McGrath Lake PCBs, Organochlorine Pesticides, and Sediment Toxicity TMDL

California Regional Water Quality Control Board

Los Angeles Region

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1 INTRODUCTION

McGrath Lake, located in the McGrath Lake sub-watershed in coastal Ventura County, exceeds water quality objectives for PCBs, DDT, Chlordane, Dieldrin, and toxicity, all in sediment. McGrath Lake is included on the California 303(d) list of impaired waterbodies for these constituents (LARWQCB, 1998, 2002, and 2006). The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed to restore the impaired waterbodies to their full beneficial uses. This document provides the background information used by the California Regional Water Quality Control Board, Los Angeles Region (Los Angeles Regional Board) in the development of TMDLs for PCBs, organochlorine (OC) pesticides and sediment toxicity for McGrath Lake.

As documented in this staff report, the PCB, OC pesticide and sediment toxicity impairments of McGrath Lake are caused by non-point sources and agricultural runoff, carrying sediment-bound contaminants to McGrath Lake. These sediment-bound contaminants ultimately settle in the bed of McGrath Lake where contaminant concentrations reach very high levels. These high concentrations in conjunction with environmental conditions may result in release of contaminants to the lake water column as well. The McGrath Lake TMDL presents the elements necessary for addressing the PCB, OC pesticide and sediment toxicity impairments in McGrath Lake. In accordance with a consent decree, this TMDL addresses the waterbody-pollutant listings in analytical unit 25.

1.1 REGULATORY BACKGROUND

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in U.S. Environmental Protection Agency guidance (U.S. EPA, 2000). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for non-point sources and natural background" (40 CFR 130.2) such that the capacity of the waterbody to assimilate pollutant loadings (the Loading Capacity) is not exceeded. TMDLs are also required to account for seasonal variations, and include a margin of safety to address uncertainty in the analysis.

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The U.S. EPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If the U.S. EPA disapproves a TMDL submitted by a state, U.S. EPA is required to establish a TMDL for that waterbody. A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999. The consent decree combined waterbody pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. In accordance with the consent decree, this document summarizes the analyses performed and presents the TMDL for PCBs, OC pesticides, and sediment toxicity for McGrath Lake (analytical unit 25).

1.2 ELEMENTS OF A TMDL

There are seven elements of a TMDL. Sections 2 through 7 of this document are organized such that each section describes one of the elements, with the analysis and findings of this TMDL for that element. The elements are:

> Section 2: Problem Identification. This section reviews the data used to add the waterbody to the 303(d) list, and summarizes existing conditions using that evidence along with new information acquired since the listing. This element identifies those beneficial uses that are not supported by the waterbody; the water quality objectives (WQOs) designed to protect those beneficial uses; and summarizes the evidence supporting the decision to list each reach, such as the number and severity of exceedances observed.
>
> Section 3: Numeric Targets. This section establishes the numeric targets for this TMDL based upon the WQOs described in the Basin Plan, sediment quality guidelines compiled by the National Oceanographic and Atmospheric Administration (NOAA), and criteria contained in the California Toxics Rule (CTR).
>
> Section 4: Source Assessment. This section develops the quantitative estimate of loading from point sources and non-point sources into McGrath Lake.
>
> Section 5: Linkage Analysis. This section provides an analysis of how the

sources of pollutants into the waterbody are linked to the observed conditions in the impaired waterbody.

Section 6: Pollutant Allocation. This section allocates for each pollutant source a quantitative load that it can discharge while still achieving the numeric targets. Allocations are designed such that the waterbody will not exceed numeric targets for any of the compounds or related effects. Allocations are based on critical conditions, so that the allocated pollutant loads may be expected to remove the impairments at all times.

Section 7: Implementation. This section describes the plans, regulatory tools, and other mechanisms by which the pollutant allocations are to be achieved. The TMDL provides cost estimates to implement actions in the McGrath Lake sub-watershed and within the lake itself to achieve the pollutant allocations. This section also describes the monitoring required to evaluate attainment of load allocations and lake recovery efforts.

1.3 ENVIRONMENTAL SETTING

McGrath Lake is a small, back dune lake located in coastal Ventura County. Situated at the southern end of McGrath State Beach Park, the lake is south of the McGrath State Beach Campground and west of Harbor Blvd (Figure 1). Prior to urban development, back dune lakes were found throughout California, but have mostly disappeared in the southern part of the state. Much of the adjacent area to the east is utilized for agricultural operations (such as strawberries, celery and cut flowers). Just north of the lake is a small, active oil field and to the south is Mandalay Bay Generation Plant.

McGrath Lake is located with in the McGrath Lake sub-watershed, which is approximately 1,700 acres (URS, 2005) and part of the larger Santa Clara River watershed. The sub-watershed is on the coastal edge of Ventura County and is in close proximity to the communities of Oxnard, Port Hueneme, Ventura and Mandalay Bay (Figure 2). The dominant land use in the McGrath Watershed is agriculture, accounting for approximately 78% of the total land use (Table 1).

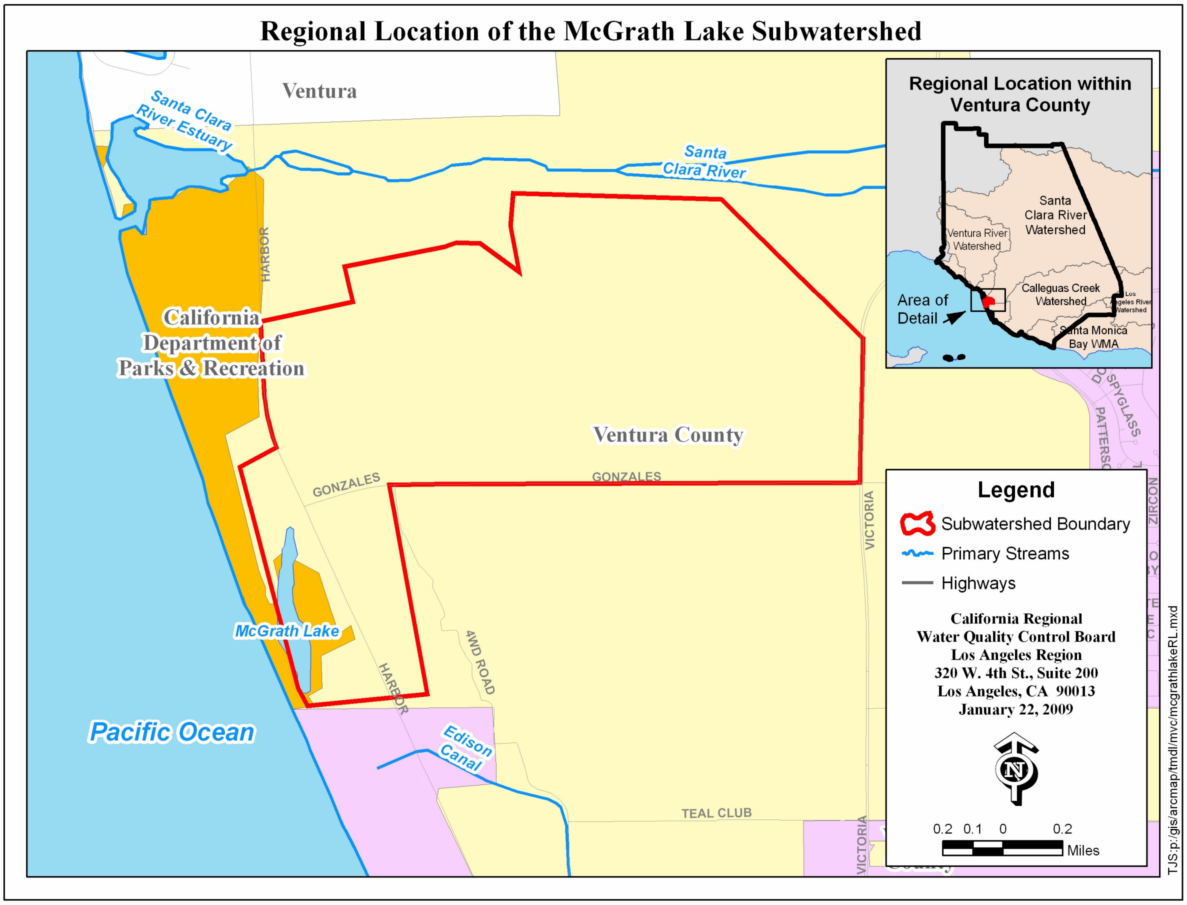

Figure 1 McGrath Lake Regional Location Map

Table 1 Land use in the McGrath Lake sub-watershed

Land use	Acres	Percent of Total
Low Density Residential	6.1	0.50
Commercial	3.5	0.28
Industrial	4.7	0.38
Public Facilities	88.1	7.16
Open	153.0	12.43
Agriculture	954.5	77.59
Water	17.8	1.45
Recreation	2.6	0.21
Total for all classes	1230.3	100

Agricultural runoff and drainage dominate the inflow to the lake. The historical wetland complex that spanned the area impacted agricultural activities, so tile drains were installed in much of the watershed upstream of the lake. The drainage was then routed to the lake by a system of open channels. During storm events, the agricultural lands and drainage canals may flood and water travels via overland flow to the lake.

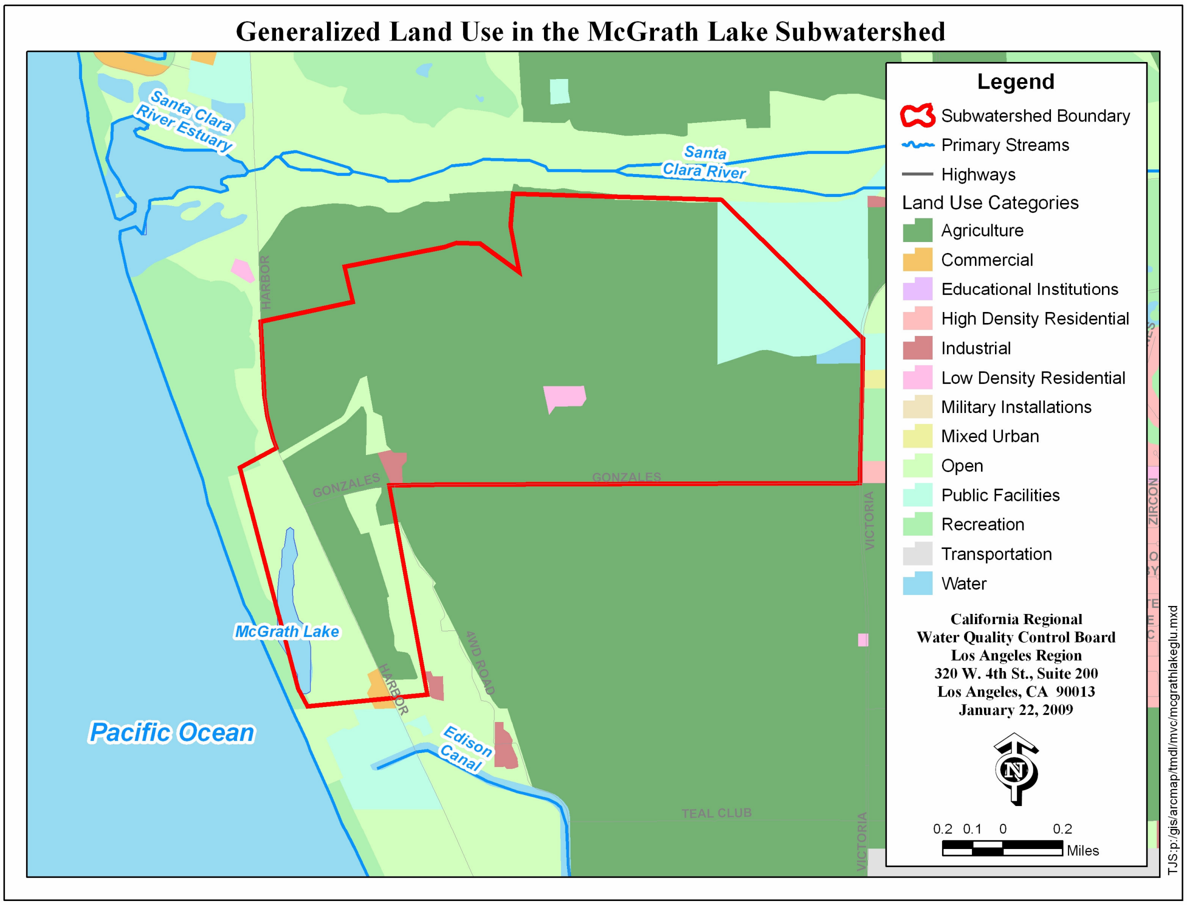

Figure 2 McGrath Lake Subwatershed Land Use Map

Prior to agricultural development within the region, the lake and surrounding area was part of the extensive wetland and floodplain complex of the Santa Clara River Delta. Tile drains installed in the region have allowed for extensive agriculture operations by greatly reducing the flooded soils and resulting wetlands. In 1958, Harbor Boulevard was built east of the lake, further disrupting the hydrological inputs to McGrath Lake. In addition to the lake serving as a repository for the agricultural drainage emanating further upstream in the watershed, the area has historically been used as a recreational feature. In 1961, ownership of most of the lake was transferred to California Department of Parks and Recreation as part of the new McGrath State Beach Park.

To keep flooding of the fields east of Harbor Boulevard to a minimum, artificial lake drainage activities have been conducted since before the state acquired the property. An artificial discharge of lake water to the state beach occurs through the use of pumps. When the surface elevation of the lake reaches 4.7 feet above sea level, pumps in the northern portion of the lake are turned on and water is transported across the dunes where it is discharged to the oceanward side of the dunes. The lake may also be drawn down in anticipation of large, incoming storm events. This practice is guaranteed in the deed transferring ownership of (most of) the lake to the state (the McGrath family or their representative were guaranteed the ability to regulate the elevation of the lake surface). Historically, during storm events that outpaced the pumps, the lake was artificially breached using large equipment. It appears this practice was last authorized in 1998 (McGrath Beach TMDL Administrative Record, p. 9-1) and is no longer utilized.

As demonstrated by the area-wide use of agricultural drains, groundwater is very shallow in the watershed. Groundwater inflows also constitute an input to the lake. Data is limited, but on at least one occasion, groundwater was noted as contributing as much as 3 inches/day to the lake elevation (URS, 2005; Pritchard and Provost, 2003). In general, the groundwater moves from southeast to northwest (KennedyJenks, 2002). Previous work indicates subsurface flows from the ocean to McGrath Lake only occur during the highest, high tides (URS, 2005). Such conditions may also occasionally result in waves overtopping the sand dunes (Anderson et al., 1998).

While there is some disagreement as to how large the lake was historically (URS, 2005; KennedyJenks, 2002), it is known to have been larger in the past. With the rerouting of some of the drainage channels and the construction of Harbor Boulevard altering the local hydrologic regime, the lake has shrunk to its present size. A 1999 study measured the lake to be about 900 m long and 140 m wide (at the broadest point; Jacobi et al., 1999). The most recent study of lake size indicates the lake covers approximately 12 acres in the southern portion of McGrath State Park (URS, 2005). The lake has a natural, mud bottom and natural edges. The northern portion of the lake bottom is dominated by fine sediments that become coarser toward the south (Moss Landing, 1999). The average depth of McGrath Lake is just over 0.6 m and the deepest point is about 1.5 m, although these values may vary greatly due to the artificial management of the lake surface elevation. The lake water tends to be brackish (ESA, 2003), with salinity increasing north to south and with depth. Water in the deepest portions of the lake may reach high enough salinities to qualify as salt water (using the criteria found in the CTR; Federal Register, 2000).

The eastern side of lake is dominated by a riparian-willow complex and the western side is sand dune (ESA, 2003). The habitat around the lake is unique and is utilized by a large number of migratory birds such as the Brown Pelican, Western Snowy Plover and the California Least Tern. The last remaining population of the endangered Ventura Marsh Milkvetch, which was once thought to be extinct, occurs just south of the lake (Federal Register, 2004). During the time the lake was owned by the McGrath Family, the lake was occasionally stocked for fishing (Conway, 2009).

