrations are some of lowest in the Bay.

Municipal and industrial wastewater discharges to surface waters are controlled through waste discharge requirements issued as federal National Pollutant Discharge Elimination System (NPDES) permits. Selected municipal wastewater dischargers (Publicly Owned Treatment Works or POTWs) and petroleum refineries have quantified PCBs in their wastewaters using U.S. EPA method 1668 to achieve lower detection limits (SFEI, 2001b; 2002a; 2002b). Wastewaters from the POTWs with secondary treatment have an average PCBs concentration of 3,600 pg/L (Table 14), while wastewaters from POTWs with advanced treatment have an average PCBs concentration of 210 pg/L (Table 15). Wastewaters from petroleum refineries in the North Bay had an average PCBs concentration of 270 pg/L (Table 16), similar to that in the POTWs with advanced treatment, while other industrial wastewater dischargers had an average concentration of 1900 pg/L.

Using average daily flows from the POTWs and industries, including refineries, and the average PCBs concentrations in wastewaters from each category, we estimate that municipal and industrial wastewater discharges annually contribute 2.3 kg and 0.035 kg of PCBs to the Bay respectively.

Urban and non-Urban Stormwater Runoff

Municipal urban stormwater runoff management agencies measured sediment PCBs concentrations within their urban and non-urban stormwater runoff conveyance systems in the summers of 2000 and 2001 (ACCWP, 2001; ACCWP 2002a, ACCWP 2002b; KLI, 2001; KLI, 2002). The purpose of these studies was to determine whether PCBs are evenly distributed and discharged from stormwater conveyance systems or whether PCBs-contaminated sites exist within watersheds. These studies also attempted to evaluate whether runoff conveyances are sources of PCBs in themselves. The studies also examined whether specific locations within watersheds are contributing to ongoing PCBs discharge to the Bay via stormwater conveyance systems due to historical or current activities at those locations. Finally, loads of PCBs from runoff to the Bay were estimated based on the sediment PCBs concentrations and estimated loadings of sediments to the Bay.

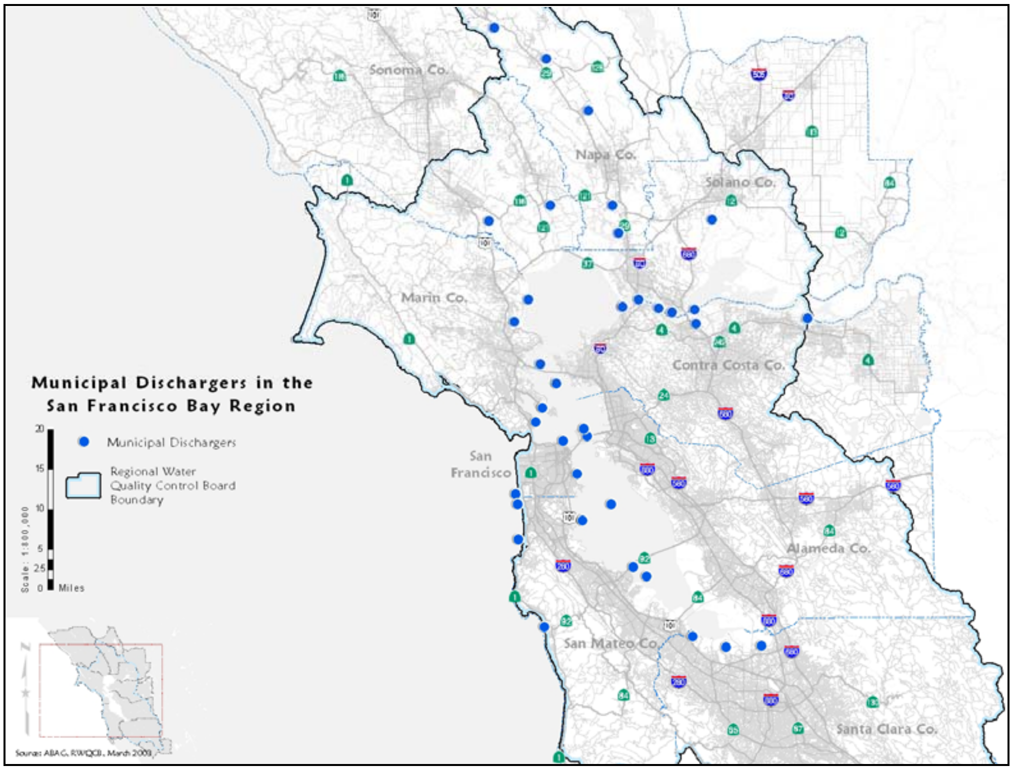

Figure 16-Municipal Wastewater Dischargers in San Francisco Bay

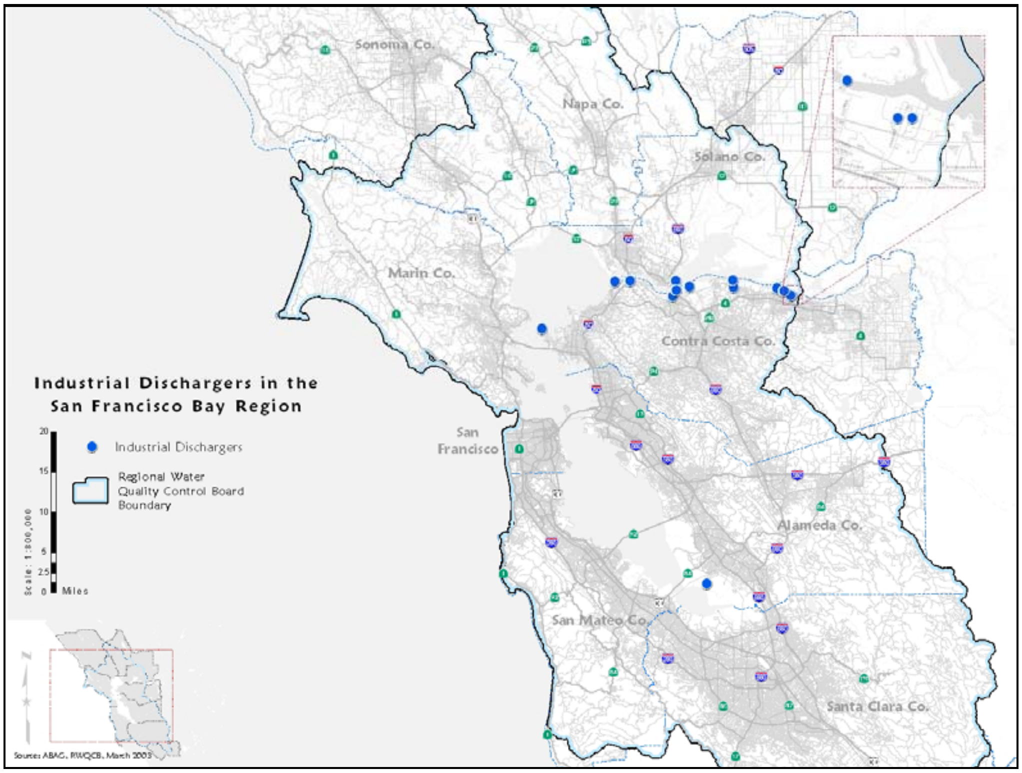

Figure 17-Selected Industrial Wastewater Dischargers in San Francisco Bay

Table 14-PCBs Concentrations in Wastewater from Municipal Dischargers with Secondary Treatment

POTW	**PCBs (pg/L)**	
	December-00	**February-01**
East Bay Municipal Utility District	7,900	5,700
Central Costa Costa County Sanitary District	1,100	1,400
East Bay Dischargers Authority	4,700	3,700
City and County of San Francisco	2,200	2,700
Millbrae	NA	2,600

NA = Not Analyzed

(SFEI, 2002a)

Table 15-PCBs Concentrations in Wastewater from Water Municipal Dischargers with Advanced Treatment

POTW	**PCBs (pg/L)**			
	November-99	**February-00**	**April-00**	**July-00**
Fairfield-Suisun	250	NA	130	NA
Palo Alto	310	310	320	240
San Jose/Santa Clara	190	170	170	190
Sunnyvale	200	190	120	160

(SFEI, 2001b)

Table 16-PCBs Concentrations in Wastewater from Industrial Dischargers

Facility	PCBs (pg/L)
Southern Energy California LLC, Potrero Power Plant	1000
	370
	260
	130
Southern Energy California LLC, Pittsburg Power Plant	830
	72
C&H Sugar Co.	860
	3700
The DOW Chemical Co.	1800
	660
San Francisco, City and Co., SF International Airport Industrial WTP	5600
	4300
	3400
	3400
Chevron Products Company, Richmond Refinery	650
	570
ConocoPhillips, San Francisco Refinery	170
	380
Shell Oil Products US and Martinez Refining Company, Shell Martinez Refinery	280
	150
Tesoro Refining & Marketing Co, Golden Eagle Refinery	110
	150
Valero Refining Company, Valero Benicia Refinery	170
	85

(SFEI, 2002b)

The urban and non-urban stormwater runoff study found sediment PCBs concentrations ranging from the low µg/kg level to the tens of thousands of µg/kg level. Sediment sampling locations were selected to reflect a variety of land use categories (Figure 18 and Figure 19). Sediment PCBs concentrations were statistically greater in areas of industrial, commercial and residential land use than in open space, clearly showing that PCBs were not evenly distributed across watersheds. Eleven of 209 locations had PCBs concentrations greater than 1,000 µg/kg (Figure 20), while 125 locations had PCBs concentrations greater than in-Bay ambient sediments which have PCBs concentrations of 4.6 µg/kg. Pilot studies of these urban stormwater runoff conveyance systems contaminated sites indicate that only in some cases can the PCBs be traced back to current or historical on-land activities (ACCWP, 2002a, ACCWP, 2002b; CCCWP, 2002; San Jose and EOA, 2002; SMCSTPPP, 2002). Elevated PCBs concentrations in the urban and industrial landscapes were expected due to the widespread use of PCBs both in closed and open applications (Table 8), such as transformers or capacitors that may have leaked hydraulic fluids, lubricants, and plasticizers, as well as its uses in building materials. PCBs in open space land use area were also expected due to the known role of atmospheric transport and deposition of PCBs around the world, as well as the direct application of PCBs to the environment in various processes (Section 4.3), such as pesticide extenders.

At several locations with elevated sediment PCBs concentrations, follow-up case studies were conducted to attempt to locate the source of PCBs to the stormwater conveyance system (CCCWP, 2002; San Jose and EOA, 2002; SMCSPPP, 2003; SMCSPPP, 2004). These case studies were successful on only some occasions to identify a potential source of PCBs to the stormwater conveyance system. In another study (Kleinfelder, 2006), targeted sampling for

PCBs in soils and sediments the public right-of-way was performed within an industrial watershed with elevated PCBs in storm drain sediments. Sampling locations were based on an analysis of current and past business, followed by inspections for compliance with the industrial general NPDES permit under which the business operate. This investigation was able to detect a number of potential sources of PCBs within the watershed at a larger frequency than in a randomly determined sampling scheme performed alongside. This study showed a need to target PCBs source and treatment controls to current and historical industrial watersheds.

PCBs loads for the Guadalupe River have been estimated to be from 0.7 to 1.2 kg/yr between 2003 and 2005 (McKee et al., 2005). SFEI extrapolated these loads to small urban tributaries and estimated a total load of 20 kg/yr (SFEI, 2007). We use this total load estimate for combined urban and non-urban stormwater runoff. The contribution to the total load from non-urban runoff is much smaller than that from urban runoff since the mean sediment concentration in open spaces is about 2 μg/kg, whereas it is about 500 μg/kg in urban spaces (KLI, 2002).

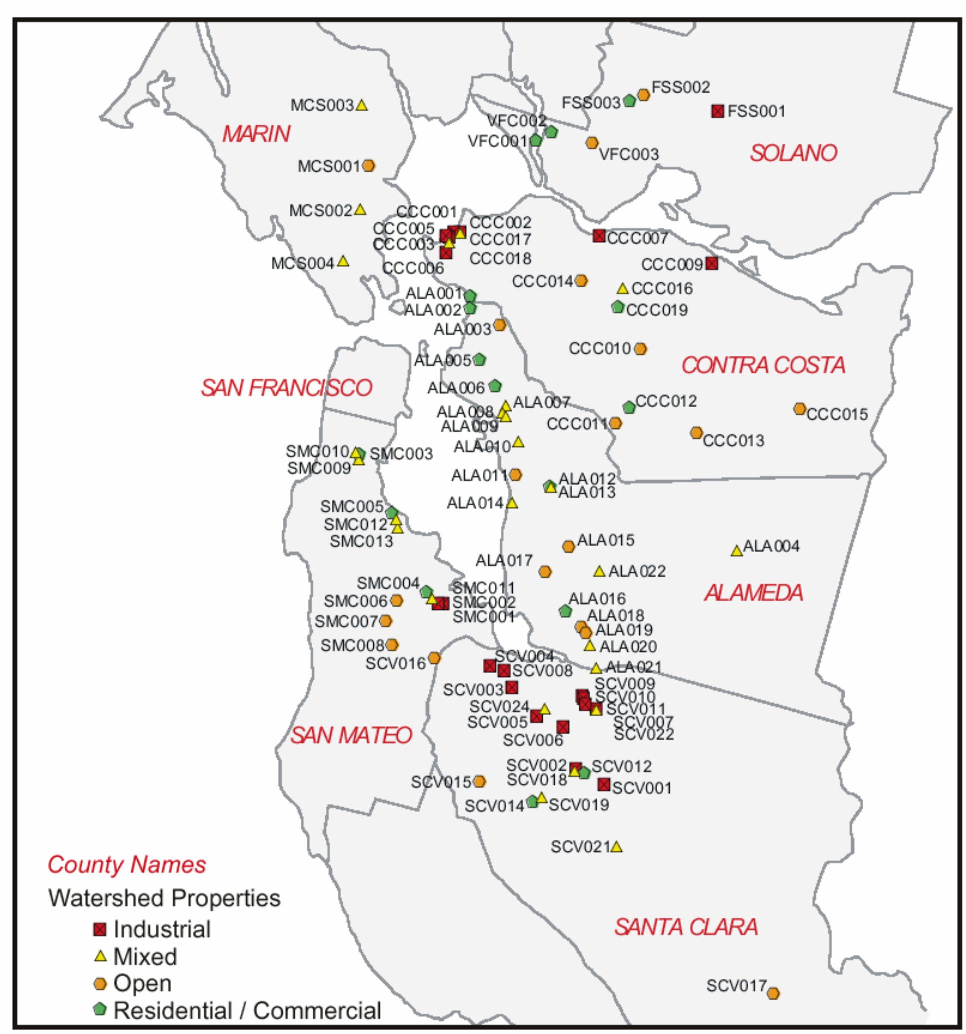

Figure 18-Sediment Sampling Locations in Stormwater Runoff Conveyance Systems (2000) (Source KLI, 2001)

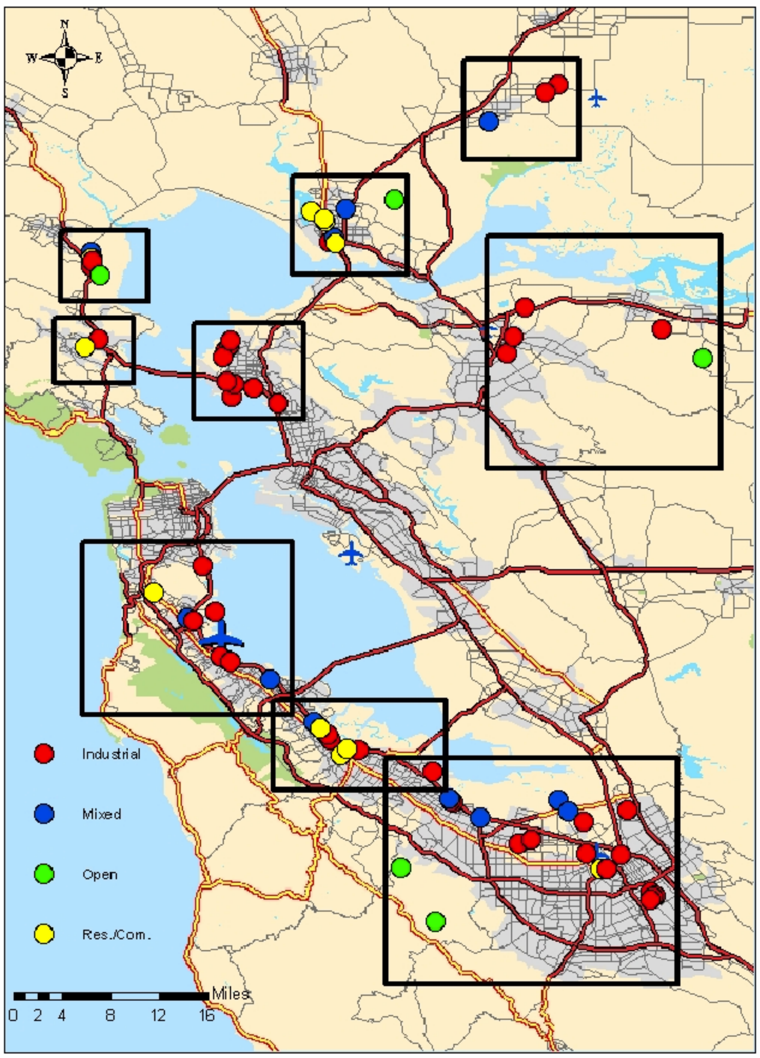

Figure 19-Sediment Sampling Locations in Stormwater Runoff Conveyance Systems (2001) (Source KLI, 2002)

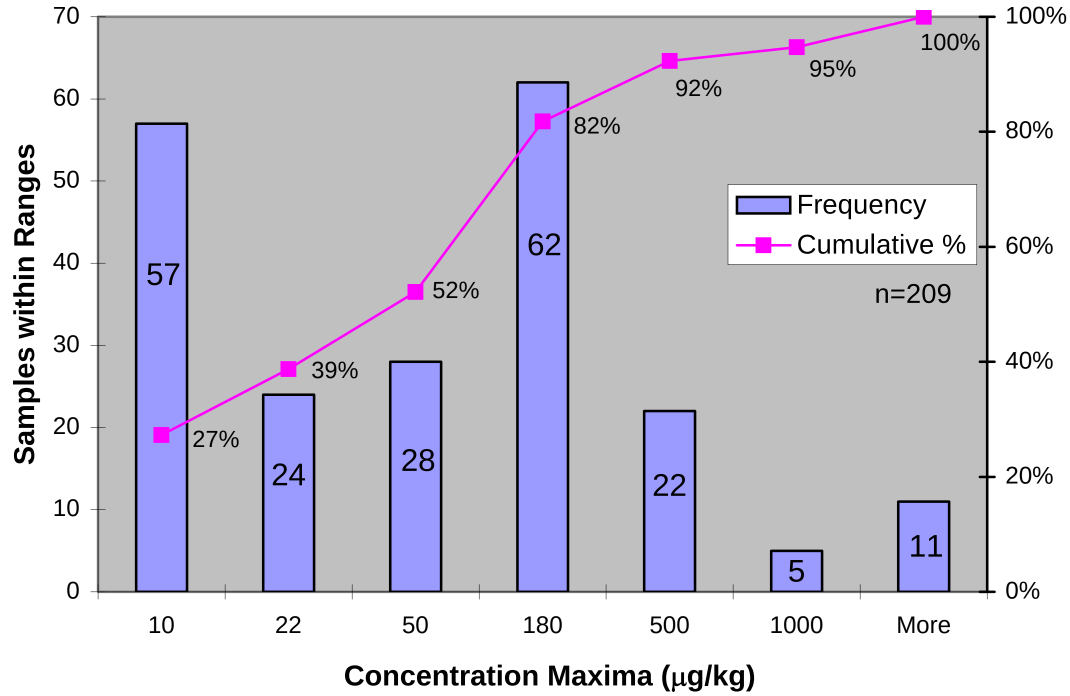

Figure 20-Sediment PCBs Concentrations Distribution in Urban Conveyance Systems (2000-2001)

7.3 Internal Sources

As discussed in Section 7.1, bottom sediments are the largest environmental reservoir of PCBs in the Bay. In general, the water column PCBs mass is mostly associated with suspended sediments. Deposition of suspended sediments and re-suspension of bottom sediments are therefore important processes controlling the mass of PCBs in Bay water. Continual mixing of bottom sediments from wave action or other disturbances, such as mixing by organisms (bioturbation) or erosion of bedded sediments, can provide an ongoing supply of PCBs to the water column and biota. The large mass of PCBs in sediment denotes the importance of sediment dynamics in predicting the fate and distribution of PCBs throughout the Bay. In this section, we look at two processes affecting the bioavailability of sediment-bound PCBs. First, PCBs in the “active” sediment layer are considered because of their potential to be resuspended along with sediment and their potential for uptake by bottom dwelling aquatic organisms (bioavailability). Second, dredging activities are also considered because they can potentially cause previously buried PCBs to become bioavailable.

Active Sediment Layer
A sediment active layer can be defined many different ways based on the biophysical mechanism and reference timeframe of interest. In this report, the active layer is defined as the Bay sediments that are in contact with biota or that can be resuspended into the water column.

In one study, radioisotope dating indicated a mixing depth of about 10 cm on a timeframe of several months in Richardson Bay (Fuller et al., 1999). Biological and physical mixing within the sediment column was further substantiated by burrow worms found to a depth of 12 to 15 cm. In San Pablo Bay, the depth of the active layer was difficult to measure, as sediments at this site are believed to have undergone episodes of rapid deposition and scouring. Worms have also been observed to a depth of one to two feet in the area offshore of Hunter's Point Shipyard (U.S. Navy, 2005).

In this report, we define the active layer as the top 15 cm of sediments in the Bay, in order to be consistent with modeling performed on the long-term fate of PCBs in the Bay. Although there is uncertainty as to the exact depth of the active layer (Davis, 2003), using 15 cm is appropriate to get an order of magnitude estimate of PCBs mass in the active layer because we are interested in the relative masses of PCBs in the various reservoirs and load categories. Using this depth and a mean sediment PCBs concentration of 4.6 µg/kg, we estimate that a PCBs mass of 650 kg resides in the active sediment layer of the Bay, with potentially a maximum between 3,100 and 4,900 kg. This mass is an order of magnitude greater than PCBs sources and loads discussed in Section 7. The large mass of PCBs in the active layer, as compared to the annual loads, is likely to affect recovery of the Bay even after load reductions have been implemented.

Navigational Dredging
Maintenance dredging of Bay sediments is an ongoing activity where sediment is removed from navigation channels and is disposed of at either designated in-Bay locations (Figure 21) or out of the Bay. Between 2001 and 2005, an annual average of 1.8 million cubic yards per year of dredged sediments were disposed of at in-Bay disposal sites (DMMO, 2006) while an average of about 2.4 million cubic yards of dredged sediments were removed annually from the Bay. Using five year annual averages, we can estimate the mass of PCBs disposed of in and out of the Bay. We converted sediment volumes to dry mass using the equation given in Section 7.1. Using mean ambient PCBs concentrations commonly found in the Bay (4.6 µg/kg), we estimate that, each year about 4.6 kg of PCBs are disposed of in the Bay at dredged sediment disposal sites. During the same period, placement of dredged sediment at either upland sites or the deep ocean disposal site removes about 6.1 kg of PCBs per year from the Bay, resulting in a net loss of about 6.1 kg of PCBs each year. However, the large volume of sediment placed upland originates from the 50-foot deepening project by the Port of Oakland. This is a one-time deepening project that does not qualify as maintenance dredging. It is unlikely that this high volume will be maintained after completion of this dredging project. Future upland beneficial reuse and deep ocean disposal will need to obtain sediments from maintenance dredging projects represented mainly by in-Bay disposal volumes. This will result in much smaller volumes taken out of Bay. These are small PCBs masses compared to that in the surface layer (650 kg), but are on the same scale as the loads discussed in Section 7. Furthermore, note that natural processes are believed to annually re-suspend much larger volumes of sediments (Table 2) and could potentially be mobilizing a significantly larger mass of PCBs.

