SWAMP
Surface Water Ambient Monitoring Program

Technical Report	**2002 - 2003**

WATER QUALITY IN THE DOMINGUEZ CHANNEL AND LOS ANGELES/LONG BEACH HARBOR WATERSHED MANAGEMENT AREA

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WATER QUALITY IN THE DOMINGUEZ CHANNEL AND LOS ANGELES/LONG BEACH HARBOR WATERSHED MANAGEMENT AREA

UNDER THE
SURFACE WATER AMBIENT MONITORING PROGRAM
FISCAL YEAR 2002-2003

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EXECUTIVE SUMMARY

California's Surface Water Ambient Monitoring Program (SWAMP) is a comprehensive monitoring program designed to assess the quality of the beneficial uses of the State's water resources. SWAMP objectives include 1) surveying each hydrologic unit in the State at least once every five years, 2) using consistent sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements, 3) analyzing spatial and temporal trends in water quality statewide, and 4) evaluating waterbodies based on water quality standards and available data. Two types of monitoring are conducted under SWAMP: ambient monitoring, in which waters are surveyed without bias to know impairment, and site-specific monitoring, in which problem sites or clean sites (reference sites) are characterized.

The Los Angeles Regional Water Quality Control Board (LARWQCB) has developed an ambient monitoring program that obtains site-specific information while still encompassing regional ambient monitoring goals. Ultimately, this data will allow the LARWQCB to answer the following questions:

- What is the percentage of streams or waterbodies in a watershed or region that support their beneficial uses (e.g., water contact recreation, cold freshwater habitat, etc.)?
- Is the percent of streams or waterbodies in a watershed or the region that support their beneficial uses increasing or decreasing over time?

During the third year of the SWAMP funding cycle (FY 2002-03), the Dominguez Channel and the Los Angeles/Long Beach Harbor Watershed Management Areas were sampled.

The Dominguez Channel and Los Angeles/Long Beach Harbor Watersheds are located in the southern portion of the Los Angeles Basin. The Dominguez Channel Watershed covers approximately 133 square miles and is located on the Los Angeles Coastal Plain in the western portion of the Transverse Ranges Geomorphic Province. Dominguez Channel flows between low hills and drainages through a heavily urbanized and industrialized area (81% of the watershed has been developed). Portions of the cities of Los Angeles, Carson and Torrance make up approximately half of the watershed. The Los Angeles/Long Beach Harbor complex is now one of the largest ports in the country in terms of shipping activity and volume of goods transported.

Machado Lake (also known as Harbor Lake or Harbor Park Lake) is located in Ken Malloy Harbor Regional Park. These areas are the remnants of a tidal slough system that was once part of San Pedro Bay and represent an important remnant of wetlands along the Pacific Flyway. As water quality has deteriorated and toxic sediments have accumulated in the lake, boating activity has been stopped and signs have been posted about the risks of eating fish from the lake.

The monitoring design included 8 sampling stations in Dominguez Channel, 5 stations in Machado Lake and 30 stations in Los Angeles/Long Beach Harbor and San Pedro Bay. Field observations and conventional water chemistry analyses were conducted at the 8 Dominguez Channel stations. Metal analyses were conducted at 1 station in the upper portion of Dominguez Channel. Benthic infaunal samples were analyzed from the 5 lower stations in Dominguez Channel. Field observations, conventional water chemistry analyses and toxicity testing were conducted at the 5 Machado Lake stations. Sediment samples were collected at all 5 Machado Lake stations and analyzed for grain size, total organic carbon, metals and organics; toxicity testing also was performed. Field observations, conventional water chemistry, metals, organics, bacteriological testing and toxicity testing were performed at the 30 Los Angeles/Long Beach Harbor and San Pedro Bay stations for surface water samples. At 10 of these stations, near-bottom and bottom water samples also were analyzed for conventional water chemistry, metals, organics and toxicity testing. Pore water samples extracted from sediments collected at these 10 stations were analyzed for metals, organics and toxicity testing. Toxicity testing also was conducted on samples collected at the sediment-water interface at these 10 stations.

Machado Lake monitoring was conducted on a single date in 2003 under SWAMP, providing a snapshot of water quality conditions in the lake. Some degradation of water quality was evident at stations 1 and 2 in the northern end of the lake, possibly due to the influence of the Wilmington Drain discharge (which is listed as impaired for ammonia). Dissolved oxygen concentration and saturation was low at these two locations, and pH values were lower and ammonia values were higher at these two stations than at other locations in the lake. In addition, nitrate values were highest in the lake at station 1. However, although high nutrient levels might be expected to increase primary productivity (plant and algal growth) at these stations, chlorophyll a (an indicator of primary productivity) was lowest at the northern end of the lake and highest at the southern end.

Warm water temperatures occurred at all five stations in the lake on the August sampling date, close to or exceeding 80 degrees Fahrenheit. Such warm water is likely to stress aquatic organisms, particularly fish. Many other water quality parameters were fairly uniform throughout the lake, including alkalinity, chloride, hardness, nitrite, orthophosphate, sulfate, total organic carbon and suspended solids. Despite some evidence of water quality problems in the lake, none of the water samples tested produced any acute or chronic toxicity at any of the five stations.

Sediment sampling indicated that stations towards the northern end and the central portion of the lake exhibited more fine-grained sediments, while the more southerly stations had coarser sediments. This may reflect the influence of the Wilmington Drain discharge, as particulates carried by the drain into the lake may settle out in the northern and central part of the lake due to decreases in velocity as the drain flows enter the lake. Typically metal and organic contaminants adhere more readily to small particles, so it might be expected that sediment contamination would be greater at the northern and central stations than at the southerly stations. This was somewhat the case for metals, as the station closest to the Wilmington Drain (which is listed as impaired for copper and lead) had the highest sediment concentrations for all ten of the metals that were measured in this study. However, the other stations had fairly similar sediment concentrations for many of the metals. The southerly stations tended to have higher metal concentrations than the central stations, which was surprising given the coarser nature of the sediments in the central portion of the lake. Organics tended to be highest in the lake sediments at the southerly stations, which had the highest concentrations of PAHs, and along with station 2 (in the north-central portion of the lake) had the highest concentrations of chlordane, DDTs and PCBs. Organic concentrations generally were lowest in the central portion of the lake.

Machado Lake sediments would be classified as "possibly contaminated" for most of the metals and organics for which sediment quality guidelines have been established for freshwater environments. However, despite this widespread sediment contamination for many metals and organics, sediment toxicity testing demonstrated acute toxicity only at stations 3 and 4, located in the central and southerly portions of the lake. All five of the stations displayed reduced growth during the chronic toxicity testing. Technically these stations all were classified as non-toxic, since the reduction in growth between the control samples and the lake samples was less than the 20% difference required for a toxicity designation. However, since all five test samples produced a reduction in growth, it seems likely that the sediment contaminants present were producing some adverse impact upon the test organisms.

Dominguez Channel monitoring also was conducted on a single date under SWAMP, again simply providing a snapshot of water quality conditions in the channel. The lower estuarine portion of Dominguez Channel is subject to tidal action. The water quality measurements for several conventional parameters clearly reflect this tidal influence. Salinity, specific conductance, alkalinity, sulfate and chlorides all were highest at the most downstream station monitored in the channel (closest to the nearly marine waters of Los Angeles Harbor) and progressively decreased as sampling moved upstream.

Certain water quality parameters did display some evidence of degradation of water quality in the upper portions of Dominguez Channel with pH values exceeding Basin Plan objectives. Chlorophyll a, total organic carbon, biochemical oxygen demand and suspended solids also were highest at the upstream stations. These changes in water quality might be due to the heavily industrialized nature of the area draining into the upper portions of the channel. However, nutrient levels were fairly low throughout the entire channel on this particular sampling date, as were organic and metal concentrations (although metals were only measured at a single station in the upper channel). In addition, no toxicity was observed at the only station tested in the upper channel. Bacteriological indicators measured during the SWAMP study indicated high levels at many of the sampling locations throughout the channel.

Dominguez Channel is listed as impaired due to benthic infaunal community effects. Benthic samples were collected at five of the estuarine stations within Dominguez Channel during the SWAMP study. The results confirm that the benthic community is adversely impacted within at least parts of Dominguez Channel, as three of the five stations were classified as being in poor condition.

Los Angeles/Long Beach Harbor and San Pedro Bay monitoring was conducted over a one-week period in October 2003 under SWAMP, once again providing only a snaphot of water quality conditions in the harbor and bay. Surface water monitoring indicated that salinity and water temperature did not vary greatly throughout the harbor and bay. However, pH values were generally lowest in Los Angeles Harbor and highest in San Pedro Bay (although all pH values were within Basin Plan objectives). Some depression in dissolved oxygen saturation (less than 80% saturation) was observed in Los Angeles Harbor, but it is not clear if this would cause any water quality problems.

Water column sampling at various depths (at 10 of the 30 stations) indicated thermal stratification at most locations, as would be expected at this time of year, with surface water temperatures generally 1 to 3 degrees Celsius higher than bottom or near-bottom temperatures. No density stratification was observed as salinity values were fairly uniform throughout the water column. Oxygen saturation and pH values generally were slightly lower at the bottom and near-bottom than in the surface waters, as would be expected.

Water quality conditions of coastal waters have been assessed nationwide utilizing a suite of several indicators (dissolved oxygen, dissolved inorganic nitrogen, orthophosphate, chlorophyll a, water clarity) [USEPA, 2004]. Only three of these indicators are available for assessment of Los Angeles/Long Beach Harbor and San Pedro Bay: dissolved oxygen, dissolved inorganic nitrogen and orthophosphate. Dissolved oxygen concentrations yielded a rating of high quality at 25 of the 30 stations sampled, and moderate quality at the remaining 5 stations (all located in Los Angeles Harbor). Dissolved inorganic nitrogen was low throughout most of Los Angeles/Long Beach Harbor and San Pedro Bay. All of the stations sampled would be categorized as being of high quality, with the exception of one in San Pedro Bay (4616) which rated as low quality. Orthophosphate concentrations were higher, as none of the stations rated as high quality. All of the stations would be characterized as being of moderate quality, with the exception of two stations in San Pedro Bay (once again station 4616 and the adjacent station 4744) which rated as being of low quality. These stations are located near the mouth of the Los Angeles River and may be receiving some nutrient inputs from that source.

Given the heavily industrialized nature of the inner areas of Los Angeles/Long Beach Harbor, and the large number of vessels utilizing and anchoring within the harbor and several marinas in the area, it would not be surprising to find high metal concentrations in water column samples. However, silver was the only metal which exceeded the water quality objective; this occurred at 20% of the stations (6 out of 30), although notable concentrations were present at all stations. There was no apparent pattern to the silver exceedances, as stations with high silver occurred at inner and outer harbor stations in both Los Angeles and Long Beach Harbor, and in San Pedro Bay. Water column concentrations were well below water quality objectives for all of other metals (arsenic, cadmium, chromium, lead, nickel, selenium and zinc), with the exception of copper. Copper concentrations were always below the water quality objective, but notable concentrations (greater than 0.5 milligrams per liter) were present at all stations. This is not unexpected as copper commonly is used in anti-fouling paints used to protect boats and in wood preservatives for docks and pilings. Organic concentrations were below the analytical detection limit for nearly all of the water samples and no toxicity was observed in any of the water samples tested.

The SWAMP water column sampling was timed to coincide with the Bight'03 survey of coastal waters from Point Conception to the Mexican border. The Bight'03 sampling design resulted in sampling at 17 stations within Los Angeles/Long Beach Harbor and San Pedro Bay (14 stations were in Los Angeles/Long Beach Harbor and 3 stations were in San Pedro Bay). Sediment sampling conducted at these 17 stations for the Bight'03 study included sediment chemistry analyses, sediment toxicity testing and benthic community analyses.

Based on the Bight'03 results, DDT contamination was widespread throughout Los Angeles/Long Beach Harbor and San Pedro Bay in 2003. The sediment concentrations for total DDT exceeded the ERM value at 6 of the 14 Los Angeles/Long Beach Harbor stations and 1 of the 3 San Pedro Bay stations and were greater than the ERL but less than the ERM value at 7 of the Los Angeles/Long Beach Harbor stations and 2 of the San Pedro Bay station (only 1 station, 4370, had a DDT concentration lower than the ERL). The probabilistic design employed by the Bight'03 study allows the results to be translated into the areal extent of sediment contamination for the entire Los Angeles/Long Beach Harbor (however, the precision of this estimate is not as high as desired, since only 14 stations were sampled, rather than the preferred minimum of 30). It is estimated that 94% of Los Angeles/Long Beach Harbor has significant DDT contamination (greater than the ERL threshold), while 43% of the harbor has sediments with DDT concentrations likely to produce toxicity (greater than the ERM threshold). This is not surprising, given that 71% of the entire Southern California Bight was found to have significant DDT contamination of sediments based on the 2003 Bight study [Schiff et al., 2006]. Although DDT was banned from use in the United States in the early 1970s, historical use for several decades and past discharges from the Montrose Chemical Corporation's manufacturing plant in Torrance have resulted in large deposits of this long-lasting contaminant and its breakdown products in the coastal waters of Southern California. All of the San Pedro Bay stations displayed DDT contamination, but it is not possible to assess the areal extent of contamination for the bay with only 3 sampling stations.

No other organic contaminants were widespread in Los Angeles/Long Beach Harbor. For example, PCB sediment concentrations never exceeded the ERM threshold and exceeded the ERL threshold only at 2 stations (one in Los Angeles Inner Harbor and one in Long Beach Inner Harbor).

Copper contamination was widespread throughout Los Angeles/Long Beach Harbor in 2003. Although none of the copper levels exceeded the ERM, 13 of the 17 stations in

Los Angeles/Long Beach Harbor and all 3 of the stations in San Pedro Bay exceeded the ERL [Schiff et al., 2006]. It is estimated that 76% of the harbor is contaminated with copper. As mentioned above, copper is commonly used in anti-fouling paints to protect boats and in wood preservatives for docks and pilings, so it is not surprising to find accumulation of copper in the sediments. No reliable estimate of the extent of copper contamination within San Pedro Bay can be provided with only 3 sampling stations in this area. The sampling results also show evidence of widespread sediment contamination for nickel and mercury in Los Angeles/Long Beach Harbor; although none of the stations exceeded the ERM threshold, approximately half of the stations exceeded the ERL threshold for these two metals [Schiff et al., 2006]. The sources of nickel and mercury contamination are unknown.

High sediment concentrations of metals or organics may or may not produce toxicity, depending on the bioavailability of these contaminants to aquatic organisms. Consequently, sediment toxicity testing and the health of the benthic infaunal community were assessed to determine whether the widespread sediment contamination observed during the Bight'03 study resulted in direct biological impacts.

Sediment toxicity occurred in more than half of the stations tested within Los Angeles/Long Beach Harbor; 8 stations were classified as moderately toxic, 1 station was classified as highly toxic and 7 stations were classified as non-toxic [Bay et al., 2006]. Based on these results, it is estimated that 56% of the harbor contains sediments that would be expected to produce sediment toxicity. In San Pedro Bay, 1 of the 2 stations tested was classified as toxic; no estimate of the areal extent of sediment toxicity for the bay can be produced from such limited data.

The benthic infaunal community was classified as being in good condition (Reference or Level 1 category) at 75% of the stations sampled in Los Angeles/Long Beach Harbor and in poor condition at the other 25% (Level 2 or Level 3 category) [Ranasinghe et al., 2006]. All of the poor condition stations were located in the innermost areas of Los Angeles Inner Harbor. In San Pedro Bay, 2 of the stations were classified as being in good condition and 1 was classified as being in poor condition.

The State of California has developed draft sediment quality objectives (SQOs) for enclosed bays and estuaries which are based upon an integration of a triad of indicators (benthic infaunal community, sediment toxicity and sediment chemistry) to produce a characterization of sediments at a given sampling location [State Water Quality Control Board, Division of Water Quality, 2006]. Although these sediment quality objectives have not yet been adopted and are subject to change, it is instructive to see how Los Angeles/Long Beach Harbor and San Pedro Bay stations would be classified via the proposed SQO approach.

The SQO approach yields five assessment categories: unimpacted, likely unimpacted, possibly impacted, likely impacted and clearly impacted. SQO calculations based on past monitoring data at probabilistic sampling sites (primarily Bight'98 and Bight'03 monitoring study data) show that approximately half of the Los Angeles/Long Beach

Harbor sites fall into the two unimpacted categories, while the other half fall into the three impacted categories (Figure 48) [Fleming, 2007]. All of the most impacted (clearly impacted and likely impacted) sites are located within the inner harbor areas of Los Angeles/Long Beach Harbor, while approximately two-thirds of the outer harbor areas are unimpacted or likely unimpacted. In San Pedro Bay, approximately 40% of the sites fell into the three impacted categories, but nearly all of these sites were only possibly impacted (only 1 site was likely impacted and none were clearly impacted).

Overall, it appears that at least half of Los Angeles/Long Beach Harbor has degraded bottom conditions, whether we assess this based on individual sediment contamination levels of metals and organics, sediment toxicity results, the health of the benthic infaunal community or through an integration of these three indicators. Degradation appears to be worse in the inner harbor areas, where industrial activities predominate, than in the more open water areas of the outer harbors. However, the low levels of metals and organics in the surface waters of Los Angeles/Long Beach Harbor and at depth and the absence of water column toxicity indicate that water quality within the harbor is good, suggesting that the contaminants drop out of the water column and accumulate in the sediments, as would be expected.

On the other hand, it appears that nearly half of Los Angeles/Long Beach Harbor has good, or at least acceptable, bottom conditions. Much of the area supports a healthy benthic infaunal community, particularly in the less developed, more open-water outer harbor areas. The five stations sampled in the harbor during the Bight'03 study all supported healthy fish communities, based on the biointegrity index (Fish Response Index) developed for assessment purposes [Allen et al., 2007].

San Pedro Bay, which is subject to influences from runoff discharged by the Los Angeles River, possibly has degraded bottom conditions in some areas based on the sediment chemistry, sediment toxicity and benthic infaunal community signals. However, the level of impact generally appears to be less than that found in the inner harbor areas of Los Angeles/Long Beach Harbor. But again, water quality appears to be good in the surface waters and at depth in San Pedro Bay.

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1.1 Overview of the Surface Water Ambient Monitoring Program (SWAMP) in California

The quality of surface waters in the state of California is provided for by the Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA). These acts require implementation of efforts intended to protect and restore the integrity of surface waters. However, current monitoring and assessment capability at the State Water Resources Control Board (SWRCB) is limited and tends to be focused on specific program needs. This has led to a fragmentation of monitoring efforts resulting in gaps in needed information and a lack of integrated analyses. A solution to this problem was presented in California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999), which required the SWRCB to prepare a proposal for a comprehensive surface water quality monitoring program. This ambient monitoring would be independent of individual water quality programs and would provide a measure of (1) the overall quality of water resources and (2) the overall effectiveness of Regional Water Quality Control Boards' (RWQCB) prevention, regulatory, and remedial actions. When fully implemented, AB 982 will help to alleviate the fragmented water quality issues within the State.

The SWRCB Report to the Legislature from November 2000 entitled "Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program" (November 2000 Legislative Report) proposed to restructure existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). The proposal focused on a number of programmatic objectives designed to assess the quality of the beneficial uses of the State's water resources. Some of these objectives are satisfied with the information produced by existing monitoring efforts within the SWRCB and other agencies. Each of the SWRCB and RWQCB's existing monitoring programs, e.g., the State Mussel Watch Program (SMWP), the Toxic Substances Monitoring Program (TSMP), the Toxicity Testing Program (TTP), Coastal Fish Contaminants Project (CFCP), and fish/shellfish contamination studies, have been incorporated to the extent and manner possible into SWAMP to ensure a coordinated approach without duplication. SWAMP also coordinates with other programs implemented in the State to assure that the ambient monitoring efforts are not duplicated.

When fully implemented, SWAMP will cover four activities:

- Comprehensive environmental monitoring focused on providing information necessary to effectively manage the State's water resources. Each hydrologic unit will be surveyed at least once every five years and all waters will be included without bias to known impairment;
- Consistency in sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements;

- Analysis of spatial and temporal trends in water quality statewide; and
- Development of a Water Quality Control Policy and consistent implementation of the CWA section 303 (d) procedures for listing and delisting of waterbodies based on water quality standards and available data. SWAMP data can also be used in the biennial water quality reports to the United States Environmental Protection Agency (US EPA) required by section 305 (b) of the CWA.

These activities contribute to the goals or expected end-products of SWAMP:

- Creation of an ambient monitoring program that addresses all hydrologic units of the State at least one time every five years using consistent and objective monitoring, sampling and analytical methods; consistent data quality assurance protocols; and centralized data management;
- Documentation of ambient water quality conditions in potentially clean and polluted areas;
- Identification of specific water quality problems preventing the SWRCB, RWQCBs, and the public from realizing beneficial uses of water in targeted watersheds; and
- Data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

During the first several years of the program, funding has not been available to implement SWAMP fully. As a result, SWAMP primarily focused on the site-specific needs of each RWQCB. The RWQCBs were charged with establishing monitoring priorities for the water bodies within their jurisdictions. Efforts primarily focused on site-specific monitoring to better characterize problem sites or clean locations (reference sites) to meet each RWQCB's needs for 303(d) listing, Total Maximum Daily Load (TMDL) development, and other core regulatory programs. During this first phase, RWQCBs were able to use SWAMP resources to address high priority water quality issues in their region, while following SWAMP protocols to ensure statewide data comparability. Additional funding has become available in recent years, so activities designed to achieve the overall goal of developing a statewide picture of the status and trends of the quality of California's surface water resources are being initiated.

1.2 Goals of SWAMP in the Los Angeles Region

The overall goal of the Site-Specific Monitoring portion of SWAMP is to develop site-specific information on representative sites or water bodies that are (1) known or suspected to have water quality problems and (2) known or suspected to be clean. This portion of SWAMP is focused on collecting information from sites in water bodies of the State that could be potentially listed or delisted under Clean Water Act Section 303(d). Other uses of this information include, but are not limited to, development of 305(b) reports, TMDL development, and NPDES permit renewals. In the Los Angeles region (RWQCB4), both the Site-Specific Monitoring goals and the Regional Monitoring goals have been integrated into a single ambient monitoring program. The scope encompasses the regional goals, while still obtaining site-specific information.

1.3 Overview of the Los Angeles Region SWAMP Program

Sampling and analysis will be used to assess ambient conditions of watersheds in Los Angeles and Ventura counties and will further delineate the nature, extent, and sources of toxic pollutants which have been detected or are suspected to be problematic for this region and its individual watersheds.

Where applicable, a triad approach (benthic community analysis, water chemistry, and toxicity testing) will be used. In addition, bioaccumulation tests will be conducted in order to address possible human health concerns and ecological concerns such as benthic community impacts, which may result if the contaminants at a site are bioavailable for uptake by organisms. These bioaccumulation tests will help to demonstrate the bioavailability of contaminants at these stations and may identify impaired beneficial uses.

There is also a large focus on bioassessment, which historically has been overlooked. The bioassessment performed in wadeable streams will follow the California Stream Bioassessment Protocol developed by CDFG which focuses on the benthic macroinvertebrate assemblage and a physical habitat assessment. The information gathered will be used in trend analysis, to identify impaired beneficial uses, as well as in the development and refinement of assessment tools and assessment thresholds.

1.4 Selection and Description of Sampled Waterbodies

Watershed Selection

RWQCB4 proposed visiting each hydrologic unit one year ahead of the Watershed Management Initiative (WMI) schedule for targeted watersheds, which rotate on a five-year cycle. This allowed for data to be gathered, analyzed, and interpreted for use the following year during NPDES permit renewals, development of 305(b) reports, 303(d) listing of Water Quality-Limited segments, and TMDL development. The Santa Clara River (STC) and Calleguas Creek (CAL) watersheds were sampled under the first year of SWAMP funding, while the Santa Monica Bay Watershed Management Area was sampled during the second year of SWAMP funding (Figure 1). During the third year of the SWAMP funding cycle (FY 2002-03), the Dominguez Channel and Los Angeles/Long Beach Harbor Watershed Management Area was sampled (Figure 1).

Figure 01. Watersheds within the jurisdiction of the Los Angeles Regional Water Quality Control Board.

Watershed Descriptions

Dominguez Channel and Los Angeles/Long Beach Harbor Watershed Management Area

The Dominguez Channel and Los Angeles/Long Beach Harbor Watershed is located in the southern portion of the Los Angeles Basin (Figure 2). Along the northern portion of San Pedro Bay is a natural embayment formed by the westerly extension of the coastline which contains both harbors, with the Palos Verdes Hills as the dominant onshore feature. Historically, the area consisted of marshes and mudflats, with a large marshy area (Dominguez Slough) to the north, and flow from the Los Angeles River entering the location where Dominguez Channel currently drains. During the late 1800s and the beginning of the 1900s, channels were dredged, marshes were filled, wharves were constructed, the Los Angeles River was diverted to the east, and a breakwater was constructed to allow deep draft ships to be directly offloaded and permit rapid movement of products throughout the region. Dominguez Slough was completely channelized and became the drainage endpoint for runoff from a highly industrialized area. Eventually greater San Pedro Bay was enclosed by two additional breakwaters and deep entrance channels were dredged to allow for entry of ships. The Los

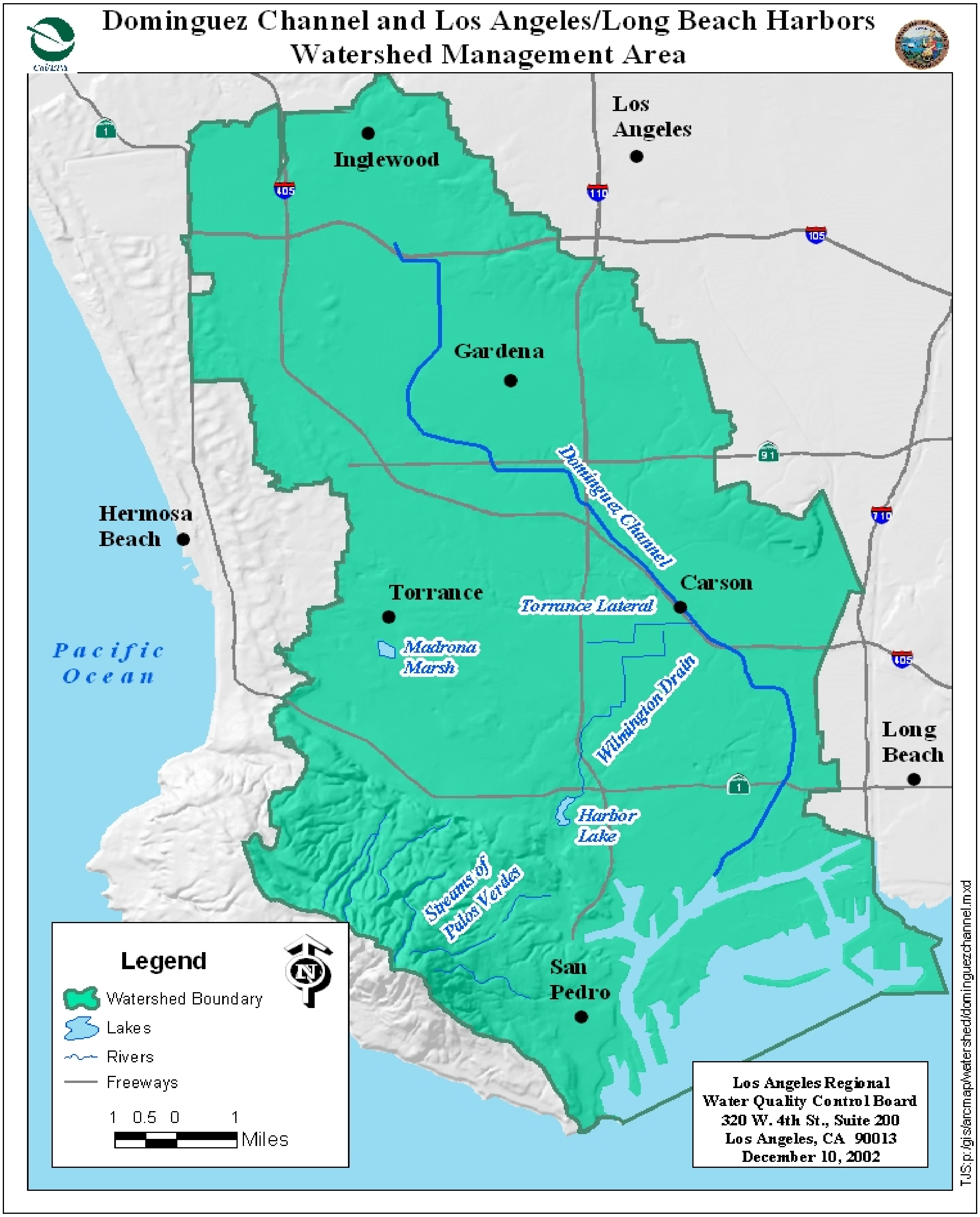
Angeles/Long Beach Harbor complex is now one of the largest ports in the country in terms of shipping activity and volume of goods transported [Birosik, 2004].

Although politically separate, the two harbors are considered to be a single oceanographic unit. Los Angeles Harbor covers approximately 7,500 acres, while Long Beach harbor covers about 7,616 acres. Despite the industrial nature, multiple contaminant sources and low flushing capability of these harbors, the inner harbor areas support diverse fish and benthic populations and provides a protected nursery area for juvenile fish. The California least tern, an endangered species, nests in one part of the harbor complex. The outer part of the harbors (greater San Pedro Bay) has been less disrupted by human activities and supports a great diversity of marine life. It is also open to the ocean at its eastern end and receives much greater flushing than the inner harbor areas [Birosik, 2004].

A POTW (Terminal Island Treatment Plant) discharges secondary-treated effluent to the outer portion of Los Angeles/Long Beach Harbor and is under a time schedule to remove the discharge by 2020 via increased water reclamation. Two generating stations discharge to the inner harbor areas, although one facility is not currently operational. Many smaller, non-process waste discharges also occur into the harbors [Birosik, 2004].

Two areas within Los Angeles/Long Beach Harbor were designated as toxic hot spots under the Bay Protection and Toxic Cleanup Program (BPTCP): Dominguez Channel/Consolidated Slip (due to degraded benthic community, fish advisory due to DDT and PCBs, sediment concentrations of DDT, PCBs, PAHs, cadmium, copper, lead, mercury and zinc, dieldrin and chlordane, and sediment toxicity) and Cabrillo Pier (fish advisory due to DDT and PCBs, sediment concentrations of DDT, PCBs and copper, and sediment toxicity). In addition, several sites were designated as sites of concern under BPTCP, including Inner Fish Harbor (sediment concentrations of DDT, PCB, copper, mercury and zinc, and sediment toxicity), Kaiser International (sediment concentrations of DDT, PCB, PAH, copper and endosulfan), Hugu Neu-Proler (PCB sediment concentrations), Southwest Slip (sediment concentrations of DDT, PCB, PAH, mercury and chromium, and sediment toxicity), Shoreline Marina (sediment concentrations of zinc, DDT, PCB, chlordane and PAH, and sediment toxicity), Long Beach Outer Harbor (sediment concentrations of DDT and chlordane, and sediment toxicity), West Basin (sediment concentrations of DDT and PCB, sediment toxicity and bioaccumulation in clam tissue), and Alamitos Bay (sediment concentrations of DDT and chlordane) [Birosik, 2004].

Figure 2. Dominguez Channel and Los Angeles/Long Beach Harbor Watershed Management Area.



Potential sources for these contaminants are considered to be historical deposition (i.e., legacy pollutants), discharges from the nearby POTW (particularly for metals), spills from ships and industrial facilities, as well as stormwater runoff. Many areas of the harbors have experienced soil and/or groundwater contamination, which may result in possible transport of pollutants to harbor surface waters. Dredging and disposal of contaminated sediments and source control of pollutants in the harbors has been a major focal point for the Los Angeles Region Contaminated Sediment Task Force (CSTF) [Birosik, 2004].

Several areas within Los Angeles/Long Beach (LA/LB) Harbor have been listed as impaired on the 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments [SWRCB, 2006]. These areas include Inner Cabrillo Beach area, outer Cabrillo Beach area, Cabrillo Marina, Consolidated Slip, Fish Harbor, LA/LB Inner Harbor area, and LA/LB Outer Harbor (Table 1).

The Dominguez Channel Watershed covers approximately 133 square miles and is located on the Los Angeles Coastal Plain in the western portion of the Transverse Ranges Geomorphic Province. Dominguez Channel flows between low hills and drainages through a heavily urbanized and industrialized area (81% of the watershed has been developed). Portions of the cities of Los Angeles, Carson and Torrance make up approximately half of the watershed [Birosik, 2004].

The Dominguez Channel Watershed contains two Superfund sites: the Montrose Chemical Corporation site and the Del Amo Facility site. The Montrose Chemical Corporation manufactured DDT on a thirteen-acre site in a light industrial/residential area in the City of Torrance from 1947 until 1982. The contaminants of concern at the Montrose site are DDT, chlorobenzene (the raw material used to make DDT) and benzene hexachloride (BHC), another pesticide. DDT and BHC are persistent chemicals that adhere strongly to soils, while chlorobenzene tends to evaporate in open air. DDT has been found in soils at the former Montrose plant site and surrounding areas, in sediments and soils in the historical stormwater pathway from the site, and in groundwater very close to the former plant property. Chlorobenzene and BHC have been found primarily in soil under the former plant property. The Del Amo site is located 600 feet east of the Montrose site. From the 1940s to the 1970s, a 280-acre synthetic rubber manufacturing facility operated on the property. The contaminants of concern at the Del Amo site are volatile organic compounds (VOCs), including benzene and toluene, PAHs, and semi-volatile organic compounds (SVOCs). Floating products, including benzene and petroleum, also have been identified on top of the water table at various locations on the site [Birosik, 2004].

Table 1.
2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments
Los Angeles/Long Beach Harbor and San Pedro Bay.

Location	Listed Impairments	Medium
Cabrillo Beach (Inner)	Copper DDT, PCBs	 Tissue (fish consumption advisory)
Cabrillo Marina	DDT, PCBs	
Consolidated Slip	Benthic community effects Cadmium, copper, lead, mercury, chromium, zinc Sediment toxicity Chlordane, DDT, PCBs Toxaphene 2-methylnaphthalene, benzo(a)pyrene, chrysene, benzo[a]anthracene, dieldrin, phenanthrene, pyrene,	 Sediment Tissue and sediment (fish consumption advisory for DDT and PCBs) Tissue
Fish Harbor	Benzo[a]anthracene, benzo(a)pyrene, chlordane, PAHs, chrysene, copper, lead, mercury, DDT, pyrene, zinc, dibenz[a,h]anthracene, phenanthrene, PCBs Sediment toxicity	
San Pedro Bay Near/Off Shore Zones	Chlordane Chromium, copper, PAHs, zinc DDT, PCBs Sediment toxicity	 Sediment Tissue and sediment (fish consumption advisory for DDT and PCBs)

Three areas within Dominguez Channel have been listed on the 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments (Table 2) [SWRCB, 2006].

Table 2.
2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments
Dominguez Channel.