2 PROBLEM STATEMENT

This section provides background information on the pollutants addressed in this TMDL, an overview of water quality standards for McGrath Lake, and a review of water quality data used in the 1996 water quality assessment and the 1998, 2002, and 2006 303(d) listings. Where available, additional pertinent data were used to assess the condition of the lake and sub-watershed.

2.1 TOXIC POLLUTANTS BACKGROUND

This section provides background information on the pollutants addressed in this TMDL. The chemical properties of DDT, Chlordane, Dieldrin and PCBs are provided in table 18 in the Linkage Analysis section of this document. The intent of this section is to provide a general background and history of the pollutants.

Organochlorine Pesticides

Organochlorine (OC) pesticides are a large group of pesticides that historically have had widespread use throughout the United States. This group of pesticides is often referred to as legacy pesticides, because even though they have been banned from use for many years they continue to persist in the environment and cause water quality impairments. The three pesticides identified on the 303(d) list for McGrath Lake -- DDT, chlordane, and dieldrin -- are organochlorine pesticides.

DDT

DDT is a broad spectrum organochlorine pesticide with two primary break-down products -- DDE and DDD. Two attributes of DDT, low water solubility and high lipophilicity (fat soluble), play a key role in its environmental fate. The low water solubility of DDT results in strong binding of the compound to soil particles (Walker, 2001). These soil particles can be easily mobilized by the force of water runoff and the soil-bound DDT is transported to surface waterbodies. The soil particles then settle out of the water column into the sediments of the waterbody. DDT is also highly lipophilic and will accumulate in the fatty tissues of exposed wildlife and biomagnify as it moves through the food chain to reach the primary predator (National Pesticide Telecommunications Network (NPTN) DDT Technical Fact Sheet, 1999). The ability of DDT to biomagnify is one of the primary environmental concerns of this pollutant because the exposure spreads and increases from one organism to another.

DDT first became widely used as a pesticide in 1939; the use was focused on controlling insects that transmit diseases, such as malaria and typhus during World War II (EPA, 1975). DDT for agricultural and commercial uses became widespread in the United States after 1945. 1959 was the peak of DDT use in the United States when approximately 80 million pounds were applied (EPA, 1975). In California DDT was used for the control of both agricultural and urban pests like mosquitoes and cockroaches (Mischke, 1985). In 1963 the California Department of Food and Agriculture (CDFA) declared DDT a restricted material. The last year that substantial amounts of DDT were applied in California was 1970 when 1.2 million pounds of DDT were applied primarily to agricultural areas (Mischke, 1985). In Ventura County DDT was know to be applied to crops including walnuts, beets, lima beans, and tomatoes (CCW OC and PCB TMDL Technical Memo, 2005). There is no specific information on the application of DDT in the McGrath Lake sub-watershed.

The use of DDT began to decline in the early 1970s, as many of the pests previously sensitive to DDT had developed resistance to the chemical (EPA, 1975). Furthermore, new more effective pesticides had been developed, and there was growing public concern over adverse human and environmental health effects from DDT exposure (EPA, 1975). On June 14, 1972 the U.S. EPA announced the cancellation of all crop uses of DDT in the United States effective on December 31, 1972 (EPA, 1975). Even though domestic usage of DDT has been banned for more than 30 years, due to its long soil half life (see table 18), there are still widespread environmental impairments from DDT. The data presented in Sections 2-5, 2-6 and 2-7 of this report document the ongoing DDT impairment in the McGrath Lake sub-watershed.

Chlordane

Chlordane was first registered and approved for both agricultural and non-agricultural uses in the United States in 1948 (NPTN Chlordane Fact Sheet, 2001). Non-agricultural uses of chlordane included treating pests in residential lawns and gardens as well as structural pests such as termites. Chlordane was used on a variety of agricultural crops including corn, citrus, deciduous fruits and nuts, and vegetables (EPA, Consumer Fact Sheet on Chlordane). In 1978 the EPA cancelled the use of chlordane on all food crops and for applications to lawns and gardens, although it was still registered for use in termite control. In 1988, the EPA cancelled all uses for chlordane.

As an organochlorine compound, chlordane has similar properties to DDT; it has low water solubility, a strong binding affinity to soil particles, and is a persistent compound. (EXTOXNET Chlordane, 1996). Thus, soils historically treated with chlordane can continue to be a present source of chlordane in the environment; these contaminated soils may be transported to waterbodies via runoff causing water quality impairments. Moreover, chlordane will bioaccumulate in the fat tissue of exposed organisms and is considered highly toxic to fish and freshwater invertebrates (NPTN Chlordane Fact Sheet, 2001, EXTOXNET Chlordane, 1996).

The 1974 and 1979 Pesticide Use Report information, collected by the California Department of Pesticide Regulation, indicates that chlordane was applied to the following crops in Ventura County:

- Beans
- Citrus
- Tomato
- Peas
- Peppers
- Celery
- Cabbage

The applications in 1974 and 1979 were predominately for beans and citrus (CCW OC and PCBs TMDL Technical Report, 2005). There is no specific information on the application of chlordane in the McGrath Lake sub-watershed.

Dieldrin

Dieldrin is also an organochlorine pesticide and a break-down product of the pesticide aldrin. Dieldrin was widely used from 1950 - 1970 as a structural pesticide for the control of termites (ATSDR, 2002) and as an agricultural pesticide for cotton, corn, and citrus crops (EPA, 2008). The agricultural use of dieldrin was banned by the US Department of Agriculture in 1970 (ATSDR, 2002) and in 1987 all uses of dieldrin were cancelled (EPA, 2008). Dieldrin is a persistent compound in the environment that easily binds to soil and is often conveyed to surface waterbodies in runoff. The Pesticide Use Report for Ventura County for 1974, reported 14 applications of dieldrin for structural pest control (CCW OC and PCBs TMDL Technical Report, 2005). Pesticide Use Report data for the years of 1974, 1979, 1984, and 1989 did not report any agriculture applications of dieldrin in Ventura County (CCW OC and PCBs TMDL Technical Report, 2005). There is no specific information on the application of dieldrin in the McGrath Lake sub-watershed.

Polychlorinated biphenyls - PCBs

PCBs belong to a group of organic chemicals called chlorinated hydrocarbons; they are a mixture of up to 209 different chlorinated compounds which are called congeners (ATSDR, 2001). PCBs generally are in the form of oily liquids or waxy solids (ATSDR, 2001; EPA, 2008). They were produced in the United States from 1929 until they were banned in 1979; because of their useful characteristics, such as non-flammability, chemical stability, and insulating ability they were used for myriad industrial and commercial purposes (EPA, 2008). PCBs have been used in the following applications (ATSDR, 2001; EPA, 2008):

- Coolants and lubricants
- Transformers
- Capacitors
- Electrical equipment
- Hydraulic equipment
- Plasticizers in paints
- Plastics
- Pesticide Extenders

- Dust Suppression

Even though PCBs are no longer manufactured in the United States they may still be present in materials that were manufactured prior to 1979. For example, the working life or electrical transformers containing PCBs is expected to be 30 years or more (EPA, 1999). In general, point sources of PCBs have been eliminated because there are no longer facilities that manufacture products containing PCBs. However, non-point sources may still exist from activities such as improper disposal of industrial waste, landfill sites not designed to accept hazardous waste, abandoned manufacturing areas, leaks and/or improper dumping of materials containing PCBs (ATSDR, 2001; EPA, 2008). Moreover, the global cycling of PCBs occurs when they are evaporated from soils and/or surface waters, transported in the atmosphere, and then redeposited to the land and water (EPA, 1999, ATSDR, 2005). This process plays an important role in the deposition of PCBs to surface waters and is considered a non-point source (EPA, 1999).

PCBs are persistent chemicals that remain in the environment for long periods of time. They have low water solubility, so they are typically attached to soil and/or sediment particles, which can be transported by water runoff leading to pollution in waterbodies (EPA, 1999). PCBs are also lipophilic and will be stored in the fat tissue of exposed organisms and bioaccumulate through the food chain (Walker, 2001). For example, concentrations of PCBs found in aquatic organisms may be 2,000 to more than one million times greater than concentrations measured in the surrounding water (EPA, 1999). Because PCBs rapidly concentrate in the food chain, a small concentration measured in water or sediment can have a significant environmental impact.

The U.S. EPA maintains two databases for the tracking and evaluation of PCB activity in the in the United States. The databases are the PCB Transformer Registration Database and the Notification of PCB Activity Report; these databases were reviewed for any listings in Ventura County. Two facilities in Ventura County submitted to EPA the required Notification of PCB Activity Report (EPA, 2008); these facilities are not located in the McGrath Lake subwatershed and there is no information that they have directly contributed to PCB impairments at McGrath Lake.

2.2 SEDIMENT TOXICITY

As previously stated, organochlorine pesticides and PCBs readily attach to sediment particles and are mobilized with runoff to surface waterbodies. The sediment particles, with attached toxic chemicals, settle out of the water column and accumulate to the point of impairing the sediment of the waterbody. The sediment quality can become impaired to the point of causing sediment toxicity. Benthic organisms are generally at the greatest risk for sediment toxicity, because they live in direct contact with the contaminated sediment (SWRCB, 2008). Moreover, many benthic species also consume sediment for nutrition and are also exposed through digestive processes (SWRCB, 2008). Organisms higher in the food chain such as birds and fish can also be exposed to contaminated sediments by eating the benthic invertebrates.

There are many physical and chemical factors that affect the bioavailability of contaminants in sediment including (Chapman et al., 2001; EPA 2000A):

- Proportion of organic matter
- Grain size
- pH
- aerobic conditions
- salinity
- chemical form of pollutant
- mineralogy of sediment

The variability of these factors can create spatial and temporal differences in pollutant bioavailability within a waterbody (Chapman et al., 2001, U.S. EPA 2001A). The sediments of a waterbody are an integral part of the whole waterbody and can act as a sink or a source for pollutants depending on sediment conditions. Maintaining and restoring sediment quality is required to support overall aquatic ecosystem health.

2.3 WATER QUALITY STANDARDS

California state water quality standards consist of the following three elements: 1) beneficial uses of the waterbody; 2) narrative and/or numeric water quality objectives; and 3) an antidegradation policy. Beneficial uses are defined by the Regional Board in the Basin Plan. Numeric and narrative objectives are also specified in the Basin Plan and other state plans and policies. These objectives are set to be protective of the beneficial uses in each waterbody in the region.

Beneficial Uses

The Basin Plan (1994) defines 7 existing (E) or potential (P) beneficial uses for McGrath Lake (Table 2). McGrath Lake has existing beneficial uses to protect aquatic life that use the estuarine, wildlife, and wetland habitat in the lake (EST, WILD, and WET). The RARE use designation protects rare, threatened or endangered species that may utilize the lake and adjacent wetlands for foraging or nesting habitat. There are also potential beneficial uses associated with human use of the lake for commercial and sport fishing (COMM). The recreational use for water contact recreation (REC1) and non-contact water recreation (REC2) applies as an existing use for lake, but use is limited due to limited public access to the lake.

Table 2 Beneficial Uses of McGrath Lake (LARWQCB, 1994)

Hydro Unit No.	REC1	REC2	COMM	EST	WILD	RARE	WET_b
403.11	E_d	E_d	P	E	E	E_e	E

E: Existing beneficial use
P: Potential beneficial use
b: Waterbodies designated as WET may have wetlands habitat associated with only a portion of the waterbody. Any regulatory action would require a detailed analysis of the area.
d: Limited public access precludes full utilization
e: One or more rare species utilize all oceans, bays estuaries, and wetlands for foraging and or/ nesting.

Discharges of PCBs and pesticides to these waterbodies may impair beneficial uses associated with aquatic life (EST, WILD, RARE, and WET), human use of these resources (COMM), and recreational uses (REC1 and REC2).

Water Quality Objectives (WQOs)

As stated in the Basin Plan, water quality objectives (WQOs) are intended to protect the public health and welfare and to maintain or enhance water quality in relation to the designated existing and potential beneficial uses of the water. The Basin Plan specifies both narrative and numeric water quality objectives. The following narrative water quality objectives are the most pertinent to this TMDL. These narrative WQOs may be applied to both the water column and the sediments:

Chemical Constituents: *Surface waters shall not contain concentrations of chemical* *constituents in amounts that adversely affect any designated beneficial use.*

Bioaccumulation: *Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels, which are harmful to aquatic life or human health.*

Pesticides: *No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.*

Toxicity: *All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life*.

The Regional Board's narrative toxicity objective reflects and implements national policy set by Congress. The Clean Water Act states that, "it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited" (33 U.S.C. 1251(a)(3)). In 2000, U.S. EPA promulgated numeric water quality objectives for several pollutants addressed in this TMDL in the California Toxics Rule (CTR; U.S. EPA, 2000b). The CTR establishes numeric aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 92 priority toxic pollutants. These criteria are established to protect human health and the environment and are applicable to inland surface waters, enclosed bays and estuaries.

For the protection of aquatic life, the CTR establishes short-term (acute) and long-term (chronic) criteria in both freshwater and saltwater. The acute criterion equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. The chronic criterion equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. Freshwater criteria apply to waters in which the salinity is equal to or less than 1 part per thousand (ppt) 95 percent or more of the time. Saltwater criteria apply to waters in which salinity is equal to or greater than 10 ppt 95 percent or more of the time. For waters in which the salinity is between 1 and 10 ppt, the more stringent of the two criteria applies.

The CTR human health criteria are established to protect the general population from priority toxic pollutants regulated as carcinogens (cancer-causing substances) and are based on the consumption of water and aquatic organisms or aquatic organisms only, assuming a typical consumption of 6.5 grams per day of fish and shellfish and drinking 2.0 liters per day of water. Table 3 summarizes the CTR aquatic life criteria (freshwater and saltwater) and human health criteria for organic constituents covered under this TMDL (chlordane, dieldrin, DDT, and PCBs).

Table 3 Water quality criteria established in the CTR for organochlorine compounds and PCBs

Pollutant	Criteria for the Protection of Aquatic Life				Criteria for the Protection of Human Health	
	Freshwater		Saltwater			
	Acute (µg/L)	Chronic (µg/L)	Acute (µg/L)	Chronic (µg/L)	Water & Organisms (µg/L)	Organisms only (µg/L)
Chlordane	2.4	0.0043	0.09	0.004	0.00057	0.00059
Dieldrin	0.24	0.056	0.71	0.0019	0.00014	0.00014
4,4'-DDT[1]	1.1	0.001	0.13	0.001	0.00059	0.00059
4,4'-DDE[2]					0.00059	0.00059
4,4'-DDD[3]					0.00083	0.00084
Total PCBs[4]		0.014		0.03	0.00017	0.00017

1. Based on a single isomer (4,4'-DDT).
2. Based on a single isomer (4,4'-DDE).
3. Based on a single isomer (4,4'-DDD).
4. Based on total PCBs, the sum of all congener or isomer or homolog or aroclor analyses.

For PCBs, the Basin Plan states that, "Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach water of the Region, are limited to 70 pg/L (30 day average) for protection of human health and 14 ng/L and 30 ng/L (daily average) to protect aquatic life in inland fresh water and estuarine waters respectively." The human health value in the Basin Plan of 70 pg/L is more stringent than the CTR value of 170 pg/L.

Sediment quality is protected by applying the narrative objectives previously detailed. The Regional Board applied best professional judgment to define elevated values for pesticides and PCBs in sediment and sediment toxicity during the water quality assessments conducted in 1996 and 1998. In the 2002 and 2006 listing cycles, the Regional Board evaluated sediment contaminants relative to sediment quality guidelines (SQGs), specifically the values for Effects Range-Median (ERM) (Long et al., 1995), and Probable Effects Level (PEL) (MacDonald, 1994). These SQGs are based on empirical data compiled from numerous field and laboratory studies performed in North America.