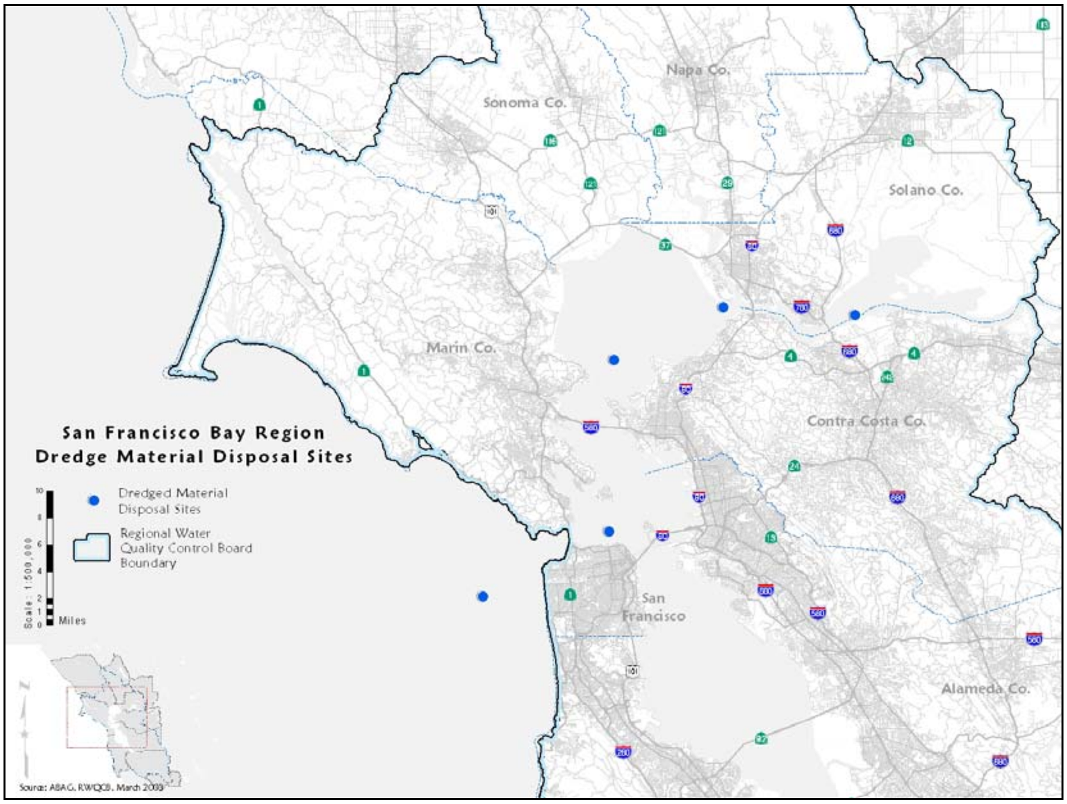

Figure 21-Dredged Sediment Disposal Sites for San Francisco Bay Region

7.4 Summary of PCBs Sources and Loads

Comparing the various load categories, excluding in-Bay sediments, the two major sources of PCBs mass to the Bay come from the Delta and urban stormwater runoff (Figure 22; Table 17) As discussed in Section 7.2, sediments from the Central Valley watershed carry a large mass of PCBs but are lower in concentrations than in-Bay sediments, potentially helping to reduce the current impact of PCBs on the Bay by burying more contaminated sediments. Therefore, implementation of the TMDL should focus primarily on reducing sediment PCBs concentrations by controlling sources in urban stormwater runoff as well as controlling the release of PCBs from contaminated sediments in the Bay.

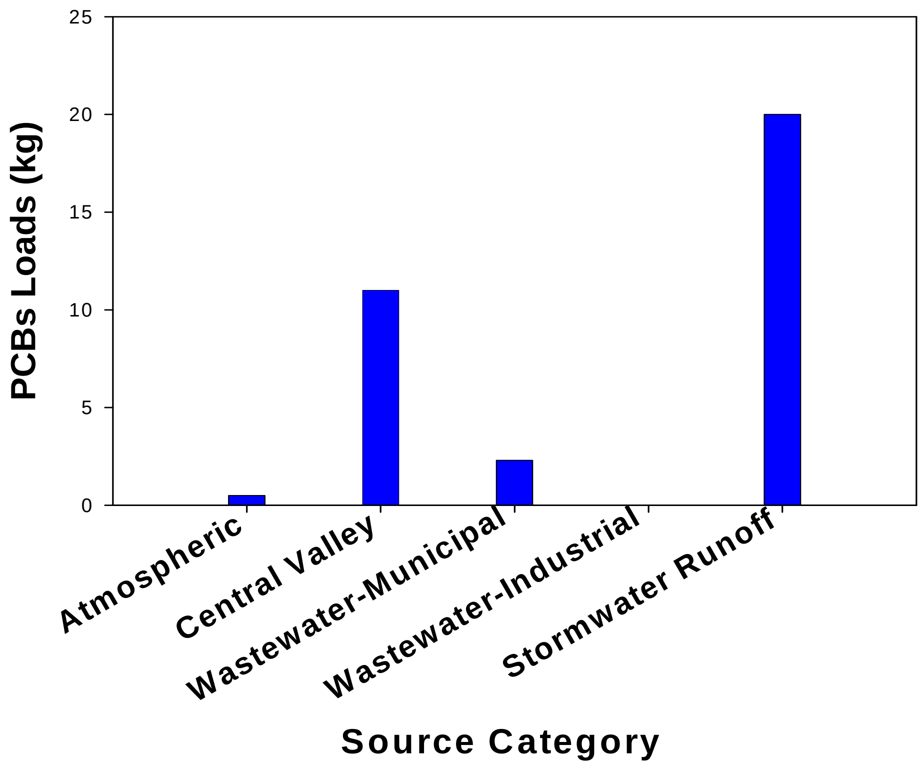

Figure 22-Sources and Loads of PCBs to San Francisco Bay

In summary, PCBs are found mostly in the central and southern portion of the Bay (Figure 23) generally in or near areas associated with historical industrial activities. Therefore, we should focus implementation to these on land areas and the remediation of the nearby in-Bay areas most impacted by PCBs discharges.

Table 17 - Synopsis of PCBs Loads to San Francisco Bay

Source Category	Current PCBs Loads (kg/yr)
Atmospheric	Net Loss
Central Valley Watershed	11
Municipal Wastewater Dischargers	2.3
Industrial Wastewater Dischargers	0.035
Urban and Non-Urban Stormwater Runoff	20

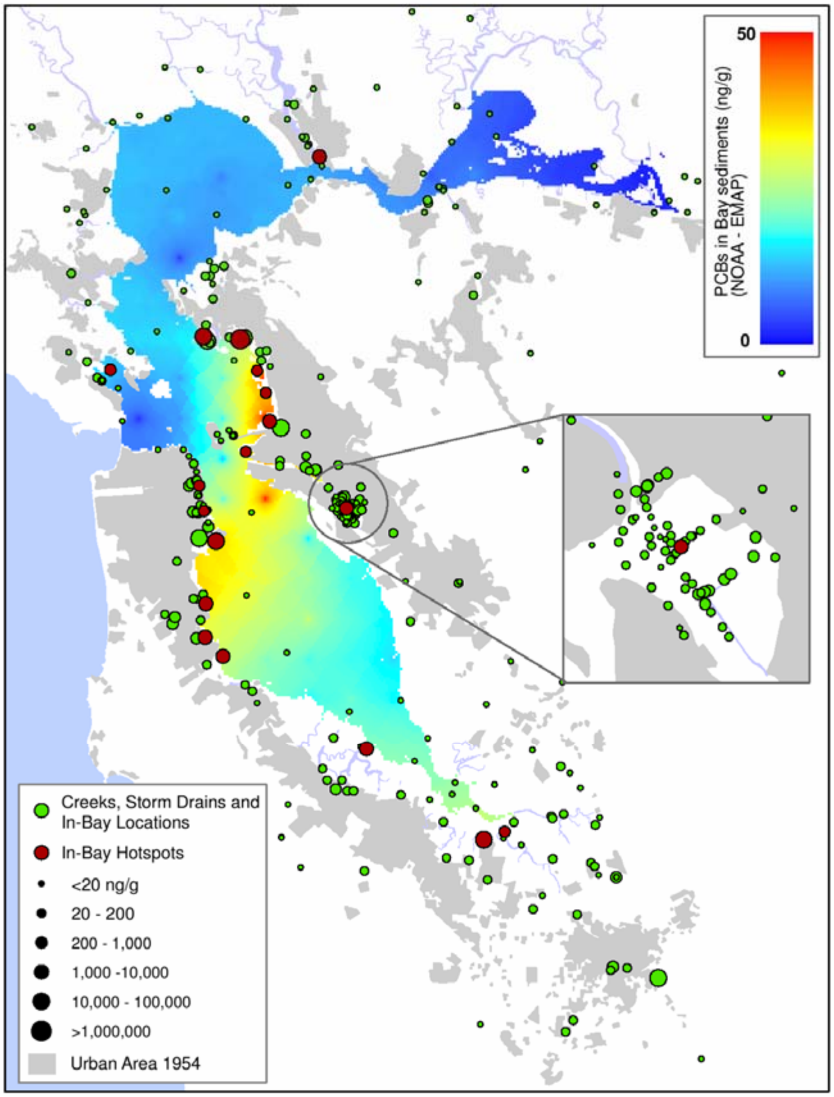

Figure 23-Overview of in-Bay and on-Land Sediment PCBs Concentrations

8. Numeric Target

A numeric target is a measurable condition that demonstrates attainment of water quality standards. A numeric target can be a numeric water quality objective, a numeric interpretation of a narrative objective, or a numeric measure of some other factor necessary to meet water quality standards. In this report, we propose a fish tissue PCBs numeric target.

The fish tissue numeric target provides for the attainment of the desired conditions that support the beneficial uses currently impaired. Fish tissue PCBs concentrations are the direct cause of impairment of beneficial uses. The CTR water quality criterion for PCBs is a surrogate measure of impairment as it is derived for the protection of human health based on the risk from eating fish caught in the Bay. This PCBs TMDL focuses on fish tissue PCBs concentrations, as this is the direct measurement of impairment of commercial (COMM) beneficial uses. We expect lower bioaccumulation will also protect estuarine (EST) and wildlife (RARE, WILD) beneficial uses. Fish tissue PCBs concentrations are currently being monitored as part of the RMP, and therefore progress towards attaining the fish tissue numeric target is directly monitored.

8.1 Fish Tissue Target

As noted above, fish tissue PCBs concentrations are the direct cause of impairment of beneficial uses. Therefore, the proposed numeric target for the PCBs TMDL is a fish tissue PCBs concentration. The proposed fish tissue numeric target for PCBs is based on a calculated screening level developed using standard protocol (U.S. EPA, 2000c). The screening level is defined as concentrations of PCBs in fish above which there are potential health concerns. The screening level for PCBs is calculated using Equation 1 (Section 7.1).

We calculated the screening level for a risk of one extra cancer case for an exposed population of 100,000 over a 70-year lifetime, using a mean body weight of 70 kg, a slope factor of 2 $(mg/kg\text{-}day)^{-1}$, and a mean daily consumption rate of 0.032 kg/day. The consumption rate is the 95^{th} percentile upper bound estimate of fish intake reported by all Bay fish-consuming anglers (SFEI, 2000a). The fish tissue screening level calculated based on these numbers is 10 ng/g. This represents about a ten-fold reduction in fish tissue PCBs concentrations from current levels. This numeric fish tissue target is applicable to fish collected in summer and fall seasons, when fish tissue concentrations are most elevated (Figure 8), in consideration of seasonality.

The screening value protective of Bay sport fish consumer is calculated using the upper 95^{th} percentile consumption rate of all consumers, 32 g/day. All consumers reflect a subpopulation of Bay area residents that catch and consume sport fish which is a subset of the fisher category. The general population includes all Bay area residents, including those that do not catch or consume sport fish. As was discussed earlier about the derivation of the CTR criterion for PCBs, the water column criterion was not derived to protect subpopulations at the same risk level as the general population. We have therefore used a 10^{-5} risk level to derive the fish tissue numeric target of 0.010 mg/kg. This numeric target is also more protective than the 10^{-5} risk level since an upper bound consumption rate, rather than the mean, was used for this subpopulation. The numeric target is protective of those consuming ten times more fish, 320 g/day, at a 10^{-4} risk. This is a greater consumption rate than the maximum reported in the fish consumption study, based on a four-week recall. Finally, it is reasonable to assume that this numeric target is protective, at a 10^{-5} risk level, of the general population as only a small fraction of the overall population catch and consume fish in the Bay. Therefore, this fish tissue numeric target is protective of the general population and the most exposed population of the Bay area and is consistent with the CTR criterion. Attainment of the fish tissue target is consistent with the narrative bioaccumulation water quality objective in the Basin Plan in that it results in removal of the detrimental effects of elevated PCBs in fish.

Attainment of the fish tissue numeric target is also consistent with the CTR criterion. Bioaccumulation factors (BAFs) are the ratios of a substance's concentration in tissue of an aquatic organism to its concentration in the ambient water ($BAF_{water}=C_{tissue}/C_{water}$), where both the organism and its food are exposed and the ratio does not change substantially over time, which seems applicable to the Bay. Once developed, BAFs can be used to either predict future fish tissue concentrations based on water concentrations or inversely water column concentrations using fish tissue concentrations. We have calculated BAFs for PCBs in the entire Bay as well as individual segments of the Bay using RMP fish tissue data collected in 1994, 1997, and 2000, and RMP water column data collected from 1993 through 2001 (Table 18). Using these BAF values, we calculated an expected concentration of PCBs in the water column when the fish tissue numeric target is met. The model calculations predict that the CTR water quality standard will be attained upon attainment of the fish tissue numeric target for PCBs.

The CTR numeric criterion is only a surrogate measure of conditions affecting fish tissue concentration. Site-specific conditions, such as water depth and magnitude of PCBs contamination of sediments, may affect fish tissue PCBs concentrations to a larger extent than water column PCBs concentrations. Measures to attain the PCBs fish tissue numeric target will focus on reductions of pollutant mass loads and contaminated site cleanups, rather than on avoidance of exceedances of concentration-based water quality standards. A decreased input of PCBs into the Bay will result in the reduction of PCBs concentrations in sediments and a decrease in PCBs available for uptake by biota.

Attainment of the fish tissue target for PCBs in San Francisco Bay will be evaluated using white croaker (size class, 20 to 30 centimeters in length) and shiner surfperch (size class, 10 to 15 centimeters in length). These two fish species are selected as the measure of attainment of the target for three reasons. First, these two fish species have the highest PCBs concentrations of all fish monitored in the Bay (Figure 6), which is expected as they are both benthic feeders. Second, they live near shore for at least part of the year and are caught from piers and jetties where recreational fishing is most likely to happen. Finally, the food model predicts that attainment of the fish tissue target for white croaker and shiner surfperch will result in attainment of the target for all other fish species currently monitored in the Bay. Comparison of the numeric target to these fish species constitutes an implicit margin of safety as sport fishers do not limit their fish consumption to these species (SFEI, 2000a) Rather, sport fishers consume a variety of fish species including many with lower PCB concentrations. Attainment of the fish tissue target in these two species ensures attainment of the fish tissue target for all Bay species sport fishers consume, and provides a implicit margin of safety as these other species consumed will have lower PCBs concentration than the fish tissue target.

The Water Board will continue to evaluate attainment of the fish tissue target and require the collection of additional information concerning Bay sport fish patterns of consumption and evaluate if fish species other than white croaker and shiner surfperch should be considered to evaluate attainment of the target. The average PCBs concentrations in the edible portion of these species will be used to determine attainment of the PCBs target following the methods currently in use by the RMP to ensure consistency and data comparability. The number of fish samples collected to determine compliance with the target will be based on guidance described in U.S. EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories

(EPA 823-B-00-007) and will be based on the desired statistical power needed to demonstrate differences over time.

Attainment of the PCBs fish tissue numeric target is also expected to result in removal of impairment of the Bay by dioxin-like PCBs. In Figure 24 we show the regression of calculated TEQ from dioxin-like PCBs to that of total PCBs in fish tissue caught in the Bay. The regression shows that a decrease of fish tissue PCBs concentrations to the fish tissue numeric target of 10 ng/g will result in a decrease of TEQ to the TEQ screening level of 0.14 pg/g.

Table 18- Bioaccumulation Factors and Estimated Water Column PCBs Concentrations upon Attainment of the Fish Tissue Target for White Croaker

Waterbody	White Croaker		Shiner Surfperch	
	BAF[a]	Water PCBs Concentration (pg/L)	BAF[a]	Water PCBs Concentration (pg/L)
Entire Bay	0.224	49	0.160	69
Central Bay	0.572	19	0.424	26
North Bay	0.259	43	0.089	123
South Bay	0.498	22	0.090	122

a)BAFs were calculated from pg/L in water and ng/g wet weight in fish

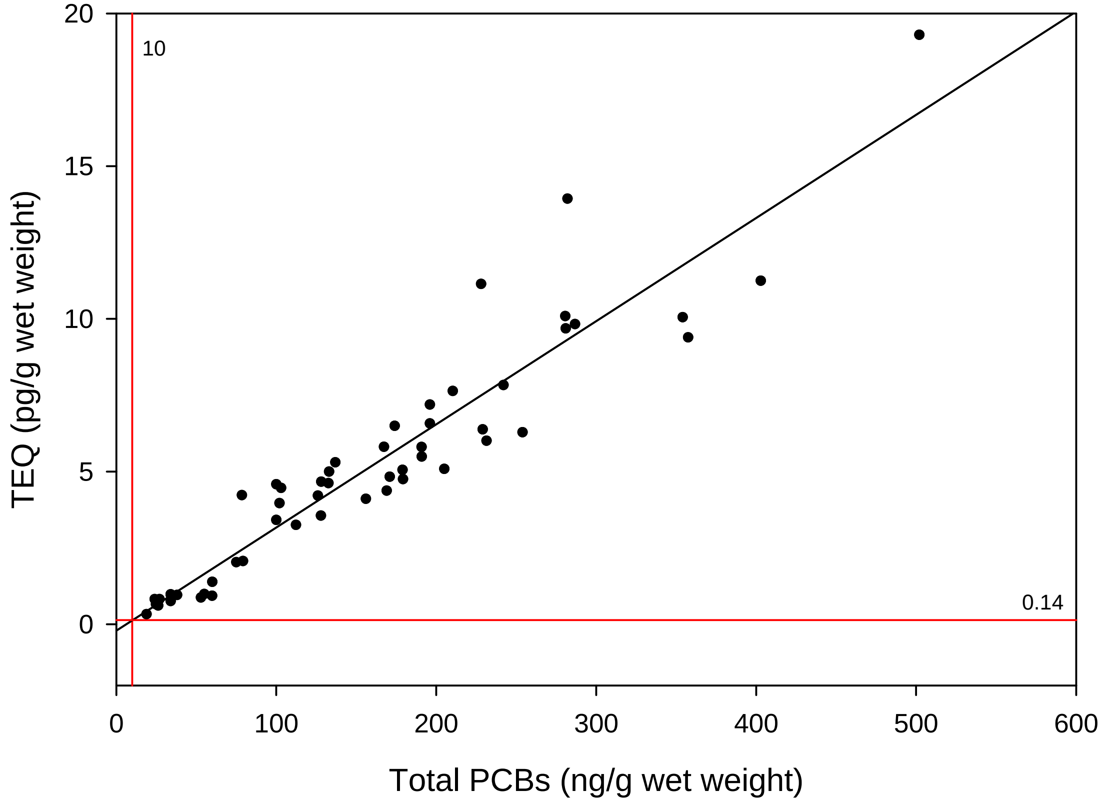

Figure 24 - Regression of Dioxin-Like PCBs Total Equivalent Toxicity by Total PCBs Concentrations in Fish

8.2 Antidegradation

A numeric target must be consistent with antidegradation policies as described in 40 CFR 131.12 and SWRCB Resolution 68-16. Antidegradation policies are intended to protect beneficial uses by ensuring that water quality will be maintained at the highest levels.

The fish tissue numeric target is designed to implement the narrative water quality objective for bioaccumulation. This numeric target is intended to achieve beneficial uses of the Bay, specifically relating to the consumption of sport fish by humans. As such, it is consistent with the established numeric water quality criterion for total PCBs. Since PCBs concentrations in sediment and fish tissue currently exceed the narrative bioaccumulation objective, attaining the numeric target will improve current water quality conditions. Therefore, the numeric target is consistent with the antidegradation policies.

9. Linkage Analysis

The TMDL linkage analysis is used to connect PCBs loads to the numeric target protective of beneficial uses in the Bay. This linkage analysis can be accomplished in a variety of ways. One common approach has been to use numerical models. Water quality models for TMDL development are typically classified as either watershed (pollutant load) models or as waterbody (pollutant response) models (NRC, 2001). A watershed model relates pollutant loads to a waterbody as a function of land use and helps allocate the TMDL among sources. A waterbody model is used to predict pollutant concentrations and other responses in the waterbody as a function of the pollutant load. Other models are used to set numerical targets such as food-web models that link sources to biological receptors.

PCBs uptake by biota from sediment is well documented in the scientific literature. In a shallow bay with a large sediment PCBs reservoir, such as San Francisco Bay, this is the most important pathway for PCBs bioaccumulation in fish. Therefore, reducing PCBs concentrations in Bay sediments is the most effective means of reducing fish tissue PCBs concentrations. In this TMDL, we use a food web model to translate the fish tissue numeric target to a corresponding sediment concentration. We then use a waterbody (mass budget) model to predict the long-term fate of PCBs in the Bay and determine the external load of PCBs that will attain the sediment concentration goal resulting in attainment of the fish tissue numeric target.

The mass budget model and food web model represent the linkage between load reductions and attainment of the fish tissue numeric target, as well as between the cause of impairment and the sources of PCBs. Based on the insights provided by these two models, we first present a conceptual model of our understanding of PCBs fate and movement between environmental reservoirs (Figure 25). Figure 25 depicts the conceptual linkage between sources, reservoirs (compartments) and receptors. In this figure, we have used larger arrows and bold text to highlight the sources and processes that we consider important. The left side of Figure 25 represents the mass budget model providing the linkage between the sources, reservoirs and processes. The right side of the conceptual model highlights the food-web model providing the linkage between PCBs reservoirs and aquatic receptors. We consider urban stormwater runoff and releases from current or historical activities as the most significant sources of PCBs to the Bay. PCBs in Bay sediments are likely to function as the major source of PCBs to biota. We consider the major mechanism of PCBs uptake by fish to result from foraging on bottom dwelling organisms (benthic organisms) living in sediment.

9.1 Food Web Bioaccumulation Modeling

PCBs impairment of the Bay is related to PCBs fish tissue concentrations. In order to implement the most effective load reductions, it is critical to understand the important factors and sources causing PCBs bioaccumulation in fish. There are two general approaches for developing a linkage between PCBs concentrations in water, sediment and biota (U.S. EPA, 2000c; U.S. EPA, 2000d). First, there is an empirical approach where one generates data to calculate bioaccumulation factors (BAFs) and biota-sediment accumulation factors (BSAFs). BAFs are the ratios of a substance's concentration in aquatic organisms to ambient water concentrations, taking the organism's trophic level into consideration. BSAFs are the ratios of concentrations in aquatic organisms compared to sediment concentrations. The second approach is to develop an equilibrium or kinetic biological food web model that considers mechanistic aspects of bioaccumulation and describes the chemical reactions and physicochemical processes taking place. These two modeling approaches are complimentary as the empirical data can be used to verify, or calibrate, the food web model results.

SFEI has developed a food web model based on Gobas (1993) and Morrison et al. (1997). Bay-specific data have shown that the fish species of concern have a diet consisting mainly of benthic organisms (Roberts et al., 2002), suggesting the importance of sediment PCBs as a source of PCBs to fish. This model predicts that the most sensitive endpoint is the protection of human health from the consumption of white croaker, and that attainment of conditions that result the fish tissue numeric target will be protective of wildlife. The model mathematically links the concentrations of PCBs in aquatic organisms and their prey to water and sediment PCBs concentrations via the food web as depicted in Figure 26 (Gobas and Arnot, 2005). Using this model, we can associate a specific PCBs concentration in fish to that in sediment, the main compartment of PCBs in aquatic environments, and water. Starting with the numeric fish tissue target of 10 ng/g, the model yields a corresponding concentration of 1 µg/kg PCBs in sediment. This sediment PCBs concentration goal is lower than the sediment concentration deemed protective of wildlife of 160 µg/kg total PCBs (U.S. EPA, 1997b), and is therefore considered to result in attainment of all beneficial uses currently impaired by PCBs. Model results validate the sediment PCBs concentration goal as protective of wildlife in San Francisco Bay. The food web model specifically predicts that this sediment goal will also be protective of wildlife, such as harbor seals, and birds such as cormorants and terns.

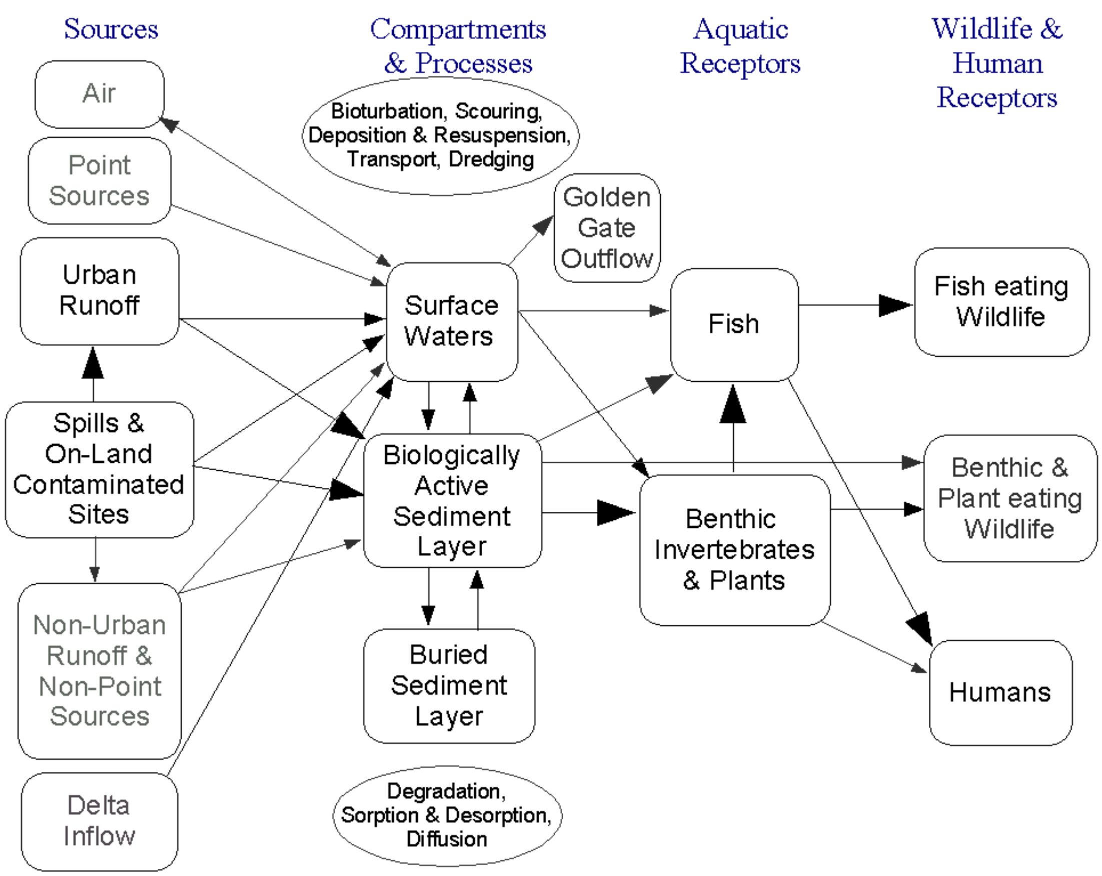

Figure 25-Conceptual Model of PCBs Movement and Fate in San Francisco Bay

This sediment goal is equivalent to reducing the total mass of PCBs in the active layer (of 0.15 m) of the entire Bay to about 160 kg. This represents a ten-fold decrease of PCBs concentrations in ambient sediments and fish tissue. The need to reduce ambient sediment PCBs concentrations by an order of magnitude to attain the 1 µg/kg sediment concentration goal is not unexpected. Empirical models such as biota-sediment accumulation factor (BSAF) are based on a one to one relationship between sediment and fish tissue PCBs concentrations. As discussed in Section 6.2, fish tissue concentrations are also an order of magnitude greater than the fish tissue numeric target for certain species. Hence the need for a ten-fold reduction in sediment to attain the fish tissue numeric target is not surprising. However, this sediment goal should not be interpreted as a clean-up goal, rather it is the long-term sediment PCBs concentration that will be attained after reduction of external loads, some targeted action on internal reservoirs of PCBs, and degradation or burial of PCBs in Bay sediments.