Location	Listed Impairments	Medium
Dominguez Channel (lined portion above Vermont Avenue)	Ammonia, copper Indicator bacteria Dieldrin, lead Sediment toxicity Zinc	 Tissue Sediment
Dominguez Channel Estuary (unlined portion below Vermont Avenue)	Ammonia Benthic community effects Benzo(a)pyrene, chrysene, PCBs, benzo(a)anthracene, phenanthrene, pyrene Lead, chlordane, dieldrin Coliform bacteria DDT Zinc	 Tissue Tissue and sediment Sediment
Torrance Carson Channel	Coliform bacteria Copper, lead	

Machado Lake (also known as Harbor Lake or Harbor Park Lake) is located in Ken Malloy Harbor Regional Park. These areas are the remnants of a tidal slough system that was once part of San Pedro Bay and represent an important remnant of wetlands along the Pacific Flyway. Ken Malloy Harbor Regional Park is a 231-acre park administered by the City of Los Angeles Department of Recreation and Parks and is located west of the Harbor Freeway (Interstate 110). The park houses Lake Machado (approximately 40 acres) and associated wetlands (approximately 64 acres), one of the last surviving pieces of an extensive wetlands system that once covered much of the area between Wilmington and Redondo Beach. The lake and wetlands now serve as flood retention basins for approximately 20 square miles of the Dominguez Channel Watershed. Discharges from the lake and wetlands enter the West Basin of Los Angeles Harbor via the Harbor Outflow structure. Machado Lake is fed by the Wilmington Drain, which delivers approximately 65% of the runoff entering the lake. The drain extends north from the lake for 1.8 miles. The drain channel is soft bottom with natural banks from where it passes under the Harbor Freeway until the point where it joins with the lake. The Los Angeles County Flood Control District has designated this section as the Wilmington Drain Waterway and Wildlife Area. Mature riparian woodland lines both sides of the channel and localized areas support freshwater marsh [Birosik, 2004].

Machado Lake and the Wilmington Drain, which discharges into the lake, have been listed on the 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments (Table 3) [SWRCB, 2006].

Table 3.
2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments
Machado Lake (Harbor Lake).

Location	Listed Impairments	Medium
Machado Lake (Harbor Park Lake)	Ammonia Algae, eutrophic, odor Chem A*, chlordane, DDT, dieldrin, PCBs Trash	Tissue (fish consumption advisory due to chlordane and DDT)
Wilmington Drain	Ammonia Coliform bacteria Copper, lead	

*Chem A consists of the following chemicals, individually or in combination: aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, total chlordane, total hexachlorocyclohexane, total endosulfan and toxaphene.

Madrona Marsh is a remnant of the once extensive marshland formerly present in the area between Wilmington and Redondo Beach. It is a vernal marsh formed in a depression flooded by runoff from surrounding upland areas. In the lowland areas there is a 10-acre vernal marsh surrounded by an alkaline margin. The upland supports a back dune system and vernal pools. After the rainy season passes, Madrona Marsh loses water via evaporation, percolation and transpiration, typically drying out by August. The Madrona Marsh Preserve is valuable habitat for birds, insects, reptiles and small mammals [Birosik, 2004].

2 METHODS

2.1 Sampling Design

Dominguez Channel is a relatively linear system without major tributaries, so a sampling design was created with sampling stations at several points along the main channel, moving from the downstream area near the junction with Los Angeles Harbor to upstream areas in the upper watershed (Figure 3). Originally, it was intended to sample at 10 locations at major street (bridge) crossings over the channel, due to ease of access to the water at such points. However, due to bridge reconstruction activities at Pacific Coast Highway, the field crew was unable to gain access to conduct sampling at this proposed station. And safe access to the concrete flood control channel was not possible at one of the proposed stations in the uppermost portion of the watershed, so that station was dropped. Consequently, a total of 8 stations were sampled during 2003 for field observations (water temperature, pH, specific conductivity, oxygen saturation, turbidity) and water column analyses (conventional pollutants, such as nutrients, and bacteria). Metal analyses were performed on a water sample from 1 station in the upper portion of the main channel. Benthic infaunal analysis was conducted at 5 of the stations within the tidal prism where soft bottom sediments were present.

Little historical water quality monitoring has been conducted at Madrona Marsh, so we planned to collect sediment and water samples at 3 sampling stations. However, the field crew was unable to locate any suitable areas for water or sediment sampling, so no samples were collected from Madrona Marsh.

Limited water quality monitoring has been conducted sporadically at Machado Lake in the past. Sampling was conducted at 5 sampling stations distributed along a line running along the north-south axis of the lake (Figure 4). Sediments were collected at the 5 sites for grain size, TOC, metal and organic analyses, and toxicity testing. Water column samples were collected at the 5 sites for conventional pollutant analyses (primarily nutrients), toxicity testing (two species) and bacterial analyses; unfortunately the water samples were not returned to the laboratory within the required holding time, so no bacterial analyses were performed.

Figure 3.
Dominguez Channel and Machado Lake SWAMP Sampling Locations in 2003

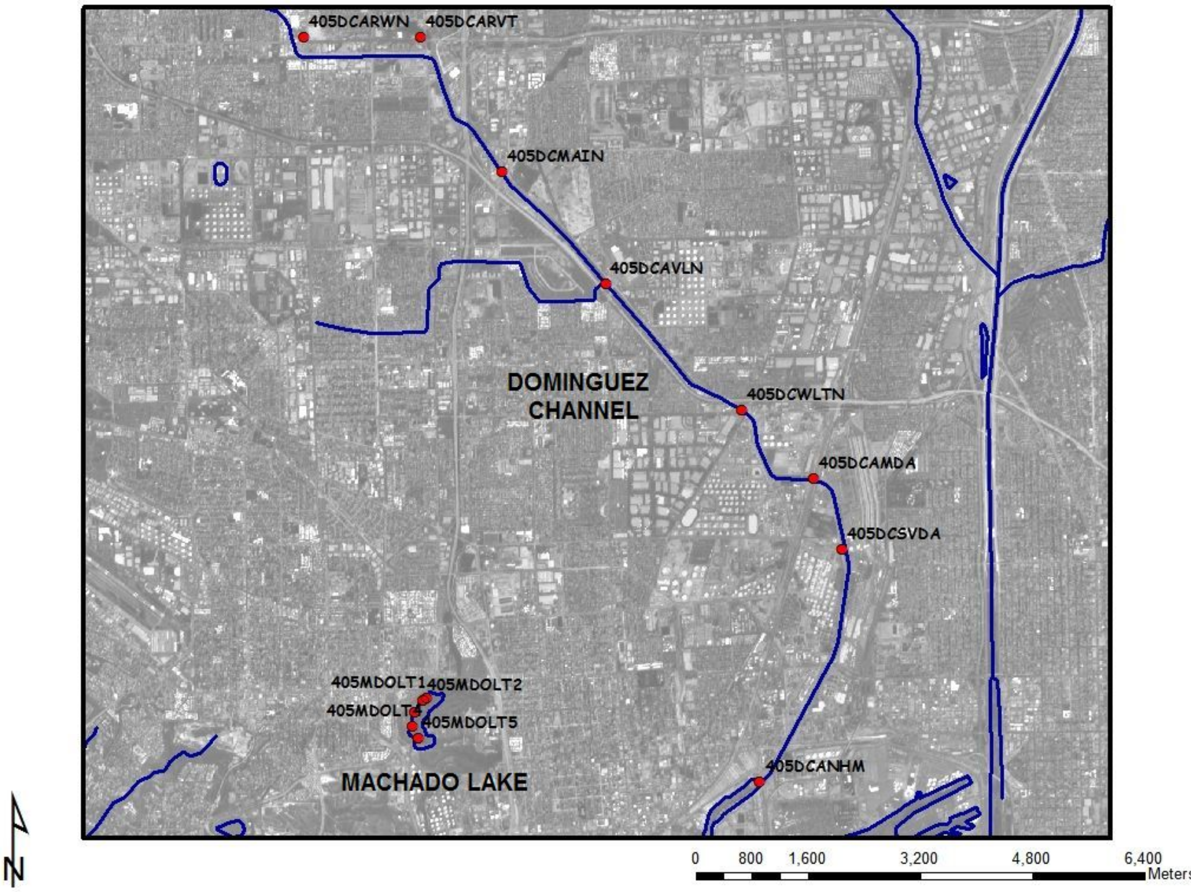


Table 4. Sampling locations in Dominguez Channel.

Station Name	Latitude	Longitude
Artesia/Western	33.87359	-118.30874
Artesia/Vermont	33.87342	-118.29085
Main	33.85587	-118.27871
Avalon	33.84128	-118.26313
Wilmington	33.82468	-118.24250
Alameda St	33.81581	-118.23164
Sepulveda	33.80662	-118.22752
Anaheim	33.77690	-118.24084

Figure 4.
Machado Lake SWAMP Sampling Locations in 2003

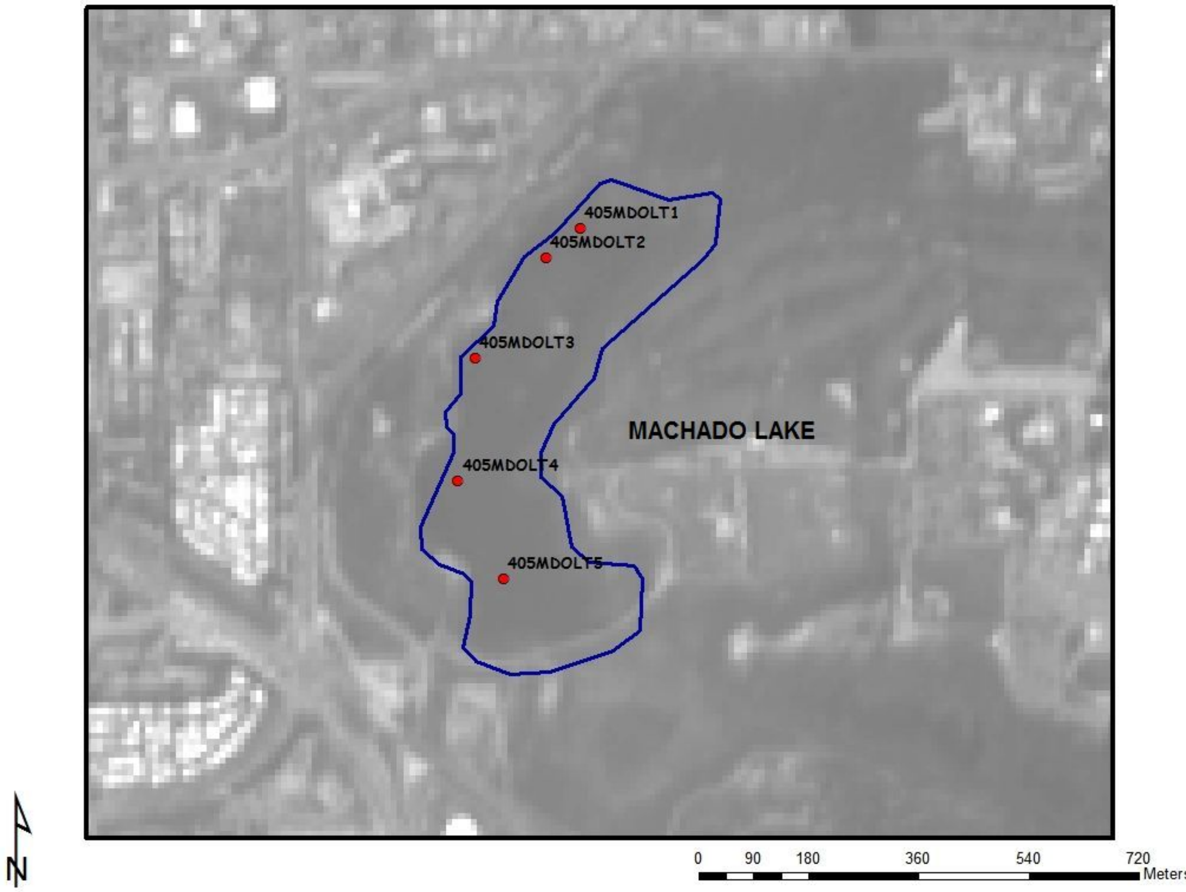


Table 5. Sampling locations in Lake Machado.

Station Name	Latitude	Longitude
LT1	33.78856	-118.29175
LT2	33.78815	-118.29236
LT3	33.78668	-118.29364
LT4	33.78488	-118.29398
LT5	33.78343	-118.29321

The Los Angeles and Long Beach Harbor area has been monitored quite often in the past, including a high level of sampling effort during the 1998 Bight'98 regional ocean monitoring program (focused on benthic infauna, sediment chemistry and sediment toxicity). The 2003 Bight'03 regional ocean monitoring program again included several sampling stations within LA/LB Harbor, focusing on the sediment quality indicators (sediment chemistry, sediment toxicity, benthic infauna). Consequently, the SWAMP program was designed to augment the Bight study by adding a limited amount of water column monitoring. Water samples were collected at the surface at 30 sampling stations, which corresponded to the locations of the Bight'03 sediment sampling sites plus additional randomly selected sites (Figure 5). Metals and organics, conventional pollutants (primarily nutrients), bacteria and toxicity testing were conducted with the water samples from these 30 sampling stations. At 10 of these sampling stations, additional water samples were collected at the bottom and one meter from the bottom for conventional pollutants, metal and organic analyses, and toxicity testing to compare surface and bottom water quality. In addition, sediments were collected at these 10 sampling sites for pore water extraction and analysis for metals and organics, and toxicity testing.

Figure 5.

Los Angeles/Long Beach Harbor and San Pedro Bay SWAMP Sampling Locations in 2003

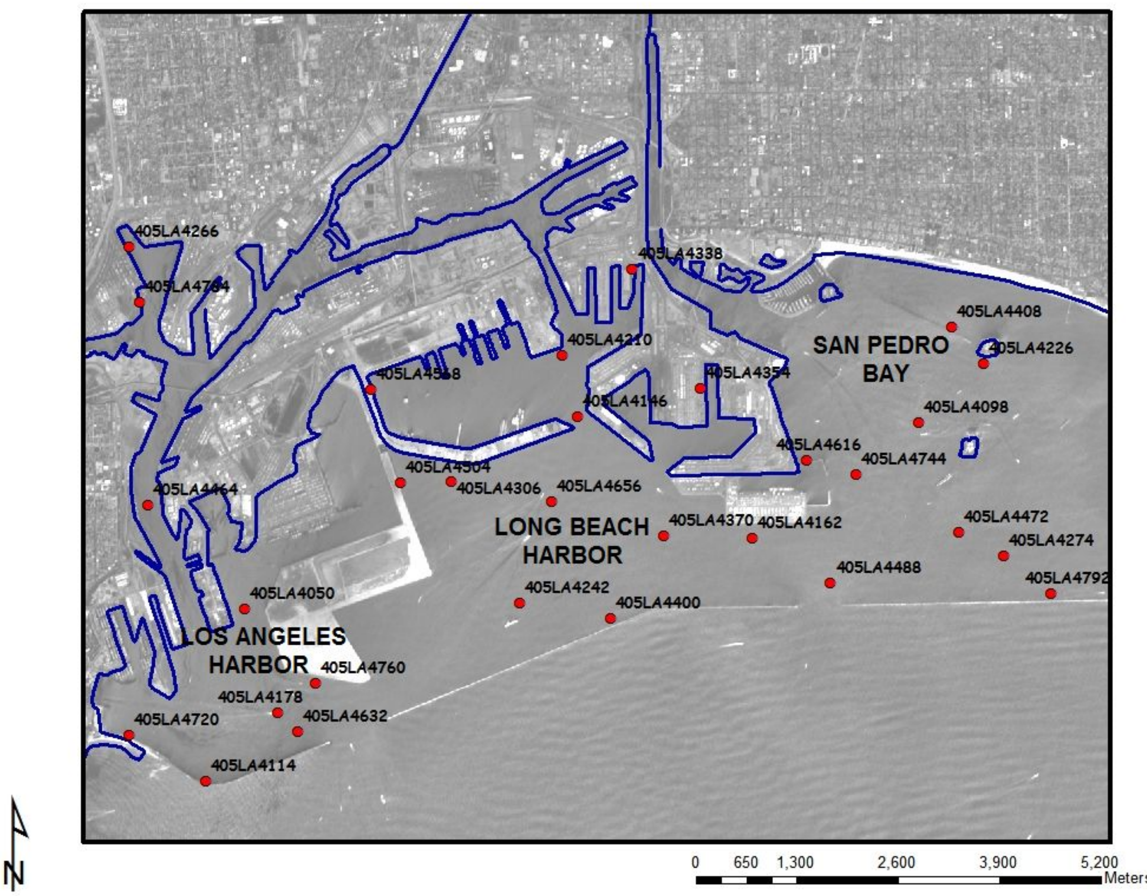


Table 6. Sampling locations in Los Angeles/Long Beach Harbor and San Pedro Bay.

Station Name	Latitude	Longitude
Bight station 4050	33.72398	-118.26284
Bight station 4098	33.74420	-118.16867
Bight station 4114	33.70442	-118.26800
Bight station 4146	33.74537	-118.21569
Bight station 4162	33.73128	-118.19202
Bight station 4178	33.71198	-118.25748
Bight station 4210	33.75274	-118.21773
Bight station 4226	33.75084	-118.15943
Bight station 4242	33.72421	-118.22423
Bight station 4266	33.76627	-118.27739
Bight station 4274	33.72896	-118.15729
Bight station 4306	33.73835	-118.23336
Bight station 4338	33.76249	-118.20779
Bight station 4354	33.74866	-118.19865
Bight station 4370	33.73175	-118.20405
Bight station 4400	33.72221	-118.21153
Bight station 4408	33.75508	-118.16377
Bight station 4464	33.73627	-118.27528
Bight station 4472	33.73143	-118.16351
Bight station 4488	33.72585	-118.18118
Bight station 4504	33.73837	-118.24028
Bight station 4568	33.74922	-118.24382
Bight station 4616	33.73996	-118.18430
Bight station 4632	33.70964	-118.25491
Bight station 4656	33.73582	-118.21960
Bight station 4720	33.70947	-118.27812
Bight station 4744	33.73843	-118.17750
Bight station 4760	33.71542	-118.25273
Bight station 4784	33.75960	-118.27587
Bight station 4792	33.72411	-118.15068

2.2 Sample Collection and Analysis

All field measurements, sample collection, transportation and chain of custody procedures were performed according to the protocols specified in the Surface Water Ambient Monitoring Program Quality Assurance and Quality Control Plan and its appendices [Puckett, 2002]. All field sampling was performed during the spring/summer of 2005 by staff from the California Department of Fish and Game Marine Pollution Studies Laboratory (Moss Landing). Field measurements were made with a Yellow Springs Instruments Meter (Model 600).

2.3 Sample Analysis

Analytical Chemistry

Test methods for various types of constituents are listed in Table 7. Samples were analyzed according to Standard Methods (Clescerl et al., 1999).

Table 7.
Test methods used for laboratory analysis of water and sediment samples.

Constituent	Test Method
Metals	EPA 1638 M
Organics	EPA 619 M EPA 8081 AM EPA 8082 M EPA 8141 AM EPA 8260 EPA 8270 M
Sediment metals	EPA 200.8
PCB Aroclors	Newman et al., 1988
Sediment Grain Size	ASTM D422
Ammonia	QC 10303311 A
Nitrate/Nitrite	QC 1010704 1B
Orthophosphate	QC 10115011 M
Alkalinity	QC 10303311 A
Chloride/Sulfate	EPA 300.0
Oil and Grease	EPA 1664 A
Total Organic Carbon	EPA 415.1 EPA 9060
Hardness	SM 2340 C
Suspended Solids	SM 2540 D
Total Coliform	SM 9221
Biochemical Oxygen Demand	EPA 405.1
Chemical Oxygen Demand	EPA 410.4
Chlorophyll a	EPA 445.0 M
Fecal Coliform	SM 9221 E
E. coli	SM 9223 B
Enterococcus	Enterolert

Laboratory chemical analyses were performed by staff from the California Department of Fish and Game Laboratory (Rancho Cordova) and Marine Pollution Studies Laboratory (Moss Landing).

Toxicity

Water samples from freshwater locations (Lake Machado, Artesia/Western in Dominguez Channel) were tested with two different organisms: 7-day test with *Ceriodaphnia dubia* (growth, survival) and 7-day test with *Pimephales promelas* (biomass, survival). Sediment samples from freshwater locations (Lake Machado) were tested via a 28-day test with *Hyalella azteca* (growth, survival).

Water column samples and water column/bottom interface samples from seawater locations (Los Angeles/Long Beach Harbor and San Pedro Bay) were tested via a 2-day test with *Mytilus galloprovincialis* (survival). Interstitial water (pore water) samples from these locations were tested via a 20-minute test with *Strongylocentrotus purpuratus* (fertilization).

Toxicity testing was performed by staff of the Aquatic Toxicology Laboratory (Davis).

Benthic Infauna

Sediment samples were collected with a 0.05 meter-squared Van Veen grab. Two samples were collected at each station and combined to form a single 0.1 meter-squared sample per station for analysis. Sediment samples were passed through a 1.0 mm sieve and all organisms retained on the sieve were identified to the lowest taxonomic level practicable (species for most groups).

Benthic infaunal samples were analyzed by staff of Weston Solutions (Carlsbad).

3 QUALITY ASSURANCE AND QUALITY CONTROL

The data generated by SWAMP is used to determine the status of beneficial uses throughout the state. Monitoring data is utilized to assess trends, make regulatory and management decisions, and to support enforcement of policies. Thorough objectives for achieving quality data are outlined in the SWAMP Quality Assurance Management Plan (QAMP) [Puckett, 2002]. In general, data quality is demonstrated through analysis of the following Data Quality Indicators:

- Laboratory method blanks
- Surrogate spikes
- Matrix spikes and matrix spike duplicates
- Certified reference materials/laboratory control spikes
- Laboratory duplicates
- Field blind duplicates

Data for Project ID 02SW4001 has been verified according to SWAMP Standard Operating Procedures (SOPs) for field, chemistry and toxicity data verification. The data verification process determines whether the data are compliant with the individual measurement quality objectives (MQOs) specified in the SWAMP QAMP. Data are classified as compliant with the SWAMP QAMP, estimated, non-compliant with the SWAMP QAMP, or rejected if the data were rejected by the reporting laboratory.

This section does not include data validation or attempt to determine whether or not data should be used. That can only be done after data validation and comparison to project-specific data quality objectives (DQOs).

The SWAMP acceptance criteria for percent recovery (%R) and relative percent difference (RPD) criteria for both water and sediments are presented in Appendix A, Table 1.

3.1 Laboratory Method Blanks

Laboratory method blanks were used to evaluate laboratory contamination during sample preparation and analysis. Blank samples undergo the same analytical procedure as samples with at least one blank analyzed per 20 samples. Two Organophosphate Pesticide and three Polynuclear Aromatic Hydrocarbon batches did not have laboratory method blanks analyzed and were classified as estimated (Appendix A, Table 2).

Acceptable data are those with concentrations less than the method detection limit (MDL) for that particular analyte. All laboratory method blanks were acceptable with the exception of eight blanks in which concentrations of target analytes were above the MDL but less than the reporting limit (RL) and two sediment blanks which had detectable levels of aluminum above the RL (Appendix A, Table 3). These data were classified as compliant with regard to the SWAMP QAMP MQO for laboratory blanks.

3.2 Surrogate Spikes

Surrogate spikes are used to assess analyte losses during sample extraction and clean-up procedures, and must be added to every field and quality control sample prior to extraction. Whenever possible, isotopically-labeled analogs of the analytes should be used.

All surrogate percent recoveries were within the acceptance criteria listed in Appendix A, Table 1, with the exception of Dibromooctafluorobiphenyl in samples 405LA4050 and 405LA4210, PCB 207 in samples 405LA4146, 405LA4162, and 405LA4210, and Benz(e)pyrene-d12, Benzo(g,h,i)perylene-d12, Naphthalene-d8, and Perylene-d12 in one or more of samples 405LA4146, 405LA4162, 405LA4178, 405LA4210, 405LA4720, 405LA4784 (Appendix A, Table 4). The associated analytes in these samples were classified as estimated with regard to the SWAMP QAMP MQO for surrogates.

3.3 Matrix Spikes and Matrix Spike Duplicates

A laboratory-fortified sample matrix (matrix spike, or MS) and a laboratory fortified sample matrix duplicate (MSD) are both used to evaluate the effect of the sample matrix on the recovery of the target analyte(s). Individually, these samples are used to assess the bias from an environmental sample matrix plus normal method performance. In addition, these duplicate samples can be used collectively to assess analytical precision.

Aliquots of randomly selected field samples were spiked with known amounts of target analytes. The %R of each spike was calculated as follows:

%R= (MS Result – Sample Result)/ (Expected Value – Sample Result) * 100

The %R acceptance criteria vary according to analyte groups (Appendix A, Table1).

This process was repeated on the same native samples to create a laboratory fortified sample matrix spike duplicate (MSD). MSDs were used to assess laboratory precision and accuracy. MS/MSD RPDs were calculated as:

RPD = (|(Value1-Value2)|/(AVERAGE(Value1+Value2)))*100

where:
Value1=matrix spike value
Value2=matrix spike duplicate value.

According to the SWAMP QAMP, at least one MS/MSD pair should be performed per 20 samples or one per batch, whichever is more frequent for conventional, organic and inorganic analyses. Twenty percent of the batches (18 out of 88 total batches) did not include MS/MSDs performed at the required frequency. These 18 batches were classified as estimated (Appendix A, Table 5).

Laboratory batches with MS/MSD %R and RPD values outside of acceptance criteria are presented in Appendix A, Table 6. All other MS/MSD %Rs and RPDs were within acceptance criteria.

3.4 Certified Reference Materials and Laboratory Control Samples

Certified reference materials (CRMs) and laboratory control spikes (LCSs) were analyzed to assess the accuracy of a given analytical method. As required by the SWAMP QAMP, one CRM or LCS should be analyzed per 20 samples or one per batch, whichever is more frequent. Twenty five percent of the batches (22 out of 88 total batches) did not include CRMs or LCSs performed at the required frequency. These 22 batches were classified as estimated (Appendix A, Table 7).

All CRM and LCS percent recoveries were within acceptance criteria.

3.5 Laboratory Duplicates

Laboratory duplicates (DUPs) were analyzed to assess laboratory precision. A duplicate of at least one field sample per batch was processed and analyzed. Although laboratory triplicates are not required by the SWAMP QAMP, a laboratory triplicate was analyzed in Volatile Organic Compound batches L-103103-8260 and L-102403-8260. Ten percent of the batches (9 out of 88 total batches) did not include DUPs performed at the required frequency. These 9 batches were classified as estimated (Appendix A, Table 8).

The duplicates and triplicates were compared and an RPD that was calculated as described in Section 3.3. RPDs <25% (<35% for total mercury in sediment) were considered acceptable as specified in the QAMP. RPDs >25% (>35% for total mercury in sediment) are presented in Appendix A, Table 9. All other RPDs were acceptable.

3.6 Field Blind Duplicates

Field blind duplicates were analyzed to assess field homogeneity and field sampling procedures. Field blind duplicates were sampled at stations 405DCMAIN, 405MDOLT3, 405LA4266, and 405LA4338 in August and October 2003 for both water and sediments. Water samples were taken by collecting a separate grab sample immediately following the collection of the field sample. Sediment blind duplicates were obtained from homogenized field samples.

Field duplicate values were compared to field sample values from each site and RPDs were calculated as described in Section 3.3. RPDs <25% (<35% for total mercury in sediment) were considered acceptable as specified in the QAMP. RPDs >25% (>35% for total mercury in sediment) are presented in Appendix A, Table 10. All other RPDs were acceptable.

3.7 Contamination

On February 12, 2004, the CDFG Water Pollution Control Laboratory (DFG-WPCL) notified SWAMP participants of a low level of contamination that occurred in samples analyzed for NO_3 by flow injection analysis method (FIA). The contamination (0.036 ± 0.027 mg l^{-1} [36 ppb]) was significant only for NO_3 results reported <0.150 mg l^{-1} (150 ppb). Samples that were analyzed via FIA and are therefore positively biased by 0.036 mg l^{-1} are presented in Appendix A, Table 11.

3.8 Toxicity Tests

There were minor deviations in water quality parameters or test conditions for dissolved oxygen in some replicates, and holding times were exceeded in some cases (see Section 3.10). Additionally, reference toxicant test were not reported for batches ATLCD1 and ATLPP1. The data should be considered acceptable for their intended purpose.

3.9 Field Data Measurements

The procedures followed when conducting routine field data measurements for the SWAMP program are detailed in Appendix E of the SWAMP QAMP. Field equipment used to collect field data measurements is required to be calibrated within 24 hours of use and within 24 hours after field measurement activities are performed. Per the SWAMP QAMP, at a minimum the following equipment should be calibrated; titration equipment, thermometers, DO meters, pH meters, conductivity meters, and multi-parameter field meters. After post-calibration checks are performed, the percent drift should be evaluated. If data has been collected outside compliance, (% drift is outside criteria found in Appendix E of the SWAMP QAMP), it should not be reported unless it has been flagged to indicate non-compliance.

Field data measurements reported for Region 4 Project ID 02SW4001 include; oxygen saturation, pH, salinity, specific conductivity, temperature, and turbidity. Of these field measurement results, all measures for sample 405DCARWN and five turbidity results were classified as estimated due to either a probe failure or no documentation of the field measurement collection existed.

3.10 Holding Times

There were 4362 results in 26 batches classified as estimated due to holding time exceedances. These batches consisted of nitrite and nitrate analyses, water and sediment organics (orthophosphate pesticides, organochlorine pesticides, PCBs, PAHs) and water toxicity analyses. Water samples analyzed for nitrate and nitrite exceeded the 48-hour holding time criteria between collection and analysis. Water organic samples exceeded either the 7-day holding time criteria between collection and extraction or the 40-day holding time criteria between extraction and analysis.

Sediment organic samples exceeded the 40-day holding time criteria between extraction and analysis. Water toxicity samples for *Mytilus galloprovincialis* were to be analyzed within 48 hours of collection, but samples 405LA4050 and 405LA4400 were analyzed one day after this time period. Data labeled as “Estimated” was considered usable for the intended purposes and for this report.

3.11 QA/QC Summary

Data that meet all SWAMP MQOs as specified in the QAMP are classified as “SWAMP-compliant” and considered usable without further evaluation. Data that fail to meet all program MQOs specified in the SWAMP QAMP, have analytes not covered in the SWAMP QAMP, or are insufficiently documented such that supplementary information is required for them to be used in reports are classified as “estimated” non-compliant with the SWAMP QAMP. Rejected data batches do not meet minimum requirements and /or have gross errors or omissions; data were classified as rejected when the reporting laboratory rejected the data.

There were 23,089 sample results, including; field measures, grab and integrated samples, field blind duplicates, and field blanks, of which 6384 were classified as compliant and 16,705 were classified as estimated. None of the data was classified as rejected. All compliant and estimated data points were used in this report since they met SWAMP project data quality objectives (listed in the SWAMP QAMP).

The summary of data classification on the dataset reported is as follows:

- All data presented in Table 3 (Appendix A) were classified as SWAMP-compliant with the exception of the aluminum results since the analytes detected in the laboratory blanks met the QAMP criteria of less than the RL for laboratory blank contamination.
- All data presented in Tables 2, 5, 7, and 8 (Appendix A) were classified as estimated due to insufficient QC samples performed.
- All data presented in Table 4 (Appendix A) were classified as estimated due to surrogate recovery exceedances.
- All data presented in Tables 9 and 10 (Appendix A) were classified as estimated due to RPD exceedances.
- Four thousand three hundred sixty two results were classified as estimated due to holding time exceedances.
- One thousand seven hundred eighty one screening level results (PAH analytes that could not be quantified or triazine pesticides) were classified as estimated.

4 RESULTS

4.1 Field Measurements – Water Samples

Machado Lake (Harbor Lake)

Field measurements were conducted at 5 station locations (LT1, LT2, LT3, LT4, LT5) within Machado Lake (also known as Harbor Lake or Harbor Park Lake) on August 4, 2003. All measurements were conducted on a surface water sample.

Dissolved oxygen (DO) saturation ranged from 42.6 to 84.5% in the lake (Figure 6). There are no numeric Basin Plan objectives for DO saturation [CRWQCB-LAR, 1994]. DO saturation was greater than 80% at the three stations sampled in the central and southern portions of the lake, while lower DO saturation values (42.6 and 57.5%) were measured at the two stations in the northern portion of the lake. The saturation values were converted by calculation to actual dissolved oxygen concentrations based on the temperature and salinity measured at each station (Figure 7). Basin Plan objectives for DO indicate that no single determination shall be less than 5.0 mg/L, except where natural conditions cause lesser concentrations [CRWQCB LAR 1994]. The DO concentrations measured at the two stations in the northern portion of the lake were below the Basin Plan objective, but it is unclear whether this was due to natural conditions or other factors.

Figure 6.
Oxygen saturation in Machado Lake in 2003.