The National Oceanic Atmospheric Administration (Long et al., 1995) assembled data from throughout the country that correlated chemical concentrations in sediments with effects. These data included spiked bioassay results and field data of matched biological effects and chemistry. The product of the analysis is the identification of two concentrations for each substance evaluated. The Effects Range-Low (ERL) values were set at the 10th percentile of the ranked data and represent the concentrations below which adverse biological effects rarely occur. The ERM values were set at the 50th percentile and are interpreted as the concentrations above which adverse effects frequently occur.

The Threshold Effects Level (TEL) and PEL values were developed by the State of Florida and were based on a biological effects empirical approach similar to the ERLs/ERMs. The development of the TELs and PELs differs from the development of the ERLs and ERMs in that data showing no effects were incorporated into the analysis. In the Florida weight-of-evidence approach, two databases were assembled: a “no-effects” database and an “effects” database. The TEL values were generated by taking the geometric mean of the 15th percentile value in the effects database and the 50th percentile value of the no-effects database. The PEL values were generated by taking the geometric mean of the 50th percentile value in the effects database and the 85th percentile value of the no-effects database. By including the no-effect data in the analysis, a clearer picture of the chemical concentrations associated with the three ranges of concern (no effects, possible effects, and probable effects) can be established.

The ERLs and TELs are presumed to be non-toxic levels and pose with a high degree of confidence no potential threat. The ERMs and PELs identify pollutant concentrations that are more probably elevated to toxic levels. The Regional Board used ERMs and PELs during the 2002 and 2006 water quality assessments (Table 4).

Table 4 Summary of marine sediment quality guidelines used in 2002 and 2006 assessments

Pollutant	ERM (µg/kg)	PEL (µg/kg)
Chlordane	6	4.79
Dieldrin	8	4.3
4,4’-DDT	7	4.77
4,4’-DDE	27	374.17
4,4’-DDD	20	7.81
Total DDTs	46.1	51.7
Total PCBs	180	189

Antidegradation

State Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality Water" in California, known as the "Antidegradation Policy," protects surface and ground waters from degradation and fulfills federal antidegradation requirements (40 CFR 131.12). Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies.

2.4 WATER QUALITY DATA SUMMARY

This section summarizes available water column and sediment data for McGrath Lake for the listed toxic pollutants. The summary includes data considered by the Regional Board and U.S. EPA in developing the 1998, 2002, and 2006 303(d) lists as well as additional data collected by the Regional Board as part of TMDL development.

McGrath Lake was listed in 1996 and 1998 based on data obtained by the Bay Protection and Toxic Cleanup Program (BPTCP) for the following pollutants:

- Chlordane (sediment)
- DDT (sediment)
- Total pesticides (sediment)
- Sediment toxicity

As part of the 2002 listing cycle, the Regional Board and State Board delisted McGrath Lake for "total pesticides" because individual chemicals could be listed. The listings for chlordane and DDT in sediment were retained and two new listings were added for dieldrin and PCBs in sediment. These listings were carried over onto the 2006 303(d) list:

- Chlordane (sediment)
- DDT (sediment)
- Dieldrin (sediment)
- PCBs (sediment)
- Sediment toxicity

2.5 SEDIMENT QUALITY DATA SUMMARY

The sediment quality data assessment is based on a review of the 1996 Water Quality Assessment (WQA) worksheets, which formed the basis for the 1998 303(d) list, and data used in the 2002 listing cycle (Tables 5, 6). The 1996 WQA was based on two sediment samples collected from McGrath Lake (site No. 44027) in January 1993 and June 1996. Both samples exceeded ERM values for chlordane, DDT and dieldrin. Concentrations of these pesticides in sediment increased between the two sampling events. Sediment toxicity was associated with the chemistry measurements.

As part of the 2002 listing cycle, the Regional Board relied upon data used in the 1996 WQA as well as additional data collected as part of the McGrath Lake Characterization Study (Jacobi et al., 1998). The McGrath study collected 11 sediment samples from the lake. ERM values were exceeded for total PCBs in eight samples, chlordane in 11 samples, DDT and its metabolites in 11 samples, and dieldrin in 10 samples.

Table 5 Summary of McGrath Lake Sediment Data used in 2002 listing cycle

Sampling Date	No. Sediment Samples	No. Samples > Chlordane Guidelines	No. Samples > Dieldrin Guidelines	No. Samples > DDT Guidelines	No. Samples > PCB Guidelines
1/13/1993	1	1	1	1	0
6/19/1996	1	1	1	1	0
10/28/1998	11	11	10	11	8

The study observed sediment toxicity associated with the chemistry measurements at 10 sites, and degraded benthic conditions at all sampling stations.

Table 6 Summary of McGrath Lake Sediment Data (Anderson, 1998; Jacobi et al., 1999; Regional Board, 2007-2008)

Lake Region	Sample Date	Station	Core Depth (cm)	Constituent of Concern (ug/kg)			
				Total Chlordane	Dieldrin	Total DDT	Total PCBs
Central Ditch	Oct 1998	Ag Drain	0-5	19	6	726	36
Northern	Oct 1998	Pump	0-5	15	6	920	18
	Dec 2007	McG4		<1.7	<3.3	62.9	<66

Lake Region	Sample Date	Station	Core Depth (cm)	Constituent of Concern (ug/kg)			
				Total Chlordane	Dieldrin	Total DDT	Total PCBs
	Jan 2008	McG4		<1.7	<3.3	227	<66
Northern	Oct 1998	N1S5	0-5	472	17	2338	148
Northern	Oct 1998	N1S5 Z1	5-35	151	14	2099	51
Northern	Oct 1998	N1S5 Z2	35-65	317	15	2943	67
Northern	Oct 1998	N1S5 Z3	65-82	41	5	1464	40
Northern	Oct 1998	N2S4	0-5	479	26	2599	98
	Dec 2007	McG3		<1.7	<3.3	42.4	<66
	Jan 2008	McG3		<1.7	<3.3	32	<66
Northern	Oct 1998	N2S4 Z1	5-35	238	14	2313	59
Northern	Oct 1998	N2S4 Z2	35-65	276	14	2757	46
Northern	Oct 1998	N2S4 Z3	65-81	76	6	1413	42
Northern	Oct 1998	N3S4	0-5	575	28	2678	98
Northern	Oct 1998	N3S4 Z1	5-35	225	14	2253	48
Northern	Oct 1998	N3S4 Z2	35-65	124	9	1713	37
Mid	1/13/1993	44027		151	24	3187	NA
Mid	6/19/1996	44027		233	17	1983	NA
Mid	Oct 1998	M4S4	0-5	786	31	2414	224
	Dec 2007	McG2		2.7	<3.3	51.4	<66
	Jan 2008	McG 2		<1.7	<3.3	40.1	<66
Mid	Oct 1998	M5S3	0-5	745	37	3488	129
Mid	Oct 1998	M5S3 Z1	5-35	31	2	543	20
Mid	Oct 1998	M5S3 Z2	35-65	237	12	1864	27
Mid	Oct 1998	M6S4	0-5	689	36	2576	120
	Dec 2007	McG1		<1.7	<3.3	41.2	<66
	Jan 2008	McG 1		<1.7	<3.3	59	<66
Mid	Oct 1998	M7S4	0-5	864	38	3412	153
Mid	Oct 1998	M7S4 Z1	5-35	497	20	2531	58
Mid	Oct 1998	M7S4 Z2	35-65	65	4	994	92
Southern	Oct 1998	S8S4	0-5	581	26	2629	112

Lake Region	Sample Date	Station	Core Depth (cm)	Constituent of Concern (ug/kg)			
				Total Chlordane	Dieldrin	Total DDT	Total PCBs
Southern	Oct 1998	S9S2	0-5	740	17	2808	49
Southern	Oct 1998	S9S2 Z1	5-35	195	7	1018	16
Southern	Oct 1998	S9S2 Z2	35-65	11	0.5	150	20
Southern	Oct 1998	S10S2	0-5	517	15	1369	45
Southern	Oct 1998	S10S2 Z1	5-35	33	1	180	4

To assess more recent sediment conditions, Regional Board staff collected additional sediment samples on December 12, 2007 and January 16, 2008 (Tables 6, 7). Samples were collected from four representative sites from the McGrath Lake study. Samples were collected following the sediment collection SOP in the SWAMP Quality Assurance Management Plan. Samples were shipped to the EPA Region IX laboratory where they were analyzed for PCBs and pesticides. No analysis of sediment toxicity or assessment of benthic community was performed. The results are presented in Tables 6 and 7.

Table 7 Summary of sediment quality data collected December 12, 2007 and January 16, 2008.

Sampling Date	No. Sediment Samples	No. Samples > Chlordane Guidelines	No. Samples > Dieldrin Guidelines	No. Samples > DDT Guidelines	No. Samples > PCBs Guidelines
12/12/07	4	0	0	2	0
1/16/08	4	0	0	2	0

Samples collected by Regional Board staff resulted in non-detect for some of the contaminants, however DDT levels were still high. Most likely, the differences between the samples collected in the 1990s and in 2007/2008 are the result of sampling location variability and sediment mobilization within the lake.

2.6 WATER COLUMN DATA SUMMARY

There is little water column data available for McGrath Lake. The McGrath Lake characterization study (Jacobi et al., 1999) analyzed surface water quality at four of the eleven sampling stations in the lake (Tables 8, 9).

Table 8 Summary of water quality data (Jacobi et al., 1999)

Pollutant	Human Health Criteria (Organisms Only) (µg/L)	Aquatic Life Criteria (Chronic) (µg/L)	No. of Samples	No. Samples > Human Health Criteria	No. Samples > Aquatic Life Criteria	No. Non-detects
Chlordane	0.00057	0.004	4	4	3	0
Dieldrin	0.00014	0.0019	4	1	1	3
4,4'-DDT	0.00059	0.001	4	4	4	0
4,4'-DDE	0.00059	--	4	4	--	0
4,4'-DDD	0.00084	--	4	4	--	0
Total PCBs	0.00007[1]	0.03	4	4	4	0

[1] Based on the Basin Plan objective rather than CTR.

Surface water concentrations exceeded the CTR aquatic life and human health criteria for chlordane, dieldrin, DDT and its metabolites, and PCBs. Although the water column data was not evaluated as part of the 303(d) listing process, current evaluation of the data demonstrates a water column impairment in the lake.

To assess more current conditions in the water column, Regional Board staff collected surface water samples in May and July 2007. Water quality samples were collected from the southern end of the lake, near the State Park property line. The results are presented in Table 9. The laboratory detection limits were higher than CTR aquatic life and human health criteria and all pesticides and PCBs were undetected in water quality samples.

Table 9 Surface water quality results collected from McGrath Lake

Lake Region	Station		Constituent of Concern (ug/L)					
			Total Chlordane	Dieldrin	4'4'-DDD	4'4'-DDE	4'4'-DDT	Total PCBs
Central Ditch	Ag Drain	Oct 1998[1]	0.003	<0.0005	0.032	0.056	0.039	0.010
		May 2007[2]	<0.5	<0.1	<5	<5	<5	<50

Lake Region	Station		Constituent of Concern (ug/L)					
			Total Chlordane	Dieldrin	4'4'-DDD	4'4'-DDE	4'4'-DDT	Total PCBs
		June 2007[2]	<0.5	<0.1	<5	<5	<5	<50
Northern	Pumphouse	Oct 1998[1]	0.002	<0.0005	0.021	0.030	0.025	0.125
Northern	N2S4	Oct 1998[1]	0.007	<0.0005	0.027	0.044	0.026	0.012
Mid	M5S3	Oct 1998[1]	0.005	0.014	0.020	0.033	0.020	0.021
		May 2007[2]	<0.5	<0.1	<5	<5	<5	<50
		June 2007[2]	<0.5	<0.1	<5	<5	<5	<50
Southern	S9S2	Oct 1998[1]	0.006	<0.0005	0.021	0.032	0.018	0.016

[1] Jacobi et al., 1999
[2] Regional Board Samples

2.7 SEDIMENT TOXICITY DATA SUMMARY

Three sets of toxicity data (Table 10) have been collected over a span of almost six years. While this is a limited data set, it demonstrates a pattern of toxicity within the lake. During the last (most extensive) sample collection, the health of the benthic community was evaluated and found to be degraded (Jacobi et al., 1999). At all sites, low numbers of species were observed and overall low individual counts were seen. The analyses also found that the family Chironomidae dominated all sites, which is also indicative of a degraded community.

Table 10 Summary of McGrath Lake Sediment Toxicity and Benthic Community Data

Sampling Date	No. Sediment Samples	Sediment Toxicity Observed	Degraded Benthic Community
1/13/1993	1	1	NA
6/19/1996	1	1	NA
10/28/1998	11	10	11

2.8 SUMMARY OF PROBLEM STATEMENT

McGrath Lake is impaired for chlordane, DDT, dieldrin (organochlorine pesticides) in sediment, PCBs in sediment, and sediment toxicity. A recent data evaluation shows PCB and organochlorine pesticide impairment of the water column as well. These toxic organic chemicals are all persistent in the environment, have low water solubility, and are highly lipophilic. Thus, they share the characteristics of binding to soil particles, being stored in the fat tissue of exposed organisms, and creating long-term environmental impairments. Because these chemicals become bound to soil, they are easily transported with runoff to surface waterbodies and expose aquatic organisms to their toxic effects. Once the suspended sediment settles to the lake bottom, desorption is possible due to the high contaminant concentrations, favorable environmental conditions and extended contact time (between the sediment and water), resulting in some release of contaminants to the water column. Moreover, all of these chemicals bioaccumulate as they move through the food chain, thereby not only spreading throughout the food chain, but increasing exposure as well. Finally, as presented in Section 2.4 sediment toxicity has been observed over time at McGrath Lake; this toxicity is likely due to the elevated concentrations of pesticides and PCBs in the sediment. The exposure of the McGrath Lake ecosystem to chlordane, DDT, dieldrin, and PCBs has impaired the aquatic life (EST, WILD, RARE, WET) and recreation (REC 1, REC 2) beneficial uses of the lake. As a result, McGrath Lake was placed on the Clean Water Act 303(d) list of impaired waterbodies in 1998, 2002, and 2006. TMDLs will be developed to reduce sediment contamination in McGrath Lake for chlordane, dieldrin, DDT and its metabolites, and PCBs. Reducing these contaminants will address the sediment toxicity as well.

3 NUMERIC TARGETS

Numeric targets are developed for organochlorine pesticides and PCBs in sediments and in the water column. McGrath Lake is on the 303(d) list for organochlorine pesticides and PCBs in sediment and sediment toxicity. In order to address these listings, water criteria and sediment guidelines are selected as numeric targets (Table 11). The sediment toxicity impairment is addressed by the sediment numeric targets, which are protective of aquatic life in sediment.

Table 11 Numeric Targets for Water Column and Sediment

Pollutant	Water Column Targets (µg/L)	Sediment Targets (ug/dry kg)
Chlordane	0.00059	0.5
Dieldrin	0.00014	0.02
4,4'-DDT	0.00059	1
4,4'-DDE	0.00059	2.2
4,4'-DDD	0.00084	2
Total DDT	--	1.58
Total PCBs	0.00007	22.7

3.1 SEDIMENT NUMERIC TARGETS

Numeric targets for sediments are protective of aquatic life beneficial uses. As discussed in Section 2, sediment quality is protected using narrative objectives in the Basin Plan. To develop the TMDLs, it is necessary to translate the narrative objectives into numeric targets that identify the measurable endpoint or goal of the TMDL and represent attainment of applicable numeric and narrative water quality standards.

The sediment quality guidelines compiled by NOAA and contained in NOAA's Screening Quick Reference Tables (SQuiRTs) (Buchman, 1999) are the applicable numeric targets for sediment. The specific numeric values are the ERL values for marine sediment. The State Board listing policy recommends the use of ERMs along with other lines of evidence as a threshold for listing. ERMs are identified by NOAA as representative of concentrations above which adverse effects frequently occur. The goal of the TMDL is to remove impairment and restore beneficial uses. Therefore, the numeric targets need to limit adverse effects to aquatic life; ERLs are identified by NOAA as representative of concentrations below which adverse effects rarely occur. In addition, the selection of the ERLs as numeric targets over the ERMs provides an implicit margin of safety.