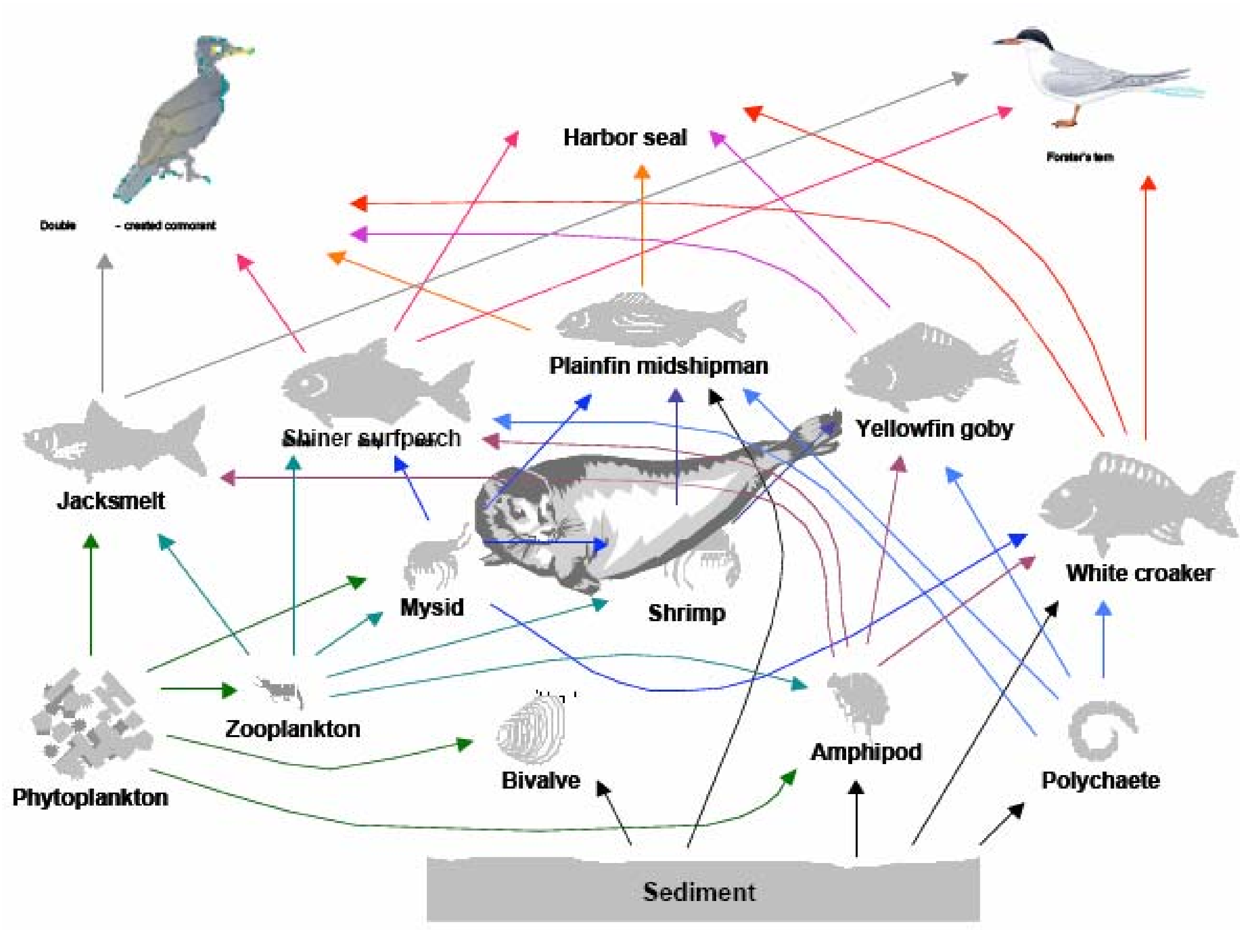

Figure 26-Food Web Model for San Francisco Bay (Gobas and Arnot, 2005)

9.2 Mass Budget Model

A mass budget model allows the exploration of different PCBs load reduction scenarios on the long-term fate of PCBs. SFEI developed a simple mass budget model for PCBs (Davis, 2003) that treats the Bay as a single box with two environmental reservoirs: water and sediment (Figure 27). This model includes eight processes of PCBs input and loss: burial in deep sediment, degradation, external loadings, outflow to the ocean, tidal mixing, exchange with the atmosphere, natural attenuation, and transfer between sediments and water.

Reduction of the external load to10 kg/year is needed to attain a PCBs mass in the Bay of 160 kg which is equivalent to the PCBs sediment goal of 1 µg/kg. The mass budget model predicts that current external PCBs loads to the Bay of about 34 kg/year will delay the attainment of the 160 kg goal for 100 years (Figure 28). Reduction of current external loads to 20 kg/yr results in a more rapid reduction of PCBs in the active layer, attaining the goal in about 70 years. An external load of 10 kg/yr attains the 160 kg mass in about 30 years. The mass budget model predictions highlight the importance of reducing current external loads of PCBs to the Bay. Achieving these load reductions, along with cleanup of in-Bay sediment PCB-contaminated sites, will form the core of the TMDL implementation strategy.

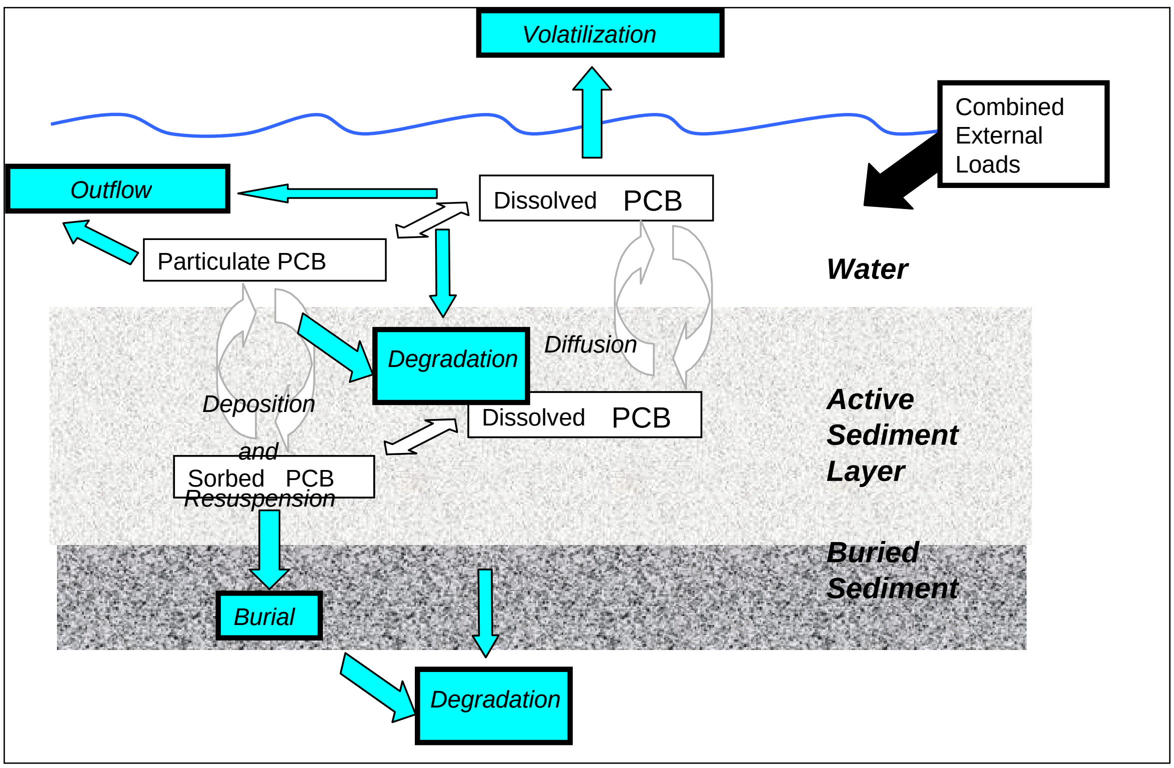

Figure 27-Mass Balance Model for PCBs in San Francisco Bay (Davis, 2003)

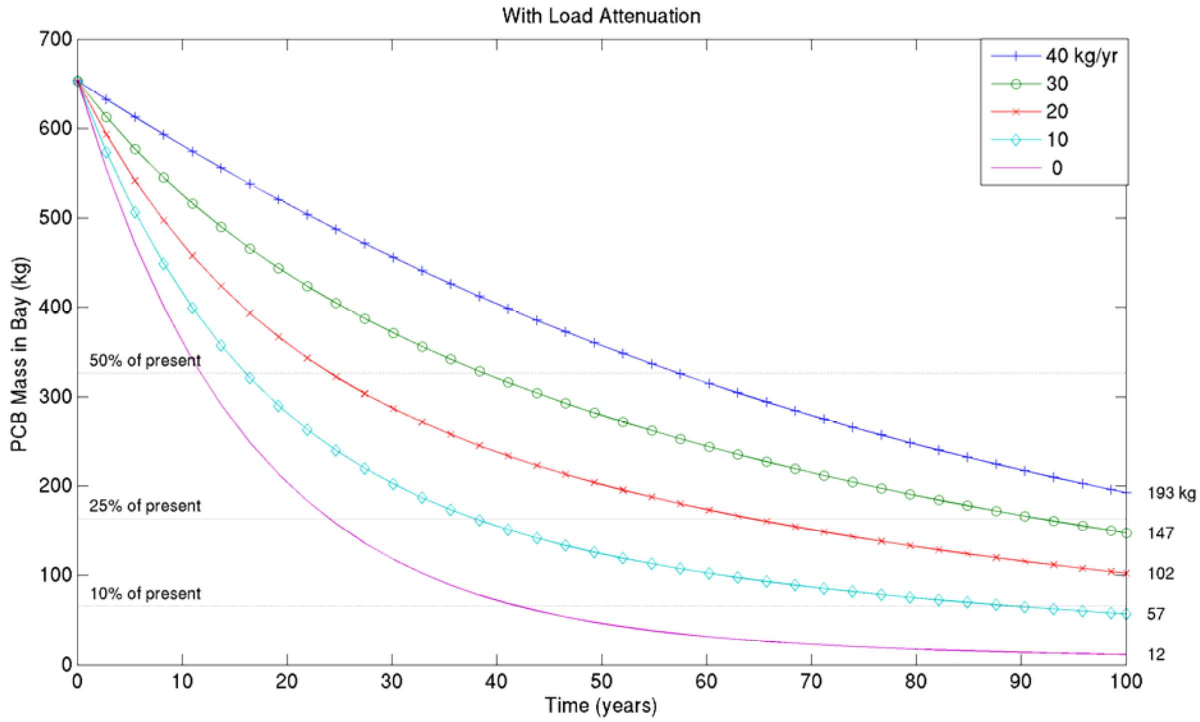

Figure 28-Predicted Long-Term Mass of PCBs in Active Sediment Layer under Different Loading Conditions (SFEI, 2007)

10. Total Maximum Daily Load and Allocations

The total maximum daily load (TMDL) is the maximum quantity of a pollutant that can enter a waterbody and attain water quality standards. The TMDL is allocated amongst the various sources of the pollutant.

10.1 Total Maximum Daily Load

The PCBs TMDL is 10 kg/yr and represents the assimilative capacity of the Bay. This TMDL necessitates achieving a load reduction of about 24 kg/yr to reduce total PCBs in the Bay active layer to 160 kg in about 30 years (Figure 28). This is equivalent to achieving the sediment PCBs concentration goal of 1 µg/kg, which will result in attainment of the fish tissue target of 10 µg/kg.

The TMDL is expressed as an average annual rather than as a daily load for several related reasons. First, the TMDL is derived from a mass budget model that depicts the long term (decadal) fate of PCBs. This model uses daily time steps derived by averaging annual load estimates, as the loadings data are not refined enough to provide discrete daily loads and therefore do not reflect variability in the data. Future data collection to verify attainment of the TMDL will also be collected on an annual timeframe, due to the large cost associated with these types of data. Therefore a TMDL is needed based on annual loads for comparison purposes. Also, the response of fish tissue PCBs concentrations to PCBs load reductions is not instantaneous. Even with immediate or rapid attainment of the sediment goal, there would be delay in attainment of the numeric fish tissue target, due to the time required for depuration (shedding from body) of PCBs by biota to occur. Finally, the TMDL is expressed as an average annual load because the natural variability in quantifying PCBs loads is much greater than the expected rate of load reductions. Long-term averaging of the loads is necessary to dampen out the variability in the data.

10.2 Categorical Load and Wasteload Allocations

We propose to allocate the TMDL (Figure 29, Table 19) among the existing external sources: direct atmospheric deposition, Central Valley watershed, wastewater dischargers, and urban and non-urban stormwater runoff. A portion of the TMDL is also allocated to potential future stormwater treatment by municipal wastewater dischargers. The linkage analysis shows that the fish tissue target can be achieved with reduction of external loads to the TMDL of 10 kg/yr. As such, internal sources are not assigned load allocations. However, reduction of internal loads will lead to an increased rate of recovery of beneficial uses. Sediment dredging and disposal, which results in an on-going net loss of PCBs from the Bay is expected to continue to decrease in-Bay disposal volumes and increase out-of-Bay disposal based on goals established in the "Long Term Management Strategy for the Placement of Dredged Material in The San Francisco Bay Region" (U.S. ACE, 1998). Therefore, sediment dredging is expected to continue to remove PCBs from the Bay. In addition, remediation of in-Bay contaminated sediment is expected to decrease potential loadings from this other internal source.

The following sections present the basis of the allocation for each source category.

10.3 Wasteload Allocations

Wasteload allocations apply to all NPDES permitted discharges to the Bay, including municipal and industrial wastewater dischargers, and municipal stormwater (urban and non-urban stormwater runoff) discharges.

Table 19-PCBs Load and Wasteload Allocations to San Francisco Bay

Source Category	**Allocations**
	Kilograms per year
Direct Atmospheric Deposition	0[a]
Central Valley Watershed	5
Municipal Wastewater Dischargers	2
Industrial Wastewater Dischargers	0.035
Stormwater Runoff	2
Reserved for stormwater treatment by municipal wastewater dischargers	1
Total	***10[b]***

[a] Zero allocation reflects overall net loss to the atmosphere
[b.] Total differs from column sum due to rounding.

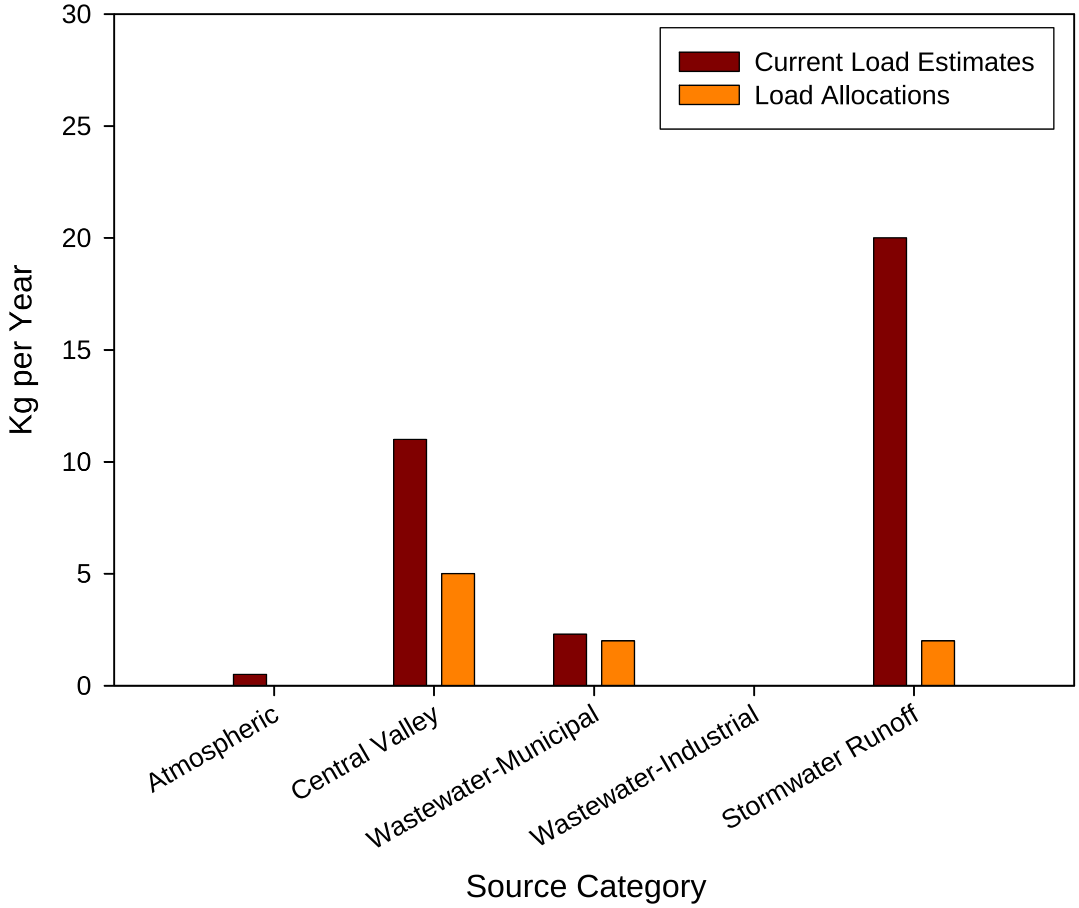

Figure 29-Loads and Allocations of PCBs to San Francisco Bay

Municipal and Industrial Wastewater Dischargers
Municipal and industrial wastewater NPDES permitted facilities discharge a small fraction of the total PCBs load to the Bay. In general, municipal and industrial wastewater dischargers operate at a high level of performance and remove PCBs via solids reduction treatment processes. The wasteload allocations for municipal wastewater dischargers total 2 kg/yr, which reflects the current estimated aggregate load to the nearest kg/yr. Although this is lower than our actual estimate of 2.3 kg/yr, it reflects the anticipated decreases in current loadings expected from implementation actions and degradation of PCBs in sources to wastewater systems. The wasteload allocations for industrial facilities total 0.035 kg/yr, which reflects estimated current loads.

Individual wasteload allocations are specified for each municipal and industrial wastewater dischargers in Table 20 and Table 21, respectively. We have insufficient or no data to calculate wasteload allocations for individual facilities based on individual facility performance at this time. Therefore, individual load allocations are based on each facility's fraction of the total yearly wastewater discharged from this source category using average annual flow data from 1999 through 2002. The resulting individual wasteload allocations do not represent individual facility actual discharge performance and do not account for variability in discharge performance. As part of the adaptive implementation plan of this TMDL, we will use data generated through implementation of the TMDL to review and revise individual allocations for Water Board consideration that account for actual performance.

Stormwater Runoff
Existing PCBs loads from stormwater runoff are estimated at 20 kg/yr. The proposed total wasteload allocation for stormwater runoff is 2 kg/yr. It reflects the resulting PCBs load when all sediment in stormwater runoff has a concentration of 1 µg/kg, the sediment PCBs concentration goal, assuming the sediment loads used to calculate the current PCBs load do not change. Sediment load estimates vary from 870,000 tons (SFEI, 2007), 930,000 tons (Krone, 1979), to 1,500,000 tons (Schoellhamer et al., 2005). Due to the uncertainty in these estimates and until they are refined, we will use 2,000,000 tons as an upper bound estimate of maximum sediment yields from local tributaries to calculate the stormwater wasteload allocations, resulting in 2 kg/yr.

Individual county-based watershed wasteload allocations for stormwater runoff are presented in Table 22. This total wasteload allocation is based on the aggregate allocation of 2 kg/yr and the fraction of the Bay-side year 2000 population residing in each permitted entity (USCB, 2000). Wasteload allocations for stormwater runoff apply to all NPDES permitted municipal stormwater discharges (Table 22). These allocations apply to unincorporated areas and all municipalities in the county that drain to the Bay and are part of the San Francisco Bay Region. They implicitly include all current and future permitted discharges within the geographic boundaries of municipalities and unincorporated areas within each county. Examples of discharges include but are not limited to California Department of Transportation (Caltrans) roadways and non-roadway facilities and rights-of-way, atmospheric deposition, public facilities, properties proximate to stream banks, industrial facilities, and construction sites. The San Francisco allocation does not account for treatment provided by San Francisco's combined sewer system. The wet weather treatment provided by the City and County of San Francisco's Southeast Plant (NPDES permit CA0037664) and the Northpoint Wet Weather Facility will be credited toward meeting the allocation.

Urban Stormwater Runoff Treatment by Municipal Wastewater Dischargers

A potential means to reduce urban stormwater runoff PCBs loads will be to strategically intercept and route runoff to municipal wastewater treatment systems. We propose a separate wasteload allocation for discharges associated with urban stormwater runoff treatment via municipal wastewater treatment systems, since such actions will result in increased PCBs loads from municipal wastewater dischargers, and the proposed individual wasteload allocations for municipal wastewater dischargers reflect current performance levels. We propose a wasteload allocation of 0.9 kg/yr, which is the difference between the TMDL of 10 kg/yr and the sum of the other proposed wasteload and load allocations.

Table 20-Individual Municipal Wastewater Wasteload Allocations

Permitted Entity	NPDES Permit	Allocations
		kilograms per year
American Canyon, City of	CA0038768	0.002
Benicia, City of	CA0038091	0.009
Burlingame, City of	CA0037788	0.01
Calistoga, City of	CA0037966	0.002
Central Contra Costa Sanitary District	CA0037648	0.1
Central Marin Sanitation Agency	CA0038628	0.04
Delta Diablo Sanitation District	CA0038547	0.04
East Bay Dischargers Authority	CA0037869	0.3
Dublin-San Ramon Services District (CA0037613)		
Hayward Shoreline Marsh (CA0037702)		
Livermore, City of (CA0038008)		
Union Sanitary District, Wet Weather (CA0038733)		
East Bay Municipal Utilities District	CA0037702	0.3
East Brother Light Station	CA0038806	0.00030
Fairfield-Suisun Sewer District	CA0038024	0.05
Las Gallinas Valley Sanitary District	CA0037851	0.01
Marin County Sanitary District, Paradise Cove	CA0037427	0.00003
Marin County Sanitary District, Tiburon	CA0037753	0.002
Millbrae, City of	CA0037532	0.007
Mt. View Sanitary District	CA0037770	0.007
Napa Sanitation District	CA0037575	0.04
Novato Sanitary District	CA0037958	0.02
Palo Alto, City of	CA0037834	0.09
Petaluma, City of	CA0037810	0.02
Pinole, City of	CA0037796	0.009
Contra Costa County, Port Costa Wastewater Treatment Plant	CA0037885	0.0001
Rodeo Sanitary District	CA0037826	0.002
Saint Helena, City of	CA0038016	0.001
San Francisco, City and County of, San Francisco International Airport WQCP	CA0038318	0.002
San Francisco, City and County of, Southeast Plant	CA0037664	0.3
San Jose/Santa Clara WPCP	CA0037842	0.4

Permitted Entity	NPDES Permit	Allocations
		kilograms per year
San Mateo, City of	CA0037541	0.04
Sausalito-Marin City Sanitary District	CA0038067	0.005
Seafirth Estates	CA0038893	0.00001
Sewerage Agency of Southern Marin	CA0037711	0.01
Sonoma Valley County Sanitary District	CA0037800	0.01
South Bayside System Authority	CA0038369	0.06
South San Francisco/San Bruno WQCP	CA0038130	0.03
Sunnyvale, City of	CA0037621	0.05
US Naval Support Activity, Treasure Island WWTP	CA0110116	0.002
Vallejo Sanitation & Flood Control District	CA0037699	0.05
West County Agency, Combined Outfall	CA0038539	0.05
Yountville, Town of	CA0038121	0.001
Total		***2*** [a]

a)Total differs from column sum due to rounding

Table 21 - Individual Industrial Wasteload Allocations to San Francisco Bay

Permitted Entity	NPDES Permit	Allocations [a]
		kilograms per year
C&H Sugar and Crockett Community Services District	CA0005240	0.00006
Chevron Products Company	CA0005134	0.003
ConocoPhillips	CA0005053	0.0006
Crockett Cogeneration LP, and Pacific Crockett Energy, Inc	CA0029904	0.0006
General Chemical	CA0004979	0.0009
GWF Power Systems, Site I	CA0029106	0.0001
GWF Power Systems, Site V	CA0029122	0.0001
Hanson Aggregates, Amador Street	CA0030139	0.00003
Hanson Aggregates, Olin Jones Dredge Spoils Disposal	CA0028321	0.00003
Hanson Aggregates, Tidewater Ave., Oakland	CA0030147	0.00003
Morton Salt	CA0005185	0.00008
Pacific Gas and Electric, East Shell Pond	CA0030082	0.00003
Rhodia, Inc.	CA0006165	0.0003
San Francisco, City and Co., SF International Airport Industrial WTP	CA0028070	0.002
Shell Oil Products US and Equilon Enterprises LLC	CA0005789	0.002
Mirant Delta LLC, Pittsburg Power Plant	CA0004880	0.0008
Mirant Potrero LLC, Potrero Power Plant	CA0005657	0.0003
Tesoro Refining and Marketing Company	CA0004961	0.002

Permitted Entity	NPDES Permit	Allocations [a]
		kilograms per year
The Dow Chemical Company	CA0004910	0.0006
USS-Posco	CA0005002	0.02
Valero Refining Company	CA0005550	0.0007
Total		***0.035*** [b]

a) Wasteload allocations for industrial wastewater dischargers do not include mass from once-through cooling waters. The Water Board will apply intake credits for once through cooling as allowed by law.
b) Total differs from column sum due to rounding.

