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IR Site 2 Remedial Investigation Report
Alameda Point
Alameda, California

Prepared For

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EXECUTIVE SUMMARY

This report documents the findings of the remedial investigation (RI) activities for Installation Restoration (IR) Site 2 at Alameda Point (formerly the Naval Air Station Alameda). IR Site 2 includes the West Beach Landfill (the landfill), the West Beach Landfill Wetland (the wetland), and associated areas designated as the interior and coastal margins. The objectives of this RI report are to describe the environmental setting and conditions at IR Site 2, assess the extent of chemical releases that may have been caused by historical activities of the US Navy, and estimate potential risks to human health and the environment associated with any releases. This RI report also establishes remedial action objectives to guide the selection of remedial alternatives to address unacceptable risk or significant uncertainties identified herein.

The RI was conducted under the regulatory context of the US Environmental Protection Agency's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The main objectives of CERCLA are to establish a program to identify sites where hazardous substances were released into the environment, and to mandate cleanup actions, as necessary, to reduce risks to acceptable levels. Sites that are subject to CERCLA regulation are listed on the National Priority List (NPL). Alameda Point was listed on the NPL in July 1999. The RI was the first part of a remedial investigation and feasibility study (RI/FS). The FS identifies and evaluates alternatives for remedial actions at a given site. Implementation of the recommendations of the FS can lead to a record of decision for the site and eventual delisting from the NPL.

Description

Alameda Point occupies 2676 acres (ac) (1083 ha) at the west end of Alameda Island. The former Naval Air Station Alameda operated there as an active naval facility from 1940 until 1997. At present, approximately 978 ac (396 ha) at Alameda Point, including the area encompassed by IR Site 2, are scheduled for transfer to the US Department of the Interior, Fish and Wildlife Service for management as the Alameda National Wildlife Refuge. The landfill, with an area of 77 ac (31 ha), was used for the disposal of approximately 1.6 million tons (1.4 Tg) of installation waste from 1956 through early 1978. Wastes deposited in the landfill included municipal solid waste, waste from berthed ships, waste-chemical drums, solvents, oily waste and sludge, paint waste, plating wastes, industrial strippers and cleaners, acids, mercury, polychlorinated biphenyl-containing liquids, batteries, low-level radiological waste from radium dials and dial painting, scrap metal, inert ordnance, asbestos, pesticides, tear gas agents, biological waste from the Oak Knoll Naval Hospital, creosote, dredge spoils, and waste medicines and reagents. Concerns regarding possible unexploded ordnance buried in the area are being addressed in a concurrent investigation and results will be published in an addendum to this report. The landfill waste materials were covered with soil when disposal operations ceased, but the landfill was not held to specific standards at its closure.

The wetland occupies approximately 33 ac (13 ha) of the southwestern corner of Alameda Point immediately southwest of the landfill, and contains two perennial ponds. The northern pond is connected to San Francisco Bay (the Bay) by a 36-in. (0.9-m)-diameter corrugated steel pipe culvert that allows inflow of seawater during high tide and outflow of freshwater after rainfall. The coastal margin, a thin strip of land separating the landfill and wetland from the sea, consists

calibrated with site-specific plant, invertebrate-, mammal-, and fish-tissue data; and comparison of average daily doses for selected indicator species (calculated by the food-chain models) to threshold response values.

The results of the ecological risk assessment indicate that average concentrations of a number of metals in landfill, wetland, and coastal margin soils exceed plant-specific screening benchmarks. The results of the sediment toxicity bioassays are equivocal, with one assay organism indicating no adverse effects at any of the seven pond-sampling locations and a second test organism showing elevated mortality at three of the seven pond locations. The average daily doses to food chain receptors showed a number of chemical constituents (primarily metals) with a hazard quotient greater than 1 for some receptors when a very protective threshold response value was used. However, when the same daily doses were compared to threshold response values developed with "best-estimate" assumptions, all hazard quotients were less than unity. The nine metals identified as potential risk drivers to upper trophic levels based on the conservative hazard quotient calculations were distributed widely across IR Site 2 and did not appear to originate from a landfill source. It is likely these metals were present in sediments deposited in the southern portion of IR Site 2 and later used as landfill cover. Collectively these results indicate that, although there is some evidence that metal-related risks may be elevated, there is no unequivocal determination of risk to receptors at IR Site 2,and that ecological risks associated with environmental media at IR Site 2 likely are negligible.

Conclusions

Additional actions to further mitigate site risks are of questionable value, based on the results of the human and ecological risk assessments. The absence of obvious chemical contamination associated with the landfill suggests that hazardous chemicals have already migrated from the landfill and/or that the quantities of such chemicals placed in the landfill were minimal. The US Navy will perform follow-up activities to reduce uncertainties in the results of the data analyses and risk assessments, and to ensure that future environmental impacts will remain insignificant. An FS will be conducted to evaluate alternative mitigation methods to further reduce uncertainties regarding the future migration of chemical constituents from the landfill to the surrounding environment, and subsequent potential ecological impacts. The scope of the FS is contingent on the results and recommendations of the ongoing investigation of possible unexploded ordnance.

2.0 SITE DESCRIPTION AND HISTORY

This section provides the description and history of Installation Restoration (IR) Site 2, which includes the West Beach Landfill (the landfill), the West Beach Landfill wetland (the wetland), and associated interior and coastal margins, hereafter collectively referred to as "IR Site 2." Section 2.1 of this document provides an overall description of these areas. Section 2.2 presents the operational history of the site, including past disposal practices at each area. Section 2.3 presents the environmental setting of Naval Air Station (NAS) Alameda (Alameda Point), the landfill, and contiguous wetland, including physical and ecological settings. Section 2.3 also discusses relevant chemical fate and transport processes. Information presented in Section 2 will be integrated with the chemical data interpretations provided in Section 4 to construct the conceptual site model presented in Section 5.