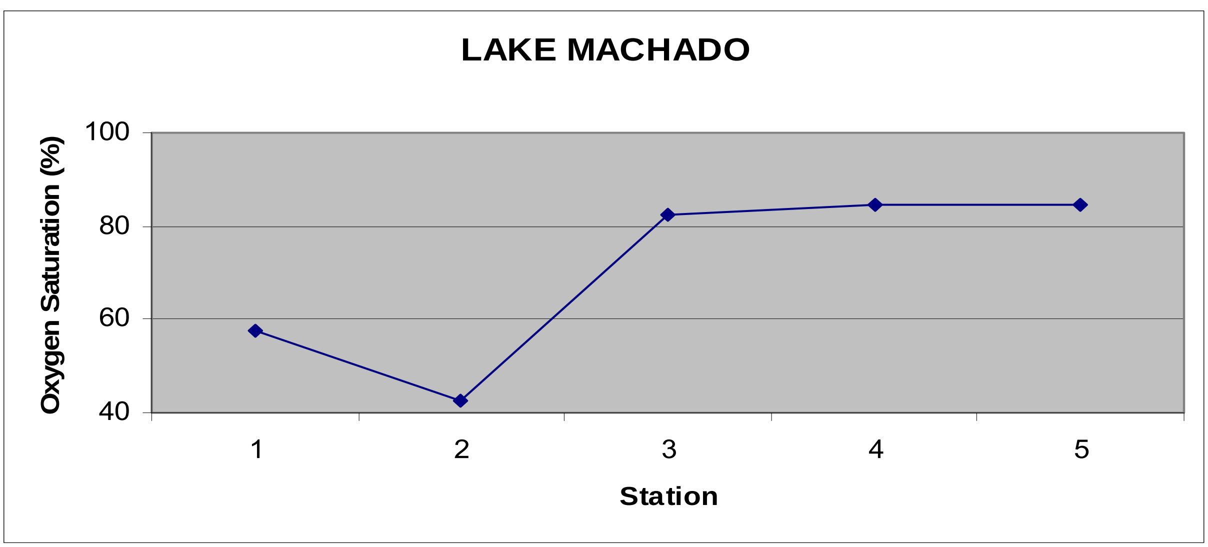
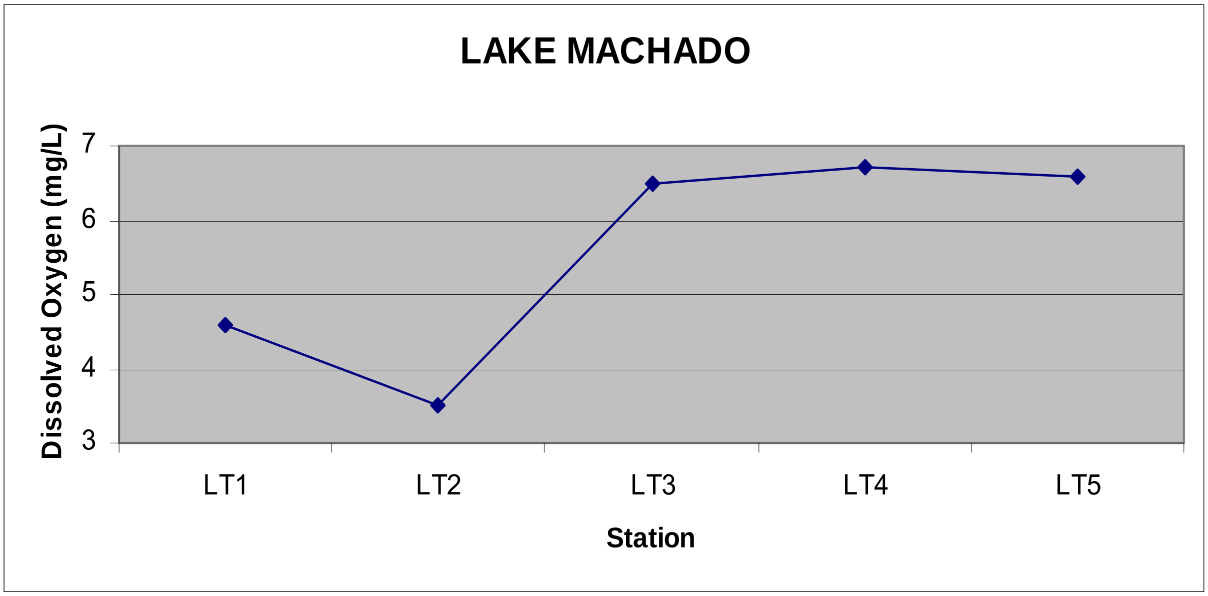
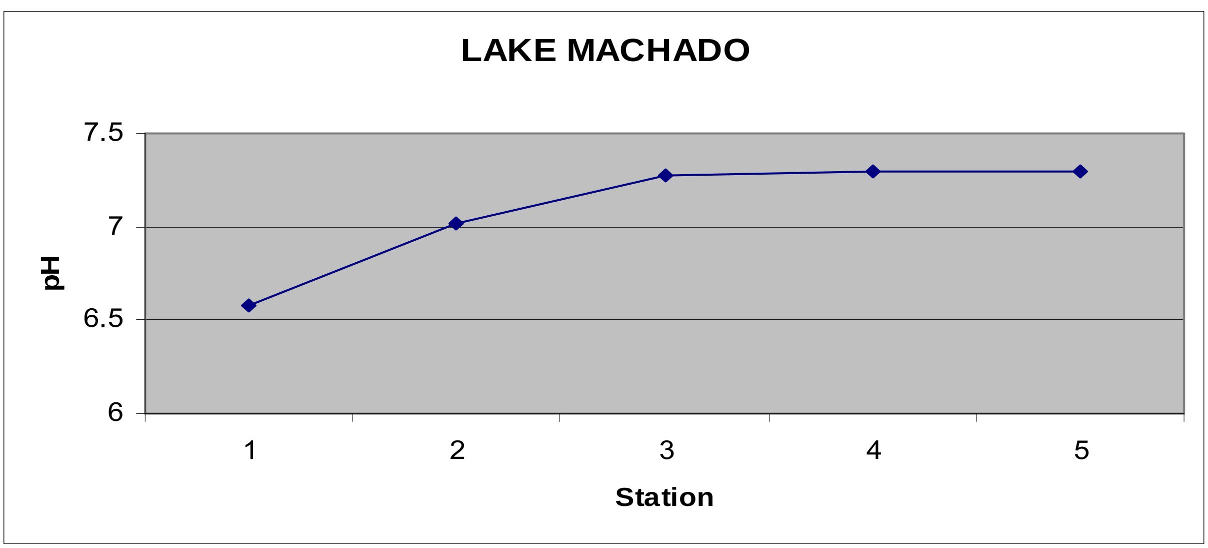


Figure 7.
Dissolved oxygen in Machado Lake in 2003.



The pH values ranged from 6.58 to 7.30 in the lake (Figure 8). The acceptable range for pH is 6.5 to 8.5 [CRWQCB-LAR, 1994] and all of the stations fell within this range. The three stations in the central and southern portions of the lake all had a pH of 7.3, while lower pH was found in the northern portion of the lake (7.0 and 6.6).

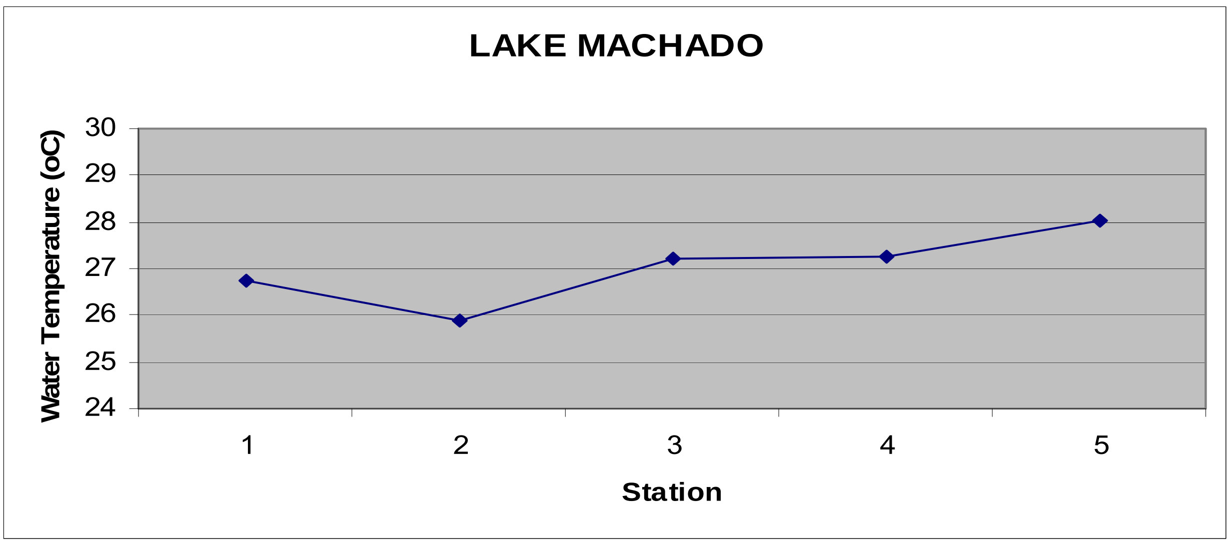
Figure 8.
pH values in Machado Lake in 2003.



Specific conductance ranged from 1012 to 1035 µS cm^{-1} in the lake, while salinity was 0.5 parts per thousand at all five stations. There are no numeric Basin Plan objectives for specific conductivity or salinity [CRWQCB-LAR, 1994]. The low specific conductance and salinity measurements indicate that Machado Lake contains fresh water.

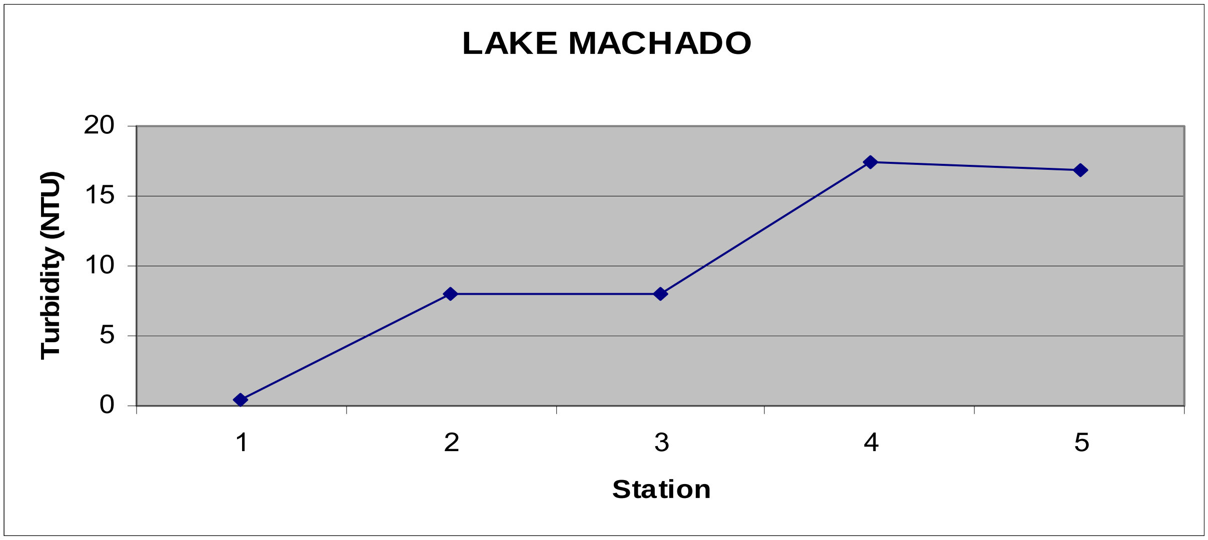
Water temperature ranged from 25.89 to 28.02 ^{o}C in the lake (Figure 9). The Basin Plan temperature objective indicates that waste discharges shall not raise the temperature above 80 ^{o}F (26.7 ^{o}C) in waters with the Warm Freshwater Habitat (WARM) designated beneficial use. The water temperature in most of the lake exceeded the 80 ^{o}F mark (all stations except LT2 were above this level), suggesting that the surface waters were warmer than might be considered optimal for aquatic life protection.

Figure 9.
Water temperature in Machado Lake in 2003.



Turbidity ranged from 0.45 to 18 NTU in the lake (Figure 10). The Basin Plan does not contain numeric water quality objectives for absolute turbidity levels required to protect aquatic life.

Figure 10.
Turbidity in Machado Lake in 2003.



Dominguez Channel

Field measurements were collected at seven station locations on Dominguez Channel on August 5, 2003 (moving from downstream to upstream along the channel, the stations were Anaheim, Sepulveda, Alameda, Wilmington, Avalon, Main, and Artesia/Vermont). Field measurements were not collected at the eighth and furthest upstream station (Artesia/Western) due to a malfunction of the instrument probe.

Dissolved oxygen (DO) saturation ranged from 61.5 to 177.2% in the channel (Figure 11). There are no numeric Basin Plan objectives for DO saturation [CRWQCB-LAR, 1994]. The saturation values were converted by calculation to actual dissolved oxygen concentrations based on the temperature and salinity measured at each station. Basin Plan objectives for DO indicate that no single determination shall be less than 5.0 mg/L, except where natural conditions cause lesser concentrations [CRWQCB LAR 1994]. All of the stations in Dominguez Channel were in compliance with the Basin Plan objective.

Figure 11.
Oxygen saturation in Dominguez Channel in 2003.

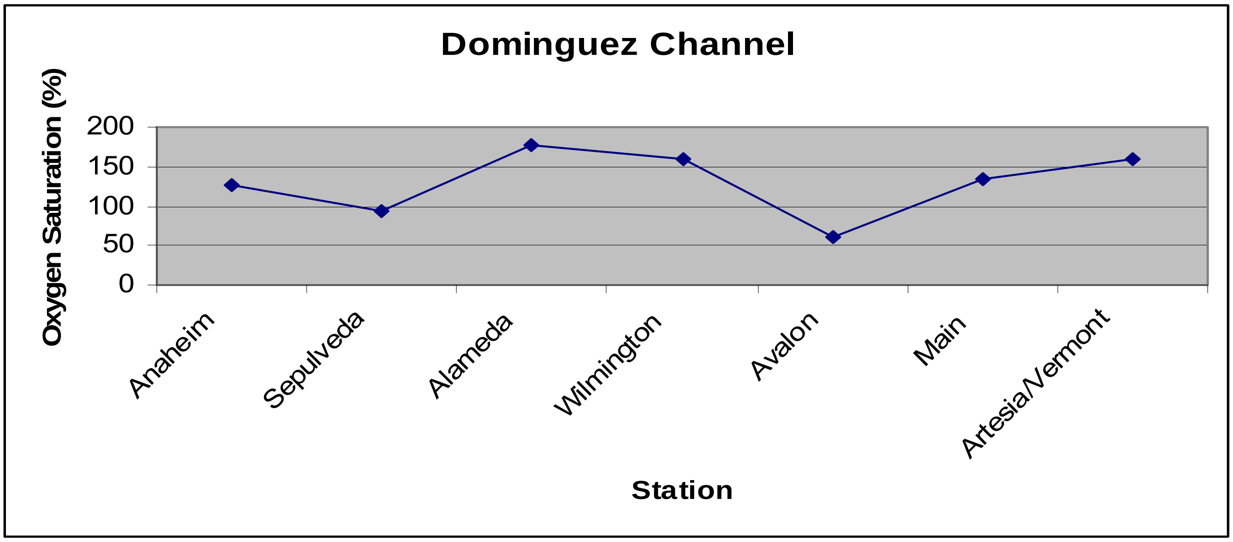
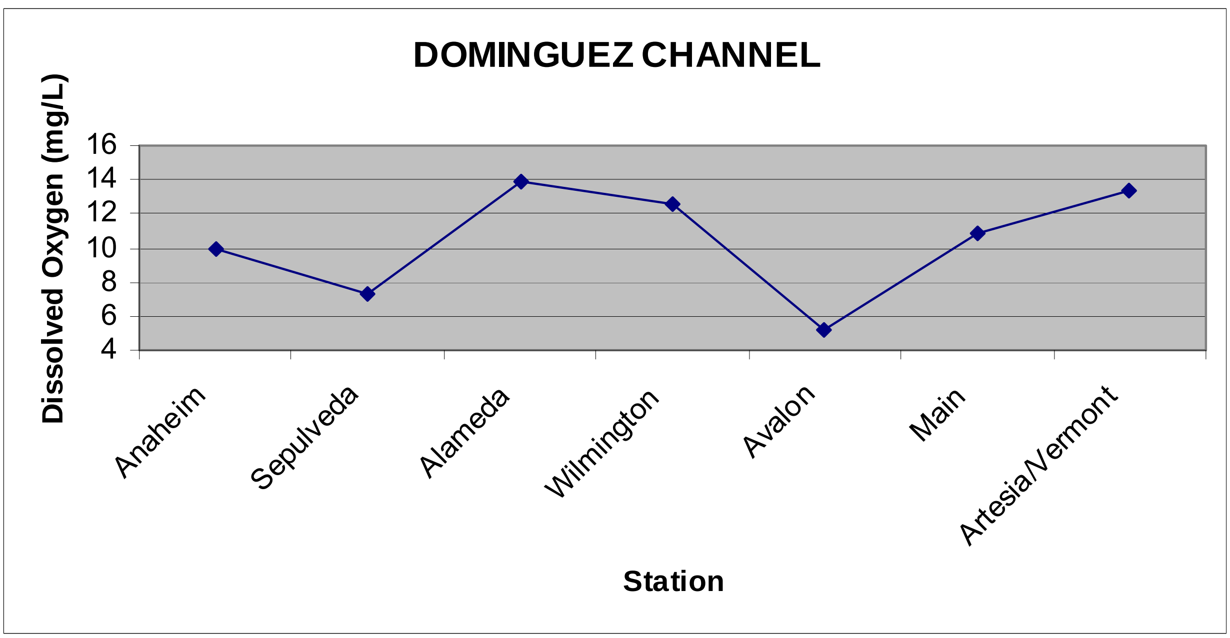
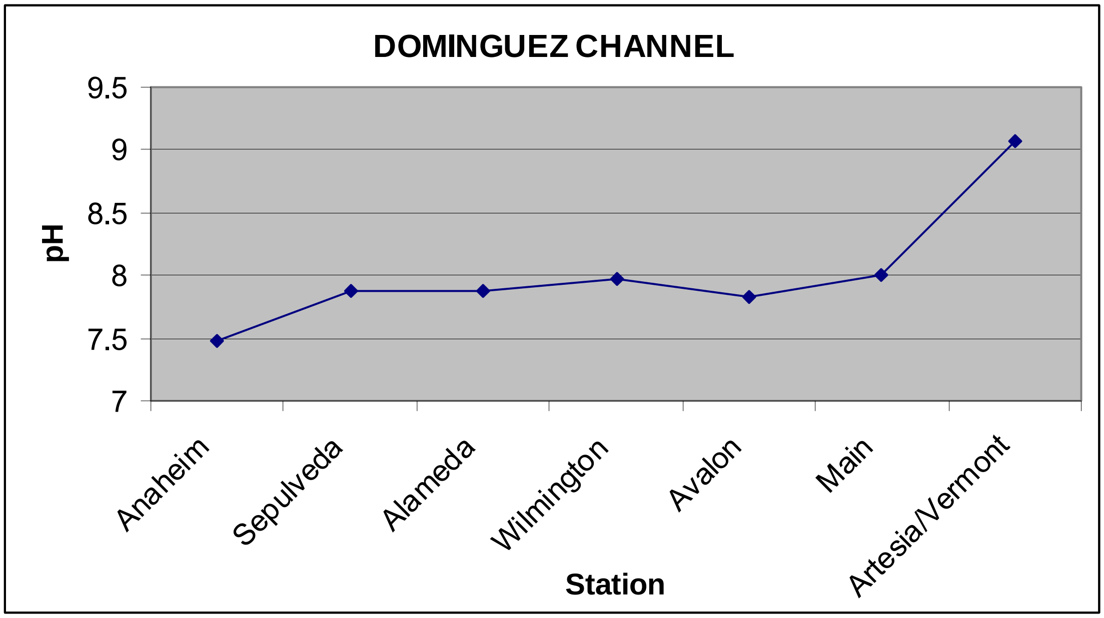


Figure 12.
Dissolved oxygen in Dominguez Channel in 2003.



The pH values ranged from 7.47 to 9.07 in the channel (Figure 13). The acceptable range for pH is 6.5 to 8.5 [CRWQCB-LAR, 1994]. Only one station (Artesia/Vermont) fell outside this range due to a high pH value (9.07). The lowest pH value was measured at the most downstream station in the channel (Anaheim), while the highest values were measured at the two upper channel stations (Main and Artesia/Vermont).

Figure 13.
pH values in Dominguez Channel in 2003.



Specific conductance ranged from 589 to 35170 µS cm^{-1} in the channel, while salinity ranged from 0.29 to 22.19 parts per thousand (Figure 14 and 15). There are no numeric Basin Plan objectives for specific conductivity or salinity in enclosed bays and estuaries [CRWQCB-LAR, 1994]. The highest specific conductance and salinity values were found at the Anaheim station, at the most downstream point sampled in the channel, while the lowest specific conductance and salinity values were found at the Artesia/Vermont station, the most upstream point sampled in the channel. The specific conductance and salinity values progressively declined from downstream to upstream locations within the channel, reflecting the extent of tidal influence from the harbor.

Figure 14.
Specific conductance in Dominguez Channel in 2003.

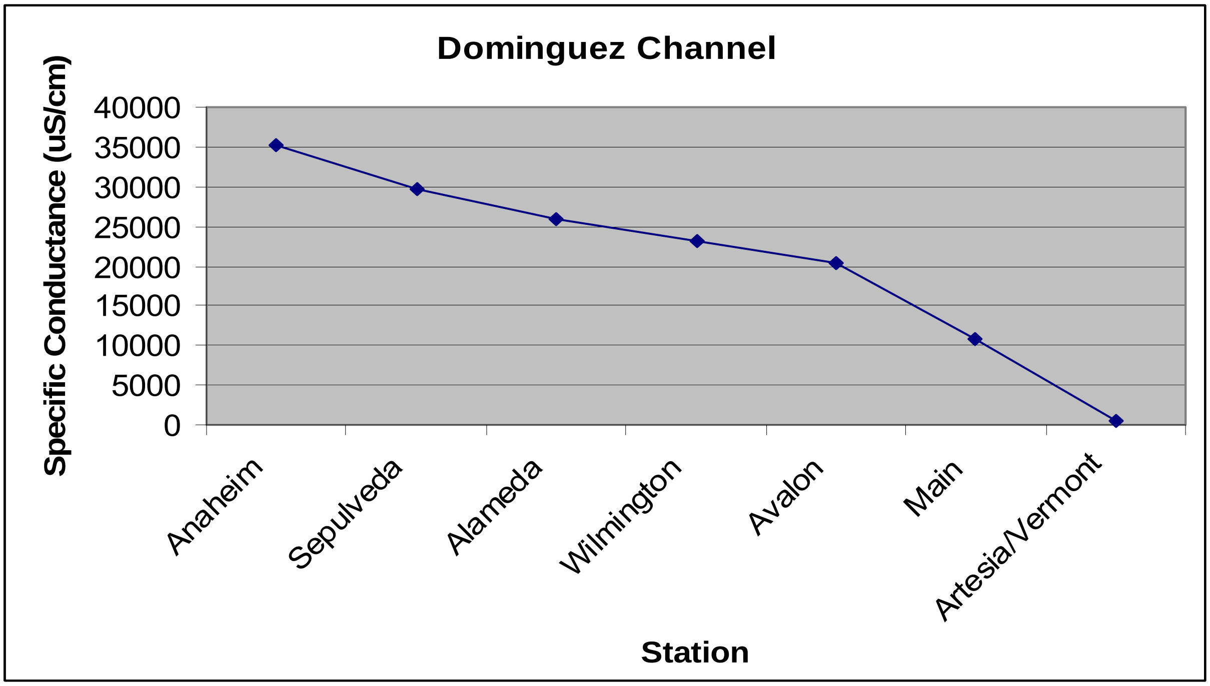
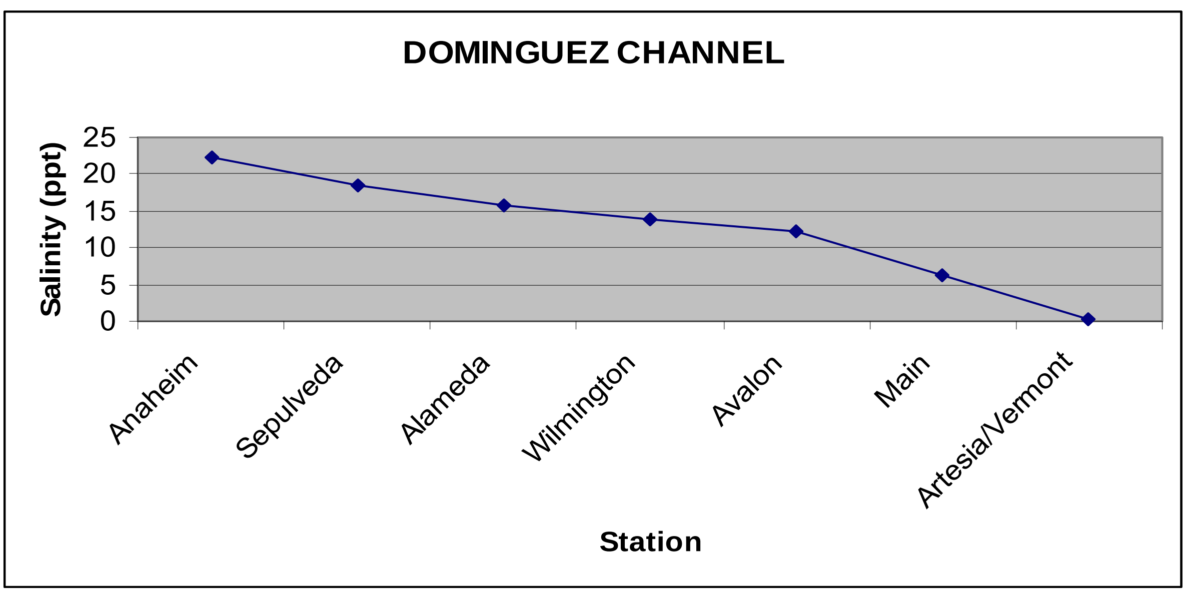
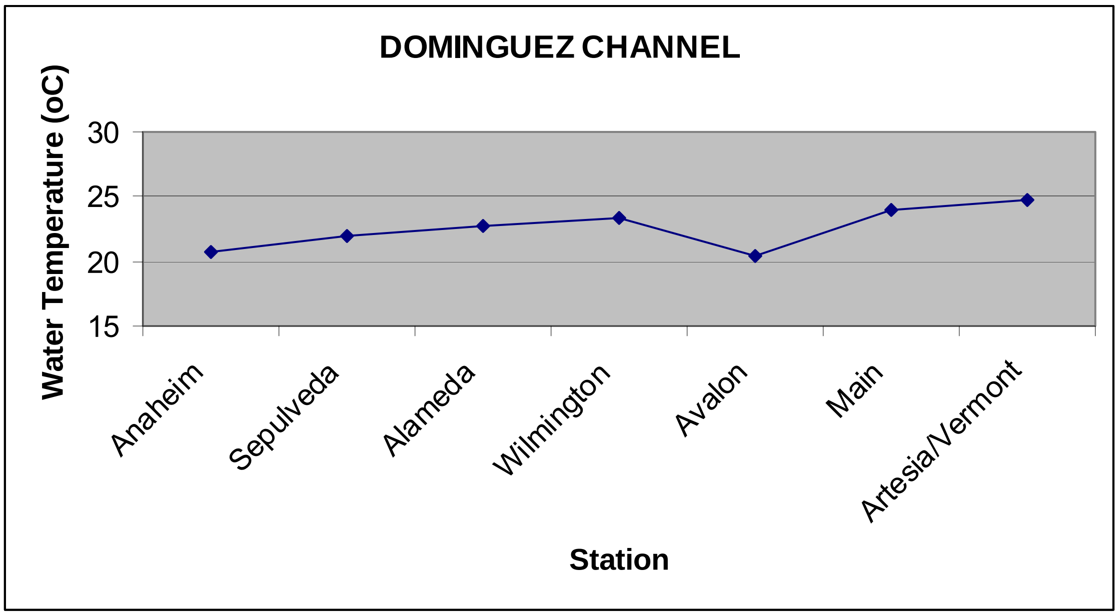


Figure 15.
Salinity in Dominguez Channel in 2003.



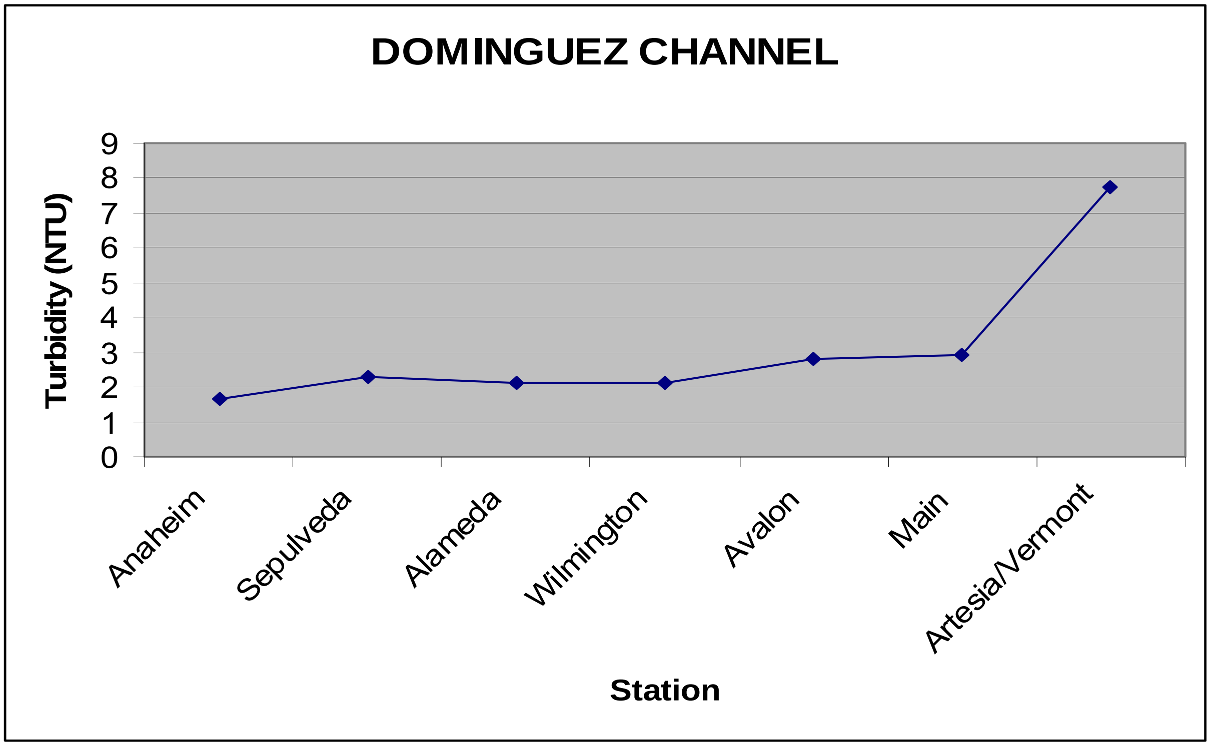
Water temperature ranged from 20.47 to 24.68 ^{o}C in the channel (Figure 16). The Basin Plan does not contain an absolute water temperature objective for enclosed bays and estuaries [CRWQCB-LAR, 1994]. The lowest water temperatures measured were at the Avalon station in the upper channel area and at the Anaheim station, at the most downstream point sampled in the channel. The highest water temperatures were recorded at the Main and Artesia/Vermont stations, the most upstream locations sampled in the channel.

Figure 16.
Water temperature in Dominguez Channel in 2003.



Turbidity ranged from 1.69 to 7.73 NTU in the channel (Figure 17). The Basin Plan does not contain numeric water quality objectives for absolute turbidity levels required to protect aquatic life. The lowest turbidity value was found at the Anaheim station, the most downstream point sampled in the channel. The highest turbidity value was found at the Artesia/Vermont station, the most upstream point sampled in the channel. Turbidity values were similar (2.1 to 2.9 NTU) at the other five stations.

Figure 17.
Turbidity in Dominguez Channel in 2003.



Los Angeles/Long Beach Harbor and San Pedro Bay

Field measurements were collected at 30 stations within Los Angeles/Long Beach Harbor and in adjacent San Pedro Bay from October 20-28, 2003. Measurements were taken for surface samples (0.1 meters below the water surface) at all 30 stations, and also recorded at near bottom (1 meter above the bottom depth) and bottom depth at 10 of the stations.

Salinity ranged from 27.13 to 30.01 parts per thousand in the surface waters (Figure 18). Near-bottom and bottom salinities were very similar to surface salinities at the 10 stations where these measurements were taken and fell within the range of surface salinities (Figure 19). The lowest surface salinity was measured at station 4226 in San Pedro Bay, although other stations in the bay had surface salinities in the 28s and 29s. The highest surface salinities were measured at stations 4306, 4338, 4354, 4504 and 4568 in Long Beach Inner Harbor, although other nearby inner harbor stations had surface salinities in the 28s. Surface salinities in the Long Beach Outer Harbor area were in the 28s and 29s. Surface salinities throughout the Los Angeles Harbor area also were in the 28s and 29s. Specific conductance ranged from 42,220 to 46,160 µS/cm in the surface waters. Specific conductance values at the mid-depth and bottom areas were very similar to surface water values. The Basin Plan does not contain a water quality objective for salinity or specific conductance in enclosed bays and estuaries.

Figure 18

Surface Water Salinity in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003

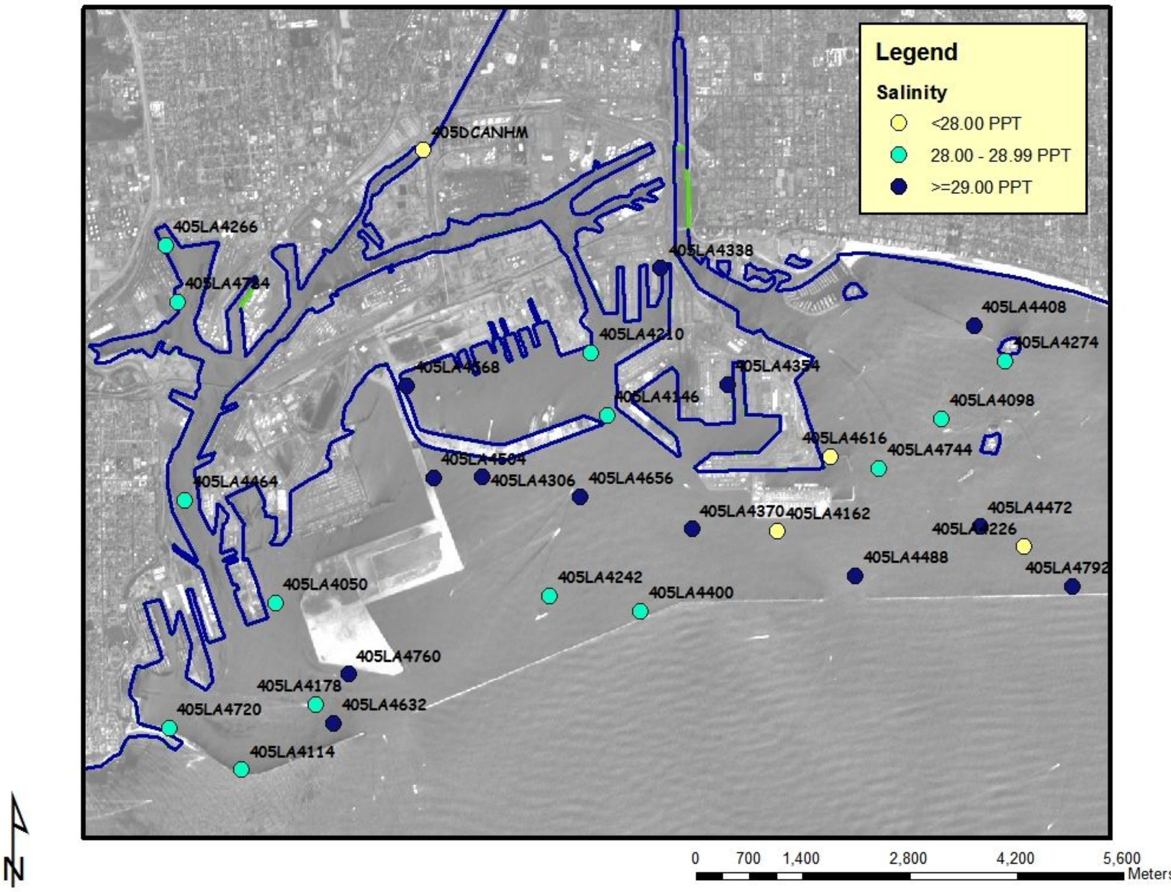
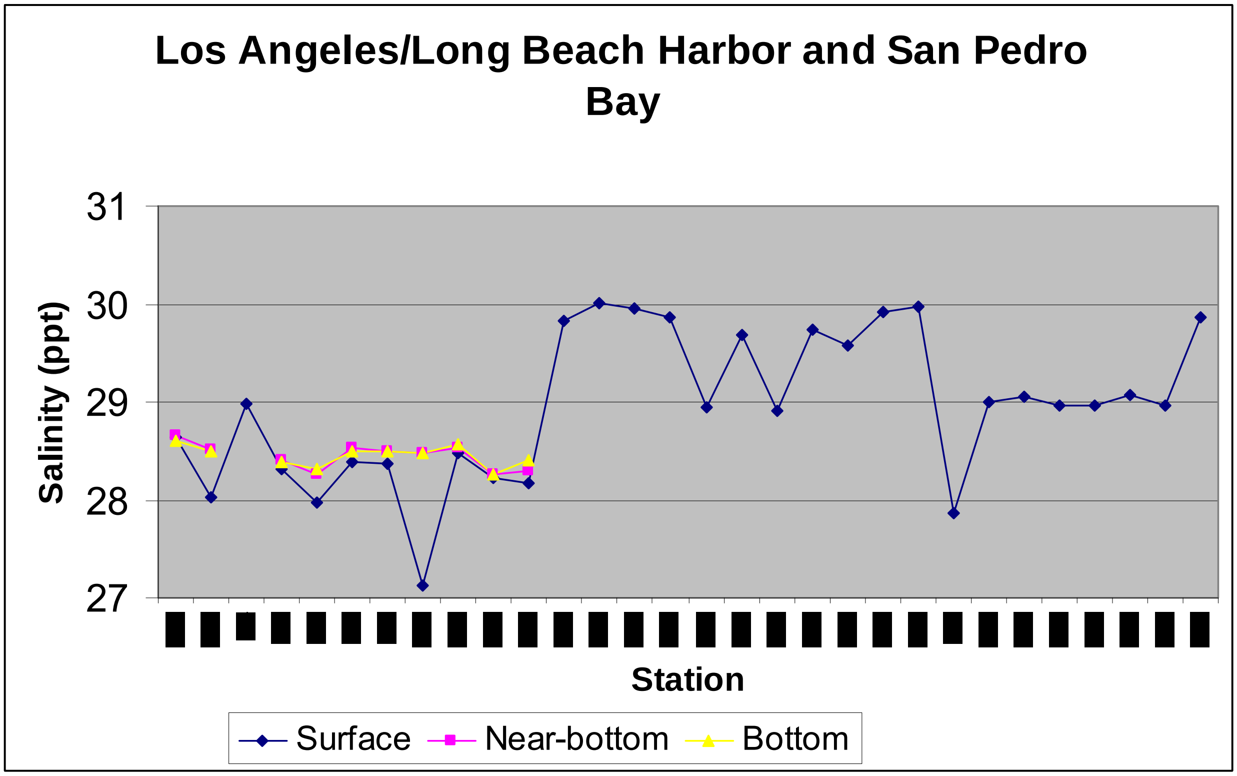


Figure 19.
Salinities at all water depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



Water temperature ranged from 17.91 to 20.6 ^{o}C in the surface waters (Figure 20). The lowest surface water temperature was measured at station 4568 in Long Beach Inner Harbor (inside the Navy Mole area). However, surface water temperatures elsewhere in Long Beach Inner Harbor were in the 18s. The highest surface water temperature was measured at station 4226 in San Pedro Bay, although other stations in the bay were in the 18s and 19s. Surface temperatures in Long Beach Outer Harbor and throughout Los Angeles Harbor were in the 18s and 19s as well. Near-bottom and bottom water temperatures always were lower than the surface water temperatures at the 10 stations were these measurements were taken (Figure 21). Near-bottom water temperatures were 1 to 3 ^{o}C lower than the surface water temperatures, with the exception of station 4266 where the difference was only 0.3 ^{o}C. Bottom water temperatures were within 0.5 ^{o}C of the near-bottom water temperatures, with the exception of station 4162 where the bottom temperature was nearly 1 ^{o}C lower than the near-bottom value. In most cases the bottom temperature was slightly lower than the near-bottom temperature, but it was higher at two stations (4050 and 4226) and equal at one station (4266). The Basin Plan was no absolute water temperature objective for enclosed bays and estuaries.