10.4 Load Allocations

In this section, we present the load allocations for nonpoint source discharges of PCBs including direct atmospheric deposition and the Central Valley watershed. Allocations focus on controllable loads of PCBs. Assessment of PCBs load reductions from sources considered uncontrollable will continue as part of the implementation of the TMDL.

Direct Atmospheric Deposition

PCBs freely exchange between the Bay and the atmosphere through both deposition and volatilization. Currently, PCBs escape to the atmosphere from the Bay at a greater rate than they are deposited from the atmosphere, resulting in a net loss of PCBs. As such, the proposed allocation to direct atmospheric deposition is zero. This load allocation is limited to PCBs that deposit directly into the Bay. Atmospheric PCBs deposited in the watershed, and indirectly washed into the Bay with runoff are not included in this source category. However, the PCBs concentrations in non-urban stormwater conveyances from open space areas are low and include indirect loads from atmospheric deposition onto the landscape (KLI, 2002). Therefore, the indirect load from atmospheric deposition in commercial and industrial areas is also estimated to be small, contributing minimally to stormwater runoff discharges.

Table 22 - County-Based Watershed Wasteload Allocations for Stormwater Runoff

County	Population	Allocations (kilograms / year)
Alameda	1,440,000	0.5
Contra Costa	790,000	0.3
Marin	240,000	0.1
Napa	120,000	0.05
San Francisco	630,000	0.2
San Mateo	600,000	0.2
Santa Clara	1,600,000	0.5
Solano	290,000	0.1
Sonoma	110,000	0.05
Total		***2***

Central Valley Watershed

PCBs loads from the Sacramento and San Joaquin Rivers are significant. However, this load results from the large volume of sediments carried into the Bay at low sediment PCBs concentrations, although the sediment PCBs concentrations are generally greater than the sediment PCBs goal. Current estimates of sediment loads to the Bay are around 1.2 millions tons (Leatherbarrow et al., 2005; Schoellhamer et al., 2005). If all of this sediment from the Central Valley had a concentration equal to the sediment goal, the resulting PCBs loads from the Central Valley would be 1.2 kg/y. However, based on natural attenuation with a half life of 56 years (Davis, 2003), loads will not be reduced to this level in the next 100 years (Figure 30). However, natural attenuation will lower the Central Valley load to 5 kg/yr in about 40 years. As this load reduction will result in attainment of the TMDL, we propose using 5 kg/yr as the load allocation to the Central Valley watershed.

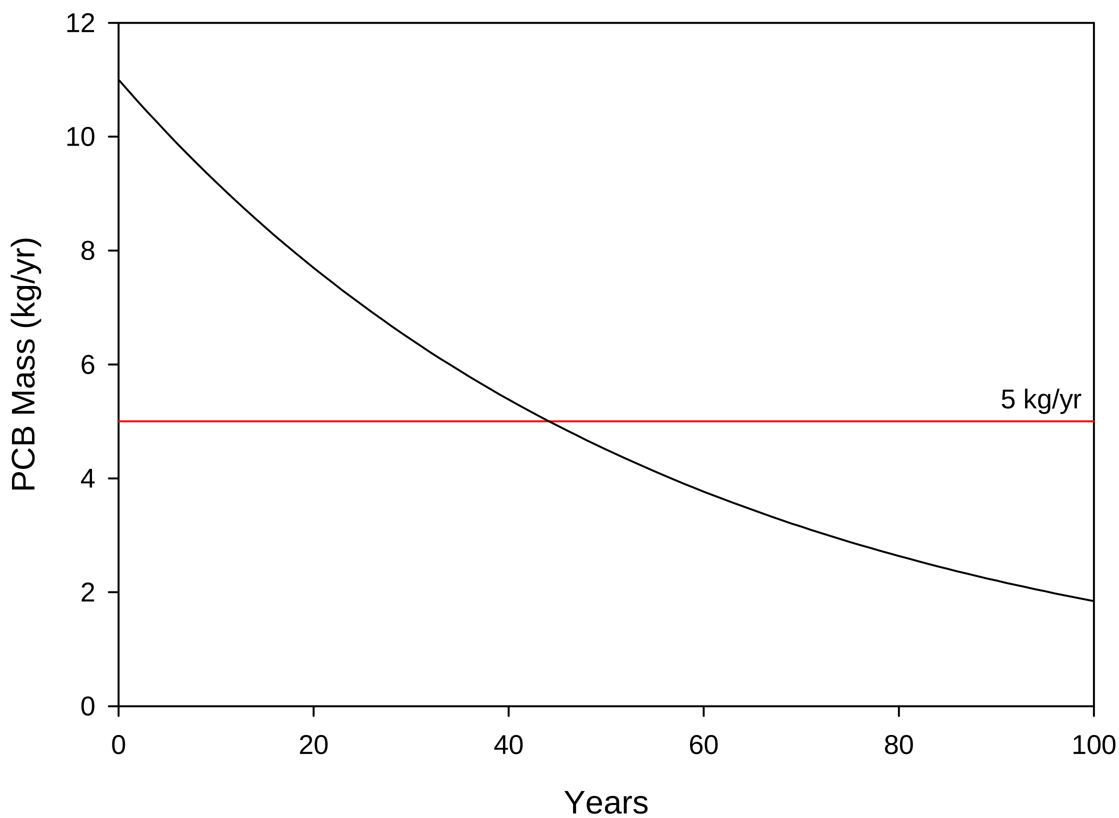

Figure 30-Natural Attenuation of Central Valley PCB Loads

10.5 Margin of Safety and Seasonality

A margin of safety needs to be incorporated into the TMDL to account for uncertainty in understanding the relationship between pollutant discharges and water quality impacts (U.S. EPA, 1991). The margin of safety can be incorporated in the TMDL either explicitly or implicitly (U.S. EPA, 2000a). Making and documenting conservative assumptions used in the TMDL analysis provides an implicit margin of safety. The purpose of the margin of safety is to ensure, given the uncertainties in developing the TMDL, that the beneficial uses currently impaired are restored.

For the PCBs TMDL, we are incorporating an implicit margin of safety. We have used a conservative approach to derive the fish tissue numeric target. We used a high-end value, the 95th percentile consumption rate, rather than the average consumption rate allowed by U.S. EPA (2000c). Therefore, the fish tissue numeric target proposed in this TMDL is as protective as possible following U.S. EPA methodology and should provide additional protection to human health from fish consumption. In addition, the wasteload allocation reserved for urban stormwater runoff treatment via municipal wastewater treatment systems is not expected to be fully utilized for several years. In the meantime, we intend to regularly review the effectiveness of implementation actions in meeting the numeric target and revise, as necessary, the proposed load and wasteload allocations. We also propose to monitor attainment of the numeric target and to reevaluate the appropriateness of the currently proposed fish tissue numeric target and associated total PCBs sediment concentration goal.

Seasonal variation also needs to be considered when developing a TMDL. As was discussed in Section 6.2, PCBs concentrations in white croaker tissue collected in the Oakland Inner Harbor showed a seasonal trend with higher concentrations in summer and fall, and lower concentrations in winter and spring. This trend does not correlate with the expected higher total loading of PCBs to the Bay during the winter associated with stormwater and Central Valley runoff. We account for this seasonal trend by applying the fish tissue target to fish collected in the summer. In this manner, attainment of the fish tissue numeric target in the season when fish are most impacted will also be protective at other times of the year.

11. Implementation

Success of the PCBs TMDL requires an adaptive management approach to implementation actions. Adaptive implementation is a cyclical process in which TMDL plans and actions are regularly assessed for their achievement of water quality standards (NRC, 2001). Adaptive implementation simultaneously makes progress toward achieving water quality standards through implementing actions while relying on monitoring and experimentation to reduce uncertainty and refine future implementation actions.

The adaptive implementation process consists of the development of a plan that includes early implementation actions based on existing knowledge that have a reasonable probability of success and an overview of options for future actions. For PCBs in the Bay, the immediate or early implementation actions are not expected to completely eliminate the Bay impairment. Therefore, future actions must be evaluated based on continued monitoring and response to the early implementation actions, as well as based on well-designed studies used for model refinement.

This implementation plan includes three general implementation categories: control of external loadings of PCBs to the Bay, control of internal sources of PCBs within the Bay, and actions to manage risks to Bay fish consumers. In addition, the monitoring section describes monitoring required to measure attainment of the numeric target, water quality objectives and to measure implementation progress towards attainment of the load and wasteload allocations. The adaptive implementation section describes the method and schedule for evaluating and adapting the TMDL and implementation plan as needed to assure water quality standards are attained based on new information, studies to fill information gaps, and tracking and evaluation of actions.

11.1. External Sources

The following sections outline the proposed approach to adaptive implementation for mass reductions of PCBs loads from external sources.

Direct Atmospheric Deposition

There is a net removal of PCBs from the Bay through the atmosphere and consequent air-borne transport. No foreseeable actions can be taken to accelerate this loss of PCBs from the Bay. In the long-term, this loss will diminish as PCBs mass in the Bay is reduced and the numeric target is attained. A reevaluation of PCBs input and loss from the atmosphere may be needed in the future as part of reevaluation of the long term fate and transport of PCBs in the Bay, or if current implementation actions do not cause a rapid enough trend towards attainment of the target.

Central Valley Watershed

Sediments entering the Bay from the Central Valley have lower PCBs concentrations than in-Bay sediment, and major PCBs mass loading events that occur during episodic high flow events mostly flow directly out of the Bay through the Golden Gate. There are very limited locations with PCBs impairment of waters within the Central Valley watershed. The allocation will be attained through anticipated natural attenuation of PCBs in the Central Valley watershed. Verification of ongoing loads and load reductions will be a regular component of the Regional Monitoring Program.

Municipal and Industrial Wastewater Dischargers
Wasteload allocations for municipal and industrial wastewater discharges reflect current PCBs loads. Loads are expected to diminish as sources of PCBs to wastewater treatment systems diminish over time. Wasteload allocations will be implemented through NPDES permits that require implementation of best management practices (BMPs) to maintain optimum treatment performance for solids removal and to identify and manage controllable sources. Developing effluent limits for PCBs that accurately reflect treatment system performance require a substantial data set that accounts for system variability of a difficult to measure pollutant that is present at very low levels (See Section 5.2). The primary PCBs treatment mechanism is solids removal, and as such, ongoing attainment of suspended solids effluent limits provides a surrogate indicator of PCBs control. In addition to maintaining optimum solids removal performance, wastewater dischargers should evaluate whether there are any controllable sources of PCBs to their systems (e.g., industrial uses of equipment that contain PCBs).

Effluent limits in NPDES permits will be based on current performance; however, it's not feasible to calculate such limits as this time. The wasteload allocations were derived from a limited data set used to estimate the total PCBs annual load to San Francisco Bay from all wastewater discharges. The data set was limited due to the technical difficulty and associated costs of measuring very low concentrations of PCBs in wastewater. Furthermore, the individual allocations, which were based on each facility's fraction of the total yearly wastewater discharged to the Bay, do not represent actual performance of individual dischargers. Consequently, implementation of the individual wasteload allocations as effluent limits is not feasible at this time. NPDES permits will require individual facilities to collect data in order to calculate daily or monthly average effluent limits that are consistent with the annual load allocations, and possibly recalculation of individual wasteload allocations based on these data. However, calculation of these limits is not feasible at this time. Implementation of the wasteload allocations is further complicated by the lack of a low-detection level analytical method that can be used for compliance determinations. The level of quantification achievable with the regulatory analytical methods promulgated under 40 CFR 136 (US EPA Method 608) is 0.5 µg/L. Accordingly, compliance with effluent limits in NPDES permits will be determined using this approved method.

NPDES permits will require quantification of PCBs loads using a lower detection level method such as Method 1668A. This method was used to derive the loading estimates that are the basis of the allocations. However, as noted above, there are technical difficulties and high analytical costs ($1,000 to $1,200 per sample) associated with measuring very low concentrations of PCBs in wastewater. Another complication is that the daily, monthly, and even annual variability of PCBs in wastewater is unknown. Consequently, calculation of limits that account for variability may require several years of data. Also, if individual performance data result in effluent limits that are not consistent with individual wasteload allocations established with this TMDL, then the Water Board will take action to revise the individual allocations as part of the adaptive implementation plan.

We also propose a separate wasteload allocation for discharges associated with urban stormwater runoff treatment via municipal wastewater treatment systems. This allocation will be implemented through a permit that will allow municipal wastewater dischargers to apply for a portion of this reserved allocation. Although we recognize that the capacity and opportunity for existing systems to receive stormwater runoff may be limited, we expect that there will be strategic opportunities to do so.

In addition to controlling PCBs sources and discharges, municipal and industrial wastewater dischargers will be required to support actions to manage the health risks associated with the consumption of PCBs-contaminated Bay fish by people that recreationally fish, and to conduct or cause to be conducted monitoring, and studies to fill critical data needs identified in the Adaptive Implementation section.

Stormwater Runoff

The stormwater runoff wasteload allocations shown in Table 22 will be implemented through NPDES stormwater permits issued to urban runoff management agencies. The stormwater runoff allocations implicitly include all current and future permitted discharges, not otherwise addressed by another allocation, and unpermitted discharges within the geographic boundaries of urban runoff management agencies including, but not limited to, California Department of Transportation (Caltrans) roadway and non-roadway facilities and rights-of-way, atmospheric deposition, public facilities, properties proximate to stream banks, industrial facilities, and construction sites.

Substantial load reductions are required to attain wasteload allocations. In addition to reductions due to natural attenuation, urban runoff management agencies can reduce PCBs loads by preventing PCBs sources from contaminating sediment or by reducing the amount of contaminated sediment discharged to the bay. Urban runoff management agencies can prevent contamination through various source control and pollution prevention activities, including remediation of on-land PCBs contaminated soils and control of releases of PCBs from electrical or other equipment, building materials and waste during demolition/remodeling, or other sources. In addition, urban stormwater PCBs loads can be reduced through capture, detention, and removal of highly contaminated sediment, and possibly by urban storm water treatment, including routing of PCBs contaminated runoff to wastewater treatment systems. Substantial infrastructure improvements are expected to result from implementation of construction and new development runoff permit requirements. These requirements, which promote controls such as planting vegetative buffers around impervious surfaces, may effectively control urban sediment discharges. Many of these actions also have the potential benefit of reducing other particle-associated pollutant loads in addition to PCBs.

Remediation of on-land PCBs-contaminated soils and effective PCBs prevention or removal infrastructure improvements will take several years to pilot test, evaluate, and then plan, design and implement on a scale sufficient to substantially reduce PCBs loads. As such, we propose a 20-year schedule for attaining the wasteload allocations. Requirements in each NPDES permit issued or reissued and applicable for the five-year term of the permit will be based on an updated assessment of best management practices, and control measures intended to reduce PCBs in urban runoff to the maximum extent practicable. This is consistent with the Water Board's phased approach towards attainment of water quality objectives in waters that receive stormwater discharges from urban areas described in Section 4.8 of the Basin Plan.

There are already efforts underway to gain insights regarding opportunities for load reductions. NPDES permit requirements will call for progressive implementation of PCBs control measures. Specific best management practices (BMPs) and control measures to be considered include:

- Abatement of PCBs in runoff from areas with elevated PCBs in soils/sediments
    - Investigate on-land PCBs contaminated soils and/or sediments – PCBs are a known historical contaminant in soils and sediments throughout the region, both in private and public properties, and public rights-of-ways. Although many contaminated sites have undergone remediation, it is likely that PCBs contaminated sites remain and continue to

contribute PCBs to stormwater. Stormwater runoff management agencies are expected to conduct, or cause to be conducted by other agencies or responsible parties, identification of on-land sites with PCBs contamination, such as private properties, public rights-of-ways, and stormwater conveyances. Stormwater runoff management agencies would be expected to report investigation results, including identifying potentially contaminated properties and/or responsible parties to the Water Board and/or DTSC, and/or in some instances to local agencies with authority to conduct oversight of hazardous materials. The Water Board, DTSC, or local agency would be expected to follow up on further investigation and oversee any necessary abatement.

  - Improve system design, operation, and maintenance to increase fine sediment—PCBs are mainly transported within the stormwater conveyances attached to sediments. Many routine maintenance BMPs exist and are currently in use to control the discharge of sediments to the Bay from urban stormwater runoff, such as storm drain inlets, detention basins and street sweeping. Urban runoff management agencies are expected to implement increased routine sediment control measures within the stormwater conveyances in locations that will result in increased reduction of PCBs loads.
  - Strategic runoff treatment retrofits – There are many sediment control BMPs, such as sand (or other media) filtration devices or multi-chamber treatment trains, that have not been evaluated or implemented for their ability to reduce PCBs loads in urban environments. As such, urban runoff management agencies are expected to investigate and implement as necessary new sediment treatment control measures within stormwater conveyances.
  - Urban stormwater runoff treatment via municipal wastewater treatment systems—Opportunities to route dry weather and/or wet weather flows from storm drain systems to wastewater systems should be investigated, pilot tested, and implemented where feasible. This includes consideration of dry weather flows, including possible street washing flows, and wet weather flows, particularly first flush flows.

- Abatement of PCBs in runoff from all areas
  - Control/oversee removal and disposal of PCBs-containing equipment—PCBs-containing equipment remains in use with varying degrees of regulatory oversight depending on equipment type and PCBs concentration. Containment of the PCBs varies depending on equipment uses and regulatory oversight. These materials may therefore be released to the environment and enter stormwater conveyances. As such, urban runoff management agencies are expected to conduct industrial inspections to identify and cause replacement of PCBs-containing equipment remaining in the urban environment.
  - Control/manage removal and disposal of PCBs from building materials and waste during demolition/remodeling – PCBs-containing building materials remain in use with little regulatory oversight. With aging, or construction or demolition activities, these materials may be released to the environment and enter stormwater conveyances. As such, urban runoff management agencies are expected to conduct or cause to be conducted a program to manage PCBs in building materials through their inspection programs.

These BMPs and control measures are expected to be implemented in phases as NPDES permits are issued and reissued. In the first five-year permit term, stormwater permittees will be required to implement control measures on a pilot scale to determine their effectiveness and technical feasibility. Permit requirements will include the following:

- Ensure that industrial inspectors can identify PCBs or PCB-containing equipment during inspections.
- Conduct pilot studies to evaluate the presence of PCBs in building materials (e.g. caulks and adhesives) and develop BMPs to prevent PCBs from being released into the environment during building demolition and renovation.
- Conduct pilot studies to develop and implement best management practices (BMPs) and control measures where areas where elevated PCBs are detected in storm drain sediments, e.g., street cleaning, on-site treatment, investigate on land PCBs-contaminated soils and/or sediments and diversion of stormwater for treatment by wastewater treatment facilities.
- Evaluate the effectiveness of the BMPs and control measures and any environmental impacts associated with their implementation as part of the pilot studies.

The second five-year term permit requirements will be based on the knowledge gained during the first permit term and will call for strategic implementation of the BMPs and control measures identified as effective and that will not cause significant adverse environmental impacts based on the pilot studies conducted during the first permit term. The second term permit will also require development of a plan to fully implement control measures that will result in attainment of allocations, including an analysis of costs, efficiency of control measures and an identification of any significant environmental impacts.

Subsequent permits will include requirements and a schedule to implement technically feasible, effective and cost efficient control measures to attain allocations. If as a consequence, allocations cannot be attained, the Water Board will take action to review and revise the allocations and these implementation requirements as part of adaptive implementation.

In addition to controlling PCBs sources and discharges, urban stormwater management agencies will be required to develop and implement a monitoring system to quantify PCBs loads and the loads reduced through treatment, source control and other actions. The current limited monitoring of PCBs loads from local tributaries by the RMP is not sufficient to quantify PCBs loads from urban stormwater runoff and the loads reduced from urban stormwater runoff control actions. The Water Board will encourage and accept a region-wide design via augmentation of the current RMP as a means of developing and implementing the required PCBs loads monitoring.

Urban stormwater management agencies will also be required to support actions to manage the health risks of consuming PCBs-contaminated Bay fish; and conduct or cause to be conducted monitoring, and studies to fill critical data needs identified in the Adaptive Implementation section.

Urban runoff management agencies have a responsibility to oversee various discharges within the agencies' geographic boundaries. However, if it is determined that a source is substantially contributing to PCBs loads to the Bay or is outside the jurisdiction or authority of an agency the Water Board will consider a request from an urban runoff management agency which may include an allocation, load reduction, and/or other regulatory requirements for the source in question.

Urban Stormwater Runoff Treatment by Municipal Wastewater Dischargers
Routing of urban stormwater runoff through municipal wastewater treatment facilities is a means of reducing PCBs, and other particle-associated pollutant loads to the Bay. The wasteload allocation for stormwater runoff treatment via municipal wastewater treatment systems provides

an incentive to implement this control measure. As described previously, proposed implementation requirements for municipal wastewater and urban stormwater runoff discharges include investigating the feasibility and PCB-removal efficiency of intercepting and routing and treating urban stormwater runoff via wastewater treatment systems, and implementing this control measure where feasible.

A wastewater discharger that accepts urban stormwater runoff will be provided an augmentation of its individual wasteload allocation that accounts for the resulting load increase. The Water Board will consider either amending individual NPDES permits or adopting a separate NPDES permit as an implementing mechanism for this wasteload allocation that would allow wastewater dischargers opportunity to apply for a portion of this wasteload allocation to account for an increase in load associated with treating urban stormwater runoff.

11.2. Internal Sources

Internal sources of PCBs have not been allocated a load. However, we expect reductions in the mass of PCBs from these source categories based on sediment removal activities or other treatment controls. Reduction of the in-Bay PCBs mass will help accelerate the recovery of the Bay from its current impairment, by driving the overall sediment PCBs concentration towards the sediment concentration goal of 1 µg/kg.

The following sections outline the proposed adaptive implementation approach to control internal sources of PCBs.

In-Bay PCB-Contaminated Sites

A number of former and current on-shore industrial and military facilities, and associated PCBs-contaminated in-Bay sediments, exist throughout the Bay. Data are not available for every site to determine whether it is currently discharging to the Bay or contributing significantly to the impairment of the Bay. The State Board adopted a statewide Consolidated Cleanup Plan (Water Code Section 13394) in 2004. Some of the sites listed in Table 12 of this report are identified in the Statewide Consolidated Cleanup Plan. While past and/or current loads of PCBs from these sites to the Bay are difficult to quantify, potentially bioavailable PCBs in off-shore sediments pose a threat to human health and the environment. As such, cleanup of these sites is a Water Board priority and many cleanups are underway. The Water Board will maintain an inventory of contaminated sites (see Table 12) and continue to set priorities for investigating and remediating the sites. Prioritization of contaminated sites may result in identifying sites where additional information is needed to determine future actions, as well as sites where sufficient information is available to determine the need for no further actions. Our initial screening focused on identification of in-Bay sites where sediment PCBs concentrations exceeded 180 ug/kg (Table 23). The Water Board will coordinate clean-up actions with U.S. EPA and the Department of Toxic Substances Control, and issue clean-up orders as necessary. Table 23 provides the status of cleanup at these sites.

The proposed approach to cleanup PCBs contaminated sites is consistent with existing efforts. This TMDL will not result in new requirements for selecting site clean-up levels and remedial options. Rather, setting of clean-up levels at contaminated sites will continue to follow current guidance (e.g. DTSC, 1996; U.S. EPA, 1997c; U.S. EPA, 1998) and continue to be derived on a site- specific basis. The sediment goal derived in this TMDL is not a de facto clean-up level for contaminated sites not should it be interpreted as an applicable or relevant and appropriate requirement (ARAR), or a to be determined (tbd) ARAR, rather it represents the desired conditions that when achieved throughout the Bay will result in attainment of beneficial uses of the Bay.