The State Board is in the process of developing sediment quality objectives (SQOs) for enclosed bays and estuaries. Phase 1 of the Sediment Quality Objectives was recently adopted by the State Board as part of the statewide Enclosed Bays and Estuaries Plan (Resolution No.

2008-014). However, the use of the SQOs would not be appropriate for the McGrath TMDL. As a lake, the waterbody does not meet the definition of bay or estuary as specified in the statewide Enclosed Bays and Estuaries Plan. Furthermore, numeric targets are a required component of a TMDL and Phase 1 of the SQOs does not provide numeric objectives for each contaminant that could be utilized as numeric targets.

3.2 WATER COLUMN NUMERIC TARGETS

The CTR criteria for human health (organisms only) are selected as numeric targets for chlordane, DDT, and dieldrin for protection of the potential commercial and sport fishing beneficial use in McGrath Lake. The water column target for PCBs is based on the Basin Plan water quality objective, also for the protection of human health. These criteria and this objective are more stringent than CTR aquatic life criteria and will thus protect both aquatic life and fish consumption beneficial uses.

4 SOURCE ASSESSMENT

This section identifies the potential sources of pollutants in the McGrath Lake subwatershed. In the context of TMDLs, pollutant sources are categorized as either point sources or non-point sources. Point sources include discharges for which there are defined outfalls such as wastewater treatment plants and storm drain outlets. Point source discharges are regulated through National Pollutant Discharge Elimination System (NPDES) permits. Non-point sources, by definition, include pollutants that reach waters from a number of diffuse land uses and source activities that generate runoff to the lake and are not regulated through NPDES permits.

4.1 POINT SOURCES

Due to the agricultural nature of the area, there are no point sources that discharge to McGrath Lake within the subwatershed.

STORMWATER PERMITS

MS4 STORMWATER PERMIT

In 1990, EPA developed rules establishing Phase 1 of the NPDES stormwater program, which was designed to prevent pollutants from being washed by stormwater runoff into the municipal separate storm sewer system (MS4) or from being directly discharged into the MS4 and then discharged into local waterbodies. Phase 1 of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a stormwater management program as a means to control polluted discharges. The Ventura County MS4 permit was renewed in May 2009 as Order No. 09-0057 and is on a five-year renewal cycle. The Ventura County Watershed Protection District (VCWPD) is the principal permittee and there are 10 co-permittees covered by this permit. The co-permittee city in the McGrath Lake subwatershed is the City of Oxnard.

There are areas in the McGrath Lake subwatershed served by the Ventura County MS4 permit; however, the MS4 system does not discharge into McGrath Lake. Rainfall in the McGrath Lake subwatershed is not conveyed into the MS4 system; it enters the lake via agricultural drainage ditches or as overland flow. Therefore, the MS4 system is not considered a current point source to McGrath Lake in this TMDL.

GENERAL STORMWATER PERMITS

In 1990 EPA issued regulations for controlling pollutants in stormwater discharges from industrial sites (40 CFR Parts 122, 123, 124) equal to or greater than five acres. The regulations require discharges of stormwater associated with industrial activity to obtain an NPDES permit and to implement Best Available Technology Economically Achievable (BAT) to reduce or prevent pollutants associated with industrial activity. On April 17, 1997, the State Water Resources Control Board issued a statewide general NPDES permit for Discharges of Stormwater Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ, NPDES permit Nos. CAS000001). The State Water Resources Control Board issued a statewide general NPDES permit for Discharges of Stormwater Runoff Associated with Construction Activities (Order No. 99-08-DWQ, NPDES Permit Nos. CAS000002) on August 19, 1999. There are no industrial permits in the subwatershed. A small oilfield is located within the subwatershed, just north of the lake, however it is not enrolled in the statewide industrial permit as oil and gas sites are exempted from stormwater regulations under the 2005 Federal Energy Policy Act. There are no other industrial sites within the subwatershed. As of the writing of this TMDL, there were no discharges enrolled under the general construction or industrial stormwater permit in the McGrath Lake subwatershed.

OTHER NPDES PERMITS

There are no other Major Individual, Minor Individual, or General NPDES Permits adopted by the Regional Board for discharges within the McGrath Lake subwatershed.

4.2 NON-POINT SOURCES

Agriculture Sources

The subwatershed contains 22 separate parcels, of which 19 are currently dedicated to agricultural production. The main commodity of most of these agricultural operations is strawberries, supplemented by other row crops (LWA, 2008). The three parcels that are not utilized for agriculture are owned by the Ventura Regional Sanitation District and include the now closed Bailard Landfill. While the landfill is no longer open, post closure activities are ongoing.

Hydrology of Agriculture Parcels

While the McGrath Lake subwatershed is about 1,700 acres, under most conditions surface water draining from only a part of the landscape (approx. 730 acres) is destined for McGrath Lake (Provost and Pritchard, 2003). The subwatershed is relatively flat, sloping east to west. Prior to cultivation and agricultural development, the area was part of the larger floodplain of the Santa Clara River. During flood events, water would flow westward toward the ocean. The overland flow hydrology of the McGrath Lake subwatershed has been modified to meet the needs of agriculture; as a result, the flow directions can vary depending on various conditions.

Due to the tilling and cultivation of the lands in the subwatershed, runoff from this area is now conveyed through a series of drainage ditches. Some of these structures deliver water north, directly to the Santa Clara River. Others collect water from various smaller ditches and flow west. The largest of these water conveyances is the Central Ditch, which discharges directly into McGrath Lake. The figure below (Figure 3) outlines the general flow patterns under typical dry- and wet-weather flow (but not flooding) conditions.

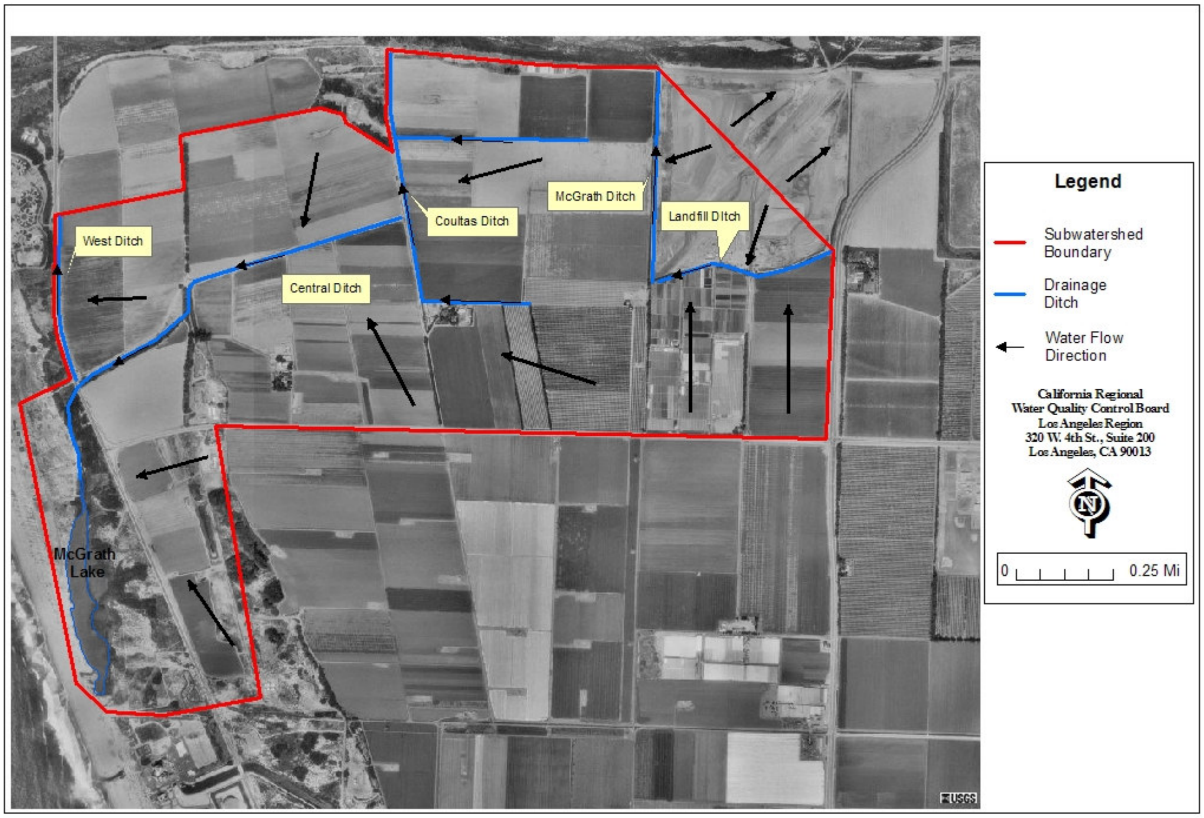

Figure 3 Flow patterns across the subwatershed in conditions less than the 10-year storm (modified from URS, 2005)

As seen in Figure 3, while McGrath Lake is the topographic low point in the watershed, water is transported in many different directions through the utilization of ditches, culverts and pumps. The Bailard Landfill, which was operated from 1962 – 1975 by Ventura Refuse Disposal (Kennedy Jenks, 2002), is located in the northeast corner of the subwatershed. Currently, the Bailard Landfill site is operated by the Ventura Regional Sanitation District; it has been clay capped and covered with uncompacted river wash soil and is planted with grasses and weeds (URS, 2005). Approximately, half (75 acres) of this site lies within the McGrath Lake subwatershed. The other half of the site drains directly to the Santa Clara River through several culverts. Along the southern boundary of the property there is a drainage ditch named the Landfill Ditch, which collects runoff from the Bailard Landfill property. The Landfill Ditch also collects discharge from two nursery properties located in the southeast corner of the subwatershed.

The Landfill Ditch runs westward to terminate at the McGrath Ditch. The McGrath Ditch runs north-south along the property line of the Coultas Ranch and eastern-most portion of the subwatershed (including Bailard Landfill). The northern portion of the McGrath Ditch discharges into the Santa Clara River through a 36” culvert that is covered with a storm flap (this flap is closed in large events to prevent river water from discharging into the agriculture fields of the McGrath Lake subwatershed). The southern portion of the McGrath Ditch discharges into a storm drain along Gonzales Road that drains to Edison Canal (KennedyJenks, 2002).

Moving west across the landscape, the next major drainage ditch is the Coultas Ditch, which is located on the western boundary of the Coultas Ranch property and also runs north-south. The Coultas Ditch discharges into the Santa Clara River through a 42” culvert and, like the Landfill Ditch, this outlet is also covered with a storm flap. There are two east-west subdrains that run across the Coultas Ranch, draining the central part of the property into the Central Ditch.

West of the Coultas Ranch is the SC Lands property. Water is shuttled to three different discharge points from the SC Lands property. Water from the northern portion of this property is discharged into the Santa Clara River via the North Ditch. The property is bisected by the Central Ditch, which runs east-west and collects runoff from about half of the SC Lands property. The Central Ditch runs through the SC Lands property, beneath Harbor Boulevard, and discharges into McGrath Lake. The portion of the property north of the Central Ditch and adjacent to Harbor Boulevard discharges into the West Ditch, which flows southward, crosses under Harbor Boulevard and discharges in the McGrath State Beach Campground near the mouth of the Santa Clara River (KennedyJenks, 2002).

The property located at the southwest corner of Harbor Boulevard and Gonzales Road conveys runoff to a low area where it is pumped into a culvert crossing under Harbor Boulevard and discharged into McGrath Lake (KennedyJenks, 2002). The area surrounding the lake, including the oil field, drains directly to the lake via overland flow.

Under flooding conditions (Figure 4), the ditches and pumps used to convey water become inundated and flooding occurs. Based on information from hydrologic modeling by the Ventura County Watershed Protection District (VCWPD), the outlets of the McGrath Ditch and the Coultas Ditch are below the Santa Clara River water level at the 10-year storm level (URS, 2005). Therefore, storms at the 10-year or greater level would not be able to discharge to the Santa Clara River due to the storm flaps covering the outlets and would flood the McGrath Lake subwatershed. Under such conditions, the flood waters may follow the natural topography of the area and flow to the low point of the subwatershed, which is McGrath Lake (URS, 2005; Kennedy/Jenks, 2002).

Much of the subwatershed is underlain with shallow, saline water. In addition to the surface runoff described above, the ditches also convey agricultural tailwaters from agricultural drains. Tile drains have been utilized to draw the groundwater below the working soil depth required for agricultural production. Drainage systems include gravity drains and sump pumps. The ditches themselves are unlined. Tile drainage contributes water to the Central Ditch year round as does the seepage of shallow groundwater.

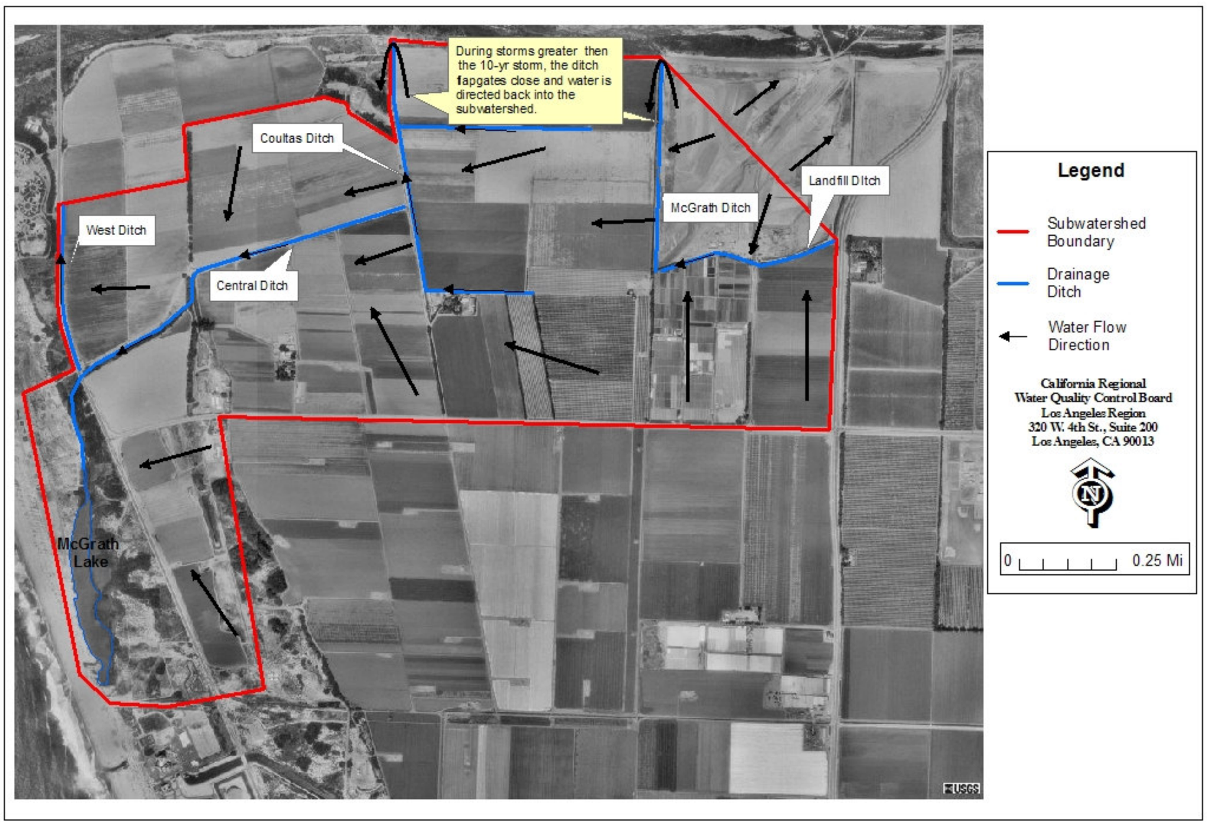

Figure 4 Flow patterns across the subwatershed in conditions more than the 10-year storm (modified from URS, 2005)

The flow paths (normal conditions and flood conditions) just discussed are relatively new. Over the last 10 years, landowners in the McGrath Lake subwatershed have reworked drainage structures on lands in the eastern portion of the subwatershed so that the lands drain to the McGrath Ditch and Coultas Ditch, which flow to the Santa Clara River (up to the conditions of a 10-year storm event; VRSD, 2006).