Figure 20.

Surface Water Temperature in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003

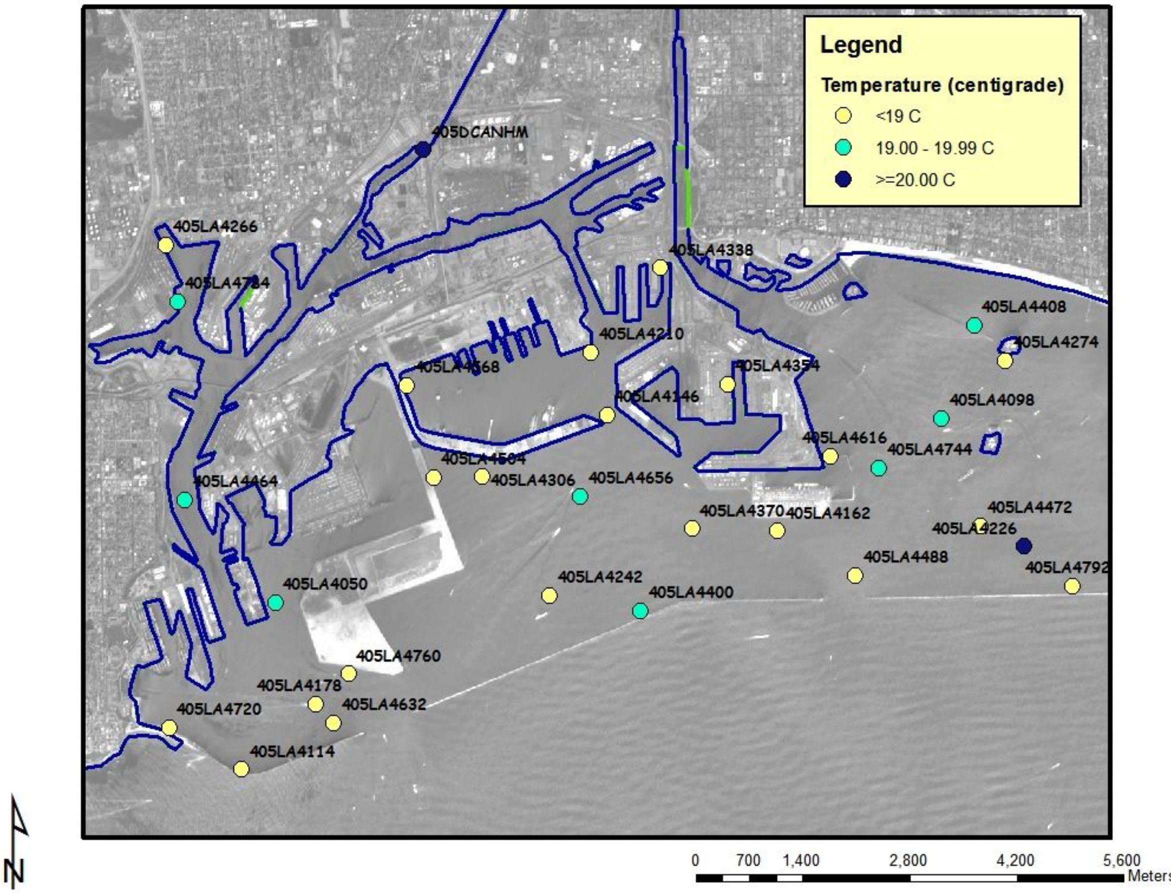
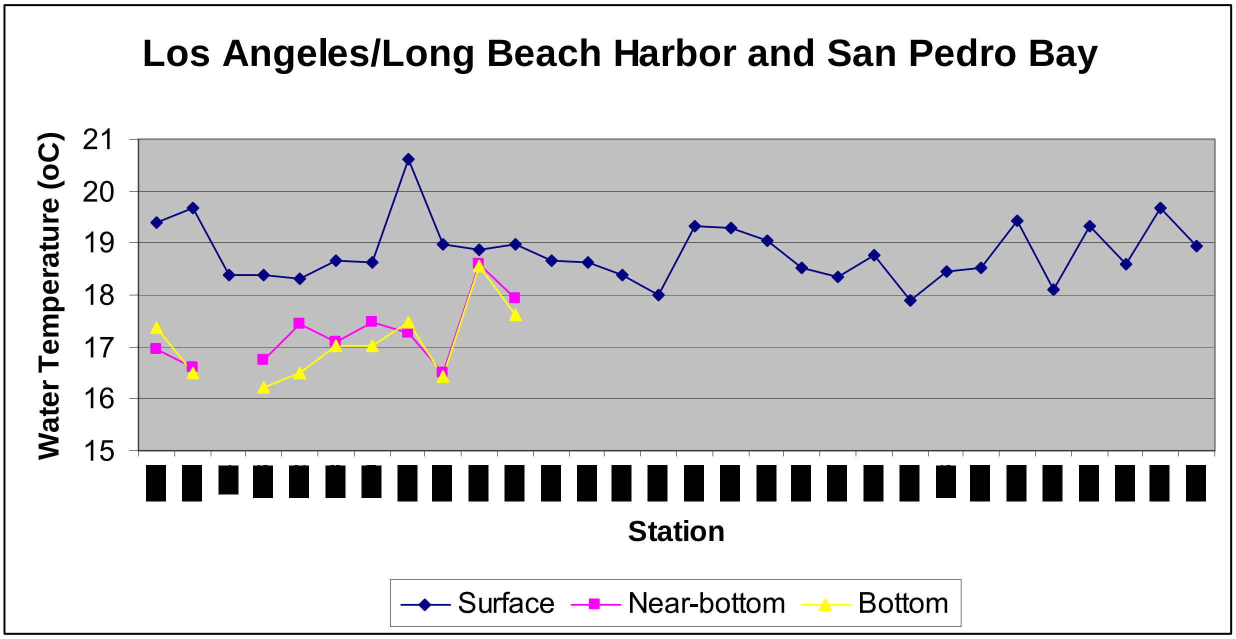


Figure 21.
Water temperature at all depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



The pH ranged from 7.57 to 8.46 in the surface waters (Figure 22). The lowest pH values were measured at stations 4464 and 4784 in Los Angeles Inner Harbor. Elsewhere in Los Angeles Harbor the surface pH values were higher (7.8 to 8.2). The highest pH values were measured at stations 4306 and 4504 in Long Beach Inner Harbor (just outside the Navy mole breakwater) and at stations 4408 and 4744 in San Pedro Bay (although other stations in San Pedro Bay had lower pH. Near bottom and bottom pH values were very similar (Figure 23), with the exception of station 4050 (where the near bottom pH was 7.23, compared to a bottom pH of 7.83), but generally 0.1 to 0.3 pH units lower than the surface pH (with the exception of station 4162, where the near-bottom and bottom pH were slightly higher than the surface pH, and station 4050, where the near-bottom pH was 0.9 units lower than the surface pH). All of the pH values fell within the acceptable range for pH of 6.5 to 8.5 [CRWQCB-LAR, 1994].

Figure 22.

Surface Water pH in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003

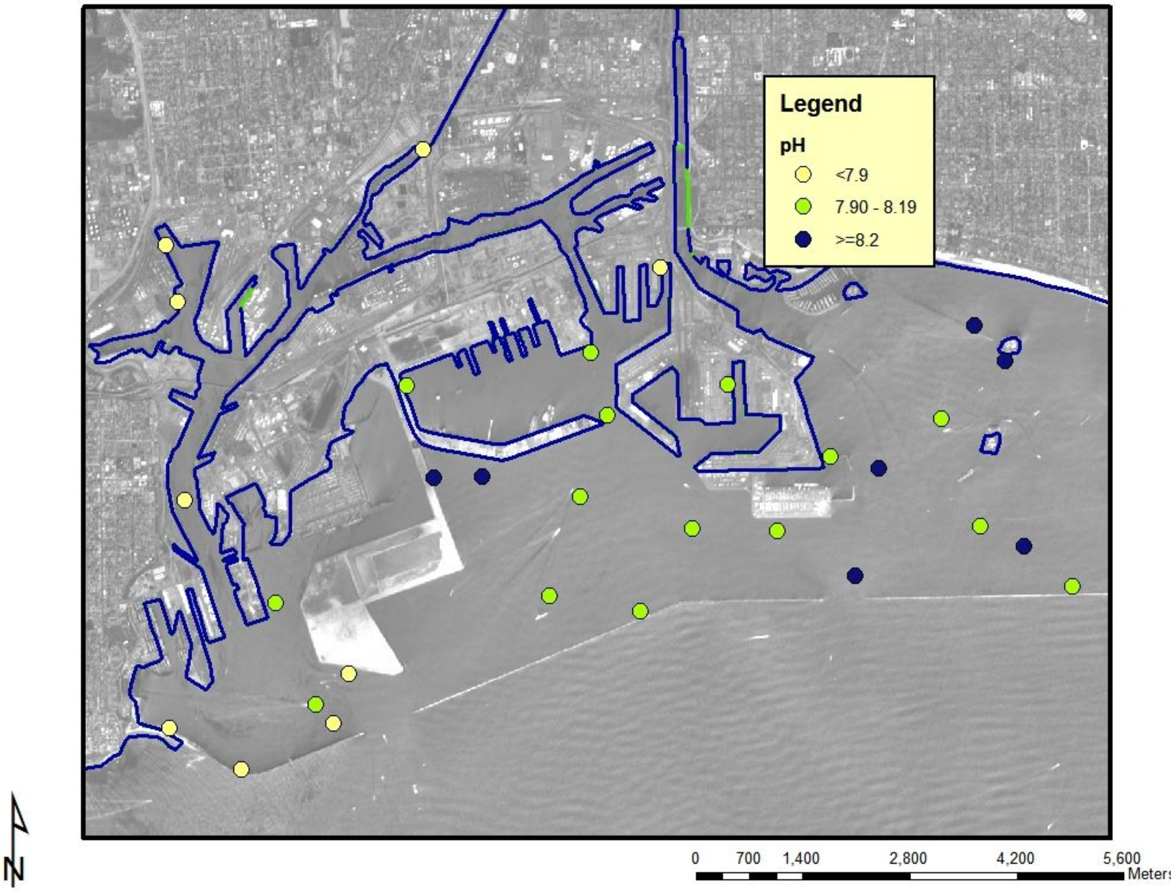
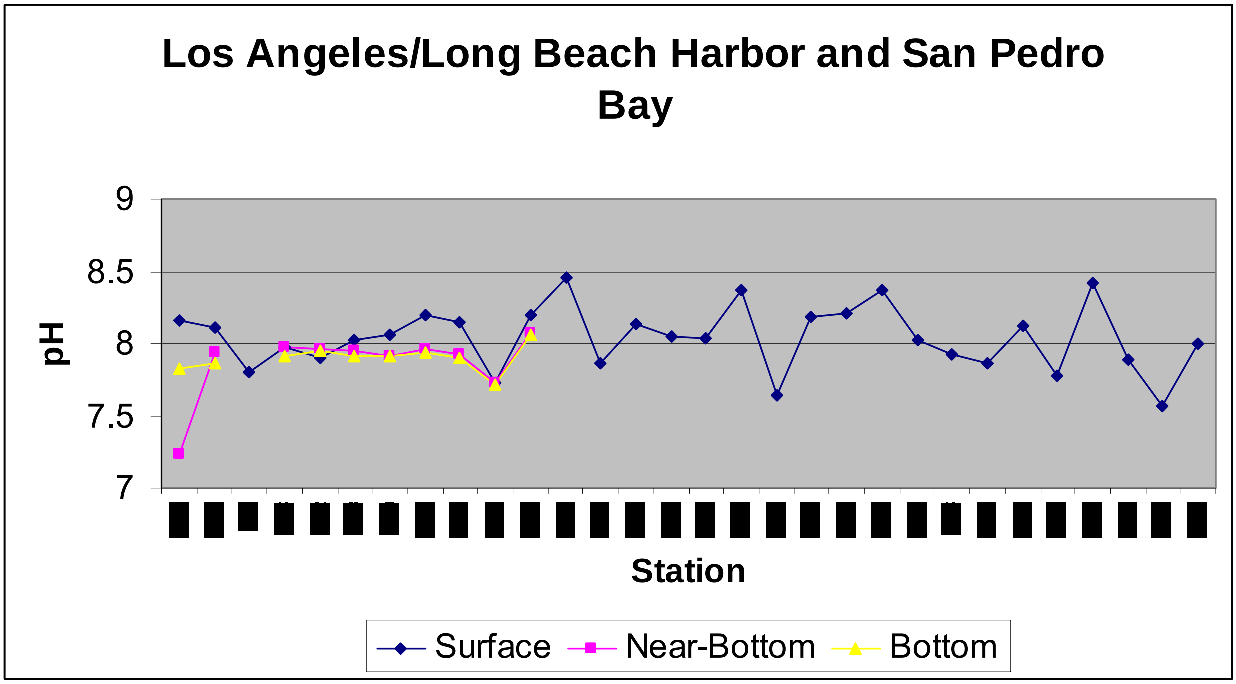


Figure 23.
pH at all water depths in Los Angeles/Long Beach Harbor
and San Pedro Bay in 2003.



Oxygen saturation ranged from 5.04 to 142.9 % in the surface waters (Figure 24). The Basin Plan does not contain a water quality objective for oxygen saturation. Oxygen saturation was greater than 80% in surface waters at 20 of the 30 stations sampled. The lowest value measured was found at station 4760 in Los Angeles Outer Harbor. Oxygen saturation values of less than 80% also were found in surface waters at all stations in Los Angeles Inner Harbor, as well as a few stations in Long Beach Inner Harbor and Long Beach Outer Harbor (although many stations in Long Beach Harbor had oxygen saturation values greater than 80%. All of the stations in San Pedro Bay had oxygen saturation values greater than 80% in the surface waters. Oxygen saturation values for near-bottom and bottom waters always were equal to or less than the surface values (Figure 25). At six stations (4146, 4162, 4178, 4210, 4226 and 4274), near-bottom and bottom oxygen saturation values were greater than 80%, while they fell below this threshold at the other four stations (4050, 4098, 4242, 4266).

Basin Plan objectives for DO indicate that no single determination shall be less than 5.0 mg/L in all surface waters, except when natural conditions cause lesser concentrations; the Basin Plan also specifically mentions that the area known as the Outer Harbor area of Los Angeles-Long Beach Harbors shall not have any single DO determination less than 5.0 mg/L [CRWQCB LAR 1994]. Four of the 30 stations sampled had DO concentrations in the surface waters that fell below the Basin Plan objective; all four stations were located in Los Angeles Harbor (two in the Inner Harbor and two in the Outer Harbor). It is unclear whether natural conditions caused these low DO concentrations. Near-bottom and bottom DO concentrations fell below the Basin Plan objective at one of the 10 stations where measurements were recorded at multiple depths in the water column (this station also was located in Los Angeles Inner Harbor, but was not one of the four stations where surface DO concentrations were low).

Figure 24.

Surface Water Dissolved Oxygen Saturation in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003

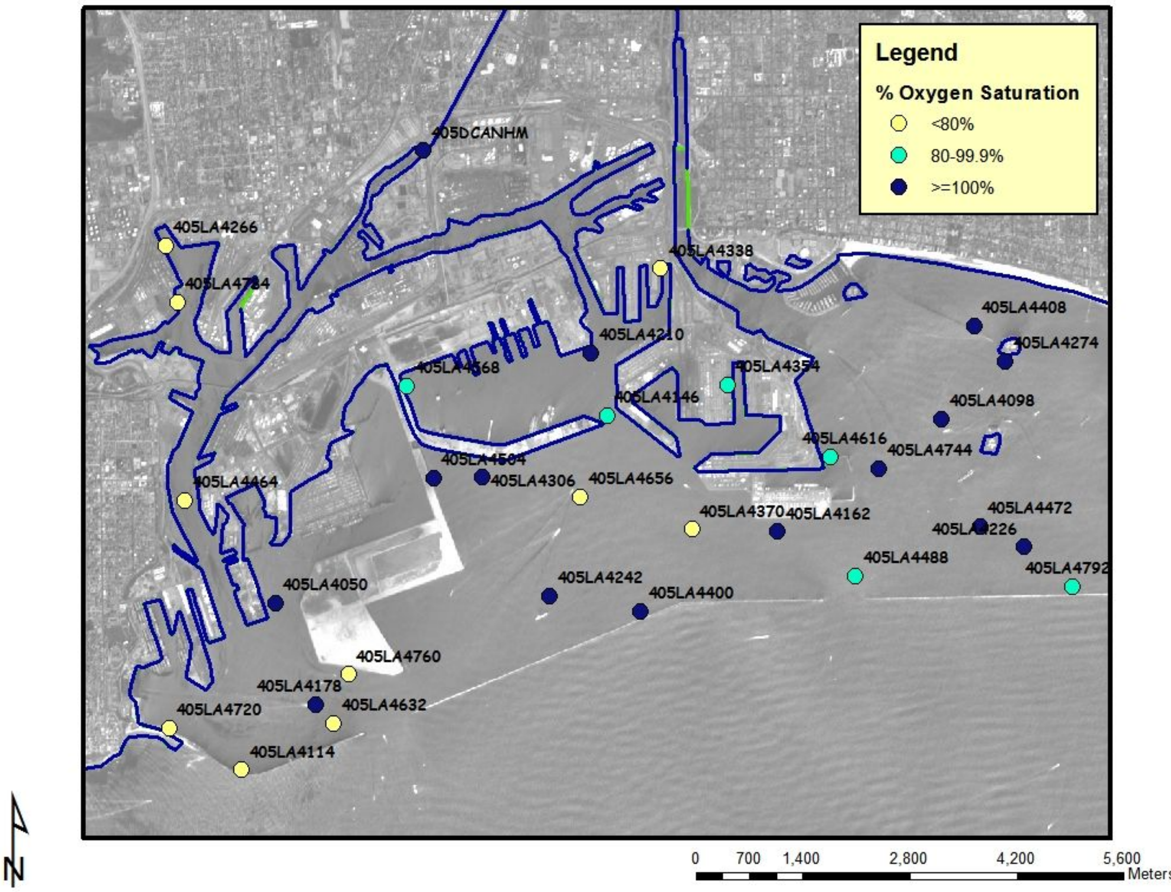


Figure 25.
Oxygen saturation at all water depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.

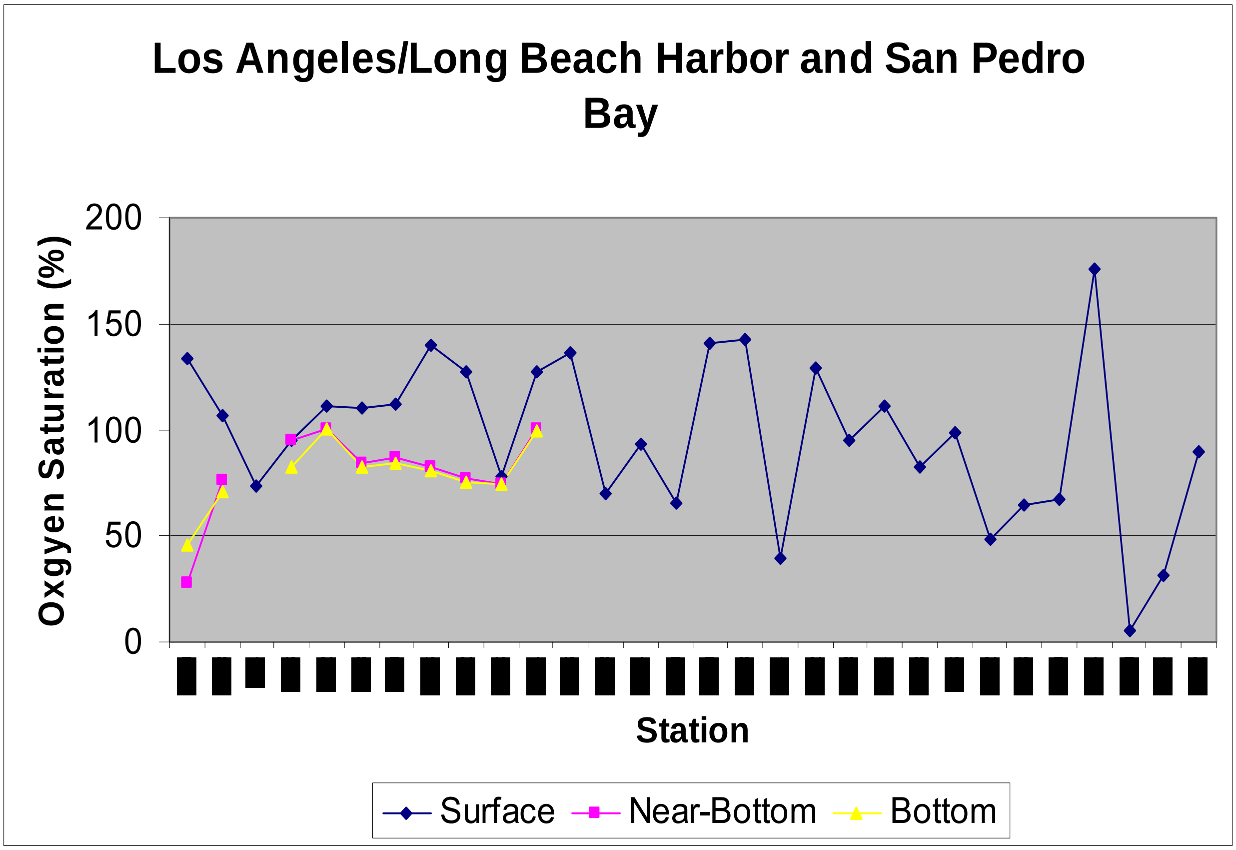
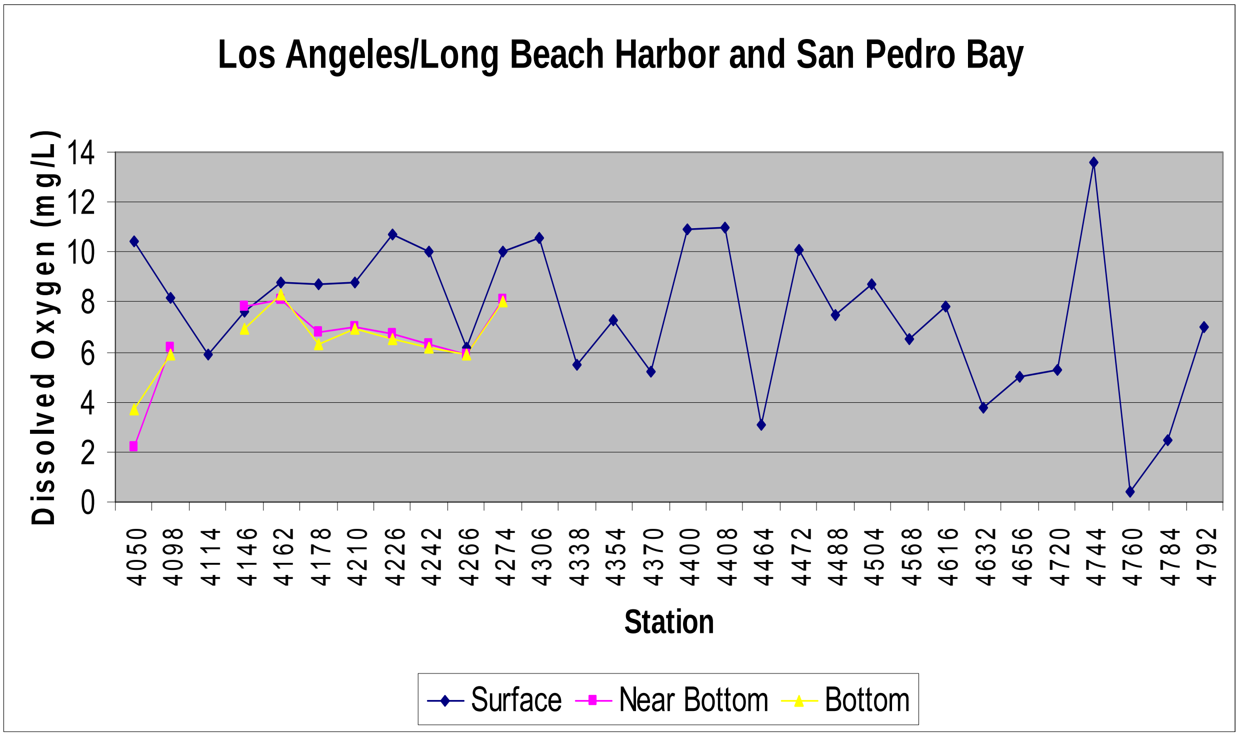


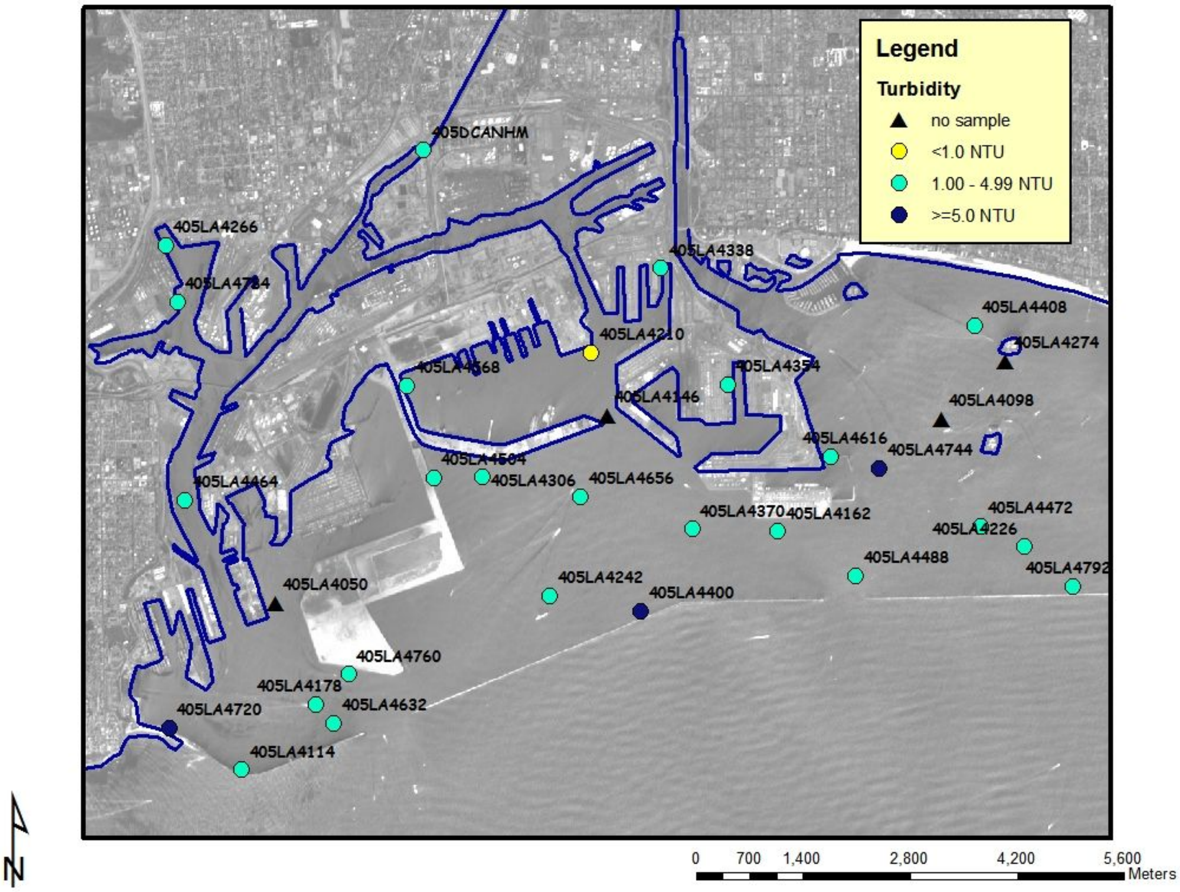
Figure 26.
Dissolved oxygen at all water depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



Turbidity ranged from 0.57 to 12.0 NTU in surface waters (Figure 27) at the 26 stations where this measurement was performed (no turbidity measurements were made at stations 4050, 4098, 4146 or 4274). The lowest turbidity was measured at station 4210 in Long Beach Inner Harbor. The highest values were measured at station 4400 in Long Beach Outer Harbor, 4720 in Cabrillo Marina (Los Angeles Harbor) and 4744 in San Pedro Bay. With the exception of these three stations, turbidity was 3.3 NTU or less throughout the study area. No turbidity measurements were conducted on near-bottom or bottom water samples. The Basin Plan does not contain an absolute water quality objective for turbidity in enclosed bays and estuaries.

Figure 27.

Surface Water Turbidity in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003



4.2 Laboratory Measurements – Water Samples

Machado Lake (Harbor Lake)

Several conventional water chemistry parameters were measured in the laboratory on water samples collected on August 4, 2003. Several parameters were fairly consistent throughout the entire lake, including alkalinity (203-206 mg/l), chloride (124-129 mg/l), hardness (349-362 mg/l), nitrite (< 0.005 mg/l), orthophosphate (1.23-1.25 mg/l), sulfate (141-145 mg/l) and total organic carbon (18.3-19.1 mg/l). The nitrite levels were below the Basin Plan objective of 1.0 mg/l. The chloride levels were below the Basin Plan objective of 230 mg/l for protection of aquatic life in freshwater systems [CRWQCB-LAR, 1994]. There are no Basin Plan objectives for alkalinity, hardness, orthophosphate, sulfate or total organic carbon concentrations in lake waters.

Ammonia was below detection levels (<0.05) in the central and southern portion of the lake, but was present at higher levels (0.8 and 1.6 mg/l) in the northern portion of the lake (Figure 28). The Basin Plan objective for total ammonia varies depending on the pH and water temperature of the waters [CRWQCB-LAR, 1994]. At station 1, the measured ammonia concentration of 1.6 mg/l was approximately equal to the calculated water quality objective of 1.63 mg/l. At station 2, the measured value of 0.8 mg/l was well under the calculated water quality objective of 1.54 mg/l. Ammonia concentrations at the other three lake stations were well below the water quality objective. Chlorophyll a values ranged from 5.29 to 9.35 µg/l, with the lowest value measured at station 1 in the north end of the lake and the highest value measured at station 5 in the south end of the lake (Figure 29). There is no Basin Plan objective for chlorophyll a. Nitrate concentrations ranged from 0.0678 to 0.987 mg/l, again with the lowest value at station 1 and the highest at station 5 (Figure 30). These concentrations are well below the Basin Plan objective of 10 mg/l. Suspended solids ranged from 8.955 to 12.5 mg/l, with the lowest value measured at station 5 and the highest at station 2 (Figure 31). There is no numeric Basin Plan objective for suspended solids.

Figure 28.
Ammonia in Machado Lake in 2003.

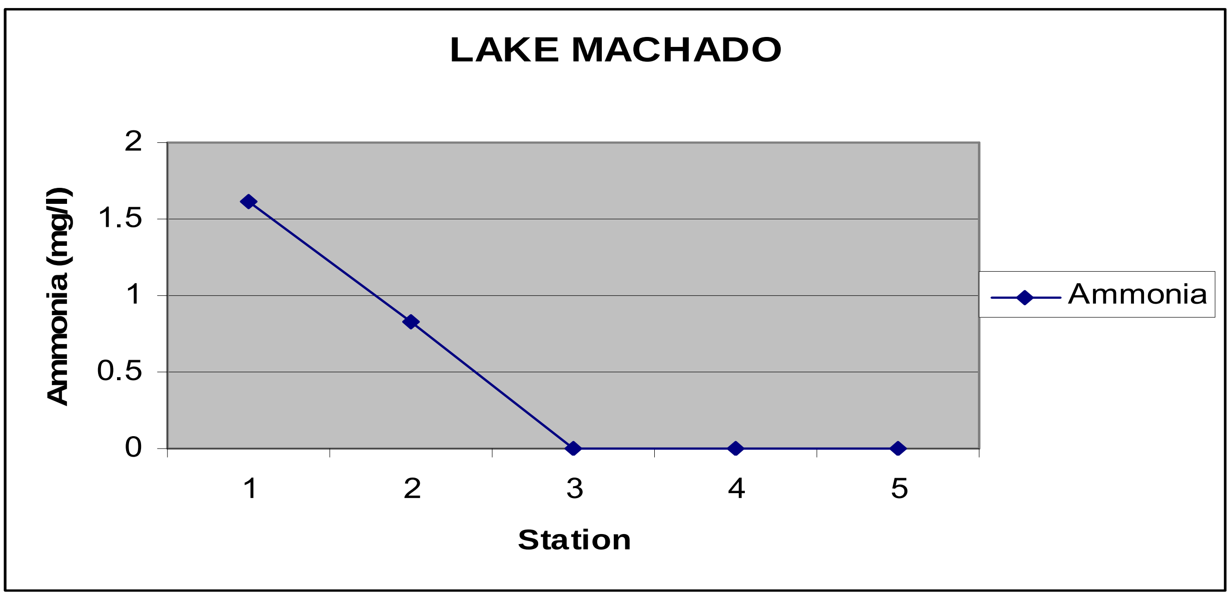


Figure 29.
Chlorophyll a in Machado Lake in 2003.