Table 23- In-Bay PCBs Contaminated Sites

In-Bay contaminated site remediation	Lead Agency	Status
Work Completed		
Emeryville Crescent	Water Board	Completed
Oyster Point/Shearwater (20,100 cyds removed)	Water Board	Completed
Peyton Slough	Water Board	Completed
Redwood City Harbor	U.S. ACE	Completed
Former Hamilton Army Airbase – Coastal Salt Marsh	Water Board	Completed
Moffett Field/NASA Ames-Northern Channel	U.S. EPA	Completed
Work In Progress		
Yosemite Slough Channel	Water Board	Site Investigation
Alameda Naval Air Station Seaplane Lagoon	U.S. EPA	Record of Decision
Hunter's Point Shipyard	U.S. EPA	Feasibility Study in preparation
Moffett Field/NASA Ames-Site 25	U.S. EPA	Feasibility Study in review
Oakland Army Base	DTSC	
Richmond Harbor/Potrero Point	DTSC	
Stege Marsh	DTSC	PCBs Interim Removal Action completed under Water Board lead
Work Not Started		
Cerrito Creek		
Cordonices Creek		
Guadalupe Slough		
Mission Creek		
Oakland Harbor		
Richardson Bay		
San Francisco Airport		
San Leandro Bay		
Vallejo Ferry Terminal		

Contaminated site investigations and evaluation of remedial activities will occur due to existing regulations whether or not called for in this TMDL. Parties responsible for PCBs contaminated sediment sites will continue to be required to gather the following information:

1. Estimate the pre-cleanup and post-cleanup vertical and lateral extent of PCBs in Bay sediments;
2. Estimate the pre-cleanup and post-cleanup mass of PCBs in Bay sediments;
3. Quantify rate(s) of sediment accretion, erosion or natural attenuation;
4. Implement on-land source control measures, if necessary, to ensure that on-land sources of PCBs do not further contaminate in-Bay sediments;
5. Evaluate, post-cleanup, the residual risks to humans and wildlife;

6. Support actions to reduce the health risks of people who consume PCBs-contaminated San Francisco Bay fish;
7. Conduct or cause to be conducted studies to fill critical data needs identified in the Adaptive Implementation section.

If not already completed, these requirements will be incorporated into individual site cleanup plans within five years of the effective date of this TMDL, with full implementation of the actions within ten years of the effective date of this TMDL or as agreed to in the individual site cleanup plan.

Navigational Dredging
Maintenance dredging involves the removal of sediments from navigation channels and the disposal of this sediment at different permitted sites. Dredged sediment from the Bay can be disposed of at upland sites, at in-Bay disposal sites, or at a deep-ocean disposal site (U.S. EPA and U.S. ACE, 1999a; U.S. EPA and U.S. ACE, 1999b). The Long Term Management Strategy for the Disposal of Dredged Material in the San Francisco Bay Region (LTMS) seeks to reduce the total volume of in-Bay disposal from about 2,000,000 cubic yards per year (yd^3/yr) to approximately 1,000,000 yd^3/yr within about 10 years (U.S. ACE, 2001). The lower in-Bay dredge material disposal will result in a net removal of PCBs from the Bay.

In order to ensure that buried PCBs are not being spread out through the Bay via dredge material disposal at dispersive sites, sediments disposed of in Bay should have total PCBs concentrations no greater than that in ambient surface sediments in the Bay. To provide this assurance, we propose that the PCBs concentration in dredged material disposed of in the Bay not exceed the 99th percentile total PCBs concentration of the previous 10 years of Bay surface sediment samples collected through the RMP (excluding stations outside the Bay like the Sacramento River, San Joaquin River, Guadalupe River and Standish Dam stations). Prior to disposal, the material should be sampled and analyzed according to the procedures outlined in the 2001 U.S. Army Corps of Engineers document "Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region." All in-Bay disposal of dredged material shall comply with the Dredging and Disposal of Dredged Sediment program described in Section 4.20 of the Basin Plan and the Long Term Management Strategy for the Disposal of Dredge Material in San Francisco Bay.

In addition to controlling PCBs sources and discharges, dredged material dischargers will be required to support actions to reduce the health risks of people consuming PCBs-contaminated Bay fish, and to conduct or cause to be conducted studies to fill critical data needs identified in the Adaptive Implementation section.

11.3. Risk Management

Load reductions and consequent attainment of the numeric target to support fishing in the Bay as a beneficial use will take time to achieve. However, there are actions that should be undertaken immediately to help manage the risk to consumers of PCBs-contaminated fish. The Water Board will work with the California Office of Environmental Health Hazard Assessment, the California Department of Toxic Substances Control, the California Department of Health Services, and dischargers to pursue risk management strategies. The risk management activities will include the following:

- Investigate and implement actions to address public health impacts of PCBs in San Francisco Bay/Delta fish, including activities that reduce actual and potential exposure of and mitigate health impacts to those people and communities most likely to be affected by PCBs in San Francisco Bay caught fish, such as sport and subsistence fishers and their families;

- Provide multilingual fish-consumption advice to the public to help reduce PCBs exposure through community outreach, broadcast and print media, and signs posted at popular fishing locations;
- Regularly inform the public about monitoring data and findings regarding hazards of eating PCBs-contaminated fish; and
- Perform special studies needed to support health risk assessment and risk communication.

11.4. Critical Data Needs

Data and other information are needed to assess both the progress toward attainment of the numeric fish tissue target and to inform the adaptive implementation of the TMDL. Dischargers will therefore be required to support the following studies to fill critical data needs.

- PCBs mass budget modeling and food web model improvements – Model refinements are needed to improve our ability to predict recovery rates of the Bay from impairment by PCBs, and to help focus implementation actions on those with the most potential for success. Better models could lead to a recalculation of the TMDL, and revised load and wasteload allocations. The TMDL will be revised if improved models predict that the current TMDL will not result in attainment of the fish tissue target. Improved models will also help evaluate whether implemented actions are effective and sufficient, and could direct the need for different or expanded implementation action. Models are also needed to improve our understanding of the role in-Bay PCBs-contaminated sites play in the Bay's recovery.

- Rate of natural attenuation of PCBs in the Bay environments – Natural attenuation is a component of the implementation of the TMDL. Attenuation rates greatly affect model prediction of recovery of the Bay from PCBs impairment. A better understanding of local rates of natural attenuation is needed in order to predict with more certainty the recovery time of the Bay, and to inform whether more, less or different implementation actions are needed. A refined understanding of the PCBs natural attenuation rate in water and sediment could lead to revised load and wasteload allocations. Specifically, load allocations to the Central Valley and navigational dredging currently rely on natural reduction of PCBs and new findings could result in load reduction actions implementation.

11.5. Monitoring

Monitoring is needed to demonstrate progress toward attainment of allocations and the numeric target. The discharger-funded RMP currently monitors PCBs in San Francisco Bay fish, sediments, and water. The Water Board will call on dischargers to support the RMP to monitor PCBs in fish (as specified in the numeric target), in sediments and water, at a spatial scale and frequency to track trends in the decline of PCBs and to demonstrate attainment of the numeric fish tissue target and sediment concentration goal. Monitoring will provide information on the progress in attaining the TMDL target, and therefore the success of actions implemented. Long term data are needed to verify the recovery rate of the Bay, and compare this with a model predicted recovery rate. These efforts will also inform whether the actions implemented are effective in reducing PCBs to the TMDL target or whether further actions are required. A refined understanding of long term PCBs concentration trend data in water, sediment and biota could lead to a recalculation of the TMDL, and revised load and wasteload allocations.

Monitoring of load allocations to demonstrate progress towards attainment shall be conducted by municipal and industrial wastewater dischargers and by urban runoff stormwater agencies. The RMP also conducts regular monitoring of PCBs loads from the Central Valley and some limited monitoring of PCBs loads from local tributaries. The current limited monitoring of PCBs loads from local tributaries by the RMP is not sufficient to quantify PCBs loads from ~~urban~~ stormwater runoff or the loads reduced from urban stormwater management control actions. As described in the discussion of implementation of Central Valley allocations, the Water Board will also call on dischargers, via the RMP, to verify ongoing loads and load reductions to allow evaluation of trends in the loads of PCBs from the Central Valley watershed and to confirm that loads are being reduced due to natural attenuation.

11.6. Adaptive Implementation

Adaptive implementation entails taking immediate actions commensurate with available information, reviewing new information as it becomes available, and modifying actions as necessary based on the new information. Taking immediate action allows progress to occur while more and better information is collected, and the effectiveness of current actions is evaluated (NRC, 2001). In this manner, this TMDL will be implemented in phases starting with actions described in each source category, risk management, monitoring, and critical data needs section above with subsequent modifications and phases based on improved knowledge of PCBs sources, control measures, and fate in the environment. In particular, there are four principal ongoing activities that may necessitate TMDL adaptation.

First, the ongoing monitoring being conducted through the Regional Monitoring Program will allow us to improve our understanding of the rate of natural attenuation and recovery and our understanding of patterns of PCB concentrations in tissue and sediment. Interpretation of these data may result in improved ways of expressing TMDL targets or of evaluating them using monitoring data.

Second, there are ongoing efforts to improve understanding of the fate and transport of PCBs in the Bay and to model the relevant biological, physical and chemical processes. Improved modeling capabilities combined with bathymetric and sediment core data allow us to better predict how the Bay will respond to management actions and changing conditions. This will, in turn, inform the need to adapt implementation schedules.

Third, we will continue to pursue clean-up of in-Bay contaminated sites. By evaluating the degree to which in-Bay contaminated sites can be remediated and evaluating the resultant impact on PCB levels in the Bay and its biota, we will gain valuable insights relevant to determining the pace at which the beneficial uses of the Bay will be restored.

Last, the success of the TMDL depends in large part on concerted efforts to locate and evaluate opportunities to control on-land PCB sources and the PCB load conveyed to the Bay via urban stormwater runoff. The progressive approach for addressing this challenge is described in the stormwater runoff implementation section above in more detail.

We will be assessing progress in each of these four areas on a continuing basis to determine if the quantity and quality of emerging information are sufficient to warrant adaptation of the TMDL.

The Water Board will adapt the TMDL and implementation plan to incorporate new and relevant scientific information such that effective and efficient measures can be taken to achieve the TMDL allocations and numeric fish tissue target. The Water Board, via an annual report by Water Board staff on TMDL implementation progress, will evaluate new and relevant information from implementation actions, monitoring, special studies, and scientific literature. Within ten years of the effective date of the TMDL, any necessary modifications to the targets, allocations, or implementation plan will be incorporated into the Basin Plan. The Water Board will make new information available to the public and will allow opportunities for public participation regarding the results of the periodic review of the TMDL, attainment of load allocations, attenuation of PCBs, or revised TMDL derivations.

The Water Board will adapt the TMDL and implementation plan to incorporate new and relevant scientific information such that effective and efficient measures can be taken to achieve the allocations and numeric fish tissue target. The Water Board staff will present an annual progress report to the Water Board on implementation of the TMDL that includes evaluation of new and relevant information that becomes available through implementation actions, monitoring, special studies, and the scientific literature, and within ten years of the effective date of the TMDL, the Water Board will consider amending the PCBs TMDL and implementation plan as necessary to ensure attainment of water quality standards in a timely manner while considering the financial and environmental consequences of new control measures.

In particular, achievement of the allocations for stormwater runoff, which is projected to take 20 years, will be challenging. Consequently, the Water Board will consider modifying the schedule for achievement of the load allocations for stormwater runoff provided that dischargers have complied with all applicable permit requirements and all of the following have been accomplished relative to that source category or discharger:

- A diligent effort has been made to quantify PCBs loads and the sources of PCBs in the discharge;
- Documentation has been prepared that demonstrates that all technically and economically feasible and cost effective control measures recognized by the Water Board as applicable for that source category or discharger have been fully implemented, and evaluates and quantifies the comprehensive water quality benefit of such measures;
- A demonstration has been made that achievement of the allocation will require more than the remaining ten years originally envisioned; and
- A plan has been prepared that includes a schedule for evaluating the effectiveness and feasibility of additional control measures and implementing additional controls as appropriate.

12. Regulatory Analyses

This section provides the regulatory analyses required to adopt the Basin Plan amendment to establish the PCBs TMDL. It includes a discussion of the results of an environmental impact analysis and a discussion of economic considerations. The environmental impact analysis is required under the California Environmental Quality Act (CEQA) when the Water Board adopts a Basin Plan amendment under the Water Board's certified regulatory program (California Public Resources Code § 15251 [g]). The environmental analysis also satisfies Public Resources Code § 21159 which applies when adopting rules or regulations requiring installation of pollution control equipment, compliance with a performance standard, or treatment requirement. It evaluates the reasonably foreseeable environmental impacts of the methods of compliance with the implementation plan in Section 11, and describes the reasonably foreseeable and feasible mitigation measures that could be used to reduce significant environmental impacts. The discussion of economic considerations is provided in accordance with Public Resources Code § 21159 [a] [3] [c] which requires an analysis of economic factors related to costs of implementation of the new rules or regulations. This Staff Report, including the CEQA checklist and these analyses, constitute a substitute environmental document.

The results of the assessment of environmental impacts and economic considerations show that the Basin Plan amendment is not likely to result in long-term, significant impacts and will not cause immediate, large scale expenditures by the entities required to implement the PCBs TMDL. Many of the actions identified in the Basin Plan amendment to implement the PCBs TMDL are built on existing efforts to improve management of urban runoff, treatment of wastewater, and to remediate upland and in-Bay PCBs-contaminated sites. Many of the actions will be implemented in a phased manner after pilot studies are conducted to evaluate those specific BMPs or control measures that are effective both from a load reduction perspective and from a cost perspective. This section analyzes environmental impacts for many of the potential individual projects that may be developed to implement the PCBs TMDL to the extent such impacts can be identified at this time. At such time as individual projects are proposed, the impacts of those individual projects will be evaluated as to location, specific technologies, size, quantity, feasibility and any mitigation necessary to address the identified environmental impacts. These project-specific impacts are too speculative to evaluate at this time. We anticipate that these projects would be required to mitigate any potential environmental impacts. Mitigation measures that are both feasible and already in common use as standard industry practice, are discussed in this analysis of environmental impacts and are expected to reduce all potentially significant impacts to less than significant levels.

12.1. Environmental Impact Analysis: CEQA Compliance

The Water Board is the lead agency responsible for evaluating the potential environmental impacts of the proposed Basin Plan amendment to establish the PCBs TMDL and implementation plan for San Francisco Bay. To accomplish this evaluation, a standard CEQA checklist was prepared (Appendix A) along with an explanation of the results of the analysis. It includes a discussion of the potential environmental impacts as well as mitigation measures that would be used to eliminate or reduce the impacts. Because the Water Board cannot mandate adoption of any specific compliance method, the analysis provided here should be viewed as comparable to a Tier 1 environmental impact review. It does not and cannot present detailed analysis of project-specific impacts at specific locations in the San Francisco Bay watershed, since such projects have yet to be defined, and thus, any analysis would be speculative at this time. Our assessment evaluates likely impacts of reasonably foreseeable means of compliance and the reasonably foreseeable mitigation measures that would reduce any potentially significant impacts.

12.2. Project Description

Sections 2.2 and 3 of this Staff Report present the project definition, objectives and environmental setting that provide the basis for the CEQA evaluation. The project is composed of a Basin Plan Amendment that includes a TMDL of 10 kg/yr for San Francisco Bay based on a numeric target for fish tissue (10 ug/kg) protective of human health and wildlife beneficial uses and allocates the TMDL among the various external sources. This target is based on evaluating the lifetime incremental cancer risk of one in a 100,000 for an adult recreational sport fisher. It is derived from assuming a 70 kilogram person, consuming on average 32 grams of fish caught in San Francisco Bay per day, over a lifetime of 70 years. The fish consumption rate of 32 g/day is based on a San Francisco Bay survey (SFEI 2000a). This consumption rate represents the 95th percentile upper bound estimate of consumption for local sport fish consumers based on their four-week recall of eating Bay-caught fish.

The Basin Plan amendment includes: a plan to implement the TMDL using a phased approach; a monitoring program to evaluate progress towards achievement of the target; and a plan and schedule for additional studies to improve our technical understanding relevant to the PCBs TMDL and implementation plan. It also requires reviewing progress toward meeting targets, implementing actions, and evaluating continued appropriateness and effectiveness of actions. The phasing of the implementation plan involves conducting pilot studies and/or feasibility studies for some actions, prior to requiring those actions to be undertaken. The proposed implementation schedule also provides a realistic timeframe in which to complete the tasks required by the TMDL and a timeframe to evaluate the need for modifications to the TMDL and the implementation plan.

12.3. Project Objectives

The primary objective of the project is to achieve the PCBs fish tissue target specified by the TMDL in order to restore the currently impaired beneficial uses of commercial and sport fishing in the Bay.

The objectives of the project with respect to PCBs, which are most relevant to the analyses of environmental impacts and alternatives, are listed below (the entire list is found in Section 2.2):

- Attain numeric PCBs water quality criteria and the bioaccumulative narrative water quality objective established for the Bay in as short a time frame as feasible.
- Protect beneficial uses of the Bay related to sport fishing and wildlife
- Provide interim risk management programs to protect recreational sport fishing anglers.
- Set target(s) to attain relevant water quality objectives in all parts of the Bay.
- Avoid imposing regulatory requirements more stringent than necessary to meet the targets designed to attain water quality standards.

- Reduce loading of PCBs to the Bay from external sources.
- Comply with the Clean Water Act requirement to adopt a TMDL for a 303 (d) listed impaired water body.
- Initiate actions to reduce PCBs discharges, while continuing to accommodate new information on PCBs fate in the environment.

12.4. Reasonably Foreseeable Methods of Compliance

Implementation Plan requirements not evaluated in this CEQA analysis
Some of the TMDL implementation plan requirements of the Basin Plan amendment are not evaluated in this Section of the Report because they are requirements that do not cause a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment. Those requirements include evaluations of potential actions, monitoring, participation in additional research to fill critical data needs, and development of public outreach and human health risk management programs.

Implementation Plan requirements evaluated in this CEQA analysis
Implementation measures that are reasonably foreseeable methods of compliance that result in a physical change in the environment are reviewed in this analysis. An explanation of what is evaluated in this analysis is provided below and organized by source category.

External Sources

Wastewater and Stormwater Implementation
The implementation plan for the TMDL is considered a phased plan because many of the actions necessary to achieve the TMDL allocations will require an evaluation as part of a pilot study or feasibility study prior to implementation. Many of the actions that are required to achieve reductions in PCBs loading to the Bay will be required as part of an NPDES permit for municipal and industrial wastewater dischargers or stormwater runoff management agencies.

The NPDES permit requirements for urban stormwater runoff would be implemented in a phased approach. The first five years of TMDL implementation are anticipated to include pilot studies that will test a variety of control measures in order to implement measures that will achieve load allocations in the most effective and cost-efficient manner. The second five-year permitting period will feature strategic implementation of those measures found to be effective through pilot testing conducted in the first permit term. In 10 years, it is expected that the permit would require a schedule for full implementation of the technically practicable, effective and cost efficient BMPs and control measures to the maximum extent practicable. It is speculative at this time to identify specific individual projects that will be implemented based on the results of the pilot studies. Instead we have has compiled a general list of reasonably foreseeable compliance measures that may be considered as part of a pilot study or may eventually be implemented to attain the load allocations identified in the Basin Plan amendment for the external sources of municipal and industrial wastewater, and urban stormwater runoff.

The general list of reasonably foreseeable means of compliance evaluated in this environmental impact analysis for these source categories includes the following:

- Removal and disposal of PCBs-containing equipment
- Removal and disposal of PCBs from building materials
- Removal and disposal of PCBs residuals in sewer lines
- Survey and remediation of contaminated soil or sediment in public rights-of-way, wastewater conveyances, and private properties
- Increased street cleaning (includes sweeping or washing)
- Storm drain and inlet maintenance (above and beyond normal practices)
- Construction, operation, and maintainance of facilities/units to intercept, divert and treat storm water (e.g., on-site system retrofits including detention basins, infiltration basins, sand filters, bioretention drainage areas etc.)
- Strategically routing/diverting stormwater to POTWs (i.e., municipal wastewater treatment plants) for treatment

These measures are evaluated in this environmental analysis without much detail as to location, size or number, or location-specific feasibility, since they will be evaluated in the future as part of the pilot projects undertaken by the dischargers. BMPs and control measures to be evaluated as part of a pilot study include both potentially new activities as well as augmentation of existing actions. For example, the number and extent of projects to remove and dispose of PCBs-containing equipment and building materials containing PCBs is currently unknown. Storm drain maintenance and street cleaning are all conducted as part of normal municipal stormwater programs. They are included in this analysis because adoption of the PCBs TMDL may increase their frequency.

Pilot studies will be required under a future NPDES stormwater permit to evaluate the feasibility of the construction, operation, and maintenance of new facilities to intercept, divert, and treat stormwater. Therefore, the number and locations of these projects are uncertain. No specific type of project is required; rather this is an implementation measure that could be selected if strategically feasible in some locations. The pilot studies are intended to analyze the environmental impacts of implementing these types of measures.

No specific project to route stormwater to a wastewater treatment plant is currently required. Studies are underway by the San Francisco Estuary Institute under funding from the State Water Resources Control Board to investigate opportunities, i.e., locations of PCB-contaminated stormwater runoff occurring in the vicinity of pump stations. Based on the results of these studies, pilot projects could be pursued by the stormwater management agencies or municipal wastewater treatment facilities.

Central Valley

No actions for the Central Valley watershed load allocations are required other than monitoring, and thus, there are no reasonably foreseeable compliance measures to evaluate here.

Internal Sources

<u>In-Bay Contaminated Hot Spots</u>

There are no load allocations to internal sources, therefore no new actions are explicitly required of any regulated party by this TMDL for in-Bay PCB-contaminated hot spots. Projects to remediate in-Bay PCB-contaminated sediments have been completed in some locations, are in-progress at others, and may occur in the future for sites identified in Table 23 of this Report.

The environmental impacts of cleanup activities at some of the sites that were identified as part of the Bay Protection Toxic Cleanup Program were analyzed in a programmatic level environmental evaluation by the State Water Resources Control Board during development of the Consolidated Toxic Hot Spots Clean Up Plan (SWRCB, 2003). The environmental evaluation concluded that the action of adoption of the Consolidated Cleanup Plan by the SWRCB will not result in significant adverse impacts. Any adverse environmental effects that may occur due to remediation under the proposed Plan would be substantially the same as environmental effects of remediation if the Plan is not adopted. This is because the regulatory framework requiring remediation and the regulatory framework protecting the environment against adverse affects of remediation, are unchanged by the adoption of the proposed Plan. In other words, the Plan will neither affect the requirements for remediation nor the way in which the environment is protected against adverse effects through permitting, CEQA, Waste Discharge Requirements, Cleanup Orders, etc. This is also true in the case of this PCBs TMDL.

Remediation of PCBs-contaminated hot spots may support attainment of the fish tissue target and TMDL, based on decreases in the mass of PCBs in localized in-Bay surface sediments. Despite the fact that these actions are not required by this Basin Plan amendment, there may be a fair argument that such actions may occur due to the project or may receive greater attention and resources from state, federal or local agencies and thus the number of projects in an active stage at any given time may be accelerated, thus the environmental impacts of selected potential remedial alternatives that involve a potential physical change in the environment are evaluated in this section. This analysis is a general evaluation of environmental impacts that could occur due to remediation of PCBs contaminated sediment. A feasibility study is anticipated to be required prior to implementing any remedial alternative. Some potential remedial alternatives, such as monitored natural recovery, are not evaluated here because they do not involve a physical change in the environment. The fact that they are not evaluated in this report has no bearing on their potential effectiveness as a remedial alternative.

Detailed clean-up plans would also require an assessment of environmental impacts that would be conducted by the lead agency at time of review and approval. These projects could be carried out under the authority of the Water Board, DTSC, US EPA, or in some cases local agencies. In each case, the lead agency is responsible for ensuring environmental impacts are avoided, minimized, and mitigated.

The reasonably foreseeable means of compliance evaluated in this environmental impact analysis for this source category include the following:

- Remediation of contaminated sediment with dredging and appropriate disposal

- Remediation of contaminated sediment with dredging, appropriate disposal, and capping of residual contamination in-situ

Navigational Dredging

There is no load allocated to navigational dredging, instead the TMDL implementation plan establishes a methodology to determine whether sediments dredged to support navigation could be disposed of in-Bay. Application of the methodology to navigational dredging project could result in less material being allowed to be disposed of in-Bay over time if the ambient concentration of PCBs in sediments decreases. A Basin Plan amendment adopted by the Water Board, and approved by State Board on November 6, 2007, sets a long-term overall goal for in-Bay disposal of dredged material at designated in-Bay disposal sites at one mcy (or less) per year to be attained step-wise over a 12-year period. This goal requires a reduction of in-Bay disposal. The environmental impacts of reductions in-Bay disposal were evaluated in the Long Term Management Strategy for Dredged Material Environmental Impact Statement/Programmatic Environmental Impact Report (US EPA 1996) and was identified as being more environmentally beneficial than allowing in-Bay disposal. Navigation dredged material not disposed of in-Bay is likely to be taken to the deep ocean disposal site. The environmental impacts of the implementation plan actions for navigational dredging are therefore not further evaluated in this analysis.

12.5. Regulatory Framework

Agencies with permit review or approval authority over the implementation of reasonably foreseeable means of compliance include the following:

San Francisco Bay Water Board

Issues Clean Water Act Section 401 Water Quality Certifications required to conduct dredging or filling of waters of the U.S., including San Francisco Bay; NPDES permits, WDRs and Cleanup and Abatement Orders for discharges that pollute or threaten to pollute surface or groundwater, and other orders as necessary to enforce the Porter Cologne Water Quality Control Act of 1969.