Historically, the ditch structure at the intersection of the Landfill Ditch and the McGrath Ditch became overwhelmed, resulting in westward flow across the landscape ultimately terminating in McGrath Lake. Projects completed on the nursery lands south of the landfill have resulted in less flooding in the lower part of the watershed. Three sedimentation basins were installed in the south-east part of the watershed to collect runoff from the nurseries up to a 25-year storm. A sediment check dam and trap was also installed at the junction of the McGrath and Landfill ditches (VRSD, 2006). Additional improvements were also made along the Central Ditch in an effort to reduce sedimentation to the lake. These improvements included leveling of some agricultural field and vegetative plantings along ditch banks (VRSD, 2006).

Central Ditch Water and Sediment Quality

As discussed in Section 2.1, the pollutants covered by this TMDL tend to migrate through the landscape by sorbing to suspended solids and particulate matter. Limited evaluations have been conducted on the quality and quantity of water and sediment entering McGrath Lake. Most of the sampling conducted has focused on the sediments and water within the lake itself. While no sampling has been completed that evaluates PCB and pesticide concentrations on suspended solids entering the lake, a small subset of water column data (Table 12) and channel-bottom sediment data (Table 13) have been collected from the Central Ditch.

Table 12 Concentration of Constituents of Concern in water from the Central Ditch (Provost and Pritchard, 2004; URS, 2005; VCAILG, 2008; VCAILG, 2009)

	Constituent of Concern (ug/L)						
Sample Date	Total Chlordane	Dieldrin	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total PCBs
03/15/2003[A]	ND	ND	NA	0.14	0.176	0.223	ND
09/08/2003	<0.05	<0.1	NA	<0.1	<0.1	<0.1	<1.0
09/18/2003	NA	NA	NA	0.02	NA	0.01	ND
06/05/2007	<0.001	<0.001	<0.001	<0.001	0.0083	<0.001	NA
09/11/2007	<0.001	<0.001	<0.001	0.0147	0.0167	<0.001	NA

	Constituent of Concern (ug/L)						
Sample Date	Total Chlordane	Dieldrin	2,4'-DDT	4,4'-DDD	4,4'-DDE	4,4'-DDT	Total PCBs
12/19/2007	<0.001	<0.001	0.0074	0.0096	0.0311	0.0201	NA
01/05/2008	<0.001	<0.001	0.0075	0.0128	0.1029	0.0439	NA
01/24/2008	0.1802	<0.001	0.2783	1.0772	2.1452	1.0539	NA
05/20/2008	<0.001	<0.001	<0.001	<0.001	0.0079	<0.001	NA
09/16/2008	<0.001	<0.001	<0.001	0.0053	0.0093	<0.001	NA
03/18/2009	<0.001	<0.001	<0.001	0.0047	0.007	0.0035	<0.001

[A] Three samples were collected on 3/15/2003, the average concentration is reported here.
ND=non-detect
NA=Not Available

The ditch, west of Harbor Boulevard, acts as a conveyance structure to the lake. The ditch most likely undergoes an erosion-deposition-erosion cycle as the hydrology changes throughout the year. Contaminated sediments deposited in the channel during the quiescent periods are expected to be flushed downstream into the lake during flooding conditions.

Table 13 Concentration of Constituents of Concern in sediment from the Central Ditch (Jacobi et al., 1999; Provost and Pritchard, 2004; LARWQCB, 2009)

	Constituent of Concern (ug/kg)			
Sample Date	Total Chlordane	Dieldrin	Total DDT	Total PCBs
10/29/1998	18.99	5.94	726.02	77.53
09/08/2003	<8.5	<8.5	85	<40
03/18/2009	39.4	13.8	1044.4	<1

Calculation of External Loading of Pesticides and PCBs to McGrath Lake

URS (2005) developed a hydrologic budget for the lake using data collected from the fall 2003 through summer 2004. The rainfall for that year was about 30% below normal (VCWPD). The resulting annual hydrologic budget estimated that approximately 204 acre-feet of water was added to the lake via surface water runoff (incorporating storm flows, tile drain discharge and groundwater discharge to the open ditches).

Using the URS hydrologic budget, average rainfall data and recent water quality and sediment quality data, the annual mass of contaminants entering the system may be approximated (table

14). This requires the use of the following equation:

Mass of Contaminants = (Volume of water entering lake) X (Concentration of Contaminants in the Water)

Using the above equation and the data in table 12, during years similar to 2003-2004, more than 34 g of total DDT and as much as 0.7 g each of total chlordane, dieldrin and PCBs may be entering the lake through the inflow of surface water to the lake. Table 14 summarizes the estimated mass of contaminants that enter the lake in dry years. Given that rainfall for 2003-2004 was about 30% below normal (Ventura County Watershed Protection District, 2009), it is expected that greater amounts of contaminants would enter during normal and above-normal precipitation years (due to increased runoff in the system).

Recent dry-weather water samples from the Central Ditch found TSS concentrations of 2 to 5 mg/L and during a wet-weather sampling this increased to 1270 mg/L (VCAILG, 2009). The contaminants covered by the TMDL are generally transported through the environment by mobilized sediment.

Table 14 Estimated concentrations of contaminants discharging to McGrath Lake from the Central Ditch (concentration data from 2003-2007).

Contaminant		Concentration (ug/L)[A]	2003-2004 Surface Flow (acre-feet [B])	Mass Inflow (g)
Chlordane	Min	0.0025[C]	204.1	0.6
	Max	0.0025[C]	204.1	0.6
	Avg	0.0025	204.1	0.6
Dieldrin	Min	0.0025[C]	204.1	0.6
	Max	0.0025[C]	204.1	0.6
	Avg	0.0025	204.1	0.6
Total DDT	Min	0.0158	204.1	4.0
	Max	0.5390	204.1	135.7
	Avg	0.1379	204.1	34.7
2,4'-DDT	Min	0.0025[C]	204.1	0.6
	Max	0.0074	204.1	1.9
	Avg	0.0041	204.1	1.0
4,4'-DDD	Min	0.0025[C]	204.1	0.6

Contaminant		Concentration (ug/L)[A]	2003-2004 Surface Flow (acre-feet [B])	Mass Inflow (g)
	Max	0.1400	204.1	35.2
	Avg	0.0374	204.1	9.4
4,4'-DDE	Min	0.0083	204.1	2.1
	Max	0.1760	204.1	44.3
	Avg	0.0580	204.1	14.6
4,4'-DDT	Min	0.0025[C]	204.1	0.6
	Max	0.2230	204.1	56.1
	Avg	0.0516	204.1	13.0
PCBs	Min	0.0025[C]	204.1	0.6
	Max	0.0025[C]	204.1	0.6
	Avg	0.0025	204.1	0.6

[A] URS, 2005; Provost and Pritchard, 2004; Larry Walker and Associates, 2008
[B] URS, 2005.
[C] Half the detection value was used for those samples reported as non-detect.

Internal Lake Non-point Sources

As stated in earlier sections, given the physio-chemical properties of the PCBs, DDT (and its derivatives), chlordane and dieldrin, these contaminants can sorb to fine sediments and the bottom organic fraction and in a terminal lake, like McGrath Lake, become sequestered in the benthic sediments. However, this is an oversimplification of the processes at work. While these contaminants do preferentially bind to sediments and particulate organic matter, through the processes of equilibration, some contaminant may be lost to the water column. It may then be bioavailable and gain entry to the food web (Birdwell and Thibodeaux, 2007).

Calculation of Internal Flux of Pesticides and PCBs in McGrath Lake

The distribution coefficient, Kd, of each contaminant dictates the degree with which the chemical binds to the sediment and how much is dispersed to the water column.

Equation 1 $Kd = \frac{[C]\ sed}{[C]\ water}$ where, Kd = distribution coefficient

[C] sed = concentration in sediment

[C] water = concentration in water

Kd may also be approximated by the equation:

Equation 2 $Kd = Koc \times foc$ where, Kd = distribution coefficient

Koc = organic-carbon-normalized distribution coefficient

Foc = organic carbon fraction in sediment

Using literature values for Koc (LWA, 2005; Ortiz et al., 2004), known sediment contaminant concentrations and known sediment organic carbon concentrations, the amount of contaminant moving into the water column can be calculated. To help demonstrate this, the data from the Moss Landing study (Jacobi et al., 1999) was used to calculate estimated water concentrations at the sediment-water interface due to the solubilization (Table 15; this data set was used as it was the most complete).

Table 15 Calculated contaminant concentration (ug/L) in water at the water-sediment interface due to solubilization processes compared to actual water column measurements (calculations based on data from Jacobi et al., 1999)

		Dieldrin		DDT		PCB 97	
Site	Region of Lake	Calculated	Measured	Calculated	Measured	Calculated	Measured
Central Ditch		0.204	ND	0.500	0.043	0.0008	0.004
Pump House		0.043	ND	0.131	0.026	0.0003	0.003
N2S4	North	0.088	ND	0.062	0.028	0.0007	0.007
M5S3	Mid	0.151	0.014	0.088	0.020	0.0009	0.006
S9S2	South	0.049	ND	0.073	0.019	0.0004	0.007

In general, the calculated and measured values are within an order of magnitude. It is likely that a portion of the contaminants sorbed to the bottom sediments of McGrath Lake are moving into the water column and then into the food chain.

Some recent studies (Ortiz, et al., 2004; Thibodeaux, 2005) more strongly illuminate the fact that bottom-dwelling hydrophobic contaminants may cross the sediment-water interface in more ways then previously considered. The accepted theories of organic contaminant sequestration may incorrectly simplify the processes that are actually occurring within a waterbody such as McGrath Lake. In a 2005 review article, Thibodeaux (2005) examined a variety of models and studies that showed significant PCB release due to solubilization rather than particle suspension. Low flow, low suspended solids conditions especially favored soluble release of PCBs. Examining eight different waterbodies, the average soluble release of PCBs was 68% (although as much as 100% was seen in some cases; Thibodeaux, 2005).

Groundwater Subsurface Flow

Groundwater comprises a significant portion of the water entering McGrath Lake. URS (2005) estimated that in 2003-2004, 258 acre-feet of water recharged to the lake through groundwater flows into the area.

However, there is no evidence that the groundwater recharge is a significant source of pesticide and PCB contamination in the lake. As part of the 2005 McGrath Lake Watershed Management Study (URS, 2005), URS investigated the groundwater flow patterns in the vicinity of McGrath Lake. Three monitoring wells were installed just east of the lake. By examining groundwater levels in the monitoring wells and other wells in the watershed, URS determined that the general direction of groundwater flow in the watershed is toward the lake. A single round of groundwater samples was collected from one of the URS monitoring wells near the lake. While the water was found to have high concentrations of nutrients, all of the TMDL constituents of concern were non-detect (Table 16; URS, 2005). It should be noted that the detection limits are higher than the CTR criteria, but it is still unlikely that groundwater is a source.

Table 16 Groundwater concentrations of TMDL constituents, collected September 8, 2003 (URS, 2005)

Constituent	Result (ug/L)
Total Chlordane	<0.005
Dieldrin	<0.1

Constituent	Result (ug/L)
4,4'-DDD	<0.1
4,4'-DDE	<0.1
4,4'-DDT	<0.1
Total PCBs	<1.0

Atmospheric Deposition

Residue from past use of OC pesticides and PCBs can be volatilized and/or resuspended as particulates, transported, and redeposited from both local and distant sources. The atmospheric deposition of OC pesticides and PCBs can be in the form of wet deposition or dry deposition (gravity settling of particles). There are two major pathways for pollutants from atmospheric deposition to enter waterbodies. One is direct deposition (pollutants falling directly on the water surface) and the other is indirect deposition, in which pollutants are deposited in the surrounding watershed and washed into the waterbody during a storm event. The loading of OC pesticides and PCBs from indirect atmospheric deposition is accounted for in the estimates of loading from agricultural land use in the watershed. The direction deposition is small, since the portion of the TMDL area covered by water is approximately 1 % of the total subwatershed area.

4.3 SUMMARY

As the topographic low point in the area, McGrath Lake receives about half of the storm flow draining off the subwatershed. The lake also receives agricultural discharge from agricultural drains and groundwater discharge. Surface water (stormwater and agricultural drainage) accounts for almost half of the total recharge of the lake, while groundwater accounts for the rest of the recharge. The source of the majority of the pesticide and PCB contamination appears to be contaminated surface water and sediments flushing into McGrath Lake. Calculations based on data from the 1999 Moss Landing Study (Jacobi et al., 1999) show that the highly contaminated sediments are a possible source of contaminants to the lake water column as well (Table 15). These soluble contaminants are more readily bioavailable and may be entering the food web. The constituents of concern have not been detected in groundwater from local monitoring wells.

5 LINKAGE ANALYSIS

The linkage analysis is used to identify the assimilative capacity of the receiving water for the pollutant of concern by linking the source loading information to the water quality target. The TMDL is then divided among existing pollutant sources through the calculation of load and waste load allocations. This section discusses the linkage analysis used for McGrath Lake. The goal of the McGrath Lake PCBs and OC Pesticides TMDL is to reduce pollutant loads of DDT, dieldrin, chlordane, and PCBs from the McGrath Lake watershed to the sediments of the lake and to remediate the existing contamination of sediments in the lake.

The chemical properties of the constituents of concern for this TMDL result in a strong binding to particulate matter, such as fine-grained sediment and organic matter. The chemical properties favor binding to particulate matter (Table 17 details the chemical properties of the chemicals included in this TMDL). However, given high enough concentrations, particular environmental conditions and time enough for equilibration, release to the aqueous phase is possible. Contaminants bound to particulate matter moving rapidly through the Central Ditch would be inclined to stay sorbed. Most of the contaminants bound to particulate matter in highly contaminated sediments at the bottom of a lake remain in the sediments. However, given the high concentrations observed in the sediments, combined with low-flow, quiescent conditions, a portion of the contaminants are likely being released to the water column.

Table 17 Chemical properties of OC pesticides and PCBs (Adapted from LWA, 2005)

Constituent	Molecular Weight[1]	Henry's Law Constant[2] (atm-m3/mole)	Log Kow2	Log Koc2	Log BCF[2]	Half Life in Soil, Low (days)[1]	Half Life in Soil, High (days)[1]	Water Solubility (mg/L)[2]
Chlordane	409.8	4.86E-05	NA	3.09	4.27	350	7300	0.056
DDD	321	4.00E-06	6.02	NA	4.9	730	2190	0.09
DDE	319	2.10E-05	5.69	4.7	4.91	1000	5475	0.12
DDT	354.5	8.10E-06	6.36	5.18	4.97	1460	5330	0.025
Dieldrin	380.93	1.51E-05	4.55	3.92	3.65	109	4560	0.195
PCBs	200.7-453	4.0E-04[3]	3.9-6.7	NA	NA	730	2190	0.004-0.91

Kow=octanol-water partitioning coefficient, Koc=organic carbon-normalized distribution coefficient, BCF=bioconcentration factor

[1] Sources: ASTDR website (www.atsdr.cdc.gov/toxfaq.html), EXTOXNET website (http://pmep.cce.cornell.edu/profiles/extoxnet), Journal of Pesticide Reform website

(www.pesticide.org), Mackay et al. (1997)

[2] Source: Syracuse Research Corporation, http://www.syrres.com/esc/chemfate.htm

[3] Source: Burkhard et al., 1985 (Henry's Law constant for PCBs not available from Syracuse Research Corporation Website)

NA=Not Available

It is the transportation of the particulate matter via suspended solids in stormwater and agricultural runoff that results in the majority of the distribution of these chemicals throughout the environment. Figure 5 depicts a general conceptual model for PCBs and OC pesticides in McGrath Lake. Past studies at McGrath Lake determined concentrations of PCBs in the lake sediments may be as much as almost ten times the water quality standards and OC pesticides in the lake sediments may be as high as 1900 times the water quality standards. The source assessment section shows water column samples from the Central Ditch leading to the lake with detectable concentrations of PCBs and pesticides as well. Given that the contaminants are being detected in both the liquid and solid phases, this TMDL assigns numeric targets and allocations to water and sediments.