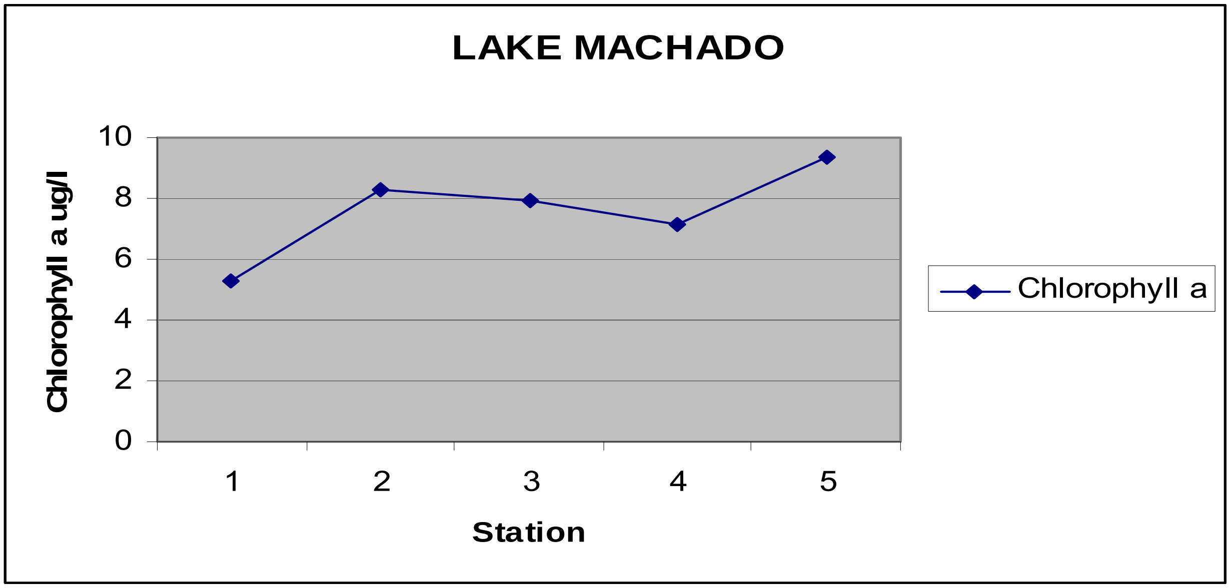


Figure 30.
Nitrate in Machado Lake in 2003.

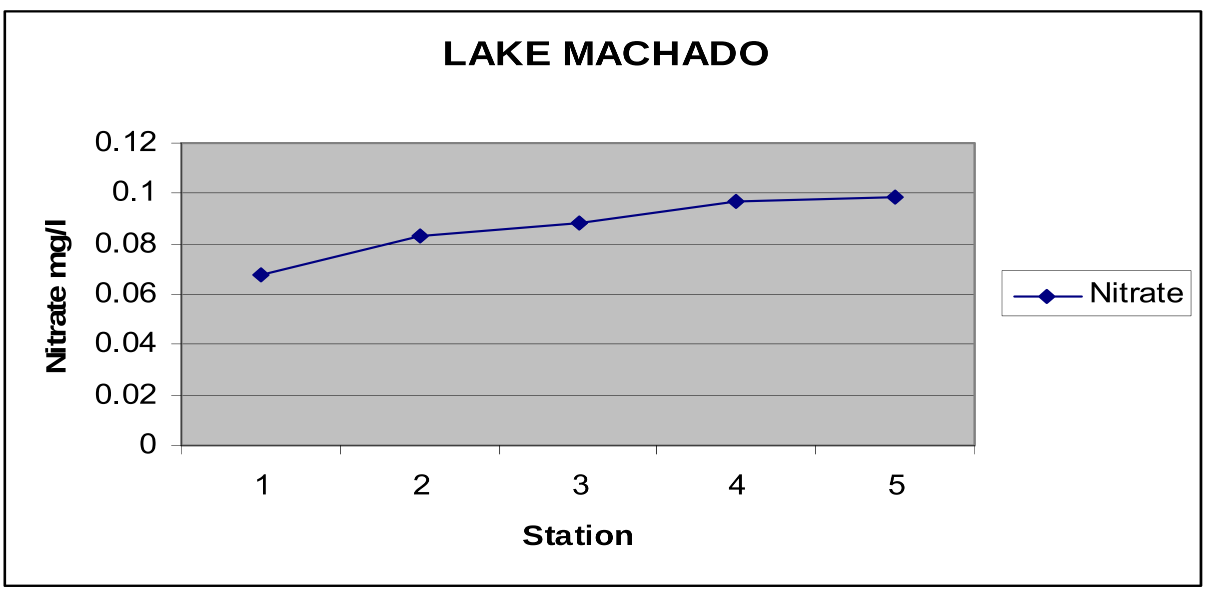
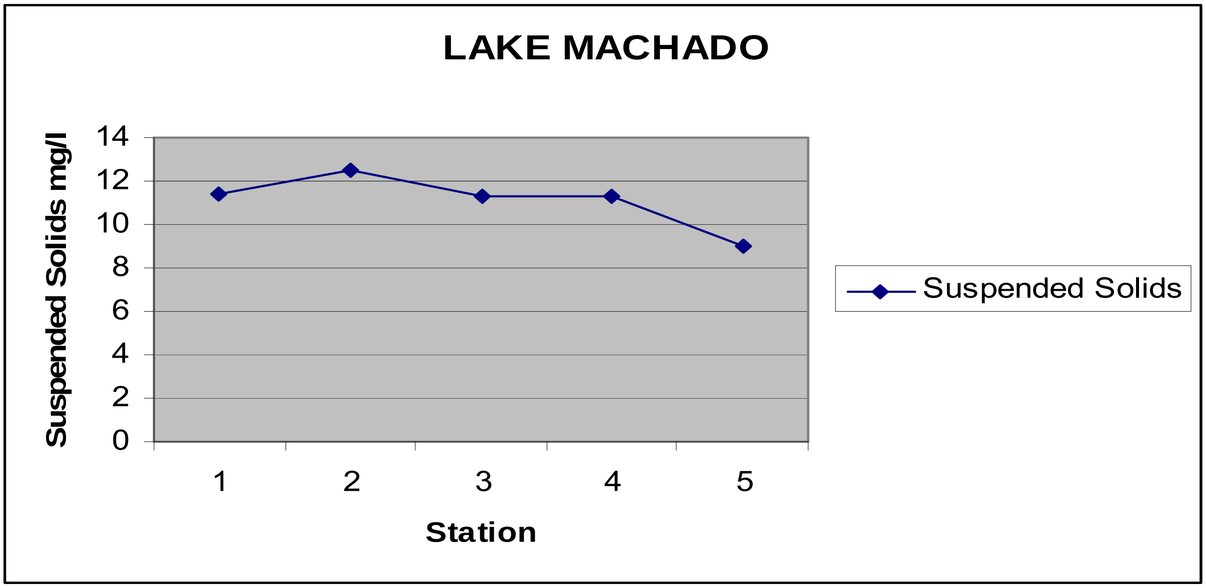


Figure 31.
Suspended solids in Machado Lake in 2003.

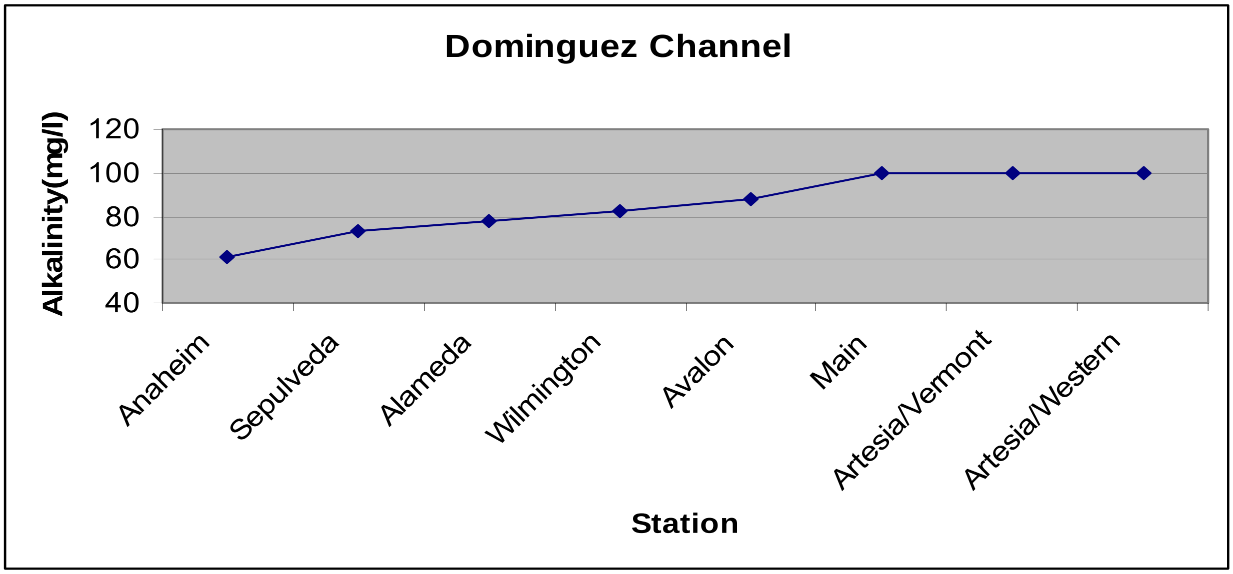


Dominguez Channel

Several conventional water chemistry parameters and organics were measured in the laboratory from water samples collected at each station on August 5, 2003. Bacteriological indicators also were measured at each station. Metals were measured at one station (Artesia/Western).

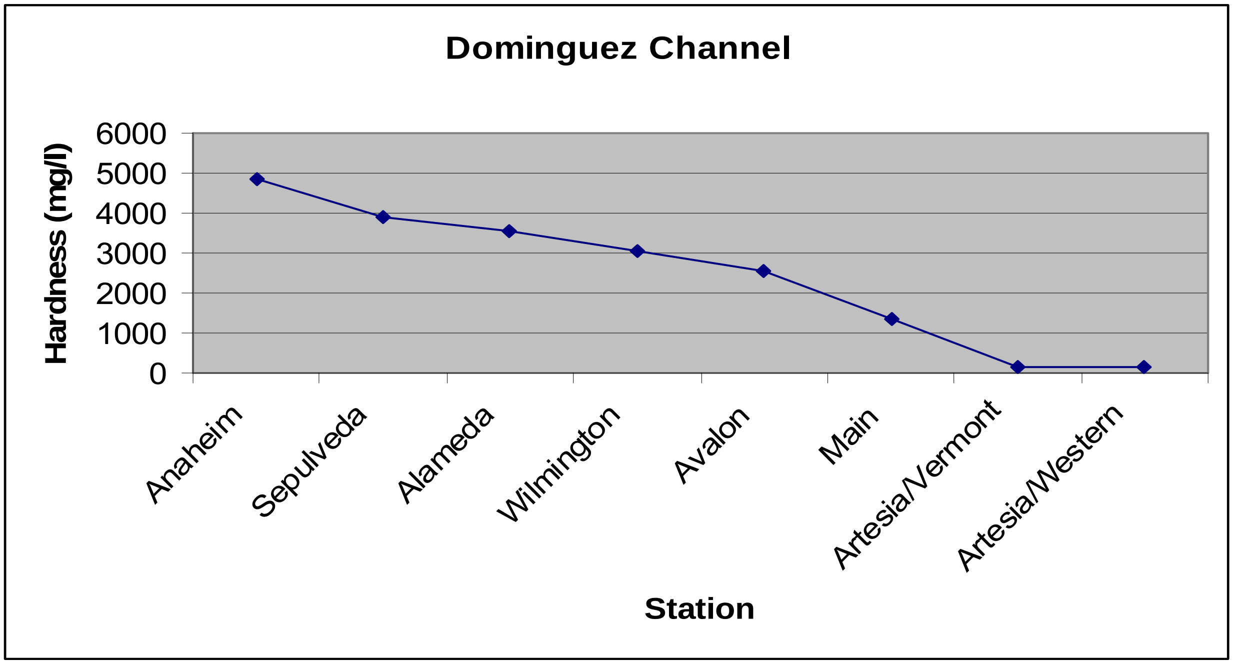
Alkalinity ranged from 61.2 to 100 mg/l (Figure 32). The lowest value was measured at the Anaheim station, at the most downstream point sampled in the channel. The highest values were measured at Main, Artesia/Vermont and Artesia/Western in the upper portion of the channel. Alkalinity progressively increased from the downstream to the upstream locations in the channel up to the Main station, after which alkalinity remained at the same level. The Basin Plan does not contain water quality objectives for alkalinity in enclosed bays and estuaries.

Figure 32.
Alkalinity in Dominguez Channel in 2003.



Hardness ranged from 143 to 4850 mg/l (Figure 33). The lowest values were measured at the Artesia/Western station at the most upstream point sampled in the channel. The highest value was measured at the Anaheim station, the most downstream point sampled in the channel. Hardness progressively decreased from the downstream to the upstream stations. Chloride ranged from 70.5 to 13300 mg/l and followed the same pattern observed for hardness. Sulfate ranged from 54.5 to 1720 mg/l and also followed the same pattern. The Basin Plan does not contain hardness, chloride or sulfate objectives for enclosed bays and estuaries.

Figure 33.
Hardness in Dominguez Channel in 2003.



Ammonia concentrations ranged from <0.05 to 0.164 mg/l (Figure 34). The lowest values were found at Artesia/Vermont and Artesia/Western, the most upstream locations sampled in the channel. The highest values were found at Avalon and Main stations, the two locations just downstream from the two Artesia stations. Total ammonia concentrations were well under Basin Plan water quality objectives at all stations [CRWQCB-LAR, 1994]. Nitrate concentrations ranged from 0.246 to 0.647 mg/l (Figure 35). The lowest value was found at the Anaheim station, the most downstream location sampled in the channel. The highest value was found at the Artesia/Vermont station in the upper channel area. Nitrate concentrations were well under Basin Plan water quality objectives [CRWQCB-LAR, 1994]. Nitrite concentrations ranged from 0.021 to 0.0288 mg/l. The lowest value was found at the Anaheim station, while the highest value was found at the Avalon station. Nitrite concentrations were well under Basin Plan water quality objectives. Chlorophyll a concentrations ranged from 1.62 to 15 mg/l (Figure 36). The lowest value was found at the Wilmington station, while the highest value was found at the Artesia/Western station. The Basin Plan does not contain a water quality objective for chlorophyll a. Orthophosphate concentrations ranged from 0.0627 to 0.122 mg/l (Figure 37). The lowest value was found at the Artesia/Vermont station, while the highest value was found at the Avalon station. The Basin Plan does not contain a water quality objective for orthophosphate.

Figure 34.
Ammonia in Dominguez Channel in 2003.

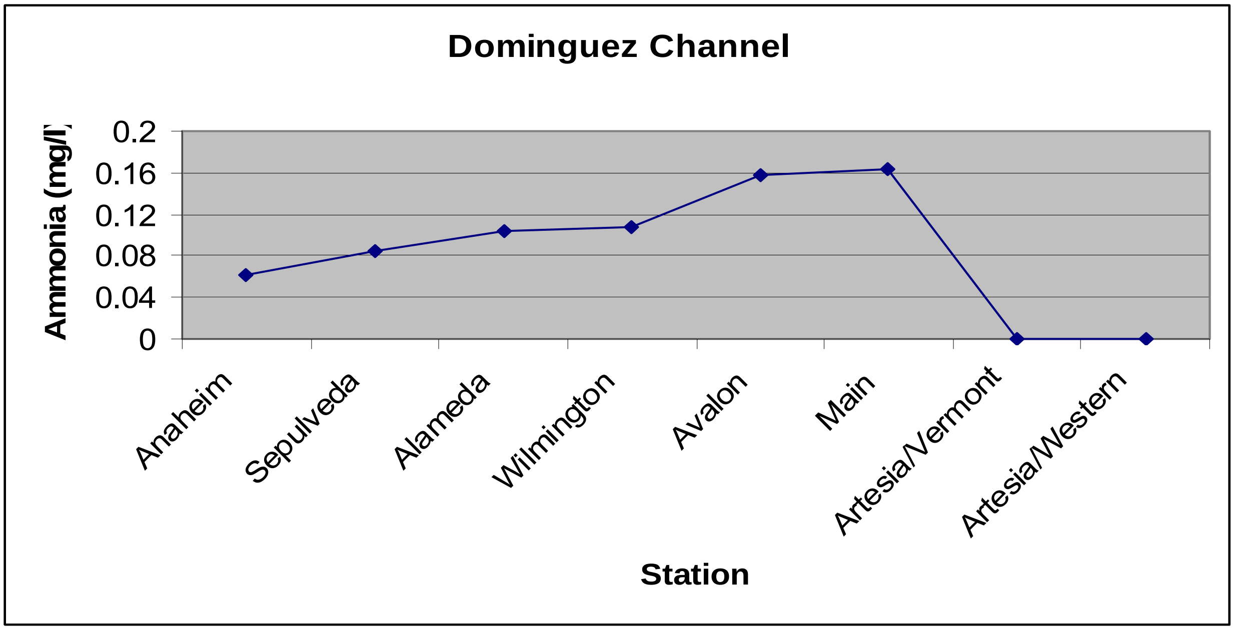


Figure 35.
Nitrate in Dominguez Channel in 2003.

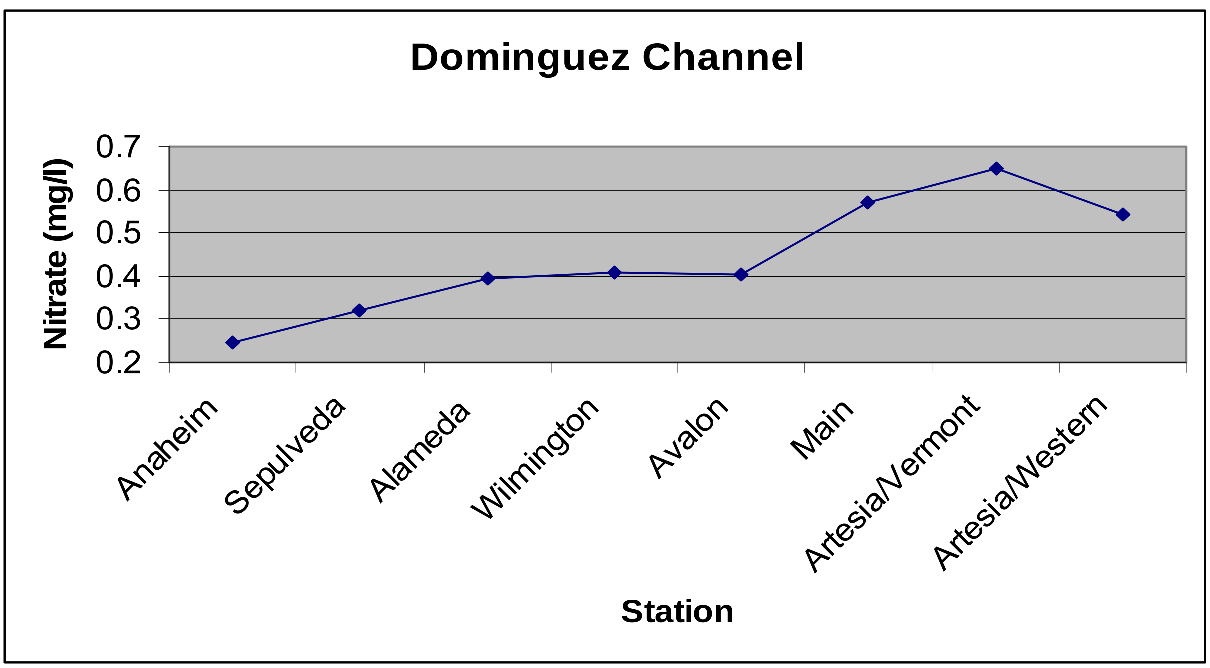


Figure 36.
Chlorophyll a in Dominguez Channel in 2003.

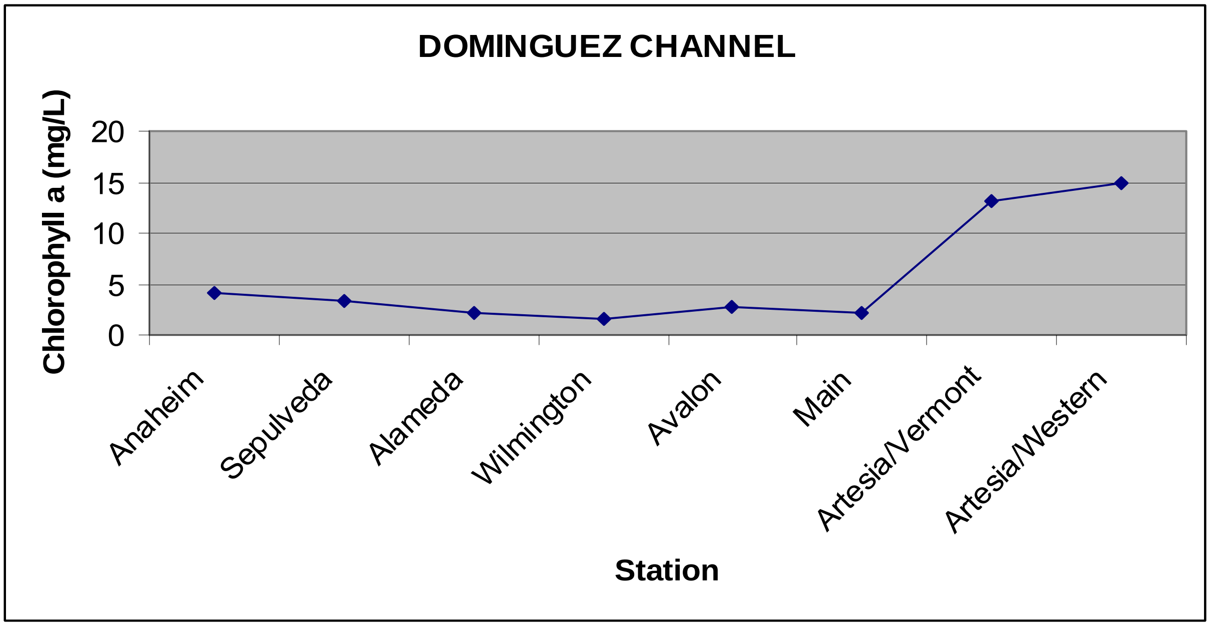
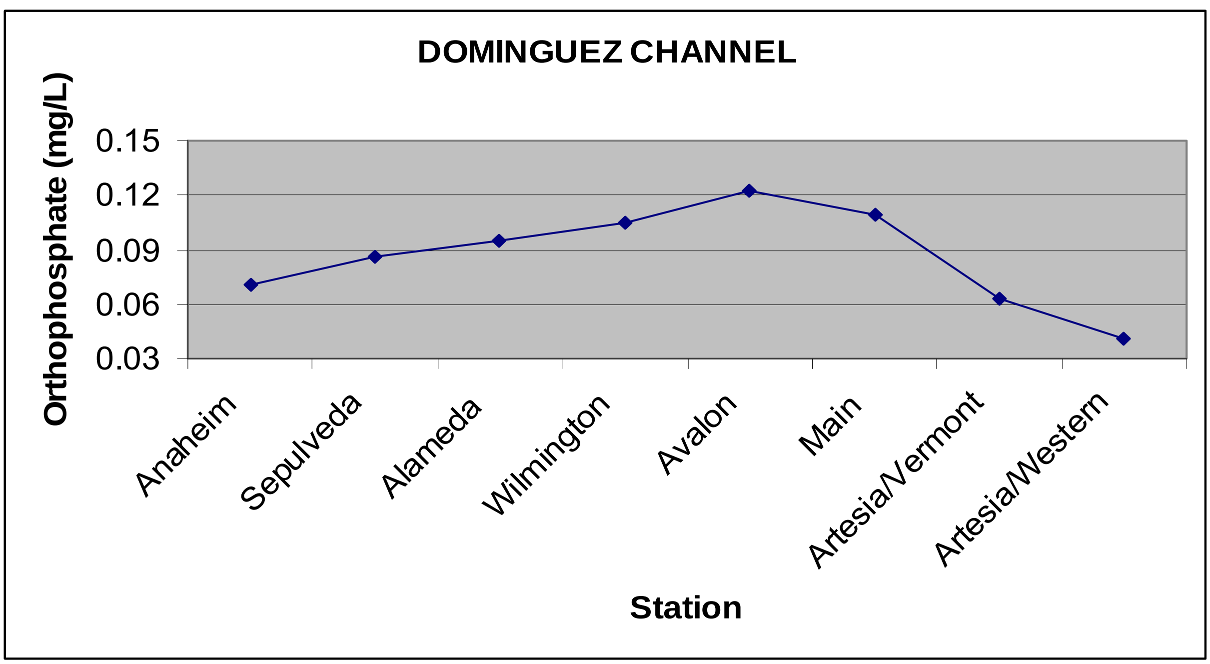


Figure 37.
Orthophosphate in Dominguez Channel in 2003.

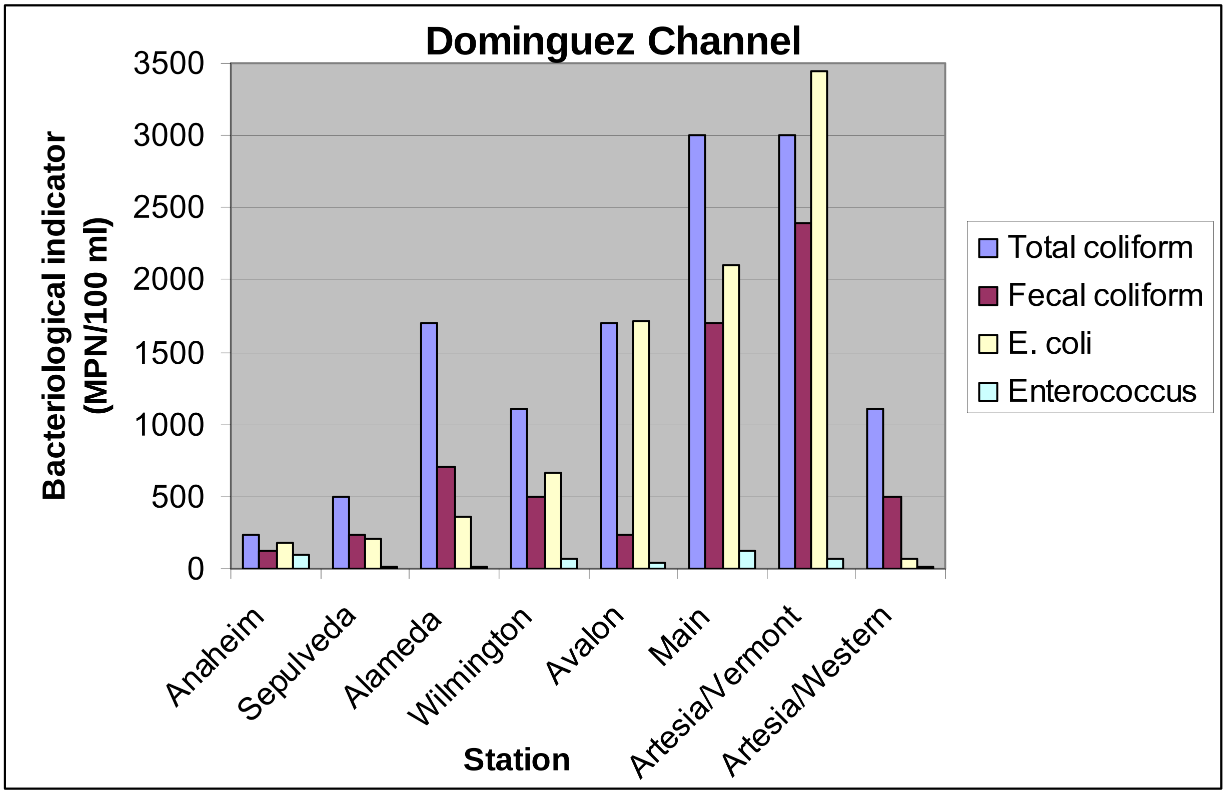


Total Organic Carbon concentrations ranged from 1.3 to 7.2 mg/l. The lowest concentration was found at the Anaheim and Sepulveda stations, the most downstream stations sampled in the channel. The highest concentrations were found at the Artesia/Vermont and Artesia/Western stations, the most upstream points sampled in the channel. Biological Oxygen Demand concentrations ranged from non-detected to 3.5 mg/l. The lowest value was found at the Main station, while the highest values were measured at the two Artesia stations. Suspended solids ranged from <5 to 22.77 mg/l. The lowest values were found at the Wilmington and Main stations, while the highest values were found at the two Artesia stations.

Four bacteriological indicators were measured at the channel stations (Figure 38). Total coliform ranged from 230 to 3000 MPN (most probable number)/100 ml. The lowest value was found at the Anaheim station, the most downstream point sampled in the channel. The highest values were found at the Main and Artesia/Vermont stations in the upper portion of the channel. Fecal coliform ranged from 130 to 2400 MPN/100 ml. Again the lowest value was recorded at the Anaheim station and the highest values at the Main and Artesia/Vermont stations. *E. coli* ranged from 63 to 3448 MPN/100 ml. The lowest value was found at the Artesia/Western station, the most upstream point sampled in the channel. The highest value was found at the Artesia/Vermont station, just downstream from the Artesia/Western station. *Enterococcus* ranged from 10 to 120 MPN/100 ml. The lowest value was found at the Sepulveda station, while the highest value was found at the Main station.

The Basin Plan has different bacteriological objectives for freshwater and marine waters. In freshwater areas, the single sample objectives for *E. coli* and fecal coliform are 235 per 100 ml and 400 per 100 ml, respectively. The Artesia/Vermont station considerably exceeded both freshwater objectives, while the Artesia/Western station slightly exceeded the fecal coliform objective. In marine waters, the single sample objectives for *E. coli*, fecal coliform and enterococcus are 10,000 per 100 ml, 400 per 100 ml and 104 per 100 ml, respectively. The Alameda, Wilmington and Main stations exceeded the marine objective for fecal coliform, but not the *E. coli* nor the total coliform objectives; the Anaheim, Sepulveda and Avalon stations were below all three objectives. In marine waters, the 30-day geometric mean water quality objectives require a minimum of 5 samples to determine compliance with these objectives, so we cannot assess compliance based on the single samples collected during this study. However, it is noted that 4 of the 6 brackish water stations (Alameda, Wilmington, Avalon, Main) exceeded the total coliform geometric mean value of 1,000 per 100 ml, 5 of 6 (all but the Anaheim station) exceeded the fecal coliform geometric mean value of 200 per 100 ml, and 4 of 6 (Anaheim, Wilmington, Avalon, Main) exceeded the enterococcus geometric mean value of 35 per 100 ml.

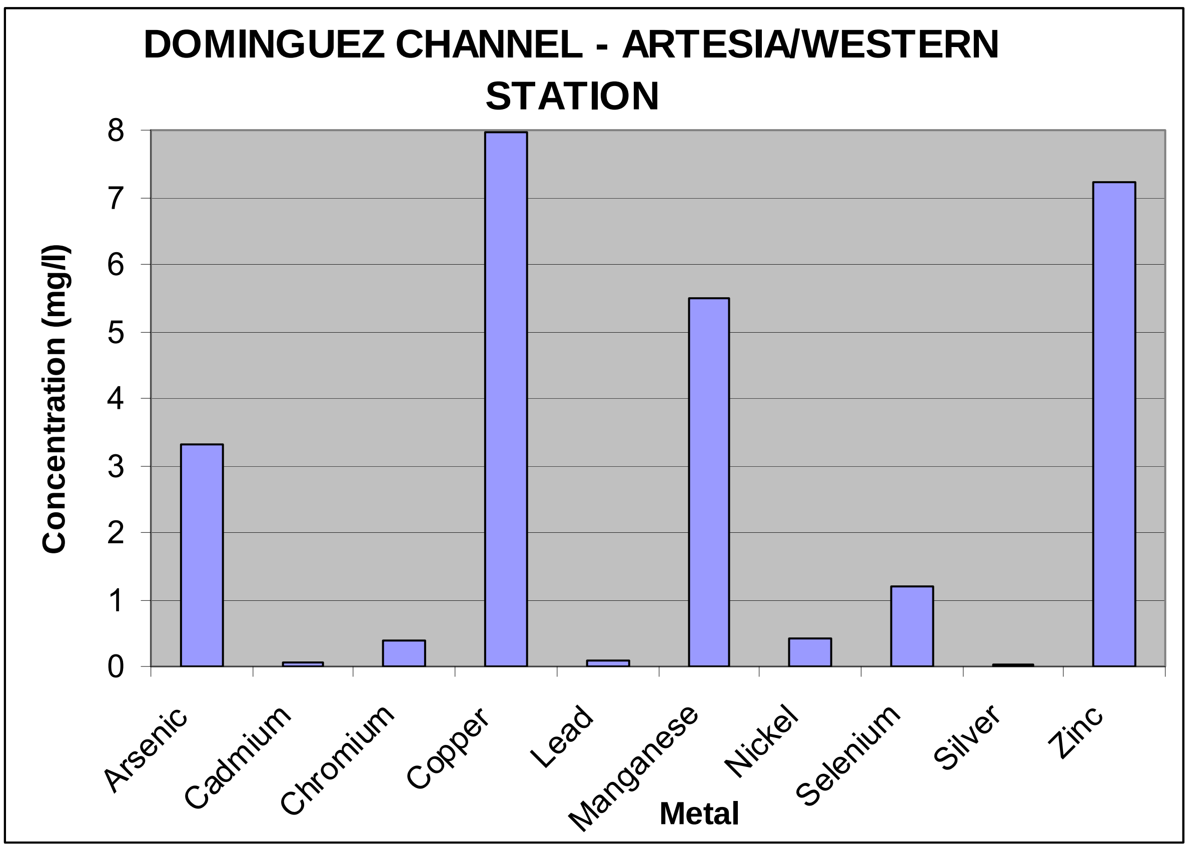
Figure 38.
Bacteriological indicators in Dominguez Channel in 2003.