Bay Conservation and Development Commission

Permits actions subject to the San Francisco Bay Plan; issues consistency determinations with the Coastal Zone Act Reauthorization Amendments of 1990.

The Department of Toxic Substances Control

Issues orders in accordance with Chapter 6.8 of Division 20 of the California Health and Safety Code.

U.S. Army Corps of Engineers

Issues Clean Water Act section 404 permits for dredging and fill projects in navigable waters.

U.S. Fish and Wildlife Service

Conducts section 7 consultation for effects to listed federal species.

National Oceanic Atmospheric Administration/National Marine Fisheries Service (NOAA/NMFS)
Conducts section 7 consultation for effects to migratory and endangered fish species

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California Department of Fish and Game
Provides section 2081 consultation for effects to listed species.

Municipalities/Counties
Issue building and/or grading permits; enforce of noise ordinances

12.6 Environmental Checklist

A significant impact is defined by CEQA as "a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by a project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historical or aesthetic significance" (14 CCR Title 14, Chapter 3, Article 20, Section 15382. Our analysis, prepared using the CEQA checklist (Appendix A), identified some potentially significant environmental impacts in the areas of air quality, biological resources, hydrology and water quality, noise, and utilities and service systems.

Mitigation Measures
Although some potentially significant impacts have been identified, recommended mitigation measures, many of which are mandatory conditions of local, state, and federal regulations and permits, (see Section 12.5, e.g., mitigation requirements of the Water Board's 401 Water Quality permits) will eliminate entirely or reduce these impacts to a "Less than Significant with Mitigation Incorporated" level. As used in this analysis and as defined by CEQA (Article 20, Section 15370), mitigation can be divided into four types:

1. Avoiding the impact altogether by not taking a certain action or part of an action.
2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectifying or eliminating the impact over time by preservation and maintenance operations during the life of the action.
4. Compensating for the impact by replacing or providing substitute resources or environments.

It is likely that all of these mitigation strategies will be used alone or in a variety of combinations to address specific impacts associated with individual projects developed as means of compliance with the Basin Plan amendment.

It should be noted that the Water Board will not require any actions or projects to implement the PCBs TMDL that would lead to significant, permanent, negative impacts on the environment. Furthermore, we anticipate that all potentially significant environmental impacts will be mitigated to less than significant levels either through the Water Board's regulatory and permitting authorities or under those of other agencies with jurisdiction in relevant areas, such as U.S. Environmental Protection Agency (U.S. EPA), U.S. Fish and Wildlife Service (USFWS), NOAA/NMFS, Occupational Health and Safety Administration (OSHA), U.S. Army Corps of Engineers (U.S. ACE), California Department of Fish and Game (CDFG), California Department of Toxic Substances

Control (DTSC), and San Francisco Bay Conservation and Development Commission (BCDC).

Results of the Environmental Analysis

The CEQA checklist (Appendix A) summarizes the results of the analysis of potential environmental impacts associated with the reasonably foreseeable means of compliance with the PCBs TMDL as proposed in the Basin Plan amendment. The standard CEQA rating system, which was used here, includes four designations of the level of significance. They are: Potentially Significant (PS), Less than Significant (LTS), Less than Significant with Mitigation Incorporated (LTSM), and No Impact (NI). Table 24 presents those environmental impacts determined to be potentially significant before mitigation and the associated mitigation measures. A discussion of the environmental impact categories on the checklist, level of significance, and recommended mitigation measures follows the summary table.

Table 24-Summary of Potentially Significant Environmental Impacts and Mitigation Measures

Reasonably Foreseeable Compliance Measures Evaluated	Environmental Impacts	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance With Mitigation
3. AIR QUALITY 3-B Contribute to Air Quality Violation				
<u>On-Land</u> • Construct, operate, and maintain facilities/units to intercept, divert, and treat stormwater • Remediation of PCBs-contaminated soil or sediment from public rights-of-way, storm water conveyances, and private property • Increased street Cleaning (washing and/or sweeping) • Storm drain and inlet maintenance • Strategically route stormwater to POTWs for treatment	Impacts: • Short-term increase in particulates (PM-10) from vehicle exhaust • Short-term increase in photo-chemical smog constituents from vehicle exhaust • Construction-related dust • Diesel exhaust (nuisance odors)	PS	<u>On-Land</u> Implementation of established BMPs and site-control measures to control and minimize dust include, but not limited to: • Spray down construction sites with water or soil stabilizers • Cover all hauling trucks • Maintain adequate freeboard on haul trucks • Limit vehicle speed in unpaved work areas • Suspend work during periods of high wind or air quality restrictions • Install temporary windbreaks • Use of low sulfur or emulsified diesel fuel to reduce constituents of photo-chemical smog • Use of soot traps on diesel equipment to reduce particulates Additional BMPs for removal of PCBs-containing equipment/building materials: • Use covered dust chutes for removal of material • Create a Soil Management Plan • Test and monitor on-site air quality	LTSM

Reasonably Foreseeable Compliance Measures Evaluated	Environmental Impacts	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance With Mitigation
In-Bay • Dredge contaminated sediment with offsite disposal (all methods)	Impacts: • Short-term increase in airborne particulates (PM-10) from barge and equipment exhaust • Short-term increase in photo-chemical smog constituents from barge and equipment exhaust	PS	In-Bay • Use of electric-powered excavating equipment and barges in place of diesel-fueled equipment and barges • Use of low sulfur or emulsified diesel fuel to reduce constituents of photo-chemical smog • Use of soot traps on diesel equipment to reduce particulates	LTSM
4. BIOLOGICAL RESOURCES 4-A, C and D Substantial adverse effect on special status species, federally protected wetlands and substantially interfere with migratory fish				
In Bay • Dredge contaminated sediment (all methods)	Impacts: • Disturbance of near-shore tidal wetlands • Short-term habitat disturbances such as vegetation removal, noise, presence of humans	PS	In-Bay Mitigation measures include: • Use of electric dredging equipment (noise reduction) • Use of clamshell buckets and silt screens to minimize re-suspension of sediment • Vibration dampening material on equipment • Adherence to established state and federal policies for "No Net Loss" of wetlands • Adherence to policy to avoid, minimize, mitigate for projects involving wetlands • Adherence to Water Board permit requirements, USFWS, NOAA/NMFS, CDFG consultation requirements • BMPs to minimize project footprint • Pre-construction survey for endangered or sensitive species • Presence of trained on-site biological monitors • Training for construction personnel to	LTSM

Reasonably Foreseeable Compliance Measures Evaluated	Environmental Impacts	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance With Mitigation
			recognize and avoid sensitive species	
8. HYDROLOGY AND WATER QUALITY 8-A Violate any water quality standards or waste discharge requirements				
In-Bay • Dredge PCBs-contaminated sediment with off-site disposal • Dredge (partial) and cap remainder in situ	Impacts: • Short term violations of water quality objectives due to sediment resuspension or creation of decant water	PS	In-Bay Mitigation measures include: • Comply with requirements of water quality certification or waste discharge requirements • Installation of temporary sheet pile enclosure or silt curtains • Treatment or proper disposal of decant water	LTSM
11. NOISE 11-A and B Expose people to noise or groundborne vibration in excess of local ordinances or other standards				
On Land • Removal and disposal of PCBs-containing equipment • Removal and disposal of PCBs-containing building materials • Removal and disposal of PCBs residuals in sewer lines • Remediation of contaminated soil or sediment from public rights-of-way, storm water conveyances, and private property • Construct, operate, and maintain facilities/units	Impacts: • Short-term noise related to construction activities and use of heavy equipment for all projects involving construction and removal and hauling of equipment/material from buildings	PS	On Land Mitigation measures include: • Compliance with local noise ordinances (typical standards include blackouts prohibiting use of heavy equipment on Sundays, early morning hours and evenings all week, and on holidays) • Use of noise dampening material or barriers around equipment • Engine and pneumatic exhaust controls • Locating equipment as far as practical from noise-sensitive areas • Selecting haul routes that affect the lowest number of people	LTSM

Reasonably Foreseeable Compliance Measures Evaluated	**Environmental Impacts**	**Level of Significance Before Mitigation**	**Mitigation Measures**	**Level of Significance With Mitigation**
to intercept, divert, and treat stormwater • Strategically route stormwater to POTWs In-Bay • Dredge PCBs-contaminated sediment with off-site disposal • Dredge (partial) and cap remainder in situ	Impacts: • Use of heavy equipment during dredging and hauling activities could cause short-term, localized noise	PS	In-Bay Mitigation measures include: • Compliance with local noise ordinances (typical standards include blackouts prohibiting use of heavy equipment on Sundays, early morning hours and evenings all week, and on holidays) • Use of noise dampening material or barriers around equipment • Engine and pneumatic exhaust controls • Locating equipment as far as practical from noise-sensitive areas • Selecting haul routes that affect the lowest number of people	LTSM
11. NOISE 11-D Substantial temporary or periodic increase in ambient noise in vicinity of project				
On Land • Removal and disposal of PCBs-containing equipment • Removal and disposal of PCBs-containing building materials • Removal and disposal of PCBs residuals in sewer lines • Remediation of contaminated soil or	Impacts: • Short-term, intermittent noise from use of heavy equipment during construction or remediation activities	PS	On Land Mitigation measures include: • Compliance with local noise ordinances (typical standards include blackouts prohibiting use of heavy equipment on Sundays, early morning hours and evenings all week, and on holidays) • Use of noise dampening material or barriers around equipment • Engine and pneumatic exhaust controls • Locating equipment as far as practical from noise-sensitive areas	LTSM

Reasonably Foreseeable Compliance Measures Evaluated	Environmental Impacts	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance With Mitigation
sediment from public rights-of-way, storm water conveyances, and private property • Construct, operate, and maintain facilities/units to intercept, divert, and treat storm water • Strategically Route Stormwater to POTWs <u>In-Bay</u> • Dredge contaminated sediment (all methods)			• Selecting haul routes that affect the lowest number of people • Compliance with work window restrictions <u>In-Bay</u> Mitigation measures include: • Compliance with local noise ordinances (typical standards include blackouts prohibiting use of heavy equipment on Sundays, early morning hours and evenings all week, and on holidays) • Use of noise dampening material or barriers around equipment • Engine and pneumatic exhaust controls • Locating equipment as far as practical from noise-sensitive areas	
16. UTILITIES AND SERVICE SYSTEMS 16-B Require or result in construction of new water or wastewater treatment facilities or expansion of facilities, construction of which could cause significant environmental effects				
<u>On-Land</u> • Removal and disposal of PCBs residuals in sewer lines • Construct facilities/units to intercept, divert, and treat stormwater	<u>Impacts:</u> • Projects to remove PCBs residuals from sewer lines may, in a limited number of cases, include replacement	PS	<u>On Land</u> Mitigation measures include: • Compliance with existing, applicable zoning, land-use, permitting requirements of all agencies (local, state, and federal) • Use of standard construction BMPs to avoid and minimize environmental impacts	LTSM

Reasonably Foreseeable Compliance Measures Evaluated	Environmental Impacts	Level of Significance Before Mitigation	Mitigation Measures	Level of Significance With Mitigation
• Strategically route stormwater to POTWs	of some sections of the line • Some dischargers may strategically select sites where feasible to intercept and divert storm water to POTWs. Construction is likely to be limited to interception devices and pipelines			
16. Utilities and Service Systems 16-C Require or result in construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects				
<u>On Land</u> • Construction of facilities to intercept and divert urban stormwater runoff • Strategically route stormwater to POTWs	<u>Impacts:</u> • Impacts related to construction activities as described above	PS	<u>On Land</u> Mitigation measures include: • Compliance with existing, applicable zoning, land-use, permitting requirements of all agencies (local, state, and federal) • Use of standard construction BMPs to avoid and minimize environmental impacts	LTSM

Discussion of Environmental Impacts and Mitigation by Checklist Category
In this section, we present the rationale for the ratings of environmental impacts listed in the CEQA checklist (Appendix A) and Table 24-Summary of Potentially Significant Environmental Impacts and Mitigation Measures
. The following sections are numbered to match the checklist.

1. Aesthetics

There are no known or reasonably foreseeable impacts to aesthetic values as a result of compliance with the proposed Basin Plan amendment. Significant impacts to aesthetics would involve introduction of new elements that are substantially out of character with existing land uses or would obscure or alter scenic vistas or occur within a designated scenic area. There are no impacts of this type associated with the reasonably foreseeable means of compliance with the Basin Plan amendment as projects will be implemented in urban industrial areas. Some projects may occur adjacent to the San Francisco Bay. Construction impacts associated with activities along the shoreline may include sheet pile installation, removal of vegetation, sediment stabilization or pipeline installation; these impacts are all short-term activities with no long-term impacts to aesthetic resources.

2. Agricultural Resources

There are no known or reasonably foreseeable impacts to agricultural resources as a result of compliance with the proposed Basin Plan amendment. Significant impacts would occur if a project substantially affected agricultural lands or production processes. The reasonably foreseeable methods of compliance with Basin Plan amendment will be implemented in urban, industrial areas where there are essentially no agricultural land uses.

3. Air Quality

The impacts of a project to air quality in the Bay Area are assessed in relation to guidelines set by the Bay Area Air Quality Management District (BAAQMD 1999) as well as in relation to federal standards established by the Clean Air Act. The air pollutants of greatest concern in the Bay area include ozone and inhalable particulate matter less than 10 microns in diameter (PM_{10}) The San Francisco Bay Area Air Basin is currently classified as a nonattainment area for both the state and federal ozone standards, and for state PM_{10} standards.

In the case of implementation activities related to the PCBs TMDL, emissions of air pollutants are primarily associated with construction activities. Given the temporal aspect of such projects, all reasonably foreseeable impacts would be short-term. Construction activities emissions are included in the emission inventory that is the basis for regional air quality plans and are not expected to impede attainment or maintenance of ozone or carbon monoxide standards in the Bay Area (BAAQMD 1999). Even if emissions are greater than anticipated they would be mitigated as discussed below.

The other pollutant of greatest concern related to construction and possible remediation work is fine particulate matter ($<PM_{10}$), which is related to activities such as excavation, grading, vehicle travel on paved and unpaved surfaces, and vehicle and equipment emissions. Construction-related emissions of PM_{10} vary depending on a variety of factors including the level of activity, specific operations taking placing, equipment being used, and local soil and weather conditions. Although particulate matter is closely associated with diesel exhaust, it is also formed from tire wear and road dust. However, despite the variability of these influences, the BAAQMD has identified numerous BMPs that are feasible control measures to significantly reduce emissions

of PM_{10} from construction projects. In addition, as of mid-2006, California law requires that all highway diesel fuel sold in the state be Ultra Low Sulfur Diesel (ULSD), which is compatible with existing, in-use vehicles. This formulation also contributes to significant reductions in particulate matter emissions. We anticipate use of this fuel and implementation of BMPs would be required as necessary for projects associated with implementation of the PCBs TMDL. Specific areas of impact and mitigation are described below.

Implementation measures for the PCBs TMDL could lead to projects or other activities with impacts to air quality in the following area as listed on the CEQA checklist:

Would the project:

Impact 3-B: Violate any air quality standard or contribute substantially to an existing or projected air quality violation.

These impacts are rated as potentially significant, but less than significant with mitigation incorporated.

<u>On Land</u>

Impacts: Implementation measures for the PCBs TMDL may include removal of PCB-containing equipment from buildings or other industrial facilities and disposal at appropriate offsite locations. Remediation projects may also be implemented to remove contaminated soils or sediments from public rights-of-way, private property, and sewer lines. Such projects would involve the use of heavy equipment during remediation or hauling and disposal of materials.

Some dischargers responsible for urban runoff/stormwater may decide to conduct additional street cleaning, including street sweeping and washing, or installation of new filtration systems for storm drains. Activities of this type could require more frequent operation of street cleaning machinery than under current maintenance schedules. This increase in maintenance could impact air quality on a short-term, periodic basis. Impacts from construction of other possible control measures, e.g., facilities/units to intercept, divert and treat stormwater may also occur but are expected to be short term in nature and the number and locations of such projects would be speculative, as the feasibility and specific nature of these projects will be evaluated by dischargers through pilot studies.

In addition, in a limited number of instances, dischargers may opt to construct facilities to divert stormwater to municipal wastewater treatment facilities. This is only likely to be undertaken where strategically feasible, such as in locations where municipal wastewater treatment facilities are proximate to areas with significant amounts of PCBs in urban runoff. These efforts would involve construction of pipelines connecting the storm collection system to municipal wastewater treatment facilities.

The implementation measures for the PCBs TMDL described above could contribute to two main types of air quality impacts: increased input of PM_{10} (as described above) from dust (in construction areas) and diesel exhaust emissions as well as an increase in vehicle exhaust emissions that contain air pollutants known to contribute to photo-chemical smog, i.e., ozone, cause annoyance odors, and potentially irritate respiratory systems (particularly in sensitive individuals). The impacts would result from use of heavy equipment during construction and construction activities and from increases in street cleaning, as well. Construction-related impacts would be short-term; impacts associated with increases in street cleaning would also be short-term and minimal, but would occur on a regular basis.

Mitigation: Use of standard BMPs should reduce these impacts to less than significant levels. For particulate matter, the BMPs include, but are not limited to: spraying of construction and staging areas to control dust; covering all hauling trucks and maintaining adequate freeboard; using electric equipment when possible; ceasing construction activities during periods of high wind or episodes of poor air quality as identified by BAAQMD; using covered dust chutes for removal of building materials or equipment; developing and implementing soil management plans at all construction sites, and ongoing testing and monitoring to detect and eliminate airborne release of PCBs during remediation activities. Measures to mitigate vehicle exhaust emissions include use of construction and maintenance equipment with lower emission engines, use of soot traps or diesel particulate filters, and use of emulsified or low sulfur diesel fuel. Over time, vacuum-assisted street sweepers could be incorporated into municipal maintenance vehicle fleets, which generate less dust during operation than conventional street sweeping equipment.

In-Bay

Impacts: Remediation of PCBs-contaminated hot spots located along the margins of the Bay may result in short term impacts to air quality. These activities may involve the use of diesel-powered dredging equipment and barges to transport the dredged material. On a localized, short-term basis, this equipment could contribute particulate matter as well as some of the ozone precursors. In addition, disposal of material from remediation of in-Bay contaminated hot spots would most likely be disposed of at upland facilities. Upland disposal could also result in increased use of diesel-fueled trucks, which would increase the release of exhaust emissions with particulates (including PM_{10}) and the constituents of photo-chemical smog.

Mitigation: It is anticipated that standard BMPs would reduce these impacts to less than significant levels. Measures to mitigate vehicle exhaust and equipment emissions include use of construction and maintenance equipment with lower emission engines, use of soot traps or diesel particulate filters, and use of emulsified or low sulfur diesel fuel. For large-scale dredging project near-shore, use of electric-powered excavating equipment and barges would significantly reduce equipment and vehicle emissions of both particulates and pollutants without a consequent loss of performance.

4. Biological Resources

Impacts to biological resources would be considered significant if the project caused substantial adverse effects directly or indirectly on a special status species (e.g., listed threatened or endangered) or candidate species. Similarly, substantial adverse impacts to sensitive natural communities, including wetlands, are considered significant impacts due to the potential presence of endangered species. Conflicts with various resource policies and plans, such as Natural Community Conservation Plans, Habitat Conservation Plans, or local tree protection ordinances, if substantial, could also be considered significant impacts.

Implementation of the TMDL for PCBs could lead to projects or activities with impacts to biological resources in three areas as listed on the CEQA checklist:

Would the project:

Impact 4-A Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local, regional *plans, policies, regulations or by California Department of Fish and Game or U.S. Fish and Wildlife Service.*

Impact 4-B Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or the U.S. Fish and Wildlife Service.

Impact 4-C Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including. but not limited to, marsh, vernal pool, coastal, etc) through direct removal, filling, hydrological interruption, or other means.

These impacts are rated potentially significant for in-Bay projects as explained below. There are no known reasonably foreseeable impacts to biological resources from on-land projects; this rating is also explained below.

<u>On Land</u>

There are no reasonably foreseeable impacts to biological resources from implementation of the PCBs TMDL at on-land sites. Although removal of soil and sediment could occur as part of land-based implementation activities, PCBs are normally found in highly urbanized, industrial areas where the presence of sensitive native species and habitats such as wetlands is improbable. As a result, removal of soil and sediment, PCBs-contaminated equipment and building materials, or other remediation activities at on-land sites are unlikely to disturb any rare or sensitive species or habitats. Implementation measures developed to intercept, and treat stormwater or to divert, urban stormwater runoff to municipal wastewater treatment systems are only likely to occur at strategic locations in highly urbanized areas where urban runoff is identified as a source of PCBs or wastewater treatment facilities are in close proximity, which is most likely to be in urban industrial areas. Given these factors, on-land projects have no reasonably foreseeable impacts to biological resources.

<u>In-Bay</u>

Impacts: Implementation of the PCBs TMDL at in-Bay locations could include remediation of sites with PCBs-contaminated sediments. One approach to site remediation dredging is to remove contaminated sediment with offsite disposal or partial dredging combined with capping the remainder in-situ. In-Bay projects to remove PCBs-contaminated sediment would occur in near-shore areas, in sub-tidal or intertidal habitats or in some cases may include sensitive tidal marsh habitat. The size of these projects varies but is generally limited to less than 10 acres. Benthic macroinvertebrate community impacts in sub-tidal or intertidal habitats are generally short-lived. These communities are not considered to be a sensitive natural community. In marine environments, recolonization of stable benthic communities occurs in 3-5 years. In the San Francisco Bay, benthic communities are subject to perturbations due to the effects of salinity changes, wind-wave action and other Bay phenomenon. Changes in community structure occur naturally and therefore remedial dredging small areas of the Bay is not considered a significant environmental impact on biological resources. In addition, one of the reasons some of these sites are on the list of contaminated hot spots, other than because of PCBs, is because toxicity was identified as a concern for the benthic community.

Dredging for remediation of in-Bay contaminated sediment could cause potential impacts to sensitive anadromous fish species such as sturgeon and coho salmon. Impacts are also possible from removal of tidal marsh vegetation and disrupting waterfowl and other wildlife, including endangered species that inhabit such ecosystems through short-term noise and disturbance caused by the presence of humans.

Mitigation: Use of BMPs, and compliance with resource agency requirements, including USFWS, NOAA/NMFS and CDFG, as part of formal or informal consultations required prior to issuance of Clean Water Act 401 water quality certifications by the Water Board and 404 dredging and filling permits should mitigate potentially significant impacts related to dredging of sediment contaminated by PCBs to less than significant levels. Specific mitigation measures include adherence to established work windows to time of dredging activities to avoid key seasonal activity of anadromous fish and bird species that inhabit near shore areas either seasonally or year round; use of electric dredge equipment; use of environmental (closed) clamshell buckets on dredges; and noise dampening material on equipment. Electric-powered dredging equipment has been used for San Francisco Bay dredging projects, such as in the Oakland Harbor. However, this technology is only feasible if the amount of material to be removed is very large and the site is close to shore. Projects that disrupt tidal marshes would be required to mitigate for the temporal and any long-term potential losses.

Any or all of these mitigation measures could be imposed on projects through the regulatory authority of the Water Board, under the Clean Water Act 401 water quality certification requirements. Therefore impacts to biological resources from in-Bay dredging projects would be mitigated to less than significant levels with mitigation incorporated.

5. Cultural Resources

Cultural resources encompass archeological, traditional, and built environment resources including, buildings, other structures, objects, districts, and sites. Significant impacts to cultural resources would occur if a project caused substantial adverse changes or destroyed cultural, historical, or archeological resources or disturbed human remains.

Implementation of the PCBs TMDL could lead to projects or activities with impacts to cultural resources in two areas as listed on the CEQA checklist:

Would the project:

Impact 5-B Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5.

Impact 5-D Disturb any human remains, including those interred outside of formal cemeteries.

These impacts are rated as less than significant as explained below.

<u>On Land</u>

Impacts: Implementation measures for the PCBs TMDL could include construction of facilities/units to intercept, divert and treat urban stormwater runoff; strategic routing of stormwater to POTWs, and removal of soil and sediment from PCBs-contaminated sites. Grading and excavation would affect near-surface soils in previously disturbed soils or artificial fill. Activities would not affect native soil or areas of high archeological sensitivity. Therefore these impacts are rated as less than significant.

<u>In Bay</u>

Impacts: Implementation of the PCBs TMDL could include dredging with offsite disposal and dredging combined with capping the remainder in-situ at sites identified as contaminated by PCBs. Such activities are most likely to be located in Bay-margin or near-shore areas adjacent to former industrial areas. It is possible, though unlikely, that dredging activities to remove PCBs-contaminated sediment in near-shore locations could uncover previously unmapped cultural resources, such as archeological sites.

6. Geology and Soils

Significant impacts to geology and soils would occur if a project exposed people or structures to potential, substantial adverse effects related to rupture of a known earthquake fault, other seismic events, or landslides. Significant impacts would also occur is a project caused substantial erosion or was located in areas with unsuitable soils or landslide-prone conditions. There are no known or reasonably foreseeable impacts to geology and soils as a result of reasonably feasible compliance measures to implement the PCBs TMDL. It is unlikely that agencies or other entities responsible for implementing this TMDL would select projects or project locations that would place people or structures at risk from seismic hazards or landslides or would develop projects requiring construction at sites with unsuitable soils.

7. Hazards and Hazardous Materials

This category refers to chemicals that have been discharged to the environment that may adversely impact the environment or human health and safety. Soil and groundwater impacted by such chemicals are also included classification. Significant impacts would occur if a project led to increased hazards to the public or environment from transport, handling, or emissions of such materials or if projects are located near airports and listed hazardous materials sites.