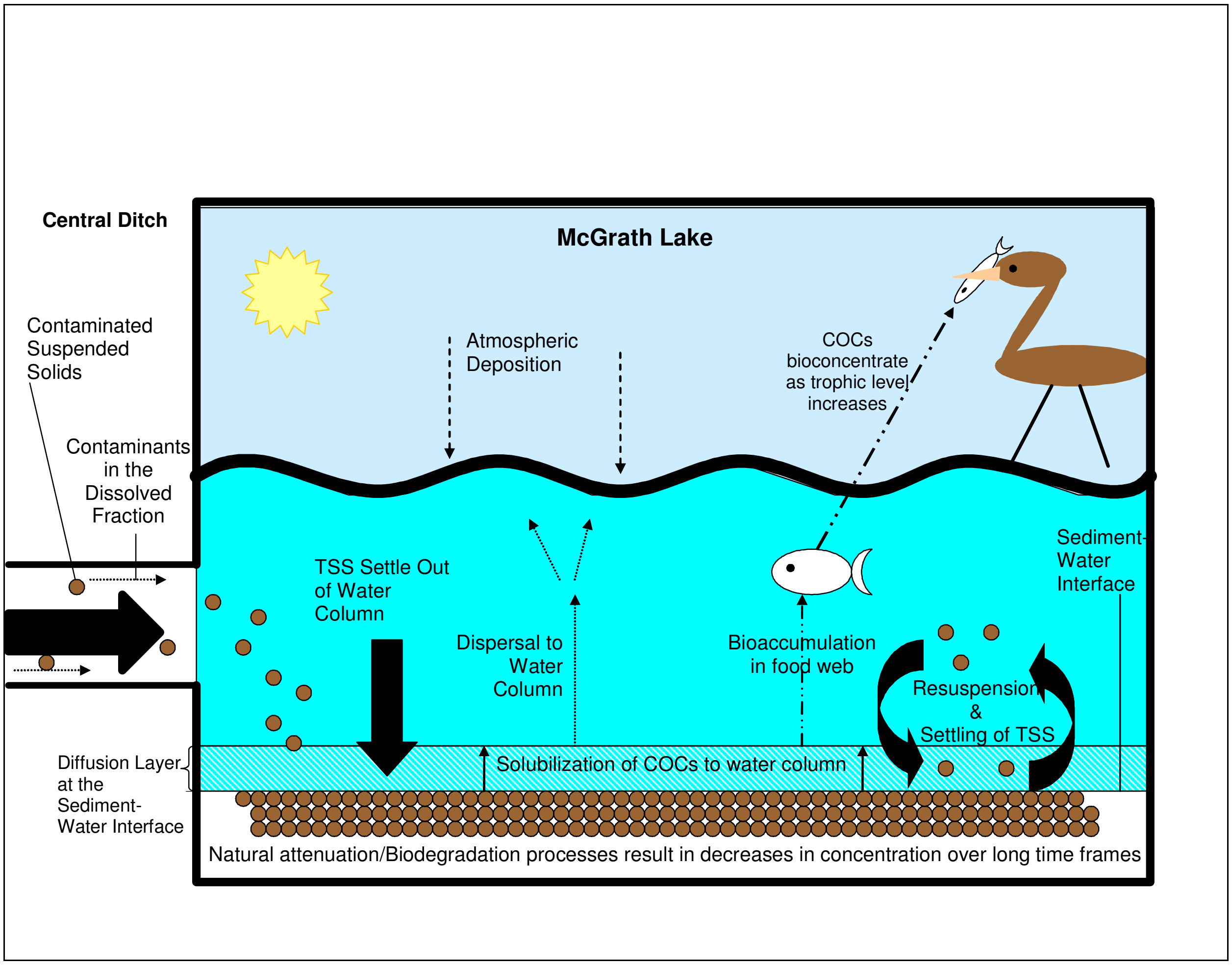

Figure 5 Conceptual model for contaminant mobilization in the McGrath Lake system.

All of the contaminants included in this TMDL are legacy pollutants. While PCBs and the OC pesticides DDT, dieldrin and chlordane are no longer legally sold or used, they remain ubiquitous in the environment, bound to fine-grained particles. As such, there are no new sources in the watershed. When these particles become waterborne, the chemicals are ferried to new locations. The more recent addition of pollutants to McGrath Lake most likely comes from the erosion of pollutant-laden sediment further up in the watershed. Irrigation and rainfall higher in the watershed mobilize the particles, which are shuttled to McGrath Lake via the Central Ditch (Figures 3 and 4). It is expected that reductions in loadings of these pollutants will lead to reductions in sediment concentrations in the lake over time.

The lake has no natural surface outlet; therefore the particulate matter and the bound PCBs and OC pesticides remain in the lake. As the pollutants settle into the sediments, some loss will occur through the slow decay and breakdown of these organic compounds. Concentrations in surface sediments may also be reduced through mixing with cleaner sediments. However, these processes occur slowly. Based on the chemical properties in Table 17, it could take between 14 and 200 years for all the organic compounds to degrade to levels below water and sediment quality standards. The degradation rates of the compounds differ greatly and may be affected by environmental conditions. The breakdown of chlordane and dieldrin would be expected to fall in the lower to middle of the time- range, while DDT and PCBs would be expected to be at the higher end of the time range. As stated in section 4.2, PCBs and OC pesticides can continue to migrate into the water column where they are then bioavailable. Also, the sediment is toxic to benthic organisms and may be taken up through bioturbation and feeding processes. Once the sediment-bound PCBs and OC pesticides contaminate benthic organisms, the contaminants may move out of the lake sediments through each trophic layer. Therefore, internal loading from contaminated sediments is a source and is assigned a load allocation. Without a natural outlet, the only manner in which the existing contaminants in surface sediments would be removed quickly is through the utilization of dredging operations.

Though there is no natural surface water outlet for the lake, water is lost through the artificial pumping utilized to manage the lake elevation. A single sample was collected in 2003 from the pump discharge (Provost and Pritchard, 2004). Chlordane, dieldrin and PCBs were not detected in the sample, however, DDD and DDT were found at levels just above the practical quantitation level (PQL; Table 18).

Table 18 Water quality results from the McGrath Lake Pump Discharge (collected September 18, 2003; Provost and Pritchard, 2004)

Constituent	Result	PQL	Units
Chlordane	ND	0.01	ug/L
Dieldrin	ND	0.01	ug/L
4,4'-DDD	0.02	0.01	ug/L
4,4'-DDE	ND	0.01	ug/L
4,4'-DDT	0.01	0.01	ug/L
PCBs	ND	0.5	ug/L

LOADING CAPACITY

Based on the conceptual model and the fact that McGrath Lake is a terminal lake, the lake loading capacity is set equal to concentration-based numeric targets of this TMDL.

6 POLLUTANT ALLOCATION

This section summarizes the pollutant allocations and identifies responsible agencies and parties to which allocations are assigned.

TMDLs are comprised of waste load allocations (WLAs), load allocations (LAs), and a margin of safety (MOS).

$$TMDL = WLA + LA + MOS$$

WLAs are assigned to point source discharges and LAs are assigned to non-point source discharges. The constituents of concern for this TMDL, OC Pesticides and PCBs, are not naturally occurring, thus, the background allocation is equal to zero. Also, there are currently no point source discharges to McGrath Lake, so there is no waste load allocation as discussed below, and the MOS is implicitly applied. Therefore, the TMDL is equal to the load allocation.

6.1 WASTE LOAD ALLOCATIONS

As identified in the Source Assessment section of this document, currently there are no MS4 discharges into McGrath Lake. Therefore, no WLAs have been assigned in this TMDL. If future development results in stormwater discharges in the McGrath Lake subwatershed, the absence of a WLA would require that stormwater discharges cannot be directed into McGrath Lake. If it was contemplated that point source discharges would be directed to McGrath Lake, then the McGrath Lake TMDL would need to be amended.

6.2 LOAD ALLOCATIONS

Load allocations addressing non-point sources of OC pesticides and PCBs will be assigned to both non-point source discharges to the lake from the Central Ditch and internal sources from the lake sediments. As discussed in previous sections, chlordane, dieldrin, DDT and PCBs migrate through the environment bound to mobilized sediment particles. The contaminants of concern have been detected in both water and sediment samples collected at McGrath Lake, therefore this TMDL will assign load allocations to both sediment and water.

Pollutant LAs have been set equal to the numeric targets set in section 3. This approach has been used in other TMDLs throughout the state (e.g. 2005 Calleguas Creek Watershed Toxicity, Chlorpyrifos and Diazinon TMDL). Pollutant LAs are assigned on a concentration basis. This applies the same standard throughout the watershed, instilling equal protection.

Tables 19 and 20 summarize the load allocations for the watershed. All load allocations apply on the effective date of the TMDL.

Table 19 Lake Sediment Load Allocations

Load Allocation Responsible Parties	Pollutant	Sediment Load Allocation (µg/dry kg)
State of California Dept. of Parks & Recreation, Hugo McGrath Family, Agricultural Dischargers, Other Subwatershed Landowners	Chlordane	0.5
	Dieldrin	0.02
	4,4'-DDT	1
	4,4'-DDE	2.2
	4,4'-DDD	2
	Total DDT	1.58
	Total PCBs	22.7

Table 20 Load Allocations for Water and TSS Discharges from Central Ditch

Load Allocation Responsible Jurisdiction	Pollutant	Water Column Load Allocation (µg/L)	Load Allocation for Suspended Sediment Associated Contaminants (µg/dry kg)
Agricultural Dischargers	Chlordane	0.00059	0.5
	Dieldrin	0.00014	0.02
	4,4'-DDT	0.00059	1
	4,4'-DDE	0.00059	2.2
	4,4'-DDD	0.00084	2
	Total DDT	--	1.58
	Total PCBs	0.00007	22.7

6.3 IDENTIFICATION OF RESPONSIBLE PARTIES

As indicated in Tables 19 and 20 above, the current owners of the lake, agricultural dischargers, and other subwatershed landowners in the watershed have been identified as the responsible parties in this TMDL. The section below discusses the rationale as to how the responsible parties were identified.

The McGrath Family has been farming in Ventura County since the 1870s and was once the sole landowner of all of the parcels in the McGrath Lake subwatershed and owned the lake as well. The McGrath Family eventually sold various parcels to new landowners. The McGrath Family still owns approximately 300 acres in the subwatershed, including approximately 5% of McGrath Lake itself. The remaining acreage in the watershed is currently owned by six different landowners. Ninety-five percent of McGrath Lake and the surrounding area, a 295-acre parcel, is currently owned by California State Parks as part of the McGrath Beach State Park.

Although Regional Board staff has partially identified historical landowner information in the watershed, there is no documentation regarding landowner practices concerning pesticide application. The California Department of Pesticide Regulation (DPR) collects Pesticide Use Report (PUR) data for the State of California. The PUR data provides detailed information about pesticide application rates according to crop type for each county in the state. However, there is no PUR data available before 1974 (DPR personal communication). It is a reasonable assumption that OC pesticides were applied to agricultural lands in the subwatershed, as these chemicals are known to have been widely used throughout Ventura County. Yet, there is not PUR data documenting the application of OC pesticides in the McGrath Lake subwatershed and in the case of DDT, the pesticide was banned prior to the reporting of pesticide use information to DPR.

Additionally, a large flood event occurred in the area in 1969; it is reported that flood flows from the Santa Clara River breached both the north and south river banks causing extensive flooding in the McGrath Lake subwatershed. This flood is reported to have done considerable damage to the agricultural lands in the subwatershed and caused sedimentation of McGrath Lake (Kennedy Jenks, 2002). It is likely that the sediments transported by the flood into the McGrath Lake subwatershed and McGrath Lake were already contaminated with OC pesticides and/or PCBs from other sources in the Santa Clara River Watershed. This flood event likely contributed contamination to the subwatershed and obscures the identification of historical contamination sources. Also, as presented in Section 2 of the document, PCBs may have been introduced into the subwatershed through several different pathways. This includes illegal dumping of equipment which contained PCBs and/or through atmospheric deposition. PCBs may also have been directly applied to land as part of agricultural operations. Area farmers may have unknowingly applied PCBs to the landscape as they were used as pesticide extenders and used oil residues containing PCBs may have been used in fields and dirt roads as dust suppression agents (ATSDR, 2000; Dennis, 1976).

While significant staff resources have been utilized to develop this TMDL, in addition to the issues described above, limitations in the currently available data make it difficult to attribute the legacy contaminants in the lake sediments to specific historical dischargers. In order to attribute the legacy sediment contamination to specific historical dischargers, a large amount of obscure technical information would be required. For example, a detailed review of the historical watershed hydrology and historical sediment loss from the watershed would be needed. Additional required information would also include:

- Historical watershed land ownership records (size of properties, length and/or era of ownership);
- Sedimentation/resuspension rates within the lake; and
- Sediment contamination profile (both within the lake and throughout the subwatershed).

Based on the information described above, the pollutants in the lake sediment are currently considered unattributable to individual responsible parties; therefore, the Regional Board shall assign joint responsibility for the lake sediment load allocation and clean up of the contaminated lake sediments to current landowners of the lake and current watershed landowners discharging to the lake.

The identified responsible parties shall attain the load allocations specified in Table 20 in the lake. It is expected that the load allocation assigned to the lake sediments will be implemented through a Memorandum of Agreement (MOA) as outlined in the Implementation section of this document. If the responsible parties do not enter into a MOA and attain the load allocations assigned to the lake sediments, the Regional Board may undertake special studies and gather the additional data necessary to individually attribute the lake sediment load allocation to historical and current watershed landowners. It is expected that such an analysis would result in a minor fraction of the total contamination being attributable to current watershed landowners. The remaining portion of the attributable contamination would most likely be allocated to historical landowners. At this time, historical landowners are considered to be those who owned land within the watershed prior to 1980 (as that is when all legal uses of the pollutants ended). Any remaining portion of contamination that cannot be attributed to watershed landowners, such as direct atmospheric deposition, would be assigned to the current owners of the lake. If necessary, the Regional Board shall employ the appropriate regulatory mechanisms, such as a Cleanup and Abatement Order, to implement the individually attributed load allocations.

6.4 MARGIN OF SAFETY

TMDLs must include an explicit and/or implicit margin of safety (MOS) to account for uncertainty in determining the relationship between pollutant loads and impacts on water quality. An explicit MOS can be provided by reserving (i.e. not allocating) part of the TMDL; thus requiring greater source load reductions. An implicit MOS can be provided by conservative assumptions in the TMDL analysis.

There are some uncertainties in the McGrath Lake PCBs and OC Pesticides TMDL. The primary sources of uncertainty include:

1) use of limited data on the amount of PCBs and pesticides entering the lake;
2) use of limited data on the amount of PCBs and pesticides currently in-situ within the confines of the lake;
3) limited flow data from the drains entering the lake;
4) inherent seasonal and annual variability in the hydrologic budget for the lake;
5) limited data on the medium by which the PCBs and pesticides are entering the lake; and
6) the estimates of natural attenuation rates for PCBs and pesticides.

Staff made conservative assumptions when calculating the loading to the lake. This approach was taken to include an implicit MOS. The implicit MOS is also based on the selection of ERLs as numeric targets for sediment, which are the most protective of the potentially applicable sediment guidelines available.