Numerous organic constituents were measured in the laboratory from water samples collected on August 3, 2003, at each channel station. For the vast majority of these organic constituents, concentrations were present at levels below the laboratory detection limit. The exceptions where detectable concentrations were measured: diazinon (detected at all stations, ranged from 0.01 to 0.021 µg/ml), oxadiazon (detected at all stations, ranged from 0.002 to 0.004 µg/ml), benzo(b)fluoranthene (detected at two stations, 0.0131 µg/ml at Anaheim and 0.0169 µg/ml at Artesia/Vermont), benzo(g,h,i)perylene (detected at one station, 0.0131 µg/ml at Artesia/Western), dibenzothiophenes-C2 (detected at four stations, ranged from 0.0103 µg/ml at Avalon to 0.0118 µg/ml at Anaheim), fluoranthene (detected at four stations, ranged from 0.0117 µg/ml at Artesia/Western to 0.0394 µg/ml at Artesia/Vermont), fluoranthene/pyrene-C1 (detected at three stations, ranged from 0.0109 µg/ml at Artesia/Vermont to 0.0139 µg/ml at Anaheim), flourenes-C3 (detected at three stations, ranged from 0.0104 µg/ml at Sepulveda and Anaheim to 0.0136 µg/ml at Artesia/Vermont), indeno(1,2,3-c,d)pyrene (detected at two stations, 0.011 µg/ml at Artesia/Western and 0.0173 µg/ml at Artesia/Vermont), naphthalenes-C2 (detected at two stations, 0.013 µg/ml at Main and 0.0148 µg/ml at Avalon), naphthalenes-C3 (detected at seven stations, ranged from 0.0119 µg/ml at Artesia/Western to 0.0195 µg/ml at Artesia/Vermont), naphthalenes-C4 (detected at two stations, 0.0115 µg/ml at Sepulveda and 0.0122 µg/ml at Main), phenanthrene (detected at one station, 0.0249 µg/ml at Artesia/Vermont), phenanthrene/anthracene-C1 (detected at all stations, ranged from 0.0168 µg/ml at Artesia/Western to 0.0275 µg/ml at Alameda), phenanthrene/anthracene-C2 (detected at six stations, ranged from 0.0104 µg/ml at Main to 0.0168 µg/ml at Artesia/Vermont), phenanthrene/anthracene-C3 (detected at 1 station, 0.0144 µg/ml at Artesia/Vermont), and pyrene (detected at three stations, ranged from 0.0105 µg/ml at Sepulveda to 0.0251 µg/ml at Artesia/Vermont).

Metal concentrations were measured in the laboratory from a water sample collected at the Artesia/Western station on August 3, 2003 (Figure 39). The concentrations of arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver and zinc all were below established water quality objectives for protection of aquatic life [California Toxics Rule, 2000]. There are no CTR or Basin Plan water quality objectives for manganese for protection of aquatic life.

Figure 39.
Metals in water at Artesia/Western station in Dominguez Channel in 2003.

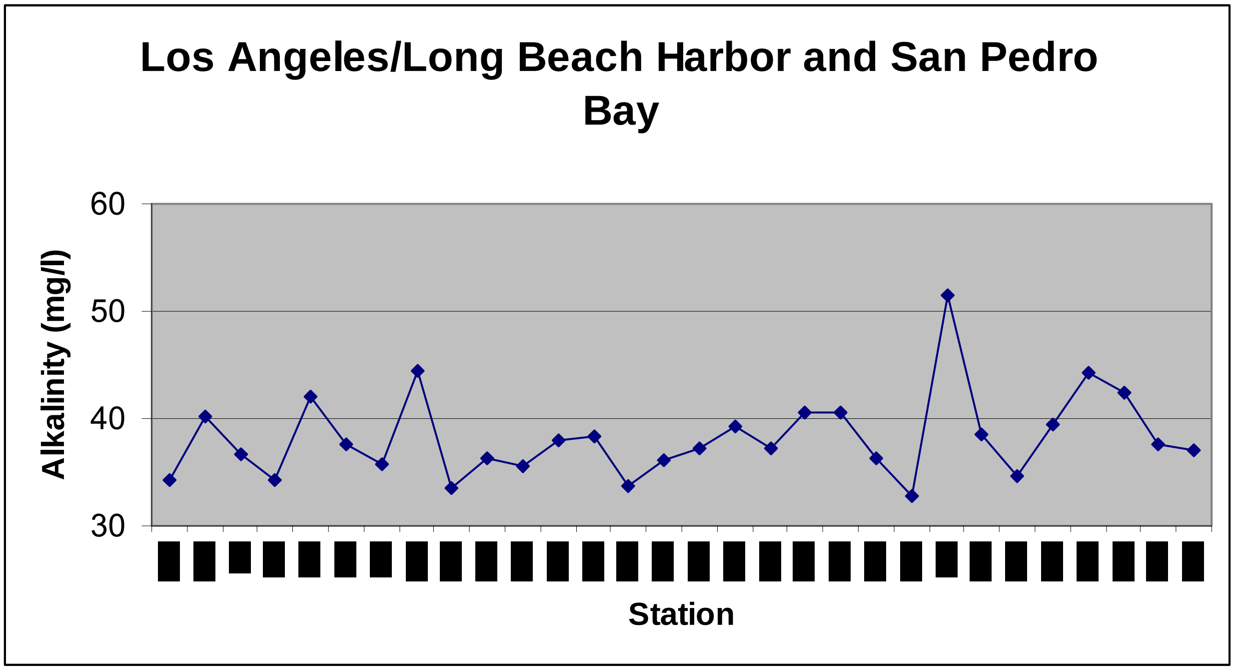


Los Angeles/Long Beach Harbor and San Pedro Bay

Several conventional water chemistry parameters, metals and organics were measured in the laboratory from water samples collected at each station from August 20-28, 2003. Surface water samples were analyzed at all 30 stations. Near-bottom, bottom and pore water samples also were analyzed at 10 stations for some of these constituents. Bacteriological indicators also were measured from surface water samples at each station.

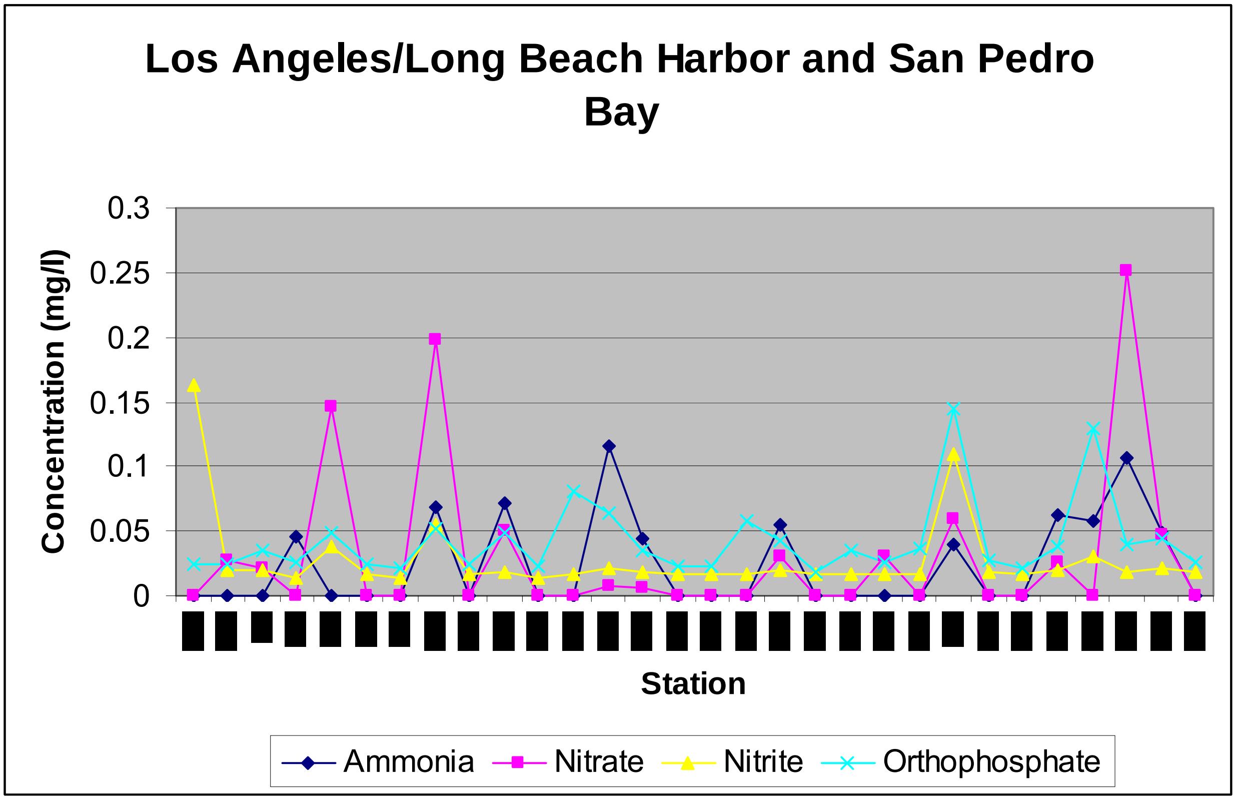
Alkalinity ranged from 32.7 to 51.5 mg/l in surface waters (no samples were analyzed from other depths) (Figure 40). The lowest value was measured at station 4568 in Long Beach Inner Harbor, while the highest value was measured at station 4616 in San Pedro Bay. Hardness ranged from 5,570 to 6,260 mg/l in surface waters (no samples were analyzed from other depths). The lowest value was measured at station 4616 in San Pedro Bay, while the highest value was measured at station 4720 in Cabrillo Marina (Los Angeles Harbor). Only 4 stations had hardness values below 6,000 mg/l. Chloride ranged from 16,400 to 25,000 mg/l in surface waters (no samples were analyzed from other depths). The lowest value was measured at station 4616 in San Pedro Bay, while the highest value was measured at station 4098, also in San Pedro Bay. Sulfate ranged from 2,080 to 2,410 mg/l in surface waters (no samples were analyzed from other depths). The lowest value was measured at station 4306 in Long Beach Inner Harbor (just outside the Navy Mole breakwater), while the highest value was measured at stations 4146 in Long Beach Inner Harbor and 4178 in Los Angeles Outer Harbor. The Basin Plan does not contain water quality objectives for alkalinity, hardness, chloride or sulfate in enclosed bays and estuaries.

Figure 40.
Surface water alkalinity in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



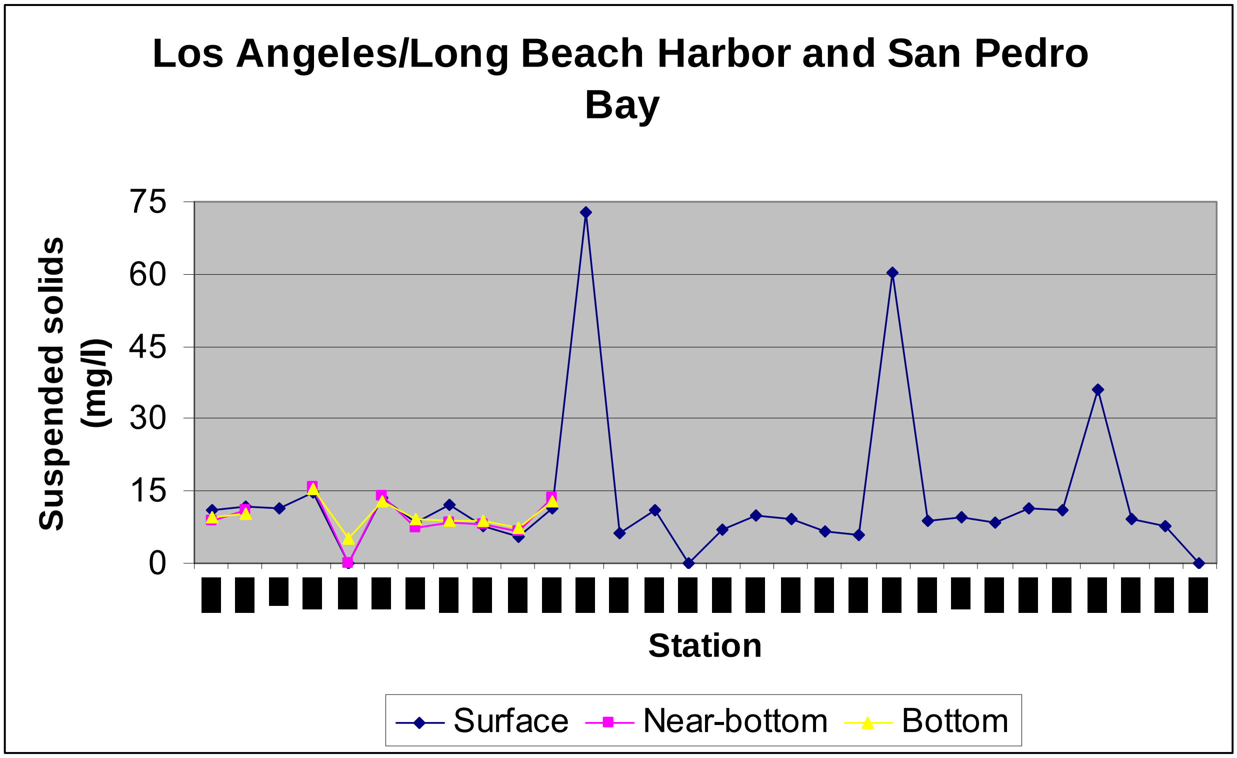
Ammonia ranged from <0.004 to 0.389 mg/l in surface waters (no samples were analyzed from other depths). The highest value was measured at station 4616 in San Pedro Bay (Figure 41). Ammonia was below the detection limit at 19 of the 30 stations sampled. All samples were below the California Ocean Plan water quality objectives (2.4 mg/l as a daily maximum and 0.6 mg/l as a 6-month median) [SWRCB, 2005]. Nitrate ranged from <0.005 to 0.588 mg/l in surface waters (no samples were analyzed from other depths). The highest value was measured at station 4616 in San Pedro Bay (Figure 41). Nitrate was below the detection limit at 17 of the 30 stations sampled. Nitrite ranged from 0.0131 to 0.11 mg/l in surface waters (no samples were analyzed from other depths). The highest value was measured at station 4616 in San Pedro Bay, while the lowest value was measured at station 4210 in Long Beach Inner Harbor, within the Navy Mole (Figure 41). Orthophosphate ranged from 0.019 to 0.144 mg/l in surface waters (no samples were analyzed from other depths). The highest values were measured at stations 4616 and 4744 in San Pedro Bay (Figure 41). There are no water quality objectives for nitrate, nitrite or orthophosphate in enclosed bays and estuaries or ocean waters.

Figure 41.
Surface water nutrients in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



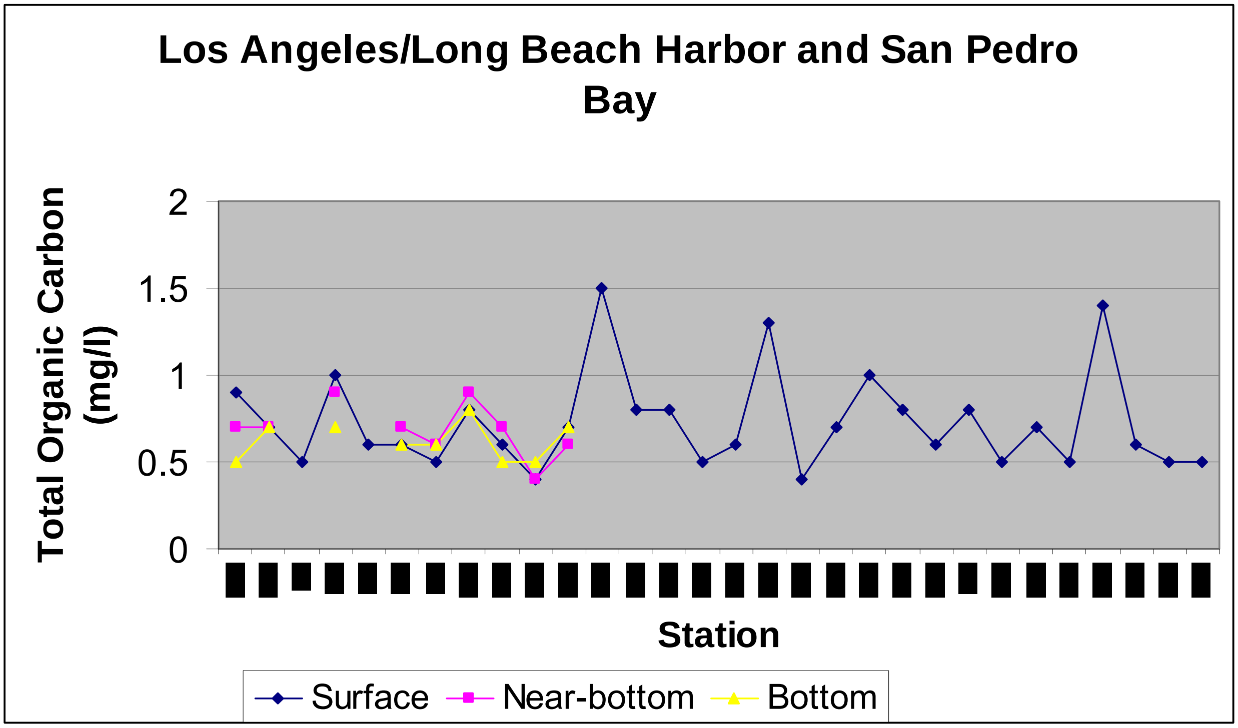
Suspended solids ranged from <5 to 72.64 mg/l in surface waters of Los Angeles/Long Beach Harbor and San Pedro Bay (Figure 42). The highest values were measured at stations 4306 and 4504 in Long Beach Inner Harbor (both stations are just outside the Navy Mole breakwater). The lowest values were measured at stations 4162 and 4370 (Long Beach Outer Harbor) and station 4792 (San Pedro Bay). Near-bottom and bottom values for suspended solids were generally fairly close to the surface values measured (in some cases they were somewhat higher at the surface, but in other cases they were somewhat lower). Neither the California Ocean Plan nor the Basin Plan contain absolute water quality objectives for enclosed bays and estuaries.

Figure 42.
Suspended solids at all water depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



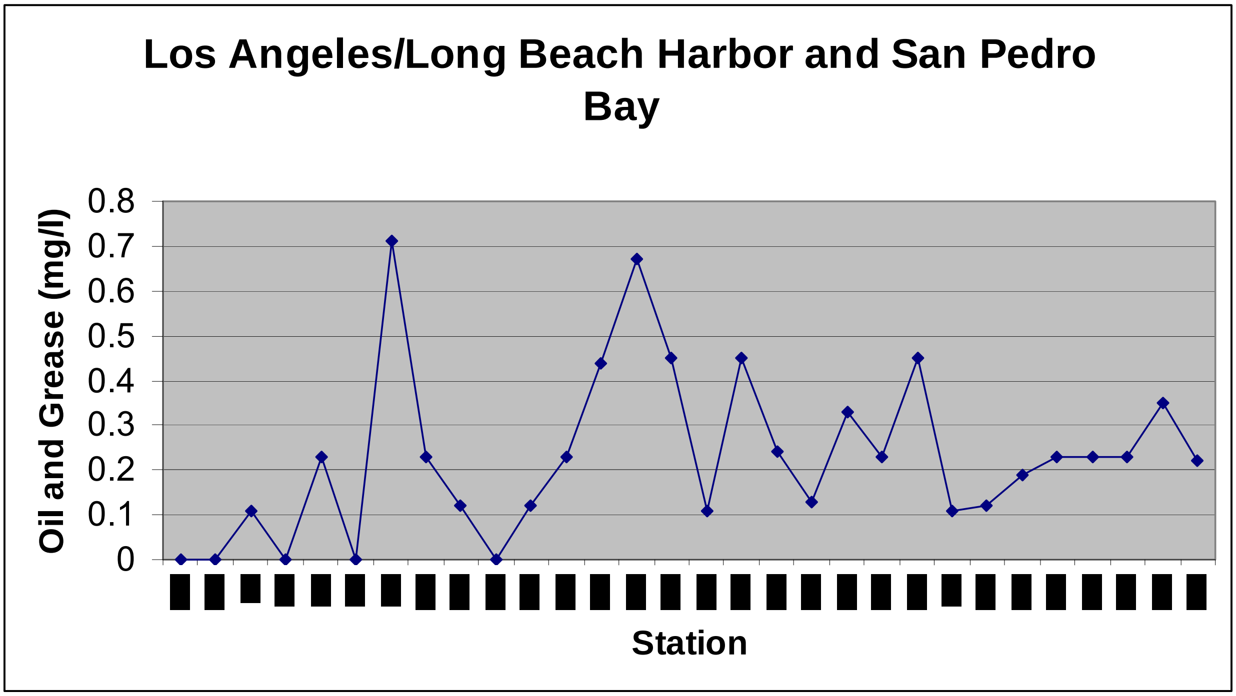
Total organic carbon ranged from 0.4 to 1.5 mg/l in surface waters of Los Angeles/Long Beach Harbor and San Pedro Bay (Figure 43). The highest values were measured at station 4306 and in Long Beach Inner Harbor and station 4744 in San Pedro Bay. The lowest values were measured at stations 4266 and 4464 in Los Angeles Inner Harbor. Total organic carbon values for the near-bottom and bottom samples generally were fairly close to the surface values. Total organic carbon ranged from 3 to 11.7 in pore water samples extracted from the sediments at 10 stations (the stations where surface, near-bottom and bottom water samples were analyzed). The highest values were found at station 4162 in Long Beach Outer Harbor and station 4178 in Los Angeles Outer Harbor. The lowest values were measured at station 4242 in Long Beach Outer Harbor and station 4050 in Los Angeles Inner Harbor.

Figure 43.
Total organic carbon at all water depths in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



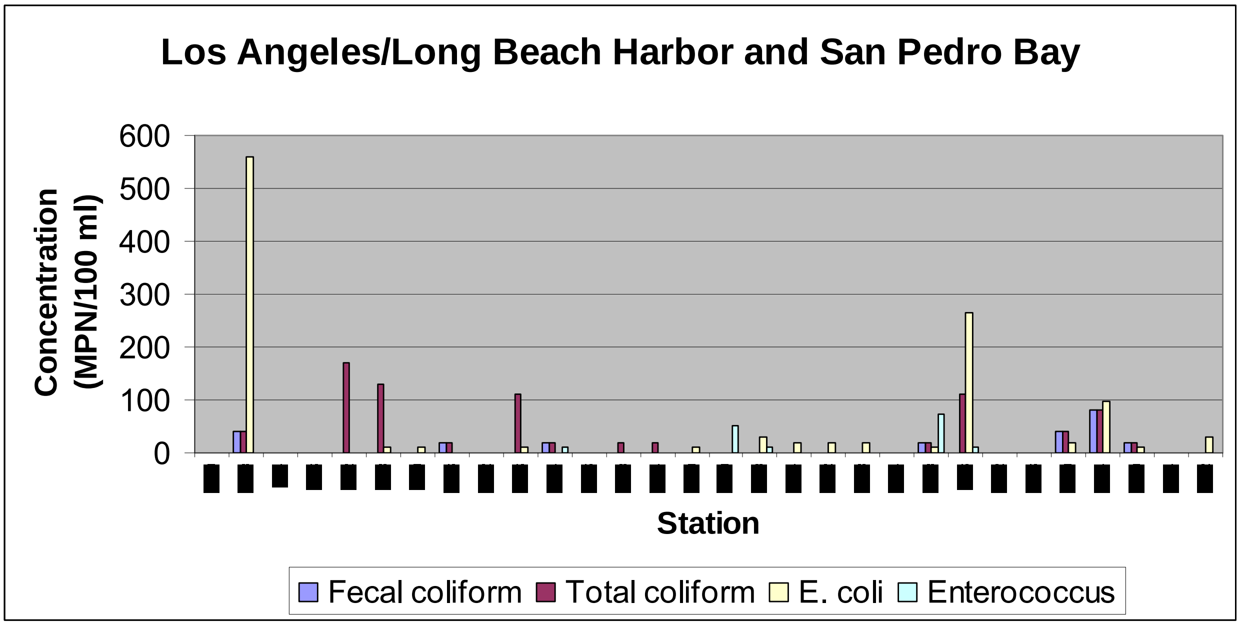
Oil and grease ranged from <0.1 to 0.71 mg/l in surface waters of Los Angeles/Long Beach Harbor and San Pedro Bay (no samples were analyzed from other depths). The highest values were measured at stations 4210 and 4354 in Long Beach Inner Harbor (Figure 44). The lowest values were measured at stations 4050, 4098, 4146, 4178 and 4266, which are spread throughout most of the study area. All of the stations were well below the Ocean Plan water quality objective [SWRCB, 2005].

Figure 44.
Surface water oil and grease in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



Total coliform ranged from <20 to 170 Most Probable Number/100 ml in surface waters of Los Angeles/Long Beach Harbor and San Pedro Bay (no samples were analyzed from other depths). The highest value was found at station 4162 in Long Beach Outer Harbor (Figure 45). Total coliform was below the detection limit at 17 of the 30 stations samples. All values were well below the single sample maximum for protection of human health (10,000 MPN/100 ml) and also well below the 30-day geometric mean of 1,000 per 100 ml (which would require 5 samples within a 30-day period for a valid determination of compliance with this objective) [SWRCB, 2005]. Fecal coliform ranged from <20 to 80 MPN/100 ml in surface waters. The highest value was found at station 4744 in San Pedro Bay. Fecal coliform was below the detection limit at 23 of the 30 stations sampled (Figure 45). All values were well below the single sample maximum for protection of human health (400 MPN/100 ml) and also well below the 30-day geometric mean of 200 per 100 ml (which would require 5 samples within a 30-day period for a valid determination of compliance with this objective) [SWRCB, 2005]. Enterococcus ranged from <10 to 72 MPN/100 ml in surface waters. The highest value was found at station 4568 in Long Beach Inner Harbor. Enterococcus values were below the detection limit at 25 of the 30 stations sampled (Figure 45). All values were below the single sample maximum for protection of human health (104 MPN/100 ml) [SWRCB, 2005]. Only 2 of the 30 stations sampled (4400 and 4568) exceeded the 30-day geometric mean for enterococcus of 35 MPN/100 ml (which would require 5 samples within a 30-day period for a valid determination of compliance with this objective). *E. coli* ranged from <10 to 560 MPN/100 ml in surface waters (Figure 45). The highest values were found at stations 4098 and 4616 in San Pedro Bay. There is no water quality objective for *E. coli*.

Figure 45.
Surface water bacteriological indicators in Los Angeles/Long Beach Harbor and San Pedro Bay in 2003.



Metals were measured in surface water samples at all 30 stations in Los Angeles/Long Beach Harbor and San Pedro Bay. Metals also were measured in near-bottom and bottom water samples at 10 of these stations, as well as in interstitial water (pore water) extracted from sediments collected at these 10 stations. The results are summarized in Table 8.

Table 8. Ranges of metal concentrations in water column and pore water samples from Los Angeles/Long Beach Harbor and San Pedro Bay.

Metal	Water concentration (total dissolved, µg/l)	Pore water concentration (total, µg/l)
Aluminum	Ranged from 0 to 5.66	Ranged from 0 to 1231
Arsenic	Ranged from 1.75 to 2.36	Ranged from 15.2 to 34.7
Cadmium	Ranged from 0.064 to 0.23	Ranged from 0.18 to 0.23
Chromium	Ranged from 0.07 to 0.16	Ranged from 1.68 to 4.0
Copper	Ranged from 0.46 to 2.56	Ranged from 4.39 to 8.29
Lead	Ranged from 0 to 0.24	Ranged from 0.67 to 8.08
Nickel	Ranged from 0 to 5.19	Ranged from 3.11 to 8.72
Selenium	Ranged from 0.14 to 0.87	Ranged from 0.37 to 2.16
Silver	Ranged from 0 to 3.29	Ranged from 7.2 to 10.3
Zinc	Ranged from 0.75 to 7.64	Ranged from 4.31 to 34.7

Metal concentrations measured in pore water (interstitial water) samples generally were much higher than the concentrations measured in water column samples, with the exception of cadmium and selenium.

Metal concentrations for arsenic, cadmium, chromium, lead, nickel, selenium and zinc in water column samples always were much lower than California Toxic Rule water quality objectives [California Toxics Rule, 2000]. Silver concentrations exceeded the water quality objective (1.9 µg/l) at 6 of the 30 stations sampled. Copper concentrations did not exceed the water quality objective (4.8 µg/l) at any of the stations, but many stations (18) had copper concentrations greater than 1 µg/l.

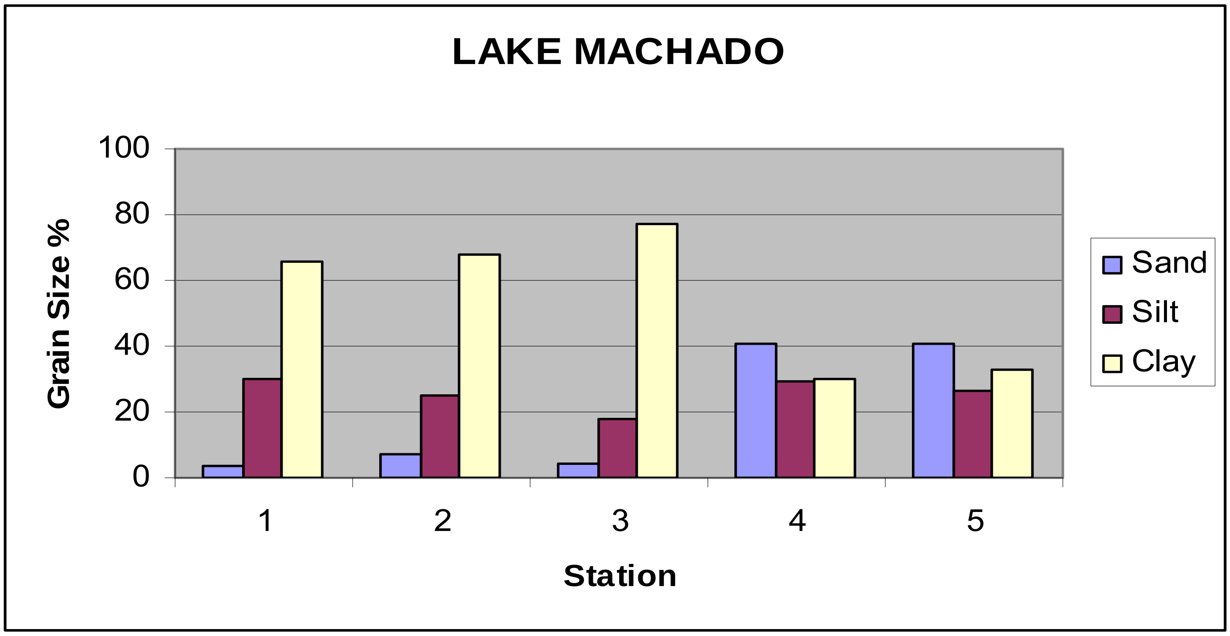
Organic concentrations in water column samples and interstitial water were generally below the analytical detection limit (more than 90% of the analyses). The highest concentration measured for any individual organic compound was 0.418 µg/l for benzene from a surface water sample collected at station 4632 in Los Angeles Outer Harbor.

4.3 Laboratory Measurements – Sediment Samples

Machado Lake (Harbor Park Lake)

Sediment samples were collected at all five lake stations. Based on grain size analyses (Figure 46), the stations in the northern and central portion of the lake (LT1, LT2 and LT3) were similar in composition and dominated by fine-grained deposits, with the sand fraction ranging from 3.7 to 7%, the silt fraction ranging from 17.9 to 30.3%, and the clay fraction ranging from 66 to 77.5%. The two stations in the southern portion of the lake (LT4 and LT5) were similar in composition, but dominated by much coarser-grained deposits. At these two stations, the sand fraction ranged from 40.6 to 40.7%, the silt fraction from 26.3 to 29.2%, and the clay fraction from 30.2 to 33%.

Figure 46.
Grain size characterization of sediments in Machado Lake in 2003.



Several metals and organics were measured in the sediments from each station. Metal analyses included arsenic, cadmium, chromium, copper, lead, manganese, nickel, silver, zinc and aluminum. Organic analyses included aldrin, biphenyl, chlorpyrifos, dacthal, diazinon, oxadiazinon, parathion, tedion, dieldrin, endosulfan, endrin, HCH, heptachlor, heptachlor epoxide, methoxychlor, nonachlor, mirex, toxaphene, chlordanes, DDTs, PCBs, and PAHs.

Arsenic concentrations ranged from 4.2 to 10.8 mg/kg. The arsenic concentration at LT1 was the only value that exceeded the effects threshold of 9.79 mg/kg developed for freshwater sediments [Macdonald et al., 2000]. Cadmium concentrations ranged from 1.6 to 4.3 mg/kg. All of the cadmium concentrations exceeded the effects threshold of 0.99 mg/kg, but none of the values exceeded the probable effects concentration of 4.98 mg/kg. Chromium concentrations ranged from 43 to 101 mg/kg. All of the chromium values, except at LT3, exceeded the effects threshold of 43.4 mg/kg, but none of the values exceeded the probable effects concentration of 111 mg/kg. Copper concentrations ranged from 35 to 79 mg/kg. All of the copper values exceeded the effects threshold of 31.6 mg/kg, but none exceeded the probable effects concentration of 128 mg/kg. Lead concentrations ranged from 31 to 119 mg/kg. All of the lead values, except at LT3, exceeded the effects threshold of 35.8 mg/kg, but none of the values exceeded the probable effects concentration of 128 mg/kg. Nickel concentrations ranged from 30 to 82 mg/kg. All of the nickel values exceeded the effects threshold of 22.7 mg/kg, but only the value at LT1 exceeded the probable effects threshold of 48.6 mg/kg. Zinc concentrations ranged from 129 to 349 mg/kg. All of the zinc values exceeded the effects threshold of 121 mg/kg, but none of the values exceeded the probable effects concentration of 459 mg/kg.

In all but one case, the highest concentrations for each of these metals were recorded at station LT1, at the northern end of the lake. The lowest concentrations for each of these metals always occurred at station LT3, in the central portion of the lake (Figure 47).

Silver concentrations ranged from 0.25 to 0.85 mg/kg (Figure 48). The same pattern occurred, with the highest concentration at station LT1 and the lowest at LT3. Manganese concentrations ranged from 205 to 404 mg/kg (Figure 49). The highest concentration was found at station LT1, but the lowest value was recorded from station LT2. Aluminum concentrations ranged from 18,159 to 44,925 mg/kg (Figure 50). The highest concentration was found at station LT5, while the lowest occurred at station LT3. No sediment thresholds have been established for silver, manganese or aluminum.

Figure 47.
Metal concentrations for cadmium, arsenic, nickel, copper, chromium, lead and zinc in sediments from Machado Lake in 2003.