Implementation of the TMDL for PCBs could lead to projects or activities with impacts related to hazards and hazardous materials in the following three areas as listed on the CEQA checklist:

Would the project:

Impact 7-B Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.

Impact 7-C Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school.

Impact 7-D Be located on a site with is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment.

These impacts are rated as less than significant as explained below.

<u>On Land</u>

Impacts: Actions to implement the PCBs TMDL would include handling and transport of equipment, building materials, soil and sediment containing PCBs or other potentially hazardous material. To protect people and the environment from potential impacts from PCBs-containing material they would be handled, transported, and stored in accordance with applicable laws and regulations.

Project workers and supervisors are required to comply with applicable Occupational of Health and Safety Administration (OSHA) training requirements for site clean-up personnel. In addition, site-specific health and safety plans would be prepared in accordance with Title 8, California Code of Regulations, §5L92 and Title 29, § 1910.120 of the Federal Code of Regulations, which govern site clean-up.

In-Bay

Impacts: There are also potential remediation projects at numerous sites within the Bay that have been identified as 'hot-spots' containing PCBs-contaminated sediment. These are also under the regulatory oversight of the Water Board, ACOE, U.S. EPA, DTSC, and BCDC. These sites were listed as toxic hot spots; the sediments are contaminated, but the available data indicate they are not at hazardous levels. Most of the available data for PCBs contaminant levels in bay sediments indicate levels below the hazardous waste designation level of >50 ppm. Many of these sites have other contaminants identified as co-occurring in the sediment; these other contaminants are also generally at levels that are not considered hazardous. Additional site investigation activities are necessary to better understand some of these sites, and feasibility studies would also be required, thus analyzing for the potential that some hazardous materials may be associated with these sites is speculative at this time.

To protect people and the environment from potential impacts from PCBs-contaminated sediment, the sediment would be handled, transported, and stored in accordance with applicable laws and regulations.

Project workers and supervisors are required to comply with applicable Occupational of Health and Safety Administration (OSHA) training requirements for site clean-up personnel. In addition, site-specific health and safety plans would be prepared in accordance with Title 8, California Code of Regulations, §5L92 and Title 29, § 1910.120 of the Federal Code of Regulations, which govern site clean-up.

8. Hydrology and Water Quality

Significant impacts to hydrology and water quality would occur if a project substantially alters existing drainage patterns, alters the course of a river or steam, violates water quality standards, or creates or contributes to runoff that would exceed local stormwater drainage systems. Significant impacts would also occur if a project placed housing or other structures within the 100-year flood plain, or exposed people or structures to significant risks from flooding, seiches, or tsunamis. There are no known, reasonably foreseeable impacts to hydrology and water quality from the PCBs TMDL as explained below.

Would the project:
Impact 8 – B Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted?

On Land

Implementation of the PCBs TMDL may include remediation projects involving removal of PCBs-contaminated soil and sediment. These projects could include activities such as excavation and backfill. They would not result in permanent changes to drainage patterns. In addition, because PCBs-contamination is most closely associated with their use in equipment such as transformers and building materials in older, highly urbanized, industrial areas, they are unlikely to occur in areas where hydrological changes or proximity to streams is of concern. Furthermore, the purpose of the PCBs TMDL and implementation plan is to attain water quality standards.

<u>In-Bay</u>

Remediation projects to remove PCBs-contaminated sediment through dredging are on-going in a number of locations along the Bay margin; some sites are the subject of feasibility studies and others are at different stages of remediation. These projects are being undertaken under regulatory programs other than the PCBs TMDL and are not required by this TMDL. To the extent that the existing pace of cleanup is affected by this TMDL, it is anticipated that any new remediation activities for sites not currently being worked on could result in potentially significant impacts to water quality due to resuspension of contaminated sediments in the water column.

Mitigation: Projects to remediate PCBs-contaminated sediment in hot spot sites through dredging or partial dredging and capping, would require a water quality certification under Section 401 of the Clean Water Act, or waste discharge requirements issued by the Water Board and permit conditions to ensure that there are no violations of water quality. Examples of mitigation measures include the use of temporary sheet pile enclosures to prevent tidal action or deployment of silt curtains to protect water quality. In addition decant water resulting from hydraulic dredging activities would need to be treated prior to discharge into the environment or properly disposed of. Potentially localized short term impacts would be mitigated by these actions. In addition, these types of remediation activities are expected to result in improved water quality in the long-term. Therefore, impacts to hydrology and water quality from in-Bay dredging projects would be mitigated to less than significant levels with mitigation incorporated.

9. Land Use and Planning

Significant impacts to land use and planning would occur if a project physically divided a community, conflicted with a land use plan, policy or regulation, or caused conflict with a habitat conservation plan. There are no projects related to the PCBs TMDL that would be of a type or scale to cause any impacts in this category. Projects anticipated by the PCBs TMDL implementation plan would occur in urban or industrial areas or on the Bay margin and are not expected to result in substantial changes to established communities or land use patterns. Impacts to land use and planning are expected to be less than significant. Pilot studies to evaluate stormwater control measures, such as use of detention basins, will be conducted by land use agencies, i.e., municipalities and counties, and compatibility with land use will be evaluated as part of those pilot/feasibility studies. It is not reasonably foreseeable that large scale implementation of stormwater detention basins will occur as a result of this TMDL as it not feasible in a densely populated urban areas. The locations of such control measures are not specifically required by this project, and therefore, analyzing the impacts would be speculative at this time.

10. Mineral Resources

Significant impacts to mineral resources would occur if a project resulted in the loss of a mineral resource of value locally, regionally, or statewide. There are no projects related to the PCBs TMDL that would be of a type or scale to cause any impacts in this category. None of the PCBs-contaminated sites are known to occur on land identified as a mineral resource of local, regional, or statewide significance. There are no known or reasonably foreseeable impacts to mineral resources as a result of compliance with the PCBs TMDL.

11. Noise

Significant impacts from noise would occur if a project exposed people to noise or groundborne vibration in excess of excess of established standards in a local general plan or noise ordinance or resulted in substantial permanent increase to ambient noise levels. Significant impacts can also occur if a project causes substantial temporary or periodic increases in noise or if a project is located in the vicinity of an airport and would expose people residing or working in the project area to excessive noise levels.

Reasonably foreseeable means of compliance with the PCBs TMDL at on land locations include projects for removal and disposal of PCBs-containing equipment and building materials; remediation of PCBs-contaminated soil or sediment in public rights-of-way; storm water conveyances; and private property; increased street cleaning (sweeping and washing); storm drain and inlet maintenance above what is currently done. Other possible means of compliance include projects to construct, operate, and maintain facilities/units to intercept, divert, and treat stormwater (e.g., pipelines, detention basins, underground sand filters). For in-Bay control of sources of PCBs, potential means of compliance include projects to dredge PCBs-contaminated sediment. These projects could employ a variety of methods including dredging combined with capping. A small percentage of material removed by these projects may require disposal at approve facilities at upland sites. Noise impacts related to the TMDL are primarily short-term and related to construction activities.

According to the Federal Transit Administration’s guidelines for evaluation of noise and groundborne vibration associated with construction activities, assessments of noise and vibration during construction are dependent upon a number of factors. These include proximity to sensitive receptors (schools, museums, some types of parks), characteristics of the soil and rock substrate to transmit vibration, sound-proofing characteristics of buildings, and the degree of noise already present in an area. It is difficult to determine the extent of noise impacts since site-specific factors are not currently known. In addition, impacts also vary based on the type of equipment used and the number of pieces of equipment operated simultaneously. The discussion below is, therefore, general in nature. However, with implementation of industry standard mitigation, we anticipate that all noise impacts could be mitigated to less than significant levels.

Implementation of the PCBs TMDL could lead to projects or activities with impacts related to noise in three areas as listed on the CEQA checklist:

Would the project result in:

Impact 11-A Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

Impact 11-B Exposure of persons to or generation of excessive groundborne vibration or groundborne noise?

Impact 11-D A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?

Impacts 11-A and 11-D are rated as potentially significant, but less than significant with mitigation incorporated as explained below. Impact 11-B is less than significant and is also explained below.

<u>On Land:</u>

Impacts: Projects involving remediation of PCBs-contaminated sites, including removal of equipment or building materials; construction of facilities to treat or intercept and divert stormwater; and clean PCBs-contaminated sewer lines could cause short-term, localized noise impacts.

Mitigation: Individual projects with noise impacts would be subject to applicable local permitting requirements and noise ordinances. Local agencies require implementation of standard construction BMPs to reduce noise impacts, and include, but are not limited to practices such as restrictions on operating hours and use buffer materials around/on machinery. In some cases, use of hydraulic or electric equipment could be substituted for noisier diesel equipment. Newer equipment, which emits less noise, could also be used. For particularly loud or lengthy activities, temporary noise buffers could be installed.

<u>In-Bay:</u>

Impacts: Dredging activities to remove PCBs-contaminated sediment from near shore or Bay margin locations could produce potentially significant noise-related impacts because they may involve the use of sheet pile to dewater work areas. Installation of sheet pile may produce short-term, potentially significant noise impacts.

Mitigation: Individual projects with noise impacts would be subject to applicable local permitting requirements and noise ordinances. Local agencies require implementation of standard construction BMPs to reduce noise impacts, such as restrictions on operating hours, for example, typical standards include blackouts prohibiting use of heavy equipment on Sundays, early mornings and evenings all week, and on holidays). Buffer materials around/on machinery and engine and pneumatic exhaust controls could be used to control noise. In some cases, use of electric powered dredging equipment may be possible as a substitute for noisier diesel machinery.

12. Population and Housing

Significant impacts to population and housing would occur if a project substantially encouraged population growth, displaced substantial numbers of people from existing housing necessitating construction of replacement housing elsewhere. There are no projects related to the PCBs TMDL that would involve construction or removal of housing or bring large numbers of people to the Bay Area. There are no known or reasonably foreseeable impacts to population and housing as a result of compliance with the PCBs TMDL.

13. Public Services

Significant impacts to public services would occur if a project resulted in substantial physical impacts as a result of requirements for increased public services such as police, fire protection, schools, or other public facilities. There are no projects related to the PCBs TMDL of a type that would increase the need for police or fire services. There are no known impacts to public services as a result of the PCBs TMDL.

14. Recreation

Significant impacts to recreation would occur if a project increased the use of existing park facilities such that physical impacts occurred of if a project included construction or expansion of park facilities leading to physical impacts. Actions to implement the PCBs TMDL would not affect use of parks or other recreational facilities or lead to physical impacts to them. There are no known impacts to recreation as a result of the PCBs TMDL.

15. Transportation and Traffic

Significant impacts to transportation and traffic would occur if a project caused a substantial increase in traffic in relation to existing traffic load/capacity of the existing street system, exceeded established level of service standards, resulted in change in air traffic patterns, lead to increases in road-related hazards, resulted in inadequate emergency access or parking.

Assessment of transportation and traffic impacts normally requires extensive study of the project area, existing traffic patterns, loads, and level of service standards. In this programmatic review, such detailed analyses are not possible, since specific projects have not yet been developed. However, Water Board staff anticipates that some reasonably foreseeable means of compliance with the PCBs TMDL could result in impacts to as identified below.

Implementation of the PCBs TMDL could lead to projects or activities with impacts to transportation and traffic in two areas as listed on the CEQA checklist:

Impact 15-A Cause an increase in traffic substantial in relation to the existing traffic load and capacity of the street system.

Impact 15-B Exceed either individually or cumulatively a level of service standard established by county congestion management agency for designated roads and highways.

These impacts are rated as less than significant as explained below.

<u>On Land</u>

Impacts: Projects to implement the TMDL could include construction of facilities to treat stormwater or to strategically divert stormwater to municipal wastewater treatment facilities for treatment. It could also result in projects for remediation or removal of PCBs-containing equipment and building materials. Remediation projects could be developed to remove soils and sediments from public rights of way, wastewater conveyances (in some limited locations), and private property. Finally, some dischargers may increase the frequency of maintenance of storm drain inlets and filtration systems as well as street cleaning (sweeping and washing).

Movement of personnel to and from work sites and hauling of equipment and materials to or from such construction or remediation sites as well as hauling of contaminated in-Bay sediments to upland disposal facilities, could potentially result in short-term impacts to traffic. Increases in the frequency of street cleaning and maintenance activities at storm drain inlets or filters could result in a minor increase in traffic.

The location, routes, and scale of such projects and activities are currently unknown and thus the impacts of any individual project would be speculative. However, standard industry practices require a traffic management plan, which includes measures such as strategic route selection and carefully planned timing for haul-truck traffic, traffic impacts would be minimized. Other traffic, such as from street cleaning, would add only very small volumes of traffic that would not affect levels of service, roadway networks, or parking capacity. We anticipate that impacts to traffic and transportation would be less than significant levels.

<u>In-Bay</u>

As described above, site remediation at in-Bay locations may produce some material that does not meet new standards for in-Bay disposal. In that case, this material is most likely to be transported to appropriate on-land sites, possibly increasing traffic. However, given the small percentage of material likely to be involved and the ability to control timing and route to minimize effects, this is impacts is considered less than significant.

16. Utilities and Service Systems

Significant impacts to utilities and service systems would occur if a project exceeded wastewater treatment standards, required construction of new water or wastewater treatment facilities, new or expanded storm water drainage facilities, or a project's water needs exceeded existing resources or entitlements. Significant impacts would also occur if a project was not served by a landfill with sufficient capacity or the project failed to comply with federal, state, or local regulations for solid waste.

Implementation of the PCBs TMDL could lead to projects or activities with impacts to utilities and service systems in three areas as listed on the CEQA checklist:

Would the project:

Impact 16-B Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.

Impact 16-C Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.

These impacts are rated as potentially significant, but less than significant with mitigation incorporated as explained below.

<u>On Land</u>

Impacts: Projects to implement the PCBs TMDL could include construction of new facilities to intercept or treat stormwater or to divert stormwater runoff to municipal wastewater facilities for treatment. While it is not anticipated that retrofits to stormwater drainage systems, construction of new stormwater treatment control measures, or diversion to POTWs, would be significant, construction of any of these facilities could be viewed as potentially significant. The number and location of projects of this type is currently unknown. Pilot studies to evaluate stormwater control measures will be conducted by stormwater management agencies. In addition, the implementation plan calls for pilot studies to evaluate the feasibility of routing stormwater to POTWs, and this would be conducted by individual stormwater agencies or municipal wastewater districts.

Mitigation: Mitigation for these projects is linked to careful site selection. The implementation plan notes that interception and diversion of stormwater is an option that could be employed where strategically feasible, such as areas where stormwater systems and municipal treatment facilities or conveyances are close together. The benefits of this are lowered cost and lowered potential environmental impacts.

The specific mitigation measures could include, but are not limited to, pre-construction BMPS, such as appropriate site selection and environmentally-friendly design; during construction, the use of standard construction BMPs appropriate to the conditions at a site; and for the project as a whole, measures appropriate to offset impacts, such as habitat restoration or enhancement, contributions to mitigation banks, etc.

In-Bay

This category is not applicable to in-Bay projects.

12.7. Mandatory Findings of Significance

The results of this analysis demonstrate that the means of compliance with TMDL for PCBs in San Francisco Bay and its Implementation Plan will not have any reasonably foreseeable potentially significant impacts on the environment that cannot be mitigated to less than significant levels.

With implementation of mitigation measures identified in the environmental checklist and required by federal, state, and local laws and regulations, impacts having a potential to degrade the environment would be reduced to less than significant levels.

Pursuant to Section 13360 of the Water Code, the Water Board cannot mandate which compliance measures responsible agencies may choose to adopt or which mitigation measures they would employ for projects to implement the PCBs TMDL that do have potentially significant impacts. However, the Water Board anticipates that appropriate mitigation measures, which are already widely in use and considered consistent with industry standards, be applied as necessary, in order to avoid and reduce as well as mitigate potential environmental impacts. These measures should ensure that impacts are reduced to less than significant levels. Since the decision to perform these measures is strictly within the responsibility and jurisdiction of the individual implementing agencies, such measures can and should be adopted by these agencies (Title 14, California Code of Regulations, Section 15091 (a) (2)).

12.8. Cumulative Impacts and Other Analyses

Cumulative Impact Analysis

This section provides an analysis of the significant cumulative impacts of the proposed Basin Plan amendment (CEQA Guidelines Section 15130). Cumulative impacts refers to “two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.”

The cumulative impact that results from several closely related projects is the change in the environment that results from the incremental impact of the project when added to other closely related past, present and reasonably foreseeable probable future projects. In this case, these are the impacts from non-TMDL required municipal and private projects to reduce PCBs that would occur in the watershed during the period of implementation of the TMDL.

Approach to Cumulative Impact Analysis

The areas of cumulative impacts analyzed in this section include: 1) the program level cumulative impacts and 2) the project level cumulative impacts. On the program level, the PCBs TMDL is one of several TMDLs planned or already adopted to address impairment in the San Francisco Bay. Other adopted or planned future TMDLs for San Francisco are considered in this program cumulative analysis. On the project level, the full environmental analysis of individual projects is the purview of the implementing counties/municipalities, POTWs or other agencies with approval authority. The cumulative impact analysis included here entails consideration of other stormwater control measures implemented in the past and present, planned future upgrades of wastewater treatment plants, and past, present and future cleanup actions for in-Bay contaminated hot spots.

Adoption of the Basin Plan amendment is intended to facilitate implementation of the TMDL. However the requirements identified in the TMDL implementation plan are generally implemented through NPDES permits, waste discharge requirements or other regulatory tools. Agencies other than the Water Board will likely use regulatory and non-regulatory tools in implementing the PCBs TMDL. The Basin Plan amendment would be cumulatively beneficial to the environment in terms of some resource areas. Conceptually, the impacts associated with improving water quality through the TMDL, if occurring with other construction projects, could contribute to temporary cumulative effects to air quality, noise or traffic impacts that would not occur with only one project.

Overall the cumulative effect is to provide an environmental benefit to the San Francisco Bay and achieve compliance with existing adopted water quality standards established by the U.S. EPA and this Water Board.

Program Cumulative Impacts

The Water Board has adopted one TMDL for San Francisco Bay. The Mercury TMDL for San Francisco Bay (adopted by the Water Board on August 9, 2006 and by the State Board on July 17, 2007) was developed due to impairments from mercury. Many of the reasonably foreseeable methods of compliance for one TMDL are the same as or similar to those that will be used to address other pollutants through the implementation of other TMDLs. In terms of stormwater, best management practices and control measures that are applicable to PCBs are likely to be similar measures to those being implemented for mercury in the urban watershed. On-land control measures for mercury also target mine sites in the watershed and would therefore be conducted in addition to on-land control measures for PCBs. The potential implementation strategies discussed in this document for the PCBs TMDL are likely relevant to the implementation of other TMDLs for the San Francisco Bay.

In addition, TMDLs for selenium, legacy pesticides, and dioxins other than dioxin-like PCBs, are in development for the San Francisco Bay and a TMDL for pathogens is in development for Richardson Bay.

Project Cumulative Impacts

Specific TMDL projects must be environmentally evaluated and cumulative impacts considered as the implementing municipality or agency designs and sites the project. However, as examples, TMDL projects and other construction activities may result in cumulative effects.

With regards to cleanup of PCB-contaminated hot spots, the TMDL requires only the collection of information about in-Bay contaminated hot spots; it does not require other actions at these sites and does not set cleanup standards to be achieved at these sites. Investigation and cleanup of contaminated in-Bay hot spots are already underway at many sites in the Bay without the adoption of the TMDL. The one part per billion sediment goal is not a cleanup goal or regulatory standard. Thus, the one part per billion sediment goal will not require a large-scale, bay-wide mass removal of contaminated sediments from in-Bay hot spots. Table 23 lists the sites where cleanup of contaminated in-Bay sediments sites have occurred in the past, those that are in the process of being addressed, and sites where some studies may have been completed but no plans currently exist for any actions to be taken. Since the TMDL does not call for specific actions to be taken, and it is unclear whether actions will be taken in the future at sites where work has yet to be started, an evaluation of the cumulative environmental impacts is speculative. However, to the degree enough information may be available to provide a general response, they are provide below by subject category.

Air Quality

Implementation of the PCB TMDL Program may cause additional emissions of ozone precursors, $PM_{10,}$ and slightly elevated levels of carbon monoxide during construction activities. Emissions of PM_{10} resulting from implementation of TMDL compliance measures may exceed the thresholds established by the Bay Area Air Quality Management District (BAAQMD), and therefore the TMDL, in conjunction with all other construction activity, may contribute to the region's nonattainment status. However, the BAAQMD CEQA guidelines (BAAQMD 1999) state that cumulative impacts should be determined based on an individual project's consistency with applicable local General Plans and whether it would affect conformance of the General Plan with the regional air quality plan. The majority of the implementation measures under consideration as reasonably foreseeable means of compliance with the TMDL do not result in operational activities that would increase emissions in the areas due to an increase in population or vehicular traffic that would be sustained over time.

The control measure that might increase vehicular traffic is street sweeping/cleaning and storm drain maintenance. Past and current stormwater control measures focus on street sweeping and litter/debris removal, which results in vehicular traffic. This TMDL would increase the amount of vehicular traffic in an incidental fashion as the areas that would be subject to increased street sweeping are geographically small and limited to industrial, former industrial or small adjacent residential areas of municipalities and the cumulative impacts due to the individual impacts from this project when considered with the impacts from existing street sweeping activities are not anticipated to be significant.

The cumulative impacts to emissions of criteria pollutants and greenhouse gases are not anticipated to be significant. Cleanup actions taken at in-Bay contaminated hot spots in the past, present, or planned for the future involve dredging for PCB contaminated sediments in sites smaller than 10 acres and the list of contaminated hot spots has only 21 sites listed (Table 23). Removal actions conducted or planned at contaminated hot spots in the bay to-date range from a few thousand cubic yards to less than 100,000 cubic yards (Battelle 2005, U.S. Navy 2006b, U.S. Navy, 2007 and URS, 2002a). Construction activities at these sites may create short-term impacts. However, these activities do not occur simultaneously and are located in different parts of San Francisco Bay. It takes a number of years to evaluate and select a remedial alternative and thus it is unlikely that multiple projects will be occurring simultaneously. Therefore, the cumulative impact of these projects are not anticipated to be significant. In addition, these types of construction activities are accounted for in the BAAQMD's emissions inventory in the regional air quality plan.

Biological Resources
Many of the compliance measures required under the TMDL are located in urban, industrial areas, do not impact sensitive habitats or biological resources. Where in-Bay contaminated hot spot cleanups conducted in the past have had the potential to impact biological resources, they have been required to mitigate by waste discharge requirements or 401 water quality certifications for the temporary impacts to sensitive wetlands and to monitor to ensure site vegetation and habitat restoration. In addition, mitigation measures for the protection of listed or endangered species are required where applicable. For example, construction is required to operate outside of nesting seasons and during migratory fish passage windows. These mitigation measures are required by any agency with approval authority for the cleanup actions.

The cumulative impacts to biological resources, i.e., destruction or damage to healthy benthic communities due to the excavation of PCBs-contaminated sediment from in-Bay PCB contaminated hot spots are not anticipated to be significant. Cleanup actions taken at in-Bay contaminated hot spots in the past have involved dredging for PCB contaminated sediments in sites smaller than 10 acres and the list of contaminated hot spots has only 21 sites listed (Table 23). Benthic macroinvertebrate community impacts in sub-tidal or intertidal habitats are generally short-lived; these communities have the ability to recolonize in a few years and are not considered to be a sensitive natural community. In San Francisco Bay, changes in benthic community structure occur naturally and therefore remedial dredging of small areas of the Bay is not considered a significant environmental impact on biological resources.

Cultural Resources
Implementation of the PCBs TMDL is not expected to contribute to a cumulative loss of cultural resources in the San Francisco Bay area. The activities related to past, present or future contol of external loading of PCBs to San Francisco Bay or remediation of In-Bay PCB-contaminated hot spots are not known, or likely, to contain cultural resources that would be lost or contribute to a cumulative loss or to impact historic districts in the Bay area.

Hazards and Hazardous Materials
Projects to cleanup on-land contamination and in-Bay contamination from PCBs in soils and sediment have been on-going in the San Francisco Bay area since the ban was enacted on PCBs. The greatest concern is in the safe transport and treatment, storage and disposal of hazardous materials. The implementation of the PCBs TMDL and all other cumulative projects must comply with the applicable laws and regulation pertaining to public safety in the transport, treatment, storage and disposal of hazardous materials. Thus, cumulative impacts would be less than significant. In addition, addressing sources of these contaminants in the environment has a cumulatively positive impact on the environment.

Hydrology and Water Quality
Implementation of the PCBs TMDL is expected to result in long-term improvement in water quality by reducing the potential for introduction of PCBs into San Francisco Bay. Other TMDLs are addressing other pollutants responsible for impairing water quality in San Francisco Bay, and thus, the cumulative impact of other program, as well as specific, projects constructed to meet Clean Water Act requirements, have resulted in long-term improvements in water quality and are expected to continue this improvement.

Land Use and Planning

The cumulative impacts to land use and planning and landfill capacity are not anticipated to be significant. Cleanup actions taken at in-Bay contaminated hot spots in the past have involved dredging for PCBs-contaminated sediments in sites smaller than 10 acres, and the list of contaminated hot spots has only 21 sites listed (Table 23). Cleanups conducted in the past or planned for the future for remediation of contaminated hot spots have occurred in the vicinity of industrial sites, brownfields, redevelopment sites and former military bases. There has been sufficient land available to process hydraulically dredged sediments prior to off-site disposal at landfills. There has also been adequate landfill capacity in the past, and in some cases, the dried sediment was clean enough to be used as alternate daily cover at landfills. In some cases, material was allowed to be managed upland at industrial sites or remain in-Bay, if properly managed, i.e., capped and isolated in place.