6.5 CRITICAL CONDITION

TMDLs must include consideration of critical conditions and seasonal factors. As the contaminants of concern for this TMDL are mobilized through the environment by the mobilization of sediment, it is expected that the greatest influx of PCBs and pesticides occurs during periods of increased runoff from the watershed. The conditions under which the targets and load allocations for the lake were developed are considered critical conditions for the lake. TDue to the artificial interference in the hydrologic cycle of the watershed, peak runoff may not necessarily correspond to the traditional wet season. There is a high degree of inter- and intra-annual variability in water flow and sediment deposition in the McGrath Lake subwatershed. This is a function of storms, which are highly variable between years, and artificial drainage. The concentration-based TMDL represents all flows at all times, and is based on levels of the pollutants found in the water and sediments. Due to the historic use of PCBs and pesticides, accumulation occurs over long time periods. Since the load allocations apply at all times, the TMDL provides for year-round protection of the water quality standards for PCBs and pesticides.

7 IMPLEMENTATION

This section describes the implementation procedures that could be used to provide reasonable assurances that water quality standards will be met. Compliance with the TMDL is based on achieving the Load Allocations and demonstrating attainment of the Numeric Targets. Compliance will require the elimination of toxic pollutants being loaded to the lake from the subwatershed and the clean up of contaminated sediments lying at the bottom of the lake. Dischargers and responsible parties may implement structural or nonstructural BMPs and work collaboratively to achieve the numeric targets and allocations in McGrath Lake.

7.1 WASTE LOAD ALLOCATION IMPLEMENTATION

Stormwater Permits

As identified in the Source Assessment Section of this document, currently there are no MS4 or other stormwater discharges into McGrath Lake and no WLAs have been assigned in this TMDL. If future development results in stormwater discharges in the McGrath Lake subwatershed, the absence of a WLA would require that stormwater discharges cannot be directed into McGrath Lake. If it was contemplated that point source discharges would be directed to McGrath Lake, then the McGrath Lake TMDL would need to be amended.

7.2 LOAD ALLOCATION IMPLEMENTATION

Load allocations addressing non-point sources of OC pesticides and PCBs are assigned to agriculture non-point source (NPS) discharges and to the lake sediments. Two primary federal statutes establish a framework in California for addressing NPS water pollution: Section 319 of the Clean Water Act (CWA) of 1987 and Section 6217 of the Coastal Zone Act Reauthorization

Amendments of 1990 (CZARA). Non-point source load allocations can also be addressed through provisions in the California Water Code, such as Conditional Waivers, Waste Discharge Requirements (WDRs), or Discharge Prohibitions. In accordance with these statutes, the state assesses water quality associated with non-point source pollution and develops programs to address NPS. In 2004, the State Water Resources Control Board (SWRCB), in its continuing efforts to control NPS pollution in California, adopted the Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program, which prescribes implementation and monitoring of management practices to address non-point source pollution.

Agriculture Non-point Source Discharges

The Los Angeles Regional Board adopted the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Order No. R4-2005-0080) on November 3, 2005 in order to address NPS discharges from irrigated agriculture land. It is expected that load allocations, assigned to agriculture non-point source dischargers, as specified in Table 20, will be implemented through the Conditional Waiver for Irrigated Lands or through other appropriate Regional Board Orders. The Waiver currently includes water quality benchmarks but not sediment quality benchmarks. The Conditional Waiver will be up for renewal in 2010 and sediment benchmarks may need to be added at that time to implement load allocations.

The Conditional Waiver program requires (1) enrollment (group or individual), (2) water quality monitoring, and (3) implementation of BMPs, as necessary, by irrigated agriculture land owners and/or operators. The goal of the Conditional Waiver Program is to improve water quality and protect beneficial uses by mitigating pollutants discharged from irrigated agriculture lands.

The Ventura County Agricultural Irrigated Lands Group (VCAILG) is a Conditional Waiver Discharger Group that has been approved by the Los Angeles Regional Board. All of the agriculture landowners in the McGrath Lake subwatershed are enrolled and participating in the Conditional Waiver through membership in VCAILG. As required by the Conditional Waiver, VCAILG is currently implementing a Water Quality Management Plan (WQMP) to address the exceedance of benchmarks in the Conditional Waiver. The VCAILG WQMP was approved by the Executive Officer on February 3, 2009. The WQMP identifies specific BMPs to address exceedances and provides a timeline for BMP implementation. Drainage areas that have both exceedances of water quality benchmarks and TMDLs have been prioritized for BMP implementation; the McGrath Lake subwatershed is a priority drainage area.

The LAs for this TMDL can be achieved through BMPs implemented as part of the WQMP and/or other projects as outlined below. It is likely that a combination of implementation measures will be needed to achieve the LAs.

- On-Farm BMPs

On-farm BMPs would focus on individual growers implementing BMPs on individual parcels throughout the watershed. Effective BMPs to reduce pollutant loading would focus on sediment and erosion management practices because as discussed in Section 2 of the document, both OC pesticides and PCBs strongly bind to sediment particles that are transported with runoff. Irrigation management practices are also important to reduce and/or eliminate dry weather runoff from fields. Listed below are some practices that may be implemented by individual growers.

- Avoid bare fields by planting cover crops or leaving plant debris in field
- Minimize road erosion by grading or using gravel on roads
- Capture and reuse irrigation/stormwater runoff on site
- Use sediment traps at the end of fields to capture sediment from runoff
- Mitigate runoff before it leaves property with grassed swales and filter strips
- Conduct tests of irrigation systems to ensure efficiency and uniformity
- Inspect irrigation systems for breaks and leaks
- Divert water from non-cropped areas
- Use current weather information to determine irrigation requirements
- Stop irrigation if runoff occurs

- Regional Sub-Watershed BMPs

Regional watershed BMPs would be similar to on-farm BMPs, but they would be designed and implemented on a larger scale to address runoff from multiple parcels. For example, the Central Ditch is the largest drainage ditch in the sub-watershed. If the Central Ditch was redesigned as a vegetative treatment ditch, it would be acting as a regional BMP as well as continuing to convey runoff.

- Regional Treatment System

The installation of a regional treatment system, such as a sand filter, to treat runoff prior to discharge into McGrath Lake is also a possible implementation option. A sand filter system typically contains two or more chambers. The first is the sedimentation chamber, which removes floatables and heavy sediment. The second chamber removes additional pollutants by filtering the runoff through a sand bed. Sand filters are able to effectively remove sediment (EPA, 1999). As previously discussed, OC pesticides and PCBs have a very strong binding affinity to sediment particles; therefore successfully reducing the sediment in the runoff will also reduce the pollutant load.

Additionally, the Los Angeles Regional Board is currently sponsoring research at the University of California Riverside to evaluate adsorbent materials and their ability to remove OC Pesticides from agriculture runoff. The experiments are laboratory based; variables considered in these experiments include flow rates and dissolved organic matter concentrations in the source water. The feasibility of transferring the materials to field scale projects will also be evaluated. Results of these experiments are expected by spring 2010.

- Redirect Agriculture Discharge

It may be possible to redirect the agriculture discharge from the Central Ditch to a different receiving waterbody, such as the Edison Canal. The Edison Canal is a Water of the State located approximately ½ mile south of McGrath Lake and discharges to the Pacific Ocean. This implementation option would address the TMDL and achieve the Central Ditch load allocations by eliminating the agriculture discharge into McGrath Lake. The agriculture discharge would be redirected to a waterbody that has a larger assimilative capacity and is better suited to accept the discharge. Moreover, the agriculture discharge would still be regulated by the Conditional Waiver and required to achieve the water quality benchmarks and implement BMPs. Therefore, requirements of the Conditional Waiver would protect the water quality of the new receiving waterbody.

Contaminated Lake Sediments

The sediments of McGrath Lake are contaminated with OC Pesticides and PCBs. These chemicals are persistent in the environment and require clean up and remediation. The responsible parties identified in the Pollutant Allocation section of this document are assigned a lake sediment load allocation and the responsibility for the clean up of the contaminated lake sediments to attain the load allocation. This section reviews the regulatory tools that may be used to ensure clean up of the lake sediments and presents possible implementation measures.

One of the options available to implement the LAs assigned to internal lake sources includes the Regional Board or Executive Officer, if delegated authority by the Regional Board, entering into a Memorandum of Agreement (MOA) with responsible parties. Alternatively, the Regional Board Executive Officer shall issue a Clean Up and Abatement (CAO) or use another appropriate regulatory mechanism if individual and/or historical responsible parties are identified as discussed in Section 6.3.

A MOA may be entered into by the Regional Board and responsible parties to implement the in-lake load allocations of the McGrath Lake OC Pesticides and PCBs TMDL. The MOA shall meet requirements pursuant to the development of a non-regulatory implementation program as presented in the Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (State Board Resolution 2005-0050) section 2 C ii and requirements of this TMDL.

To be a valid non-regulatory implementation program adopted by the Regional Board, the MOA shall include the following requirements and conditions:

- The MOA shall direct development of a monitoring and reporting program plan that addresses the impaired water as approved by the Regional Board's Executive Officer.
- The MOA shall contain conditions that require trackable progress on attaining load allocations and numeric targets. A timeline shall be included that identifies the point or points at which Regional Board regulatory intervention and oversight will be triggered if the pace of work lags or fails.
- The MOA shall contain a provision that it shall be revoked based upon findings by the Executive Officer that the program has not been adequately implemented, is not achieving its goals, or is no longer adequate to restore water quality.
- The MOA shall be consistent with the California Policy for Implementation and Enforcement of the Non-point Source Pollution Control Program, including but not limited to the "Key Elements of a Non-point Source Pollution Control Implementation Program".

Responsible parties entering into a MOA with the Regional Board shall submit and implement a McGrath Lake Work Plan (MLWP). The MLWP must be approved by the Executive Officer and may be amended by Executive Officer approval, as necessary. The MLWP shall identify implementation measures, which responsible parties will implement, that will achieve the lake sediment LAs. Additionally, the MLWP shall include a Monitoring and Reporting Program (MRP) Plan and strategy to secure funds to remediate the lake sediments. The MLWP shall include tasks and a clear timeline for task completion leading to the attainment of lake sediment LAs. The roles and responsibilities of each responsible party shall also be outlined in the MLWP. The MLWP shall include annual reporting requirements. The work plan shall include a detailed description of how remediation of McGrath Lake sediments will complement other restoration efforts currently ongoing at McGrath State Beach and other area restoration projects.

Three years from the effective date of the TMDL, the responsible parties entering into the MOA shall submit a letter of intent and McGrath Lake Work Plan for approval by the Executive Officer in order to be in compliance with the MOA that is entered into to implement this TMDL. The implementation of the work plan must result in attainment of the lake sediment load allocations. Responsible parties of the MOA shall submit annual progress reports to the Regional Board for review and approval by the Executive Officer. At the time Phase 2 monitoring commences (see section 7-4) the annual monitoring results shall be submitted as part of the annual progress report.

If the MOA and McGrath Lake Work Plan are not implemented such that the lake sediment load allocations are achieved, the Regional Board may revoke the MOA and the lake sediment load allocations shall be implemented through a CAO or other appropriate regulatory mechanism. The implementation of the MOA or other regulatory mechanism will be coordinated with the implementation measures to achieve the Central Ditch load allocations assigned to agricultural discharges into McGrath Lake. This is will ensure that recontamination of the lake sediments does not occur after the clean up is completed.

Regional Board staff will work cooperatively and actively with the responsible parties to develop the MOA or other regulatory mechanism that will completely clean up the lake sediments, restore beneficial uses, and address the concerns and goals of stakeholders. Described below are three potential measures to clean up contaminated sediments in McGrath Lake.

- Sediment Capping

The objective of sediment capping is to cover contaminated sediments by a layer of clean sediment, clay, gravel, or other material. The cap reduces the mobility of the pollutants and places a physical barrier between the water column and the contaminated sediment. Capping can be an effective remediation action; however it is most effective in large deep waterbodies under certain conditions. For example, the bottom sediments of the waterbody must be able to support the cap and the hydrologic conditions of the waterbody must not disturb the cap site. This option would require long term monitoring and maintenance to ensure that the contaminated sediments are not moving and that the cap is still in place. A feasibility study considering the conditions of McGrath Lake would be necessary before this option could be implemented.

- Dredging/Hydraulic Dredging

Dredging is the removal of accumulated sediments from the lake bottom. In the case of McGrath Lake, the objective would be to remove the sediments that are contaminated with OC pesticides and PCBs. Therefore, it would be necessary to dredge to a depth that would ensure the removal of all contaminated sediments. A method of sediment removal from lakes is hydraulic dredging. A hydraulic dredge floats on the water and is approximately the size of boat. It has a flexible pipe that siphons a mix of water and sediment from the bottom of the lake. The flexible pipe is attached to a stationary pipe that extends to an off site location. The sediment that is removed from the lake bottom is pumped to a settling pond to dry prior to disposal. Hydraulic dredging does not require draining the lake or damage to the shoreline of the lake; however, it can cause damage to aquatic life, create short term turbid conditions, and low dissolved oxygen. Hydraulic dredging does require careful planning and mitigation for non-target disturbances.

- Monitored Natural Attenuation of Contaminants

Natural attenuation encompasses the physical, chemical, and biological processes that the sediments may undergo, which over time will attenuate (i.e. reduce concentration and bioavailability) the impacts of contamination. These are natural processes that will occur without other remediation actions. Monitoring would be required, as part of this remediation strategy, to demonstrate that contaminants are in fact attenuating and that human health and the environment are protected. A disadvantage of choosing natural attenuation as a remediation strategy is that it generally requires long periods of time to be effective. Based on current contamination levels at McGrath Lake, it is estimated that the average time required for natural attenuation is from 27 to 211 years depending on the contaminant. Given the concentrations found in the lake sediments, it could take much longer to achieve water quality standards than other alternatives (Table 21).

Table 21 Estimated Timeframe for Monitored Natural Attenuation

Contaminant	T1/2	k[1] (years -1)	ERL (ug/dry kg)	Contaminant Concentration (ng/g)			Times above ERL			Years to reach ERL[2]		
				Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Chlordane	7.7	0.09	0.5	11	864	333	22	1729	667	70	119	101
Dieldrin	3	0.231	0.02	0	38	16	24	1905	778	14	33	27
DDT, total	13	0.0533	1.58	150	3488	1933	95	2207	1223	167	226	211
PCBs	9.5	0.0729	22.7	19	461	205	1	20	9	94	138	123

7.3 Determine Compliance with Targets and Allocations

The goal of the TMDL is to restore all of the beneficial uses of McGrath Lake through attainment of water quality objectives. Compliance with this TMDL will be determined through water and sediment quality monitoring and comparison with the TMDL load allocations. The compliance point for responsible parties receiving a Central Ditch load allocation shall be the Central Ditch at Harbor Boulevard, which is the current location of the VCAILG Conditional Waiver monitoring site. The VCAILG Monitoring Program site identification for this location is OXD_CENTER. The compliance point for responsible parties receiving a lake sediment load allocation shall be in the northern end of the lake and in the deepest portion of the lake. These are separate sampling sites and both points must meet the TMDL lake sediment load allocation to achieve compliance.

7.4 Monitoring and Reporting Plan

The McGrath Lake PCB and Pesticide monitoring program will be designed to monitor and implement this TMDL. The monitoring program is required to measure the progress of pollutant load reductions and improvements in water and sediment quality. The monitoring program has several goals:

- Determine attainment of PCBs, pesticides and toxicity numeric targets;
- Determine compliance with the load allocations for PCBs and pesticides; and
- Monitor the effect of implementation actions on lake water quality.

Monitoring will begin 90 days after Executive Officer approval of the MRP. The sampling plan will be delineated into two phases. The first phase will focus on sampling the Central Ditch (for the first 10 years of the TMDL implementation schedule) and will be conducted by the responsible parties for the Central Ditch LAs. For the remaining portion of the TMDL implementation schedule, water and sediment samples will be collected from the Central Ditch and the lake and will be conducted by the responsible parties for the lake sediment Las and the Central Ditch LAs.