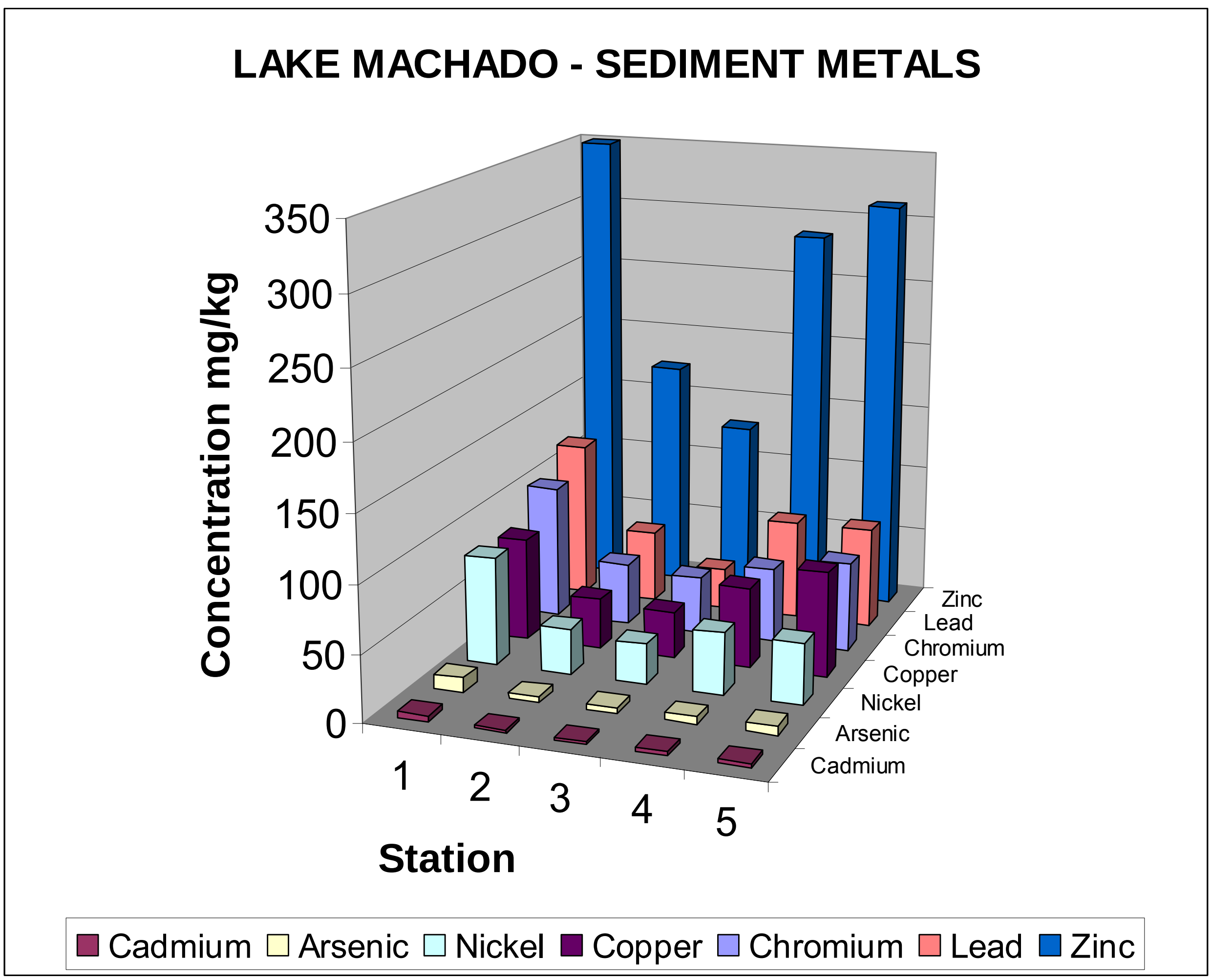


Figure 48.
Metal concentrations for silver in sediments from Machado Lake in 2003.

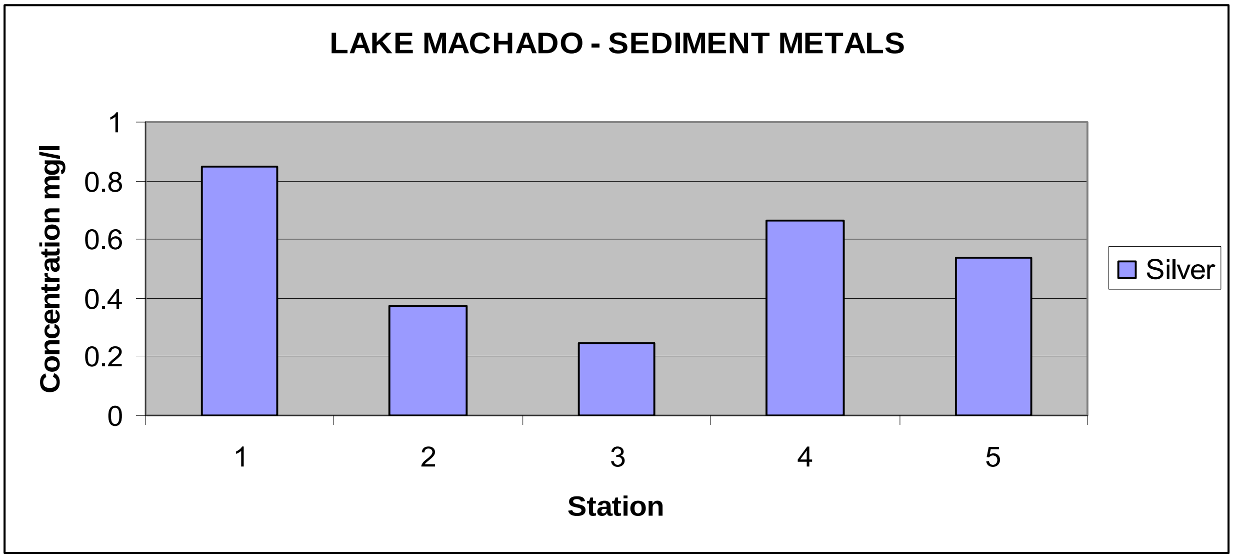


Figure 49.
Metal concentrations for manganese in sediments from Machado Lake in 2003.

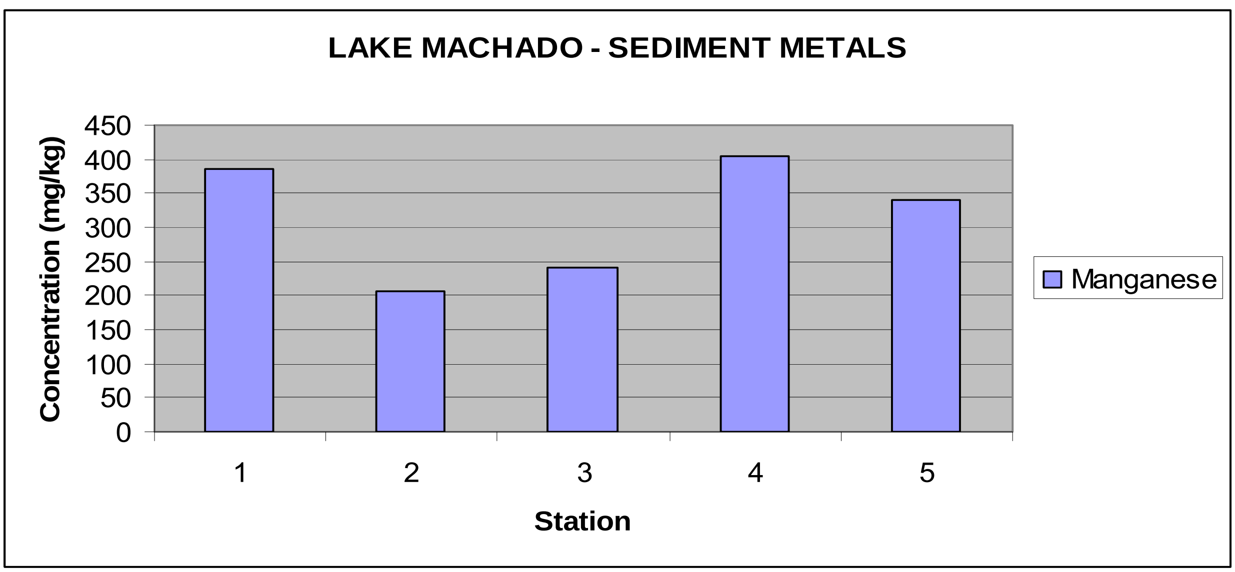
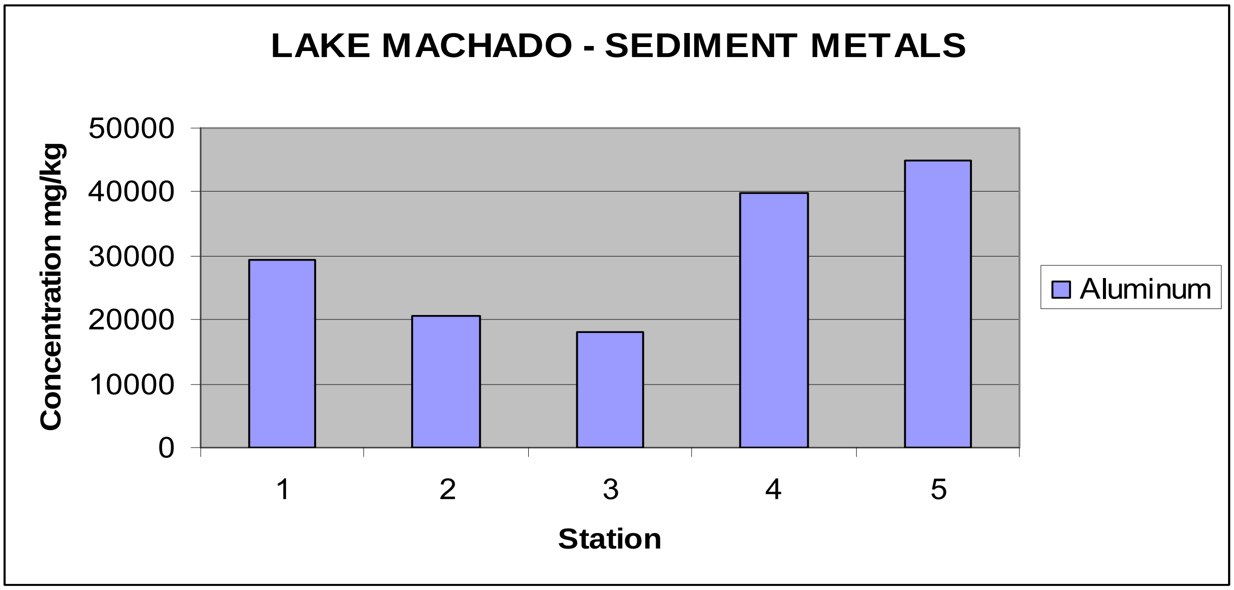


Figure 50.
Metal concentrations for aluminum in sediments from Machado Lake in 2003.



Biphenyl concentrations ranged from 3.17 to 5.61 µg/kg. The highest concentration was found at station LT5. Chlorpyrifos concentrations ranged from non-detect (ND) at three stations (LT1, LT2 and LT3) to 5.18 µg/kg. The highest concentration was found at station LT4. Dieldrin concentrations also ranged from ND at stations LT1-3 to a high of 1.54 µg/kg at station LT4. Oxadiazon ranged from ND to 7.8 µg/kg. The highest concentration was found at station LT4. Heptachlor epoxide ranged from 2.25 to 5.23 µg/kg. The highest concentration was found at station LT2. Nonachlor ranged from 9.94 to 29.74 µg/kg. The highest concentration was found at station LT4. All of the dieldrin values were below the effects threshold of 1.9 µg/kg established for freshwater sediments [Macdonald et al., 2000]. All of the heptachlor epoxide values, except at LT4, exceeded the effects threshold of 2.5 µg/kg, but none of the values exceeded the probable effects concentration of 16.0 µg/kg. No sediment thresholds have been established for biphenyl, chlorpyrifos, oxadiazon or nonachlor.

Total chlordane ranged from 8.2 to 34.5 µg/kg (Figure 51). The lowest concentration was found at station LT3 and the highest concentration occurred at station LT5. All of the chlordane values exceeded the effects threshold of 3.2 µg/kg, and the values at all stations except LT3 exceeded the probable effects concentration of 17.6 µg/kg [Macdonald et al., 2000]. Total DDT ranged from 34.5 to 82.8 µg/kg (Figure 51). The lowest concentration again was found at station LT3, but the highest concentration occurred at station LT4. All of the total DDT values exceeded the effects threshold of 5.3 µg/kg, but none of the values exceeded the probable effects concentration of 572 µg/kg. Total PCB ranged from 94.0 to 191.9 µg/kg (Figure 51). The lowest concentration was found at station LT1 and the highest at station LT2. All of the total PCB values exceeded the effects threshold of 59.8 µg/kg, but none of the values exceeded the probable effects concentration of 676 μg/kg. Total PAH ranged from 2,223 to 8,062 μg/kg (Figure 52). The lowest concentration was found at station LT3 and the highest at station LT5. All of the total PAH values exceeded the effects threshold of 1,597 μg/kg, but none of the values exceeded the probable effects concentration of 22,800 μg/kg.

Figure 51.
Organic concentrations for total chlordane, total DDT, and total PCB in sediments from Machado Lake in 2003.

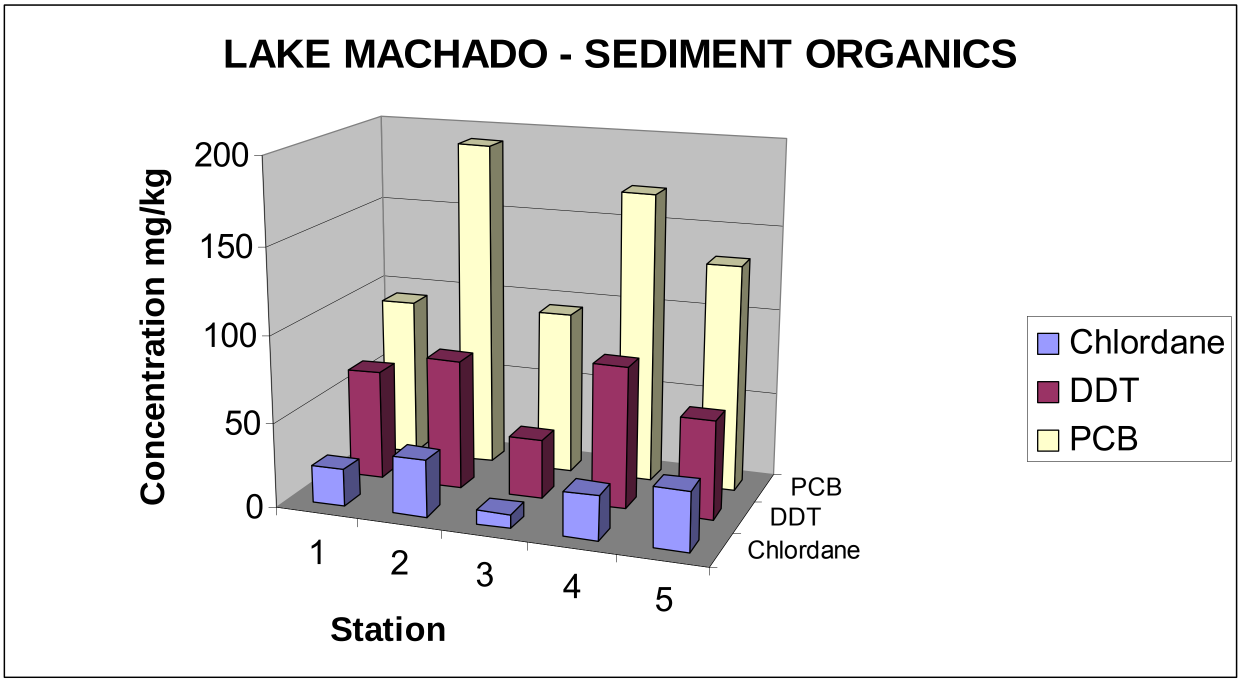
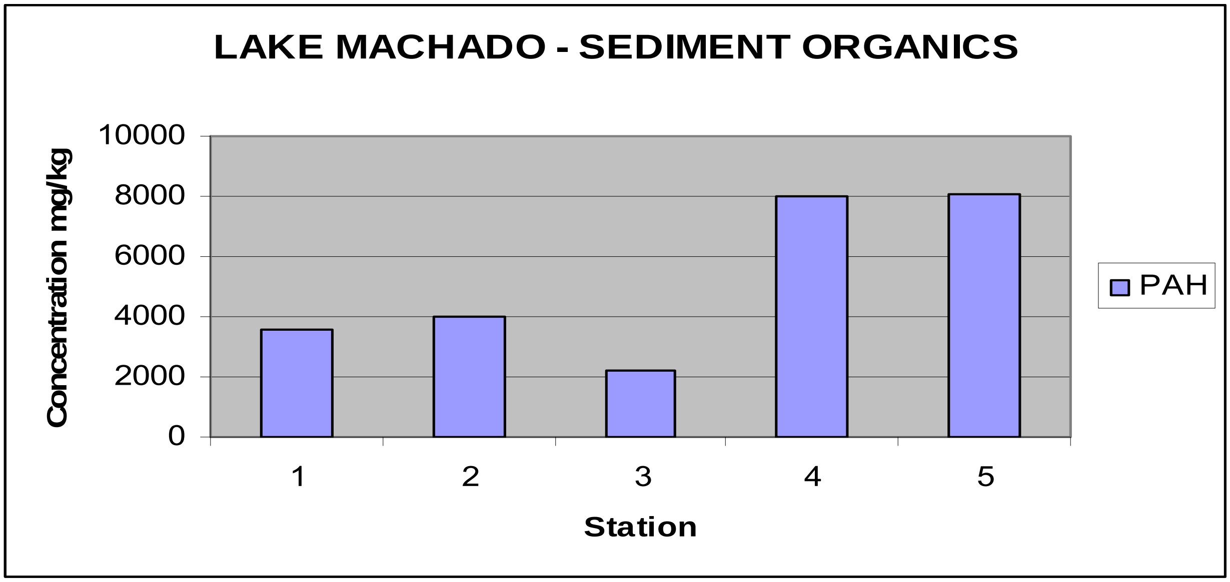


Figure 52.
Organic concentrations for total PAH in sediments from Machado Lake in 2003.



4.4 Toxicity - Water and Sediment Samples

Machado Lake (Harbor Lake)

Toxicity tests were conducted on water samples from each of the five lake stations using two different species, the water flea (*Ceriodaphnia dubia*) and the fathead minnow (*Pimephales promelas*). Both acute toxicity (survival) and chronic toxicity (growth) were measured for both species at all stations. All of the water samples were non-toxic.

Toxicity tests were conducted on sediment samples from each of the five lake stations using the amphipod *Hyalella azteca*. Both acute toxicity (survival) and chronic toxicity (growth) were tested at each station. Two of the stations (LT3 and LT4) displayed acute toxicity, while the other three stations were non-toxic. All of the stations were deemed non-toxic based on the chronic toxicity test. However, all five stations displayed statistically significant reduced growth compared to controls (but these samples are not considered to be toxic unless the absolute difference in growth results between control and test samples also exceeds 20%, which was not the case for any of these stations).

Dominguez Channel

Toxicity tests were conducted on water samples from the Artesia/Western station using two different species, the water flea (*Ceriodaphnia dubia*) and the fathead minnow (*Pimephales promelas*). Both acute toxicity (survival) and chronic toxicity (growth) were measured for both species. All of the water samples were non-toxic.

<u>Los Angeles/Long Beach Harbor and San Pedro Bay</u>

Toxicity tests were conducted on surface water samples at 30 stations in Los Angeles/Long Beach Harbor and San Pedro Bay using a 2-day test with the mussel *Mytilus galloprovincialis*. Additionally, toxicity tests were conducted on near-bottom and bottom water samples from 10 of these stations with the mussel. Interstitial water (pore water) extracted from sediment samples from these 10 locations were tested via a 20-minute test with the purple sea urchin *Strongylocentrotus purpuratus*. Samples collected at the sediment-water interface from these 10 locations were tested via a 2-day test with the mussel *Mytilus galloprovincialis*.

No toxicity was observed in any of the water column samples for surface water samples (30 stations tested) or near-bottom or bottom water samples (10 stations tested). No pore water toxicity was observed for the 10 stations tested. However, toxicity was observed in sediment-water interface samples tested with the mussel for 3 of the 10 stations tested (station 4242 in Long Beach Outer Harbor, station 4266 in Los Angeles Inner Harbor and station 4274 in San Pedro Bay). Survival was low (70%) at station 4226 (San Pedro Bay), but the sample was designated as non-toxic because the survival rate was not statistically different from the control sample. At 5 of the 10 stations, the survival rate was statistically different from the control sample, but since the percent survival was greater than 80% compared to controls these samples also were designated as non-toxic.

4.5 Benthic Infauna

Benthic infaunal samples were collected at 5 stations in Dominguez Channel (Alameda, Avalon, Main, Sepulveda and Wilmington). Benthic community results were evaluated using a benthic line of evidence (LOE), where the results are expressed on a four-category scale. Category 1 is "Unaffected − a community that would occur at a reference site for that habitat." Category 2 is "Marginal deviation from reference − a community that exhibits some indication of stress, but might be within measurement variability of reference condition." Category 3 is "Affected − a community that exhibits clear evidence of physical, chemical, natural, or anthropogenic stress." Category 4 is "Severely Affected − a community exhibiting a high magnitude of stress." Affected and severely affected communities are those believed to be showing clear evidence of disturbance, while unaffected and marginal communities do not [Ranasinghe, personal communication].

The benthic infaunal community was rated as category 2 at the Alameda and Sepulveda stations. These two stations would be characterized as being in “good” condition based on the occurrence of only marginal deviations from reference conditions. The benthic infaunal community was rated as category 4 at the Avalon, Main and Wilmington stations. These three stations would be characterized as being in “poor” condition based on severe effects.

5 Discussion

Machado Lake

Machado Lake is a 40-acre waterbody located within Ken Malloy Harbor Regional Park, serving the Wilmington and Harbor City areas. The lake originally was intended for boating and fishing and until recent years was stocked with fish. As water quality deteriorated and toxic sediments have accumulated in the lake, boating was stopped and signs were posted with warnings about the risk of eating fish from the lake. The Los Angeles Regional Board has listed the lake waters as impaired for nutrient related conditions and trash, as well as for historic pesticides and PCBs in fish tissue which have resulted in a fish consumption advisory. Mosquitoes have been a chronic problem in the lake, a problem which is exacerbated by flourishing tule growth in the accumulated sediments along the eastern shore of the lake (dense stands of vegetation protect mosquito larvae from predation by fish). Concerns about encephalitis have prompted increased oversight from the county mosquito abatement district and as a result, various water quality improvement projects have been implemented in the lake over the past fifteen years, including dredging, installation of aeration pipes and frequent removals of aquatic vegetation [Parsons, 2002].

The lake receives urban and stormwater runoff from several storm drain systems covering the approximately 20-square-mile watershed [Parsons, 2002]. The Wilmington Drain discharges into the northern end of the lake (approximately 65% of the Machado Lake Watershed area flows through this drain into the lake), closest to SWAMP station 1. However, other storm drains discharge into the southern portion of the lake, near SWAMP stations 4 and 5. The lake is fairly shallow, normally maintained at a level approximately ten feet above mean sea level by the low dam separating the upper lake from a lower wetland area.

The SWAMP monitoring in 2003 only provides a snapshot of water quality conditions in the Machado Lake, since sampling was only conducted on a single date. Some degradation of water quality was evident at stations 1 and 2 in the northern end of the lake, possibly due to the influence of the Wilmington Drain discharge (which is listed as impaired for ammonia). Dissolved oxygen concentrations were low (less than 5 milligrams per liter) at these two locations, and pH values were lower and ammonia values were higher at these two stations than at other locations in the lake. In addition, nitrate values were highest in the lake at station 1. Chlorophyll a (an indicator of primary productivity) was lowest at the northern end of the lake and highest at the southern end.

Warm water temperatures occurred at all five stations in the lake on the August sampling date, close to or exceeding 80 degrees Fahrenheit. Many other water quality parameters were fairly uniform throughout the lake, including alkalinity, chloride, hardness, nitrite, orthophosphate, sulfate, total organic carbon and suspended solids. Despite some evidence of water quality problems in the lake, none of the water samples tested produced any acute or chronic toxicity at any of the five stations.

Sediment sampling also was conducted at all five stations in Machado Lake. Stations towards the northern end and the central portion of the lake exhibited more fine-grained sediments, while the more southerly stations had coarser sediments. This may reflect the influence of the Wilmington Drain discharge, as particulates carried by the drain into the lake may settle out in the northern and central part of the lake due to decreases in velocity as the drain flows enter the lake. Typically metal and organic contaminants adhere more readily to small particles, so it might be expected that sediment contamination would be greater at the northern and central stations than at the southerly stations. The station closest to the Wilmington Drain (which is listed as impaired for copper and lead) had the highest sediment concentrations for all ten of the metals that were measured in this study. However, the other stations had fairly similar sediment concentrations for many of the metals. The southerly stations tended to have higher metal concentrations than the central stations, which was surprising given the coarser nature of the sediments in the central portion of the lake. Organics tended to be highest in the lake sediments at the southerly stations, which had the highest concentrations of PAHs, and along with station 2 (in the north-central portion of the lake) had the highest concentrations of chlordane, DDTs and PCBs. Organic concentrations generally were lowest in the central portion of the lake.

Sediment quality guidelines have been developed for freshwater sediments [MacDonald et al, 2000] for many of the metals and organics measured in this study. These sediment quality guidelines have two components: a lower possible effects threshold and a higher probable effects threshold. If sediment concentrations fall below the possible effects threshold, the sediments could be considered to be “clean”, while if the concentrations are above the probable effects threshold, the sediments could be considered to be “contaminated”. When sediment concentrations fall between the possible and probable effects thresholds, the sediments could be considered as “possibly contaminated”. Machado Lake sediments would be classified as “possibly contaminated” for most of the metals and organics for which guidelines exist. Cadmium, chromium, copper, lead, nickel and zinc concentrations fell between the possible effects and probable effects thresholds at 4 or all 5 of the stations. However, only the nickel concentration at the northern end of the lake exceeded the probable effects threshold. Sediment concentrations of DDT, PCBs and PAHs also fell between the two thresholds at all 5 stations. Chlordane concentrations exceeded the probable effects threshold at all but one of the stations sampled in the lake.

Despite the widespread sediment contamination for many metals and organics, sediment toxicity testing demonstrated acute toxicity only at stations 3 and 4, located in the central and southerly portions of the lake. All five of the stations displayed reduced growth during the chronic toxicity testing. However, these stations all were classified as non-toxic, since the reduction in growth between the control samples and the lake samples was less than the 20% difference required for a toxicity designation.

Sediment sampling previously was conducted at several stations in Machado Lake in 2001 [Parsons, 2002]. The ranges of metal concentrations found in the lake sediments were similar to those measured during the SWAMP study in 2003. Although organics were present at many of the lake locations sampled in 2001, sediment concentrations for several of these organic contaminants appeared to be substantially higher in 2003.

Fish have been collected from Machado Lake periodically in the past as part of the Toxic Substances Monitoring Program (TSMP) to assess bioaccumulation of metals and organics. Machado Lake is listed as impaired due to the elevated concentrations of chlordane and DDT found in fish tissue samples (which led to issuance of a fish consumption advisory). The most recent TSMP sampling of the lake occurred in 1991 and 2002, when largemouth bass and carp were collected and composite samples of muscle tissue were analyzed for both of these species in both years. Carp tissue levels of total chlordane and DDE (a breakdown product of DDT) were well above the screening thresholds for protection of human health in both 1997 and 2002, as were the concentrations of dieldrin and PCBs. Largemouth bass tissue levels of total chlordane and DDE were elevated, but did not exceed the screening thresholds during either year; however, the PCB tissue levels in one of the two composites analyzed in 2002 did exceed the screening threshold. Neither the largemouth bass nor the carp had significant levels of mercury, which would be the primary metal of concern from a human health risk standpoint.

Dominguez Channel

Dominguez Channel drains a heavily urbanized and industrialized watershed. The upper freshwater area of the channel (lined portion above Vermont Avenue) is listed as impaired for ammonia, copper, and indicator bacteria in the water column. The lower estuarine area of the channel (unlined portion below Vermont Avenue) also is listed for ammonia and coliform bacteria in the water column, for several contaminants in sediments and fish tissue and for benthic infaunal community effects.

The lower estuarine portion of Dominguez Channel is subject to tidal action. The water quality measurements for several conventional parameters clearly reflect this tidal influence. Salinity, specific conductance, alkalinity, sulfate and chlorides all were highest at the most downstream station monitored in the channel (closest to the nearly marine waters of Los Angeles Harbor) and progressively decreased as sampling moved upstream.

Water quality in Dominguez Channel probably is affected by a number of urban runoff discharges and other sources of contamination during dry weather periods, as well as by stormwater discharges during wet weather periods. Consequently, it is not possible to draw definitive conclusions about water quality in the channel from water column data collected during a single sampling event in August 2003. However, certain water quality parameters did display some evidence of degradation of water quality in the upper portions of the channel with pH values exceeding Basin Plan objectives. Chlorophyll a, total organic carbon, biochemical oxygen demand and suspended solids also were highest at the upstream stations. However, nutrient levels were fairly low throughout the entire channel on this particular sampling date, as were organic and metal concentrations (although metals were only measured at a single station in the upper channel). In addition, no toxicity was observed at the only station tested in the upper channel.

Similarly, it is not possible to characterize bacteriological problems in the channel on the basis of a single sampling event. However, the bacteriological indicators measured during the SWAMP sampling did indicate high levels at many of the sampling locations throughout the channel.

No sediment samples were collected during the SWAMP monitoring to perform sediment chemistry analyses or sediment toxicity testing, since several studies have been conducted in the past to document sediment contamination problems in Dominguez Channel, particularly within the Consolidated Slip portion of Inner Los Angeles Harbor. An extensive sediment characterization study conducted in 2002 provided metal and organic monitoring data from sediment samples collected in four areas within the Dominguez Channel watershed: Torrance Lateral (14 locations), Dominguez Channel above Vermont Street (2 locations), Dominguez Channel below Vermont Street (29 locations) and Consolidated Slip (16 locations) [AMEC Earth and Environmental, 2003]. Metal (including copper, lead, mercury and zinc) and organic (including DDTs, PCBs and PAHs) contamination was widespread throughout those areas. Sediment contaminant levels exceeded probable effects thresholds at several locations and exceeded possible effects thresholds at most locations for one or more of the chemicals of concern. Core samples were collected at most sampling locations and sediment contamination generally was present both in surficial samples (top 2 centimeters of sediment) and deeper sediments (down to 20 feet in the deepest cores from Consolidated Slip) [AMEC Earth and Environmental, 2003].

Dominguez Channel is listed as impaired due to benthic infaunal community effects. Benthic samples were collected at five of the estuarine stations within Dominguez Channel during the SWAMP study. The results confirm that the benthic community is adversely impacted within at least parts of Dominguez Channel, as three of the five stations were classified as being in poor condition.

Los Angeles/Long Beach Harbor and San Pedro Bay

Los Angeles and Long Beach Harbor consists of inner harbor areas, which tend to be heavily developed with many marine terminals, tank farms and other industrial activities, and outer harbor areas which consist of primarily open water areas. The harbor areas listed as impaired (due to several metals and organics in sediments and fish tissue) are primarily within the inner harbors, including Cabrillo Beach, Cabrillo Marina, Consolidated Slip, Fish Harbor. Portions of San Pedro Bay also are listed for the same problems.

Investigations of conditions within harbors and bays and trend monitoring studies often focus on sediment characterizations, since many of the pollutants of concern (e.g., metals and organics) tend to accumulate in sediments, thus integrating contaminant loadings over an extended period of time. The Bight'03 comprehensive regional monitoring program conducted in 2003 utilized this approach, monitoring a triad of sediment condition indicators (benthic infaunal community, sediment chemistry, sediment toxicity) to assess the health of harbors and bays, as well as nearshore coastal areas throughout the Southern California Bight. To supplement the data collected by the Bight'03 study, the SWAMP monitoring program was designed to include surface water sampling at all of the stations sampled by the Bight study (plus additional stations to bring the total number of sites sampled to 30) within Los Angeles/Long Beach Harbor and San Pedro Bay. In an attempt to determine whether water quality conditions varied with depth, a subset of 10 stations were chosen for additional water sampling at a point near the bottom (one meter above the bottom) and at the bottom.

Surface water monitoring indicated that salinity and water temperature did not vary greatly throughout Los Angeles/Long Beach Harbor and San Pedro Bay during the October 2003 sampling period. However, pH values were generally lowest in Los Angeles Harbor and highest in San Pedro Bay (although all pH values were within Basin Plan objectives). Surface dissolved oxygen concentrations were depressed (less than 5 milligrams per liter) at a few of the stations in Los Angeles Harbor.

Water column sampling at various depths (at 10 of the 30 stations) indicated thermal stratification at most locations, as would be expected at this time of year, with surface water temperatures generally 1 to 3 degrees Celsius higher than bottom or near-bottom temperatures. No density stratification was observed as salinity values were fairly uniform throughout the water column. Oxygen concentrations and pH values generally were slightly lower at the bottom and near-bottom than in the surface waters, as would be expected.

Water quality conditions of coastal waters have been assessed nationwide utilizing a suite of several indicators (dissolved oxygen, dissolved inorganic nitrogen, orthophosphate, chlorophyll a, water clarity) [USEPA, 2004]. Only three of these indicators are available for assessment of Los Angeles/Long Beach Harbor and San Pedro Bay: dissolved oxygen, dissolved inorganic nitrogen and orthophosphate. Dissolved oxygen can be used to rate coastal waters as being of low quality (concentrations less than 2.0 milligrams per liter), moderate quality (concentrations between 2.0 and 5.0 milligrams per liter) or high quality (concentrations greater than 5.0 milligrams per liter). Dissolved inorganic nitrogen (the sum of ammonia, nitrate and nitrite) can be used to rate coastal waters as being of low quality (concentrations greater than 1.0 milligrams per liter), moderate quality (0.5 to 1.0 milligrams per liter) or high quality (less than 0.5 milligrams per liter). Similarly, orthophosphate concentrations can be translated into low (greater than 0.1 milligrams per liter), moderate (0.01 to 0.1 milligrams per liter) or high (less than 0.01 milligrams per liter) quality ratings [USEPA, 2004].

Dissolved oxygen concentrations yielded a rating of high quality at 25 of the 30 stations in Los Angeles/Long Beach Harbor and San Pedro Bay, and moderate quality at the remaining 5 stations (all located in Los Angeles Harbor). Dissolved inorganic nitrogen was low throughout most of Los Angeles/Long Beach Harbor and San Pedro Bay. All of the stations sampled would be categorized as being of high quality, with the exception of one in San Pedro Bay (4616) which rated as low quality. Orthophosphate concentrations were higher, as none of the stations rated as high quality. All of the stations would be characterized as being of moderate quality, with the exception of two stations in San Pedro Bay (once again station 4616 and the adjacent station 4744) which rated as being of low quality. These stations are located near the mouth of the Los Angeles River and may be receiving some nutrient inputs from that source.

Given the heavily industrialized nature of the inner areas of Los Angeles/Long Beach Harbor, and the large number of vessels utilizing and anchoring within the harbor and several marinas in the area, it would not be surprising to find high metal concentrations in water column samples. However, silver was the only metal which exceeded the water quality objective; this occurred at 20% of the stations (6 out of 30). There was no apparent pattern to the silver exceedances, as stations with high silver occurred at inner and outer harbor stations in both Los Angeles and Long Beach Harbor, and in San Pedro Bay. Water column concentrations were well below water quality objectives for all of other metals (arsenic, cadmium, chromium, lead, nickel, selenium and zinc), with the exception of copper. Organic concentrations were below the analytical detection limit for nearly all of the water samples and no toxicity was observed in any of the water samples tested.

As mentioned above, the SWAMP water column sampling was timed to coincide with the Bight'03 survey of coastal waters from Point Conception to the Mexican border. The Bight'03 sampling design resulted in sampling at 17 stations within Los Angeles/Long Beach Harbor and San Pedro Bay (14 stations were in Los Angeles/Long Beach Harbor and 3 stations were in San Pedro Bay). Sediment sampling conducted at these 17 stations for the Bight'03 study included sediment chemistry analyses, sediment toxicity testing and benthic community analyses.

Sediment chemistry contamination was assessed by comparing sediment concentrations for individual chemical contaminants to sediment quality guidelines. These guidelines establish two thresholds: the effects range low (ERL) and the effects range median (ERM) are empirically derived sediment quality guidelines based on relationships between observed biological responses and the measured concentrations of sediment contaminants. Based on a nationwide dataset, the ERL and ERM values correspond to the 10^{th} and 50^{th} percentiles of measured sediment concentrations in samples with significant biological response (i.e., toxicity). Concentrations below the ERL represent sediment quality that likely will not result in adverse biological effects. Concentrations above the ERM represent sediments that likely will result in adverse biological effects [Long et al., 1995].