The TMDL does not envision the use of multiple, large detention basins capable of treating all Bay area stormwater. Much of the available land in the Bay Area has been developed for housing, industrial or commercial purposed. Stormwater management agencies are required to conduct pilot studies to evaluate the effectiveness of such control measures prior to strategically implementing them. Therefore, there is no basis to conclude that the proposed project would result in cumulative impacts to land use.

Noise

Construction activities associated with the implementation of the PCBs TMDL in combination with other noise-generating sources may exacerbate noise conditions in some locations, however, these impacts are short term in nature. Most noise is associated with traffic. Noise levels from construction activities, once completed, would return to current levels. Other activities, such as street sweeping, are expected to occur intermittently, over small geographical areas and be of short term duration. Overall, with mitigation, the activities resulting from the PCBs TMDL would not be expected to contribute considerably to a cumulative noise impact.

Transportation and Circulation

Implementation of control measures will create additional short terms increases during construction and maintenance. Implementation, after successful completion of the initial pilot studies, will likely be staggered over time and will occur in a few locations throughout the watershed. This decreases the likelihood that these projects cumulatively will cause significant impacts. The PCBs TMDL would require implementation of control measures and best management practices in locations within the watershed where existing land use indicates a historical use of PCBs. Most of the implementation measures, for example, additional street sweeping, are unlikely to create significant cumulative impacts.

Existing stormwater runoff permits currently require the installation of control measures at new developments or redevelopment projects. Some cities in the Bay area are actively requiring construction of stormwater control measures as part of new development projects. These control measures are generally smaller elements of much larger construction projects, residential subdivisions, commercial high rises, and these larger projects require a consideration of the permanent impacts to traffic and transportation. The stormwater control measures are thus inconsequential to these projects.

Overall, it is anticipated that implementation of the TMDL is unlikely to create cumulatively permanent, significant additions to traffic or transportation.

Utilities and Service Systems
Implementation of the PCBs TMDL would not increase water use. There is the possibility that strategically routing of stormwater to wastewater treatment plants would increase the amount of wastewater processed by these plants. However, the requirement of the TMDL is to evaluate the feasibility of this type of approach with an emphasis on using currently available existing capacity at municipal treatment plants. Therefore no significant additions to wastewater treatment plants are expected. The addition to the plant facilities would be limited to construction of pipelines or pumping capacity to route the stormwater. A few wastewater treatment plants in the Bay Area are planning upgrades to their facilities, improving their capacity or collection system rehabilitation. Some of these facilities have analyzed the environmental impacts of these activities and others are still in the planning stages. All these projects are anticipated to conform with their General Plans. It is not anticipated that construction to support routing of stormwater will create a significant impact on available services.

Growth Inducement
Approval and implementation of the proposed Basin Plan amendment would have no direct effect on growth inducement. Implementation of the PCBs TMDL would not directly or indirectly foster economic or population growth or the construction of additional housing. The project does not require the construction of additional capacity at wastewater treatment plants that might be considered to indirectly foster growth.

Significant Irreversible Changes in the Environment
Approval and implementation of the proposed Basin Plan amendment would result in the irretrievable commitment of petroleum products to fuel vehicles and equipment and the creation of some greenhouse gases that might be viewed as contributing to significant irreversible environmental changes already occurring globally.

12.9. Alternatives Analysis

The discussion that follows evaluates four alternatives to the proposed Basin Plan amendment establishing the PCBs TMDL. It presents a brief evaluation of each alternative. None of the alternatives evaluated significantly lessen the environmental impacts of the proposed project. The proposed project is not expected to result in significant impacts that cannot be mitigated and thus it is not reasonable to look to other alternatives to lessen significant impacts. Some of the alternatives do meet some of project’s objectives. However, they generally result in attainment of water quality objectives in a longer period of time and thus do not meet one of the primary objectives which is attainment of water quality objectives in the shortest time frame possible. In addition, there would be a longer period of time during which the environmental impact of exposure to Bay fish contaminated with PCBs would continue. The proposed project is thus the preferred alternative.

No-Project Alternative

The “No-Project” alternative means that the Water Board would not adopt the Basin Plan amendment that establishes the numeric fish tissue target and associated PCBs TMDL, allocations, implementation plan, monitoring requirements, or special studies. A “No-Project” alternative would not set targets, nor would monitoring be required to demonstrate achievement of those targets or protection of beneficial uses. The Regional Monitoring Program (RMP) may continue to collect and evaluate data on the status and trends of PCBs in San Francisco Bay.

The “No-Project” alternative is anticipated to achieve some of the objectives of the proposed project, including protection of the beneficial uses for sport fishing and wildlife habitat. As seen in Figure 28, the Bay is projected to recover without the project due to natural attenuation of PCBs in the environment. However, it would take nearly 100 years to attain the desired condition, about 60 years more than if the proposed project alternative is implemented. The “No-Project” alternative would delay recovery of the Bay and attainment of beneficial uses by about 60 years, and unduly prolong the associated impacts to Bay sports fish consumers. This alternative would unnecessarily maintain human health risk to Bay sport fish consumers for a longer time than under the proposed project. Thus, it would not meet the objective of attaining water quality objectives in as short a time frame as feasible.

Finally, the “No-Project” alternative would not lessen the environmental impacts over the proposed project because 1) other regulatory programs already require many of the actions and the associated environmental impacts of the proposed project, and 2) the environmental impacts of exposure to PCBs contaminated Bay fish would continue for a longer period of time than with the proposed project and there would be no measures to address risk management of the potential health impacts of consuming PCB-contaminated Bay fish.

Alternative TMDL of 20 kg/yr

We considered doubling the TMDL to 20 kg/yr, using the same long-term mass balance model used to set the proposed TMDL. A higher TMDL of 20 kg/yr would result in higher load and wasteload allocations for each source category. This alternative will result in attainment of the TMDL target in about 70 years. This alternative would delay recovery of the Bay and attainment of beneficial uses by about 30 years, and unduly prolong the associated impacts to Bay sports fish consumers. This alternative would unnecessarily maintain human health risk to Bay sport fish consumers for a longer time than under the proposed project. Under this alternative, we could assign a higher load allocation to the Central Valley, resulting in earlier attainment of the allocations. However, wasteload allocations for industrial and municipal wastewater would remain the same, as they are set at current performance. Therefore, the proposed implementation actions for industrial and municipal wastewater dischargers would remain the same and the associated environmental impacts would remain the same. The stormwater wasteload allocations would likely increase under this alternative. However, there would still be a need for load reductions from stormwater discharges, maintaining the requirements for stormwater agencies to evaluate and implement PCBs source and treatment control BMPs through pilot studies as in the proposed project. Requirements for in-bay contaminated sites, special studies, monitoring, dredgers, and risk management would remain the same as in the proposed project under this alternative. This alternative would not significantly change environmental impacts compared to the proposed project. As the implementation actions would remain the same under this alternative, i.e., implementation requirements for wastewater, stormwater, Central Valley, in-bay contaminated sites, special studies, monitoring, navigational dredging, and risk management in the first phase of implementation would remain the same.

Alternative Based on Equal Percentage Load Reductions

Under this alternative, we could propose load and wasteload allocations based on an equal percentage reduction from each source category to achieve the TMDL of 10kg/yr. This alternative would result in a higher wasteload allocation to stormwater, and lower allocations to all other source categories. Figure 31 below presents the proposed equal percentage load reductions.

This alternative is not acceptable for several reasons. First, this alternative allows stormwater, the highest controllable source of PCBs in the watershed, to continue to discharge PCBs in sediment at concentrations above the sediment goal. This is anticipated to delay recovery of the Bay from impairment and attainment of beneficial uses. The environmental impacts of exposure to PCBs contaminated Bay fish would continue for a longer period of time than with the proposed project. Increased stormwater load allocations would not relieve the need for implementation of source and treatment control BMPs for PCBs to the maximum extent practicable. As such, it would be speculative to contend that there would be either increased or reduced environmental impacts associated with increased stormwater load allocations. Third, this alternative would place a large financial burden on industrial and municipal wastewater treatment plants. Most treatment plants would need to upgrade to advanced treatment technology to lower PCBs loads to meet the wasteload allocations under this alternative. This would require a large capital investment for wastewater treatment plants upgrades to achieve small load reductions and potential increased environmental impacts to air quality and noise due to the facility upgrades. Requirements for in-bay contaminated sites, special studies, status and trend monitoring, navigational dredging, and risk management would remain the same as in the proposed project under this alternative and thus any relevant environmental impacts would be the same.

This alternative would not significantly change environmental impacts compared to the proposed project. Increased stormwater wasteload allocations would still require load reductions from stormwater discharges, maintaining the requirements for stormwater agencies to evaluate and implement PCBs source and treatment control BMPs through pilot studies as in the proposed project. It would be speculative to contend that there would be either increased or reduced environmental impacts associated with increased stormwater load allocations.

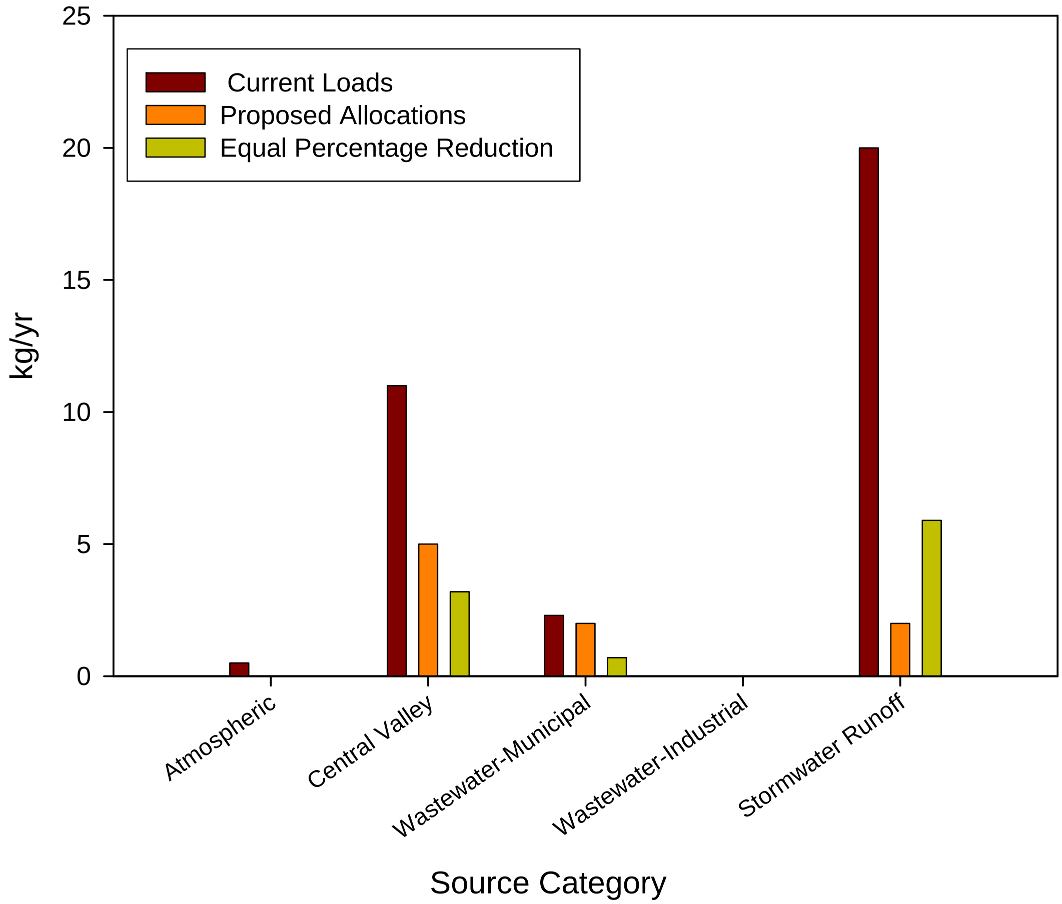

Figure 31-Current Loads, Proposed Allocations and Equal Percentage Reduction Alternative Allocation

Lowest Possible Cost Alternative

Under this alternative, we would propose a TMDL that would attain the project objectives at the lowest possible costs. This alternative would establish a TMDL and set a fish tissue target but would limit implementation to existing on-going implementation actions and monitoring requirements. No new implementation actions, special studies, or pilot studies to evaluate stormwater control measures would be required under this alternative.

As with the "No Project" alternative, the lowest possible cost alternative would achieve some of the objectives of the proposed project, including protection of the beneficial uses for sport fishing and wildlife habitat. As seen in Figure 28, the Bay is projected to recover without the project due to natural attenuation of PCBs in the environment. However, it would take nearly 100 years to attain the desired condition, about 60 years more than if the proposed project alternative is implemented. The "No-Project" alternative would delay recovery of the Bay and attainment of beneficial uses by about 60 years, and unduly prolong the associated impacts to Bay sports fish consumers. This alternative would unnecessarily maintain human health risk to Bay sport fish consumers for a longer time than under the proposed project. Thus, it would not meet the objective of attaining water quality objectives in as short a time frame as possible.

Finally, the lowest possible cost alternative would not lessen the environmental impacts over the proposed project because: 1) other regulatory programs already require many of the actions and the associated environmental impacts of the proposed project, and 2) the environmental impacts of exposure to PCBs contaminated Bay fish would continue for a longer period of time than with the proposed project and there would be no measures to address risk management of the potential health impacts of consuming PCB-contaminated Bay fish.

12.10. Economic Considerations Related to Potential Implementation Plan Actions

The California Environmental Quality act requires that whenever a Water Board adopts a rule that requires the installation of pollution control equipment or establishes a performance standard or treatment requirement, it must conduct an environmental analysis of reasonably foreseeable means of compliance. This analysis must take into account a reasonable range of factors, including economics. This proposed Basin Plan Amendment for the PCBs TMDL includes performance standards (e.g., targets and allocations). This part of the Staff Report discusses the reasonably anticipated costs associated with implementation methods and monitoring that might result from the proposed Basin Plan amendment.

Discussion of Costs

The costs of implementation actions are difficult to estimate because the PCBs TMDL implementation plan applies to the entire nine-county, Bay-wide region and applies to numerous public agencies as well as individual dischargers all of which have a variety of ways to comply with the plan and will be guided in selecting those implementation measures by their technical needs and budgetary constraints. Thus it is difficult to anticipate which implementation measures are most likely to be adopted. Furthermore, phased pilot or feasibility studies will be used to identify and evaluate the feasibility (which includes relative costs and effectiveness) of most compliance measures. These assessments need to be completed before the dischargers select which action or combination of actions will be most effective and appropriate to their allocations. Also, as mentioned previously, many of the implementation measures are part of ongoing programs, and will only result in incremental increases to costs of existing programs.

These factors result in the likelihood that short-term costs will be modest. In the longer term, achieving the proposed allocations set by the TMDL may be more substantial for some dischargers. However, the implementation plan and schedule provide an opportunity to analyze alternative means of compliance and time to identify and secure adequate funding. Furthermore, because PCBs adhere to soil as do numerous other pollutants such as PBDEs, PAHs, chlorinated legacy pesticides, and heavy metals, efforts to reduce PCBs loads to the Bay will produce multi-pollutant reduction benefits. Thus, some of the costs to comply with this TMDL will also result in compliance with other TMDLs and regulatory requirements for those other pollutants.

This discussion provides an overview of the relative costs for each of the source categories that are required to implement new actions, or increased actions to attain allocations or implementation requirements. Cost information is based on similar work performed elsewhere and the best professional judgment of Water Board staff. All costs discussed below are rough estimates and only provide an order-of-magnitude characterization of costs. The main focus of the implementation plan is on control of PCBs in stormwater. Thus, the largest implementation costs are anticipated to result from implementation of the stormwater runoff allocation portion of the TMDL.

The following provides an overview:

Municipal and Industrial Wastewater Dischargers

Wastewater dischargers are required to maintain optimum treatment performance for solids removal and identify and manage controllable sources, i.e., maintain their existing performance. Existing overall annual wastewater management costs exceed $500 million to control all pollutants in wastewater, including PCBs.

The costs of implementing the TMDL are considered to be incidental increases associated with identifying and managing controllable sources. For municipalities, we expect this effort would be part of existing pollution prevention and source control programs and new costs would be minimal. Industrial facilities are already required to manage their use of PCBs. Use of PCBs is allowed in enclosed containers such as in transformers and capacitors. However, as this equipment ages, it must be removed and replaced with PCBs-free products. There will be some new costs associated with conducting or causing to conduct monitoring and special studies to fill critical data gaps and to participate in risk management activities (see discussion below).

Stormwater Runoff Dischargers

The costs of attaining load reductions above and beyond natural attenuation may be substantial. Five California municipalities and one metropolitan area with stormwater programs that were demonstrating meaningful progress toward maximum extent practicable compliance were surveyed for their stormwater compliance costs in the 2002/2003 time frame (SWRCB, 2005). Annual cost per household for the six stormwater programs surveyed ranged from $18 to $46. The City of Fremont, included in this cost survey, has costs estimated at $46 per household. The majority of these program costs were for street sweeping and litter/debris removal. We estimate Bay Area municipalities currently spend approximately $100 million per year to manage urban stormwater runoff (assuming 2.5 million households and average fees of $40 per year per household). An upper bound estimate of the cost of complying with stormwater control requirements for all pollutants, including PCBs, can be thought of in terms of the costs of treating wastewater in the Bay area. The load allocations in the TMDL for stormwater and wastewater are equal. The current cost of treating wastewater, $500 million annually, results in wastewater loads that are equal to what the Basin Plan amendment allocates for stormwater. We consider $500 million to be the reasonable cost estimate to the stormwater runoff management agencies annually. The $500 million would translate into average fees of $200 per year per household.

The TMDL implementation plan calls for dischargers to conduct pilot studies of best management practices and control measures. Based on these studies the effective, cost-efficient control measures will be implemented through NPDES permits. It is anticipated that the overall costs are likely to be less than $500 million per year.

These include:

- Removal and disposal of PCBs from building materials
- Remediation of contaminated soil or sediment in public rights-of-way, wastewater conveyances, and private property
- Street cleaning (includes sweeping or washing)
- Storm drain and inlet maintenance (above and beyond normal practices)

- Construction, operation, and maintenance of facilities/units to intercept, divert, and treat urban stormwater runoff (e.g., detention basins, wetlands, underground sand filters, swales)
- Diversion of urban storm water runoff to wastewater treatment

To provide further perspective on costs, we expect that facilities which treat urban stormwater runoff will have the highest costs of these options. As discussed in the Implementation Plan section of this report, we anticipate dischargers' pilot studies will include consideration of strategic runoff treatment in areas with elevated PCBs in soils/sediments, such as older industrial urban areas. Underground sand filters, such as the Austin sand filter, are likely retrofit treatment unit candidates in these areas. Typically the Austin sand filter system is designed to handle runoff from drainage areas up to 50 acres (U.S. EPA, 1999b), and Caltrans has considered these filters for treatment of highway runoff and has estimated the cost of installing the Austin sand filter unit at around $240,000 (Caltrans, 2004). The Ettie Street pump station drainage area in Oakland, CA, which encompasses 100 acres, is one of the industrial urban areas that drain to the Bay that have high levels of PCBs in storm drain sediments. In the case of Ettie Street watershed, installing Austin sand filters to treat the entire drain area would cost less than $5 million, based on the above figures. Assuming there are about 20 Ettie Street-like watersheds that have high levels of PCBs in storm drain sediments that drain to the Bay, the cost of installing these sand filters would be around $100 million. Annual costs for maintaining sand filter systems
average about 5 percent of the initial construction (U.S. EPA, 1999b). These are rough estimates, but they likely represent the order of magnitude of costs of retrofit treatment units.

The proposed implementation plan and schedule provides opportunity to analyze alternative means of compliance and allows time for urban stormwater runoff agencies to secure reasonable funding. There will be some new costs associated with conducting or causing to conduct monitoring and special studies to fill critical data gaps and to participate in risk management activities (see discussion below.)

Navigational Dredging and Disposal

The proposed sediment dredging and disposal implementation actions are based on the Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region (U.S. ACE 1998) that is already being implemented. We estimate the current annual costs of dredging and dredged sediment disposal exceeds $50 million per year. Although the LTMS is expected to result in substantial costs over time as less dredged material is disposed of in the bay and more is disposed of in the ocean or at upland sites, little or no new costs should be incurred as a result of this PCBs TMDL and implementation plan, because the overall goal of the LTMS is to limit in-Bay disposal and to the degree the TMDL requires less in-Bay disposal it is furthering the LTMS program's overall goals. There will be some new costs associated with conducting or causing to conduct monitoring and special studies to fill critical data gaps and to participate in risk management activities (see discussion below).

In-Bay Contaminated Sediment

A number of sites within the Bay have already been cleaned up or are currently undergoing remediation or feasibility studies to determine the type and level of clean-up required. The costs per site vary significantly; a few past and planned projects are discussed below.

In 2001, remedial actions, including dredging three feet of PCB and metal contaminated sediment and placement of an underwater isolation cap were completed for the offshore portion of the former U.S. Steel property in South San Francisco (URS, 2002b). A total of 20,100 cubic yards of sediment were removed from San Francisco Bay at this site. 14,100 cubic yards were dredged from the subtidal area and 6,000 cubic yards were removed using land-based equipment from the intertidal area. The majority of the sediments were taken to a landfill for disposal. The cost of this cleanup was estimated to be about $12 million for three acres.

A Draft Final Feasibility Study for Parcel F (offshore PCB-contaminated sediments) completed for Hunters Point Shipyard (U.S. Navy, 2007) evaluated a range of alternatives from no action, to complete removal and off-site disposal and included a number of alternatives and a mix of remedial actions, including focused removal, off-site disposal and monitored natural recovery. Other than no action, the costs of conducting some level of active remediation were from $13,060,000 to $42,630,000. The costs included base costs, including costs for remedial design and construction, as well as future costs for 30 years of operation and maintenance. The costs of monitored natural recovery, an element of multiple remedial alternatives, were considered to include the costs of deed restrictions, (documentation, posting and enforcement) baseline monitoring, (bathymetric survey and sediment core sampling using a vibracore sampler (30 samples) and annual monitoring over a 30 year period.

A Final Feasibility Study for Seaplane Lagoon at Alameda Point (Battelle 2005) to address PCBs and cadmium and other contaminants in subtidal sediments evaluated a range of remedial alternatives, including but not limited to, no action, monitored natural recovery with institutional controls, isolation capping, dredging/dewatering and off-site disposal and focused dredging/upland confinement. Other than no action, the costs of conducting some level of active remediation were from $2,280,106 to $40,947,000. The costs included base costs, including costs for remedial design and construction, as well as future costs for 30 years of operation and maintenance. The Water Board and other regulatory agencies signed a Record of Decision in 2005 (U.S. Navy 2006b) with the U.S. Navy, agreeing to the selected remedial alternative of dredging, dewatering, and off-site disposal at a 30-year net present value of $24,600,000. The remedy calls for dredging 63,000 cubic yards of contaminated sediment over approximately a 6-acre area. Even though there are and will be substantial costs associated with completing existing and new clean-ups, these sites will be subject to clean-up with or without this TMDL and therefore little or no new costs are anticipated as a result of this TMDL as the costs of cleanup would be driven by other regulatory programs.

Monitoring and Special Studies

The Regional Monitoring Program (RMP) conducted by the San Francisco Estuary Institute collects much of the data that are required as part of the ongoing assessment of the health of the Bay. The RMP is jointly funded by municipal and industrial wastewater dischargers.The current budget for the program is $3.4 million, which includes monitoring of PCBs and other pollutants in water, sediment, and fish throughout the Bay. Maintaining this effort should be sufficient to track attainment of the TMDL target and recovery of the Bay. In addition, the RMP also conducts regular monitoring of PCBs loads from the Central Valley and limited monitoring of PCBs loads from local tributaries. Additional monitoring will be necessary to sufficiently quantify loads from urban stormwater runoff and the loads reduced from urban stormwater runoff control actions. As with the control measures, this loads monitoring would also address other pollutants of concern such as heavy metals, pesticides, and petroleum hydrocarbons. This additional monitoring could cost $500 thousand to $1 million per year.

There are critical data needs to improve our understanding of PCBs fate and transport, particularly PCBs in Bay sediments. Also, a better understanding of the rate of natural attenuation of PCBs in Bay environments is needed to predict with more certainty the recovery time of the Bay, and to inform on the need for more, less or different implementation actions. We estimate these costs, which would be shared by all source category dischargers, urban stormwater dischargers, and dredgers, would total approximately $1 to 3 million, some of which would be accounted for within the existing RMP. These costs include the costs of collecting information regarding pollutants other than PCBs that are the subject of study by the RMP.

Risk Management

The risk management activities range from conducting studies to support health risk assessment and risk communication associated with eating Bay fish, providing outreach and advice to the general public and regular consumers of Bay fish, and investigating and implementing direct actions that reduce the actual and potential exposure of, and mitigate health impacts to, people and communities most likely to be consuming PCBs-contaminated fish from San Francisco Bay. Responsibility and costs associated with these activities will be shared among the California Office of Environmental Health Hazard Assessment, the California Department of Toxic Substances Control, the California Department of Health Services, dischargers, community-based organizations, and the Water Board. Although the direct risk reduction, studies, outreach efforts and mitigation actions have yet to be determined, they will likely cost in the range of $100 thousand to $1 million dollars per year. Some of these costs are likely to be incurred without this TMDL as the San Francisco Bay mercury TMDL and mercury watershed NPDES permit require similar risk management activities.

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