Phase 1

Samples collected for Phase 1 of the monitoring program will be collected from the Central Ditch, just west of Harbor Blvd. Phase 1 requires the development of a MRP plan to comply with the TMDL requirements. The MRP shall propose a monitoring frequency for water and sediment sampling that will characterize the variability in water and sediment quality observed in the Central Ditch. Water samples will be analyzed for the following constituents:

- Total Suspended Solids
- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

Sediment samples will be analyzed for the following constituents:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

The annual monitoring reports will summarize proposed changes to the MRP based on the results of the previous year's monitoring. Sampling frequency may be reduced during future years once characterization of the variability in water and sediment quality has been achieved. In addition to TMDL constituents, general water chemistry (temperature, dissolved oxygen, pH and electrical conductivity) and a flow measurement will be required at each sampling event.

Responsible parties for phase 1 monitoring shall submit a MRP plan to assess compliance with LAs and a Quality Assurance Project Plan (QAPP). The MRP and QAPP must be submitted to the Executive Officer for approval within six months of the effective date of the TMDL. The QAPP shall include protocols for sample collection, standard analytical procedures, and laboratory certification. All samples shall be collected in accordance with Surface Water Ambient Monitoring Program (SWAMP) protocols, where available, or alternative protocols proposed by dischargers and approved by the Executive Officer. Monitoring shall begin 90 days after the Executive Officer has approved the MRP and QAPP.

Currently, several of the constituents of concern have numeric targets that are lower then the readily available detection limits. As analytical methods and detection limits continue to improve (i.e. development of lower detection limits) and become more environmentally relevant, responsible parties shall incorporate new method detection limits in the MRP and the QAPP.

A monitoring report shall be prepared and submitted to the Regional Board annually within three months after the completion of the final sampling event of the year.

Phase 2

Phase 2 of the monitoring program will commence following the remediation of the lake (and possible adjacent areas) sediments to monitor the effect of implementation actions. The sampling, analysis and flow measurements begun in Phase 1 will continue. Additionally, samples will be collected from within the lake. Surficial sediment samples (top 2 cm) will be collected at the northern end of the lake and from the deepest portion of the lake. Water samples will be collected from each site as well. All samples will be collected in accordance with SWAMP protocols. Sediment samples will be analyzed for:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin

- Total Chlordane

Water Column samples will be analyzed for:

- Total Suspended Solids
- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

Samples from the lake will be collected annually. The annual reports required for Phase 1 will continue during Phase 2. Additional monitoring may be required depending on which implementation alternative is pursued by the responsible parties.

Three years from the effective date of the TMDL, responsible parties must submit the MLWP. The MLWP shall include any additional monitoring needed to assess the effectiveness of the chosen implementation option. The MLWP shall include a MRP and QAPP for the Phase 2 monitoring.

Currently, several of the constituents of concern have numeric targets that are lower then the readily available detection limits. As analytical methods and detection limits continue to improve (i.e. development of lower detection limits) and become more environmentally relevant, responsible parties shall incorporate new method detection limits in the MRP and the QAPP.

A monitoring report shall be prepared and submitted to the Regional Board annually within three months after the completion of the final sampling event of the year.

Special Studies

Special studies may be utilized to evaluate the implementation alternatives outlined in this TMDL. The results of the special studies can be used to guide the implementation process.

Sediment Contamination Extent Study

As stated in Section 1-3, the areal extent of McGrath Lake has varied historically. The current footprint of the lake is smaller than past sizes that were documented during the period the TMDL-targeted PCBs and pesticides were legally manufactured, sold and utilized. Therefore, the sediment contamination may extend beyond the current margins of the lake. A special study could be undertaken to determine the horizontal and vertical extent of contamination. Sites may include sampling locations across the lake (using a grid pattern), along the margins of the lake and along the Central Ditch (between Harbor Blvd and McGrath Lake).

Determination of sediment-bound versus dissolved contamination

Given the documented physio-chemical properties of the contaminants of concern for this TMDL, it is assumed that sediment and water column exceedances are being caused by mobilized sediment particles to which the contaminants have sorbed. In general, it is expected that higher loads of total suspended solids would result in greater exceedances. Recent data collected by VCAILG (2008, 2009) has shown benchmark exceedances of some pesticides even when very low concentrations of total suspended solids are present. Collected samples could be utilized to verify that the form and quantity in which contaminants are entering the Central Ditch and McGrath Lake.

Agricultural Drain Flow Characteristics

A majority of the surface flows into McGrath Lake come from up-watershed agricultural fields in the form of stormwater runoff and agricultural tile drain discharges. Few data are available regarding the volume of water being discharged by the tile drain system. Generally, contamination from pollutants transported by mobilized soil particles is exacerbated by storm conditions as flowing water is required to move the particles (and attached contaminants). However in this case, the agricultural tile drains provide a source of flowing water throughout the year. The acquisition of site-specific flow information would aid in the development of BMPs to reduce pollutant loading to the lake.

7.5 IMPLEMENTATION SCHEDULE

The TMDL Implementation Schedule (Table 22) is designed to provide responsible parties flexibility to implement appropriate BMPs and lake management strategies to address PCB, pesticide and sediment toxicity impairments at McGrath Lake. Implementation consists of development of monitoring/management plans and work plans by responsible parties, implementation of BMPs to address external contaminant loading to the lake, and lake management activities to remediate the high levels of sediment contamination currently within the lake.

Table 22 Implementation Schedule for McGrath Lake PCBs and Pesticides TMDL

Task Number	Task	Responsible Party	Deadline
1	TMDL Load Allocations (LAs) for Chlordane, Dieldrin, 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, Total DDT, and Total PCBs apply.	State of California Dept. of Parks and Recreation, McGrath Family (owners of the Central Ditch west of Harbor Blvd and the northern end of the lake), Agriculture Dischargers, Other sub-watershed landowners	Effective Date of TMDL
2	Responsible parties assigned Central Ditch LAs shall submit a Monitoring and Reporting Plan (MRP) to the Executive Officer for review and approval to address Phase 1 monitoring.	Agriculture Dischargers	6 months from the effective date of the TMDL
3	Responsible parties assigned Central Ditch LAs shall begin monitoring as outlined in the approved MRP.	Agriculture Dischargers	90 days from the date of MRP approval
4	Responsible parties assigned Central Ditch LAs shall submit annual monitoring reports. Reports shall be submitted within three months after the completion of the final sampling event of the year.	Agriculture Dischargers	Annually
5	Responsible parties shall enter into a Memorandum of Agreement (MOA) with the Regional Board to implement the lake sediment LAs.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	Two years from the effective date of the TMDL
6	Responsible parties subject to the MOA shall submit a McGrath Lake Work Plan (MLWP) for review and approval by the Executive Officer.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	Three years from the effective date of the TMDL

Task Number	Task	Responsible Party	Deadline
7	Responsible parties subject to the MOA shall submit annual progress reports.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	Annually from the date of MLWP approval
8	Responsible parties shall attain Central Ditch LAs.	Agriculture Dischargers	10 years from the effective date of the TMDL
9	Responsible parties shall begin implementation of McGrath Lake sediment remediation actions as outlined in the MLWP.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	As soon as possible, but no later than 10 years from the effective date of the TMDL
10	Responsible parties shall begin Phase 2 monitoring as outlined in the MLWP. The results shall be included as part of the annual progress reports initiated in Task 8.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	13 years from the effective date of the TMDL or at the time lake sediment remediation actions are completed, whichever is earlier.
11	Responsible parties shall achieve lake sediment LAs.	State of California Dept. of Parks and Recreation, McGrath Family, Agriculture Dischargers, Other sub-watershed landowners	14 years from the effective date of the TMDL

7.6 COST CONSIDERATIONS

The purpose of this cost analysis is to provide the Regional Board with a reasonable range of potential costs of implementing this TMDL, and to address concerns about costs that have been raised by responsible parties. An evaluation of the potential costs of implementing this TMDL amounts to evaluating the costs of preventing loading of PCBs and pesticides from agricultural discharges to the lake and remediating the contaminant-laden sediments at the bottom of the lake. This section provides an overview of the potential costs associated with generalized discharge reduction and sediment remediation implementation methods.

Cost of Implementing TMDL

The cost of implementing this TMDL will range widely, depending on the methods that the responsible parties select to meet the load allocations. Based on the implementation measures discussed previously, approaches can be categorized as management of agricultural discharges and management of in-situ McGrath Lake sediments. Both components will be necessary to address the impairments to the lake.

<u>Agricultural Discharge</u>

- Dispersed On-Farm BMPs

The Natural Resources Conservation Service (NRCS) provides knowledgeable assistance to farmers in reducing soil mobilization. NRCS staff can provide technical assistance on installing on-farm BMPs. The NRCS website (http://efotg.nrcs.usda.gov/treemenuFS.aspx) provides cost estimates for various on-site BMPs. Within the McGrath Lake subwatershed, on-farm BMPs may include buffer crops, filter strips and sedimentation basins. The cost of implementing each of these BMPs would vary depending on the extent with which they are installed. The costs may further increase if productive land is replaced by non-productive BMPs. Table 23 summarizes the estimated costs for various on-farm BMPs.

Table 23 Per acre costs for potential on-farm BMPs (NRCS, 2000).

BMP	Cost (per acre)	Annual O & M Cost (per acre)
Field Border	$373	$8.15
Filter Strip	$1002	$15.28
Sedimentation Basin	$10,000	$196

Often replacing a traditional irrigation system with a drip irrigation system can aid in reducing the mobilization of sediment (and the sorbed contaminants). As many of the producers in the watershed are growing strawberry crops, drip irrigation systems are already widely used in the area. However, improved maintenance of the systems may reduce farm runoff. Maintenance for micro-irrigation systems cost about $40/acre/year (NRCS, 2000).

- Regional Watershed BMPs

In addition to on-farm BMPs, there are also regional BMPs that can be initiated. These would be similar to the on-farm BMPs, but larger in scale. One potential BMP that could be instituted would be to convert the Central Ditch to a grassed waterway. According to the NRCS (2000), it would cost approximately $1,288/per acre to convert the ditch to a grassed waterway. Additionally, about $18/acre/year would be required for maintenance costs over the ten-year lifespan of the grassed waterway.

Another regional BMP option is to effectively convert the dirt road that runs along the Central Ditch into a filter strip. As mentioned in the previous section, filter strips cost about $1002/per acre plus an additional $15/year/acre in operations and maintenance fees.

- Regional Treatment System

There are numerous options that could be employed for a regional treatment system. One potential system would be the utilization of an activated carbon system (AC). While AC filter plants can be custom designed and built for smaller-scale projects (as would be expected in this case) a pre-built, “package plant” would be a more economical option. The unit cost of AC systems generally decreases as capacity increases. Data from AC plants across the state show the unit costs, including annualized capital and O&M costs, to range from $0.21-1.823/1000 gallons of water treated (2007 dollars; ACWA, 2007). As a treatment plant needed to address the Central Ditch water would be fairly small, the price would likely be at the high end of the range resulting in an estimated cost of $151,536/year.

Additional costs may also be incurred as activated carbon systems have trouble treating water with high TSS concentrations. Most of the year the Central Ditch has fairly low TSS, but the concentrations can be quite high during storm events. This could require a treatment train consisting of settling tank and/or sand filter prior to the AC system. If such a pretreatment was required, the treatment costs would increase.

- Redirect Agriculture Discharge

Provost and Pritchard (2003) evaluated the possibility of rerouting the Central Ditch away from McGrath Lake using either an open-air ditch or enclosing the drainage in pipes. It was estimated that to reroute the water to the Santa Clara River would cost $558,684 via an open air ditch and $997,335 through a piped diversion.

Another alternative is to reroute the water to Edison Canal. The distance to Edison Canal from the Central Ditch is about 50% longer than the distance to the Santa Clara River. Estimated costs to reroute drainage toward Edison Canal are $612,611 (open ditch) to $1,287,402 (piped diversion).

In-Lake Approaches

- Monitored Natural Attenuation

As a remediation option, Monitored Natural Attenuation (MNA) is the most passive and, therefore, the least expensive of the possible in-lake implementation approaches. However, given the high concentrations of contaminants, this method would take a long time to resolve the in-situ sediment contamination issues and would likely not meet the required implementation schedule.

MNA requires monitoring to document that contaminant concentrations are decreasing. Monitoring requirements would be similar to those laid out in section 7.2. Sediment, water column (bottom, mid and surface depths), and porewater samples would need to be collected twice a year from the north end of the lake and the deepest part of the lake and analyzed for:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

Annual monitoring costs would run approximately $13,500 (including sample collection and analyses).

- In-situ Capping

In-situ capping results in the containment of contaminated sediments rather than treatment. Due to the fact the contaminants remain on-site and potentially could be exposed after the capping layer is installed, monitoring is required to verify that contaminants are not mobilizing to the water column and food web. To calculate the cost of in-situ capping, it is assumed that the entire current footprint of the lake (approx 12 acres) would be covered with a sand cap approximately 1 ft thick. In-situ capping would cost about $1,423,852 for installation activities (Table 24).

Table 24 Installation costs for an in-situ capping approach at McGrath Lake.

Cost Component	Unit Cost	Area, ft^2	Total Cost
Mobilization/ Demobilization[a]	$300,000		$300,000
Capping Activities[b]	$2.15/$ft^2$	522,722	$1,123,852
			$1,423,852
[a] U.S. Army Corps of Engineers, 2005 [b] U.S. EPA, 2002			

Provided the cap is not disturbed by high flow and/or storm events, annual maintenance should not be required. However, as with the MNA alternative, more extensive monitoring may be required. If monitoring reveals that the sediment contaminants are being transported across the sand cap, additional costs may be accrued to strengthen the cap. Sediment porewater samples would need to be collected twice a year from the north end of the lake and the deepest part of the lake annually and analyzed for:

- Total Organic Carbon
- Total PCBs
- DDT and Derivatives
- Dieldrin
- Total Chlordane

Annual monitoring costs would run approximately $4500 (including sample collection and analyses).

- Dredging

The costs to dredge McGrath Lake and the contaminated riparian corridor are dependent on the lateral and horizontal extent of the contamination. While past samples indicate the sediments within the current footprint of the lake are contaminated, it is unknown if, due to the larger historical size of the lake, the soil outside the current margins is also contaminated. It has also yet to be determined how deep the sediments are contaminated. Two costs estimates were completed to reflect two different possibilities: sediment contamination that is restricted to the current lake footprint; and sediment contamination that extends beyond the current footprint.

Currently there are no beneficial reuse opportunities in the region for the dredged sediments from McGrath Lake; therefore, any dredged material will need to be transported to a landfill. Sediment removal and disposal costs were obtained from the Army Corps of Engineers estimates at the nearby Port Hueneme Harbor. The costs for sediment removal and disposal from Port Hueneme are considered applicable to McGrath Lake because the level of contamination in the sediments at both sites is similar. The estimate for sediment removal and disposal at Port Hueneme includes dredging, offloading, dewatering, rehandling, transporting, and disposing in an upland Class III landfill. The costs range from $61-76 per cubic yard of dredged sediment (California Coastal Commission, 2008). The estimated total costs for dredging McGrath Lake range from $3,245,566 to $11,826,980 (Table 25) depending on the total per unit (cubic meter) costs and the extent to which the area is contaminated.

Table 25 Estimated costs to dredge McGrath Lake.

		Current Lake Footprint			Dry Margins of the Lake	Option 1 Dredge Current Lake Footprint	Option 2 Dredge Historical and Current Footprint of Lake
		North Portion	South Portion	Total			
Approximate Area	acres	4.1	7.9	12	12.8	12	24.8
	ft^2	178,596	344,124	522,720	557,568	522,720	1,080,288
Estimated Dredge Depth	ft	3.3	2.5		4.9		
Estimated Dredge Volume	ft^3	585,945	846,762	2,734,937		1,432,707	4,176,644
	yd^3	21,702	31,362	101,627		53,063	154,691
Total Cost	Low ($61/$yd^3$)					$3,236,843	$9,36,151
	High ($76/$yd^3$)					$4,032,788	$11,826,127

The costs may also increase if further tests indicate that the riparian corridor is contaminated and/or contaminant loads are determined to be classified as hazardous waste. Given the erosional characteristics of the riparian corridor, it is expected that any contamination will be relatively minor and costs will only increase slightly.

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