DDT contamination was widespread throughout Los Angeles/Long Beach Harbor and San Pedro Bay in 2003. The sediment concentrations for total DDT exceeded the ERM value at 6 of the 14 Los Angeles/Long Beach Harbor stations and 1 of the 3 San Pedro Bay stations and were greater than the ERL but less than the ERM value at 7 of the Los Angeles/Long Beach Harbor stations and 2 of the San Pedro Bay station (only 1 station, 4370, had a DDT concentration lower than the ERL). The probabilistic design employed by the Bight'03 study allows the results to be translated into the areal extent of sediment contamination for the entire Los Angeles/Long Beach Harbor (however, the precision of this estimate is not as high as desired, since only 14 stations were sampled, rather than the preferred minimum of 30). It is estimated that 94% of Los Angeles/Long Beach Harbor has significant DDT contamination (greater than the ERL threshold), while 43% of the harbor has sediments with DDT concentrations likely to produce toxicity (greater than the ERM threshold). This is not surprising, given that 71% of the entire Southern California Bight was found to have significant DDT contamination of sediments based on the 2003 Bight study [Schiff et al., 2006]. Although DDT was banned from use in the United States in the early 1970s, historical use for several decades and past discharges from the Montrose Chemical Corporation's manufacturing plant in Torrance have resulted in large deposits of this long-lasting contaminant and its breakdown products in the coastal waters of Southern California. All of the San Pedro Bay stations displayed DDT contamination, but it is not possible to assess the areal extent of contamination for the bay with only 3 sampling stations.

No other organic contaminants were widespread in Los Angeles/Long Beach Harbor. For example, PCB sediment concentrations never exceeded the ERM threshold and exceeded the ERL threshold only at 2 stations (one in Los Angeles Inner Harbor and one in Long Beach Inner Harbor).

Copper contamination was widespread throughout Los Angeles/Long Beach Harbor in 2003. Although none of the copper levels exceeded the ERM, 13 of the 17 stations in Los Angeles/Long Beach Harbor and all 3 of the stations in San Pedro Bay exceeded the ERL [Schiff et al., 2006]. It is estimated that 76% of the harbor is contaminated with copper. As mentioned above, copper is commonly used in anti-fouling paints to protect boats and in wood preservatives for docks and pilings, so it is not surprising to find accumulation of copper in the sediments. No reliable estimate of the extent of copper contamination within San Pedro Bay can be provided with only 3 sampling stations in this area. The sampling results also show evidence of widespread sediment contamination for nickel and mercury in Los Angeles/Long Beach Harbor; although none of the stations exceeded the ERM threshold, approximately half of the stations exceeded the ERL threshold for these two metals [Schiff et al., 2006]. The sources of nickel and mercury contamination are unknown.

High sediment concentrations of metals or organics may or may not produce toxicity, depending on the bioavailability of these contaminants to aquatic organisms. Consequently, sediment toxicity testing and the health of the benthic infaunal community were assessed to determine whether the widespread sediment contamination observed during the Bight'03 study resulted in direct biological impacts.

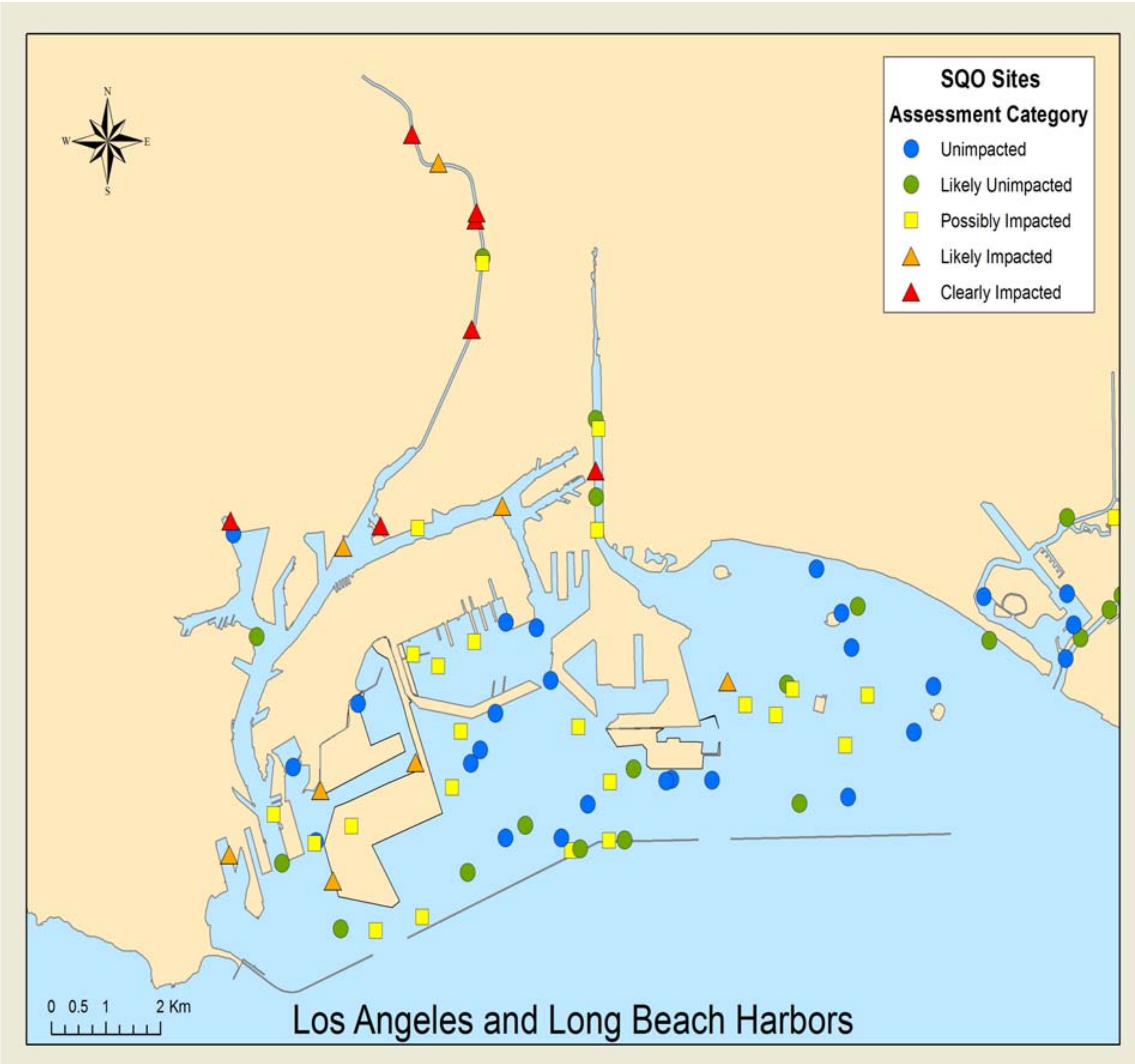
Sediment toxicity occurred in more than half of the stations tested within Los Angeles/Long Beach Harbor; 8 stations were classified as moderately toxic, 1 station was classified as highly toxic and 7 stations were classified as non-toxic [Bay et al., 2005]. Based on these results, it is estimated that 56% of the harbor contains sediments that would be expected to produce sediment toxicity. In San Pedro Bay, 1 of the 2 stations tested was classified as toxic; no estimate of the areal extent of sediment toxicity for the bay can be produced from such limited data.

The benthic infaunal community was classified as being in good condition (Reference or Level 1 category) at 75% of the stations sampled in Los Angeles/Long Beach Harbor and in poor condition at the other 25% (Level 2 or Level 3 category) [Ranasinghe et al., 2006]. All of the poor condition stations were located in the innermost areas of Los Angeles Inner Harbor. In San Pedro Bay, 2 of the stations were classified as being in good condition and 1 was classified as being in poor condition.

The State of California has developed draft sediment quality objectives (SQOs) for enclosed bays and estuaries which are based upon an integration of a triad of indicators (benthic infaunal community, sediment toxicity and sediment chemistry) to produce a characterization of sediments at a given sampling location [State Water Quality Control Board, Division of Water Quality, 2006]. Although these sediment quality objectives have not yet been adopted and are subject to change, it is instructive to see how Los Angeles/Long Beach Harbor and San Pedro Bay stations would be classified via the proposed SQO approach.

The SQO approach yields five assessment categories: unimpacted, likely unimpacted, possibly impacted, likely impacted and clearly impacted. SQO calculations based on past monitoring data at probabilistic sampling sites (primarily Bight'98 and Bight'03 monitoring study data) show that approximately half of the Los Angeles/Long Beach Harbor sites fall into the two unimpacted categories, while the other half fall into the three impacted categories (Figure 48) [Fleming, 2007]. All of the most impacted (clearly impacted and likely impacted) sites are located within the inner harbor areas of Los Angeles/Long Beach Harbor, while approximately two-thirds of the outer harbor areas are unimpacted or likely unimpacted. In San Pedro Bay, approximately 40% of the sites fell into the three impacted categories, but nearly all of these sites were only possibly impacted (only 1 site was likely impacted and none were clearly impacted).

Figure 53.
Sediment Quality Objectives Assessment Categories for Selected Sites within Los Angeles/Long Beach Harbor and San Pedro Bay.



Overall, it appears that at least half of Los Angeles/Long Beach Harbor has degraded bottom conditions, whether we assess this based on individual sediment contamination levels of metals and organics, sediment toxicity results, the health of the benthic infaunal community or through an integration of these three indicators. Degradation appears to be worse in the inner harbor areas, where industrial activities predominate, than in the more open water areas of the outer harbors. However, the low levels of metals and organics in the surface waters of Los Angeles/Long Beach Harbor and at depth and the absence of water column toxicity indicate that water quality within the harbor is good, suggesting that the contaminants drop out of the water column and accumulate in the sediments, as would be expected.

On the other hand, it appears that nearly half of Los Angeles/Long Beach Harbor has good, or at least acceptable, bottom conditions. Much of the area supports a healthy benthic infaunal community, particularly in the less developed, more open-water outer harbor areas. The five stations sampled in the harbor during the Bight'03 study all supported healthy fish communities, based on the biointegrity index (Fish Response Index) developed for assessment purposes [Allen et al., 2007].

San Pedro Bay, which is subject to influences from runoff discharged by the Los Angeles River, possibly has degraded bottom conditions in some areas based on the sediment chemistry, sediment toxicity and benthic infaunal community signals. However, the level of impact generally appears to be less than that found in the inner harbor areas of Los Angeles/Long Beach Harbor. But again, water quality appears to be good in the surface waters and at depth in San Pedro Bay.

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APPENDIX A. QUALITY ASSURANCE/QUALITY CONTROL INFORMATION.

Table 1. Percent recovery (%R) and relative percent difference (RPD) acceptance criteria for different categories of analytes in water and sediment

Analyte Category	% Surrogate Recovery Acceptance Criteria	% MS/MSD Recovery Acceptance Criteria	% CRM & LCS Acceptance Criteria	RPD Criteria (MS/MSD, Laboratory Duplicate, Field Duplicate)
Conventional Constituents	NA	80-120	80-120	25
Metals (Including Mercury)	NA	75-125	75-125	25 (35 for total mercury in sediment)
Organics (PCBs, OCHs, OPs)	50-150	50-150	50-150	25

Table 2. Batches for which laboratory blanks were not run.

Analyte	Batch ID	Notes	Laboratory
OP Pesticides	L-102203-OP	LAB: no QC(blk, LCS, MS/MSD) for 10/22,23,24,28	DFG-WPCL
OP Pesticides	L-103003-OP	QAO: no blank for 10/31	DFG-WPCL
PAHs	L-080703-PAH	QAO: no QC for 8/7, 8/11	DFG-WPCL
PAHs	L504-505-03-PAH	QAO: no QC for 10/22, 10/23, 10/24, 10/25, and 10/28	DFG-WPCL
PAHs	L508-512-03-PAH	QAO: no QC for 10/24, 10/25, 10/27, 10/28, 10/29, 10/30	DFG-WPCL

Table 3. Laboratory method blanks in which analytes were detected.

Analyte	Result	Units	MDL	RL	Detected	Analysis Date	Method Name	Laboratory	Batch ID
Alkalinity as CaCO3	3	mg/L	3	8	DNQ	03/Nov/2003	QC 10303311A	MLML_TM	110303-ALK
Aluminum	4.19	mg/Kg	0.1	0.3		04/Dec/2003	EPA 200.8	MPSL-DFG	2003Dig16
Aluminum	0.98	mg/Kg	0.1	0.3		15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Aluminum	1.26	mg/Kg	0.1	0.3		15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Chloride	0.24	mg/L	0.2	0.35	DNQ	26/Oct/2003	EPA 300.0	MLML_TM	102603-CL
Chromium	0.047	µg/L	0.03	0.09	DNQ	18/Nov/2003	EPA 1638M	MPSL-DFG	ICP111803w
Copper	0.006	mg/Kg	0.003	0.01	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Copper	0.005	mg/Kg	0.003	0.01	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Manganese	0.003	mg/Kg	0.003	0.01	DNQ	01/Apr/2005	EPA 200.8	MPSL-DFG	2003Dig24
Manganese	0.003	mg/Kg	0.003	0.01	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Manganese	0.003	mg/Kg	0.003	0.01	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Manganese	0.032	µg/L	0.003	0.01		18/Nov/2003	EPA 1638M	MPSL-DFG	ICP111803w
PCB AROCLOR 1254	23	ng/g	12.4	30.9	DNQ	24/Sep/2003	Newman, et al., 1988	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 028	0.455	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 031	0.525	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 044	0.423	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 056	0.316	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 074	0.444	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 095	0.126	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 097	0.438	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 099	0.527	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 101	0.78	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 128	0.344	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 149	0.368	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 153	0.594	ng/g	0.309	0.618	DNQ	24/Sep/2003	EPA 8082M	DFG-WPCL	L38303_BS257_KR_CONGENERS
Toluene	0.075	µg/L	0.07	0.2	DNQ	28/Oct/2003	EPA 8260	DFG-WPCL	L-102803-8260
Zinc	0.035	mg/Kg	0.02	0.06	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24
Zinc	0.034	mg/Kg	0.02	0.06	DNQ	15/Jan/2004	EPA 200.8	MPSL-DFG	2003Dig24

Table 4. Surrogate recoveries that did not meet quality control acceptance criteria.

Surrogate	Station Code	Batch ID	% Recovery	Laboratory
Benz(e)pyrene-d12(Surrogate)	000EQP002	L504-505-03-PAH	24.8	DFG-WPCL
Benzo(g,h,I)perylene-d12(Surrogate)	000EQP002	L504-505-03-PAH	3.09	DFG-WPCL
Perylene-d12(Surrogate)	000EQP002	L504-505-03-PAH	8.99	DFG-WPCL
Naphthalene-d8(Surrogate)	405DCAMDA	L-080703-PAH	44.2	DFG-WPCL
Dibromooctafluorobiphenyl(Surrogate)	405LA4050	L510-03-OCH	48.5	DFG-WPCL
PCB 207(Surrogate)	405LA4146	L510-03-PCB	38	DFG-WPCL
PCB 207(Surrogate)	405LA4146	L510-03-OCH	39	DFG-WPCL
Perylene-d12(Surrogate)	405LA4146	L-103003-PAH	42.9	DFG-WPCL
Benz(e)pyrene-d12(Surrogate)	405LA4146	L-103003-PAH	31.6	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4146	L-103003-PAH	28.5	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4162	L508-512-03-PAH	26.7	DFG-WPCL
PCB 207(Surrogate)	405LA4162	L510-03-PCB	46.3	DFG-WPCL
Perylene-d12(Surrogate)	405LA4162	L508-512-03-PAH	41.3	DFG-WPCL
Benz(e)pyrene-d12(Surrogate)	405LA4178	L-103003-PAH	39	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4178	L-103003-PAH	32.5	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4210	L508-512-03-PAH	45.7	DFG-WPCL
Perylene-d12(Surrogate)	405LA4210	L-103003-PAH	36	DFG-WPCL
PCB 207(Surrogate)	405LA4210	L510-03-OCH	48.6	DFG-WPCL
Dibromooctafluorobiphenyl(Surrogate)	405LA4210	L510-03-OCH	43.8	DFG-WPCL
PCB 207(Surrogate)	405LA4210	L510-03-PCB	46.3	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4210	L-103003-PAH	19.1	DFG-WPCL
Benz(e)pyrene-d12(Surrogate)	405LA4210	L-103003-PAH	26.9	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4720	L504-505-03-PAH	12	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	405LA4784	L504-505-03-PAH	21.9	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LabBlank	L504-505-03-PAH	26.8	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LCS	L504-505-03-PAH	36.39	DFG-WPCL
Perylene-d12(Surrogate)	LabBlank	L-080703-PAH	32.3	DFG-WPCL
Benz(e)pyrene-d12(Surrogate)	LabBlank	L508-512-03-PAH	30.6	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LabBlank	WPCL_L-383-03_BS390_S_PAH	28	DFG-WPCL
Perylene-d12(Surrogate)	LabBlank	L508-512-03-PAH	20.6	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LabBlank	L508-512-03-PAH	3.94	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LCS	L508-512-03-PAH	25	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LCS	WPCL_L-383-03_BS390_S_PAH	43	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	CRM	WPCL_L-383-03_BS390_S_PAH	49	DFG-WPCL
Benzo(g,h,i)perylene-d12(Surrogate)	LCS	L508-512-03-	43.8	DFG-WPCL

Surrogate	Station Code	Batch ID	% Recovery	Laboratory
		PAH		

Table 5. Batches for which matrix spikes (MS) or matrix spike duplicates (MSD) were not run.

Analyte	Batch ID	Notes	Laboratory
Biochemical Oxygen Demand	30805BOD	No MS/MSD	CALSCI
Chemical Oxygen Demand	30807OD	No MS/MSD	CALSCI
Oil & Grease	2341-9149	No MS/MSD	CRGML
Oil & Grease	2341-9152	No MS/MSD	CRGML
OCH Pesticides	L504-505-03-OCH	No MS/MSD	DFG-WPCL
OCH Pesticides	L508-512-03-OCH	No MS/MSD	DFG-WPCL
OCH Pesticides	L510-03-OCH	No MS/MSD	DFG-WPCL
OP Pesticides	L-102203-OP	No MS/MSD	DFG-WPCL
OP Pesticides	L-102403-OP	No MS/MSD	DFG-WPCL
OP Pesticides	L-103003-OP	No MS/MSD	DFG-WPCL
PCBs	L504-505-03-PCB	No MS/MSD	DFG-WPCL
PCBs	L508-512-03-PCB	No MS/MSD	DFG-WPCL
PCBs	L510-03-PCB	No MS/MSD	DFG-WPCL
PAHs	L-080703-PAH	No MS/MSD	DFG-WPCL
PAHs	L508-512-03-PAH	No MS/MSD	DFG-WPCL
PAHs	L-103003-PAH	No MS/MSD	DFG-WPCL
PAHs	L504-505-03-PAH	No MS/MSD	DFG-WPCL
Triazines Pesticides	L-080703	No MS/MSD	DFG-WPCL

Table 6. Matrix spikes (MS), matrix spike duplicates (MSD), percent recoveries (%R), and relative percent differences (RPD) that did not meet specified criteria. Boldface type indicates values that did not meet quality control criteria.

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Indeno(1,2,3-c,d)pyrene	405DCMAIN	05/Aug/2003	L-080703-PAH	164	**170**	4	DFG-WPCL
Dibenz(a,h)anthracene	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	**151**	150	2.3	DFG-WPCL
Dimethylphenanthrene, 3,6-	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	134	**180**	12	DFG-WPCL
Endosulfan I	405MDOLT2	04/Aug/2003	L38303_BS257_KR_PESTICIDES	**47**	**48**	2	DFG-WPCL
Fluorenes, C1 -	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	**190**	**190**	2.6	DFG-WPCL
Fluoranthene	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	102	**230**	12	DFG-WPCL
Fluoranthene/Pyrenes, C1 -	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	155	300	10	DFG-WPCL
Indeno(1,2,3-c,d)pyrene	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	**175**	**180**	0.58	DFG-WPCL
Methylfluorene, 1-	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	125	**160**	9.1	DFG-WPCL
Phenanthrene/Anthracene, C2 -	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	**34.3**	110	17	DFG-WPCL
Pyrene	405MDOLT2	04/Aug/2003	WPCL_L-383-03_BS390_S_PAH	129	**270**	13	DFG-WPCL

Table 7. Batches for which certified reference material (CRM) or laboratory control spike (LCS) samples were not run.

Analyte	Batch ID	Notes	Laboratory
Grain Size	081503-01	QAO: no SRM	AMS
Oil & Grease	2341-9149	QAO: no MS/MSD or DUP, or CRM	CRGML
Oil & Grease	2341-9152	QAO: no MS/MSD , DUP or CRM	CRGML
OCH Pesticides	L504-505-03-OCH	QAO: no QC for all dates except 10/25, no MS/MSD for 10/25	DFG-WPCL
OCH Pesticides	L508-512-03-OCH	QAO: no QC for all extraction dates except 11/4, no MS/MSD for 11/4	DFG-WPCL
OCH Pesticides	L510-03-OCH	QAO: 10/30 no MS/MSD, 10/31 no QC	DFG-WPCL
OP Pesticides	L-102203-OP	LAB:no MS/MSD analyzed for 10/25, no QC(blk, LCS, MS/MSD) for 10/22,23,24,28	DFG-WPCL
OP Pesticides	L-102403-OP	Only one set of QC analyzed with 36 samples; no MS/MSD analyzed	DFG-WPCL
OP Pesticides	L-103003-OP	QAO: no MS/MSD for 10/30, no blank, LCS or MS/MSD for 10/31	DFG-WPCL
PAHs	L-080703-PAH	QAO: no QC for 8/7, 8/11	DFG-WPCL
PAHs	L-103003-PAH	QAO: no QC for 10/30 or 10/31, no samples analyzed on 11/6.	DFG-WPCL
PAHs	L504-505-03-PAH	QAO: no QC for 10/22, 10/23, 10/24, 10/25, and 10/28	DFG-WPCL
PAHs	L508-512-03-PAH	QAO: no QC for 10/24, 10/25, 10/27, 10/28, 10/29, 10/30, 10/31, 11/3, or 11/4	DFG-WPCL
Total Suspended Solids	TSS080803	QAO: no CRM	
Total Suspended Solids	TSS102403	QAO: no CRM	
Total Suspended Solids	TSS102703	QAO: no CRM	
Total Suspended Solids	TSS102703a	QAO: no DUP or CRM	
Total Suspended Solids	TSS110303	QAO: no CRM	
Volatile Organic Compounds	L-102303-8260	QAO: no CRM or LCS, Grab, DUP and Triplicate RPD outside limit, no travel blank	DFG-WPCL
Volatile Organic Compounds	L-102403-8260	QAO: no CRM or LCS, Grab, DUP and	DFG-WPCL

Analyte	Batch ID	Notes	Laboratory
		Triplicate RPD outside limit, no travel blank	
Volatile Organic Compounds	L-102803-8260	QAO: no CRM or DUP, no travel blank	DFG-WPCL
Volatile Organic Compounds	L-103103-8260	QAO: no CRM or LCS, DUP RPD outside limit	DFG-WPCL

Table 8. Batches for which laboratory duplicates (DUP) were not run.

Analyte	Batch ID	Notes	Laboratory
Bacteria	0805	QAO: no DUP	CRGML
Bacteria	1020	QAO: no DUP	CRGML
Bacteria	1021	QAO: no DUP	CRGML
Bacteria	1022	QAO: no DUP	CRGML
Bacteria	1023	QAO: no DUP	CRGML
Bacteria	1028	QAO: no DUP	CRGML
Oil & Grease	2341-9149	QAO: no MS/MSD or DUP, or CRM	CRGML
Oil & Grease	2341-9152	QAO: no MS/MSD , DUP or CRM	CRGML
Total Suspended Solids	TSS102703a	QAO: no DUP or CRM	MPSL-DFG

Table 9. Laboratory duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
Benzene	405LA4632	0.418	0.043	µg/L	163	DFG-WPCL	L-103103-8260/L-102403-8260
Benzene	405LA4632	0.418	-0.04	µg/L	200	DFG-WPCL	L-103103-8260/L-102403-8260
Benzene	405LA4792	0.094	0.063	µg/L	39	DFG-WPCL	L-103103-8260
cis-Chlordane	405MDOLT1	7.59	4.55	ng/g	50	DFG-WPCL	L38303_BS257_KR_PESTICIDES
trans-Chlordane	405MDOLT1	13.3	6.17	ng/g	73	DFG-WPCL	L38303_BS257_KR_PESTICIDES
alpha-Chlordene	405MDOLT1	4.37	1.98	ng/g	75	DFG-WPCL	L38303_BS257_KR_PESTICIDES
Dissolved Chromium	405LA4464	0.16	0.09	µg/L	56	MLML-TM	HiResICP011404
Dissolved Chromium	405LA4568	0.1	0.13	µg/L	-26	MLML-TM	HiResICP011404
(p,p')DCBP	405MDOLT1	9.19	5.05	ng/g	58	DFG-WPCL	L38303_BS257_KR_PESTICIDES
(o,p')DDD	405MDOLT1	3.5	-3.01	ng/g	200	DFG-WPCL	L38303_BS257_KR_PESTICIDES
(p,p')DDD	405MDOLT1	13.8	3.65	ng/g	116	DFG-WPCL	L38303_BS257_KR_PESTICIDES
(o,p')DDE	405MDOLT1	4.92	-2.63	ng/g	200	DFG-WPCL	L38303_BS257_KR_PESTICIDES
(p,p')DDE	405MDOLT1	42	24.8	ng/g	51	DFG-WPCL	L38303_BS257_KR_PESTICIDES
Ethylbenzene	405LA4632	0.047	-0.041	µg/L	200	DFG-WPCL	L-103103-8260/L-102403-8260
Ethylbenzene	405LA4632	0.047	-0.041	µg/L	200	DFG-WPCL	L-103103-8260/L-102403-8260
Ethylbenzene	405LA4792	0.074	0.1	µg/L	30	DFG-WPCL	L-103103-8260
C2-Fluorenes	405MDOLT1	96.2	130	ng/g	30	DFG-WPCL	WPCL_L-383-03_BS390_S_PAH
C3-Fluorenes	405DCMAIN	-0.01	0.0111	µg/L	200	DFG-WPCL	L-080703-PAH
Heptachlor epoxide	405MDOLT1	4.99	3.18	ng/g	44	DFG-WPCL	L38303_BS257_KR_PESTICIDES
Total Nickel	405LA4242	3.11	4.12	µg/L	28	MLML-TM	HiResICP011404
cis-Nonachlor	405MDOLT1	6.73	-3.84	ng/g	200	DFG-WPCL	L38303_BS257_KR_PESTICIDES
trans-Nonachlor	405MDOLT1	6.84	3.31	ng/g	70	DFG-WPCL	L38303_BS257_KR_PESTICIDES
Oxadiazon	405MDOLT1	4.67	-3.67	ng/g	200	DFG-WPCL	L38303_BS257_KR_PESTICIDES
PCB 018	405MDOLT1	0.58	0.773	ng/g	29	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 028	405MDOLT1	1.68	1.11	ng/g	41	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 033	405MDOLT1	-0.305	0.864	ng/g	200	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 056	405MDOLT1	1.3	0.669	ng/g	64	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 060	405MDOLT1	0.836	0.481	ng/g	54	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 066	405MDOLT1	2.61	1.8	ng/g	37	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 070	405MDOLT1	3.38	2.52	ng/g	29	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 074	405MDOLT1	1.08	0.747	ng/g	36	DFG-WPCL	L38303_BS257_KR_CONGENERS

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
PCB 087	405MDOLT1	2.33	1.53	ng/g	41	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 095	405MDOLT1	3.87	2.46	ng/g	45	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 097	405MDOLT1	1.79	1.12	ng/g	46	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 099	405MDOLT1	2.09	1.45	ng/g	36	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 101	405MDOLT1	4.78	3.5	ng/g	31	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 105	405MDOLT1	3.12	2.15	ng/g	37	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 110	405MDOLT1	7	4.26	ng/g	49	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 118	405MDOLT1	6.66	3.68	ng/g	58	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 128	405MDOLT1	1.67	0.935	ng/g	56	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 138	405MDOLT1	8.31	5.34	ng/g	44	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 141	405MDOLT1	1.15	0.619	ng/g	60	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 149	405MDOLT1	4.64	2.72	ng/g	52	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 151	405MDOLT1	2.52	0.77	ng/g	106	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 153	405MDOLT1	5.67	3.64	ng/g	44	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 156	405MDOLT1	0.831	0.44	ng/g	62	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 158	405MDOLT1	0.722	0.392	ng/g	59	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 170	405MDOLT1	1.71	0.832	ng/g	69	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 174	405MDOLT1	1.8	0.927	ng/g	64	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 177	405MDOLT1	1.08	0.701	ng/g	43	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 180	405MDOLT1	4.05	2.26	ng/g	57	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 183	405MDOLT1	0.975	-0.392	ng/g	200	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 187	405MDOLT1	2.13	1.17	ng/g	58	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 194	405MDOLT1	1.1	0.572	ng/g	63	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 201	405MDOLT1	1.32	0.636	ng/g	70	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 206	405MDOLT1	0.58	-0.392	ng/g	200	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB 209	405MDOLT1	1.78	-0.392	ng/g	200	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB AROCLOR 1248	405MDOLT1	42	-39.2	ng/g	200	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB AROCLOR 1254	405MDOLT1	72	42	ng/g	53	DFG-WPCL	L38303_BS257_KR_CONGENERS
PCB AROCLOR 1260	405MDOLT1	39	27	ng/g	36	DFG-WPCL	L38303_BS257_KR_CONGENERS
C2-Phenanthrene/Anthracene	405DCMAIN	0.0104	-0.01	µg/L	200	DFG-WPCL	L-080703-PAH
Dissolved Selenium	405LA4098	0.14	0.26	µg/L	60	MLML-TM	HiResICP011404
Total Selenium	405LA4242	0.41	0.53	µg/L	26	MLML-TM	HiResICP011404

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
Total Suspended Solids	405LA4178	13.83	18.72	mg/L	30	MPSL-DFG	TSS102403
Total Suspended Solids	405LA4744	36	53.47	mg/L	39	MPSL-DFG	TSS110303
Toluene	405LA4632	0.236	0.1	µg/L	76	DFG-WPCL	L-103103-8260/L-102403-8260
m/p-Xylene	405LA4632	0.081	-0.043	µg/L	200	DFG-WPCL	L-103103-8260/L-102403-8260
o-Xylene	405LA4632	0.067	-0.048	µg/L	200	DFG-WPCL	L-103103-8260/L-102403-8260

Table 10. Field duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
Acenaphthylene	405MDOLT3	04/Aug/2003	-1.16	2.55	ng/g	200	DFG-WPCL
Dissolved Aluminum	405LA4266	23/Oct/2003	1.52	18.2	µg/L	169	MLML-TM
Chlordane, cis-	405MDOLT3	04/Aug/2003	5.95	4.02	ng/g	39	DFG-WPCL
Chlordane, trans-	405MDOLT3	04/Aug/2003	8.2	5.53	ng/g	39	DFG-WPCL
Chlorophyll a	405DCMAIN	05/Aug/2003	2.24	2.93	µg/L	27	MPSL-DFG
C1 -Chrysenes	405MDOLT3	04/Aug/2003	43	56.1	ng/g	26	DFG-WPCL
Fecal Coliform	405LA4266	23/Oct/2003	-20	20	MPN/100 mL	200	CRGML
Fecal Coliform	405LA4338	28/Oct/2003	-20	40	MPN/100 mL	200	CRGML
Total Coliform	405LA4266	23/Oct/2003	110	80	MPN/100 mL	32	CRGML
Total Coliform	405LA4338	28/Oct/2003	20	40	MPN/100 mL	67	CRGML
(p,p')DDE	405MDOLT3	04/Aug/2003	30.2	22.6	ng/g	29	DFG-WPCL
C2-Dibenzothiophenes	405DCMAIN	05/Aug/2003	-0.01	0.0106	µg/L	200	DFG-WPCL
E. coli	405LA4338	28/Oct/2003	-10	20	MPN/100 mL	600	CRGML
Ethylbenzene	405LA4338	28/Oct/2003	0.057	-0.041	µg/L	200	DFG-WPCL
C3-Fluorenes	405DCMAIN	05/Aug/2003	-0.01	0.0101	µg/L	200	DFG-WPCL
1-Methylnaphthalene	405MDOLT3	04/Aug/2003	3.91	5.31	ng/g	30	DFG-WPCL
C4-Naphthalenes	405DCMAIN	05/Aug/2003	0.0122	-0.01	µg/L	200	DFG-WPCL
trans-Nonachlor	405MDOLT3	04/Aug/2003	5.09	3.16	ng/g	47	DFG-WPCL
OilandGrease	405LA4266	23/Oct/2003	-0.1	0.12	mg/L	200	CRGML
OilandGrease	405LA4338	28/Oct/2003	0.44	0.33	mg/L	29	CRGML
PCB 008	405MDOLT3	04/Aug/2003	-0.358	0.405	ng/g	200	DFG-WPCL
PCB 018	405MDOLT3	04/Aug/2003	-0.358	0.708	ng/g	200	DFG-WPCL
PCB 033	405MDOLT3	04/Aug/2003	0.512	0.99	ng/g	64	DFG-WPCL
PCB 151	405MDOLT3	04/Aug/2003	1.49	0.841	ng/g	56	DFG-WPCL
PCB 153	405MDOLT3	04/Aug/2003	4.55	3.42	ng/g	28	DFG-WPCL
PCB 158	405MDOLT3	04/Aug/2003	0.652	-0.386	ng/g	200	DFG-WPCL
PCB 174	405MDOLT3	04/Aug/2003	1.19	0.918	ng/g	26	DFG-WPCL
PCB 177	405MDOLT3	04/Aug/2003	0.829	0.507	ng/g	48	DFG-WPCL

Analyte	Station Code	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
PCB 183	405MDOLT3	04/Aug/2003	0.535	-0.386	ng/g	200	DFG-WPCL
PCB 203	405MDOLT3	04/Aug/2003	0.726	-0.386	ng/g	200	DFG-WPCL
PCB AROCLOR 1260	405MDOLT3	04/Aug/2003	30	22	ng/g	31	DFG-WPCL
C2-Phenanthrene/Anthracene	405MDOLT3	04/Aug/2003	43.6	58.1	ng/g	29	DFG-WPCL
Fine 0.075 to <0.425 mm Sand 0.075 to <4.75 mm	405MDOLT3	04/Aug/2003	4.5	2.57	%	55	AMS
Medium 0.425 to <2.0 mm Sand 0.075 to <4.75 mm	405MDOLT3	04/Aug/2003	0.12	0.28	%	80	AMS
Selenium,Dissolved	405LA4266	23/Oct/2003	0.19	0.39	µg/L	69	MLML-TM
Total Suspended Solids	405LA4266	23/Oct/2003	-5	5.523	mg/L	200	MPSL-DFG
m/p Xylene	405LA4338	28/Oct/2003	0.059	-0.043	µg/L	200	DFG-WPCL

Table 11. Samples with low level (0.36 ± 0.27 mg l^{-1}) nitrate-N contamination.

Site	Sample Date	Batch ID	Nitrate-N (mg l^{-1})	Method Name
405MDOLT1	04/Aug/2003	080703-NO3	0.0678	QC 10107041B
405MDOLT2	04/Aug/2003	080703-NO3	0.083	QC 10107041B
405MDOLT3	04/Aug/2003	080703-NO3	0.0879	QC 10107041B
405MDOLT3 (FieldDuplicate)	04/Aug/2003	080703-NO3	0.0913	QC 10107041B
405MDOLT4	04/Aug/2003	080703-NO3	0.0968	QC 10107041B
405MDOLT5	04/Aug/2003	080703-NO3	0.0987	QC 10107041B