2.1 Site Description

IR Site 2 is subdivided into four areas: the landfill, the wetland, the coastal margin, and the interior margin. The demarcation of these areas is based on site topography, land use, and sampling locations. Each is described in the following sections.

2.1.1 West Beach Landfill

The landfill occupies approximately 77 acres (ac) (31 hectares [ha]) at the extreme southwestern end of Alameda Point. It operated according to the standards of the day, which allowed simple dumping of a wide variety of largely municipal-waste materials onto the ground and into surface waters, with daily cover of waste material late in the operational life of the landfill. An aerial photograph, circa 1968 (Figure 2-1), shows the landfill during its operation. The landfill was used for disposal of installation waste from 1956 through early 1978. In 1956, a sea wall was constructed to delineate and protect the area, running along the southern and western margins. Figure 2-2 shows the landfill during its construction. A culvert was installed in the sea wall so that waters inside the sea wall would be hydraulically connected to San Francisco Bay (the Bay). This culvert, the interior remnant of the Bay, and the tidal connection remain (see Plate 2a in the correspondence at the end of this section). After landfill operations ceased, a substantial dike was constructed around the perimeter of the site, completely containing it. The landfill extends to the inside edge of this dike and to the edge of the wetland. A map identifying the extent of the landfill and the entire site in its current state is shown in Figure 2-3.

Artificial dredge fill of varying origins was hydraulically placed inside the sea wall. Waste was emplaced into the area starting from the northern edge, and eventually covered most of the northern and eastern areas and part of the northern pond. An April 2000 photograph illustrating the current condition of northern pond is shown in Figure 2-4.

Map of Alameda IR Site 2

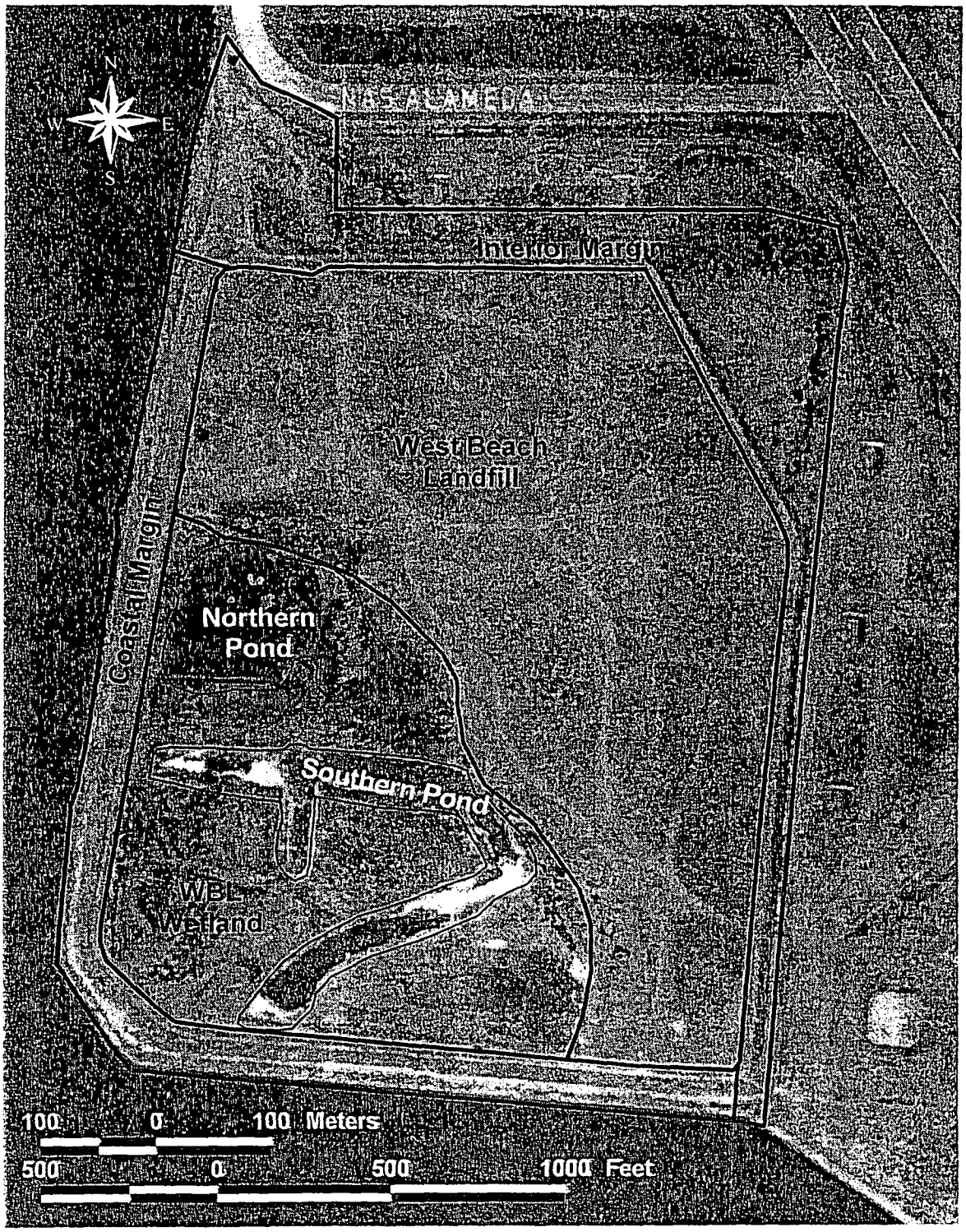

Figure 2-3. Map of Alameda IR Site 2.

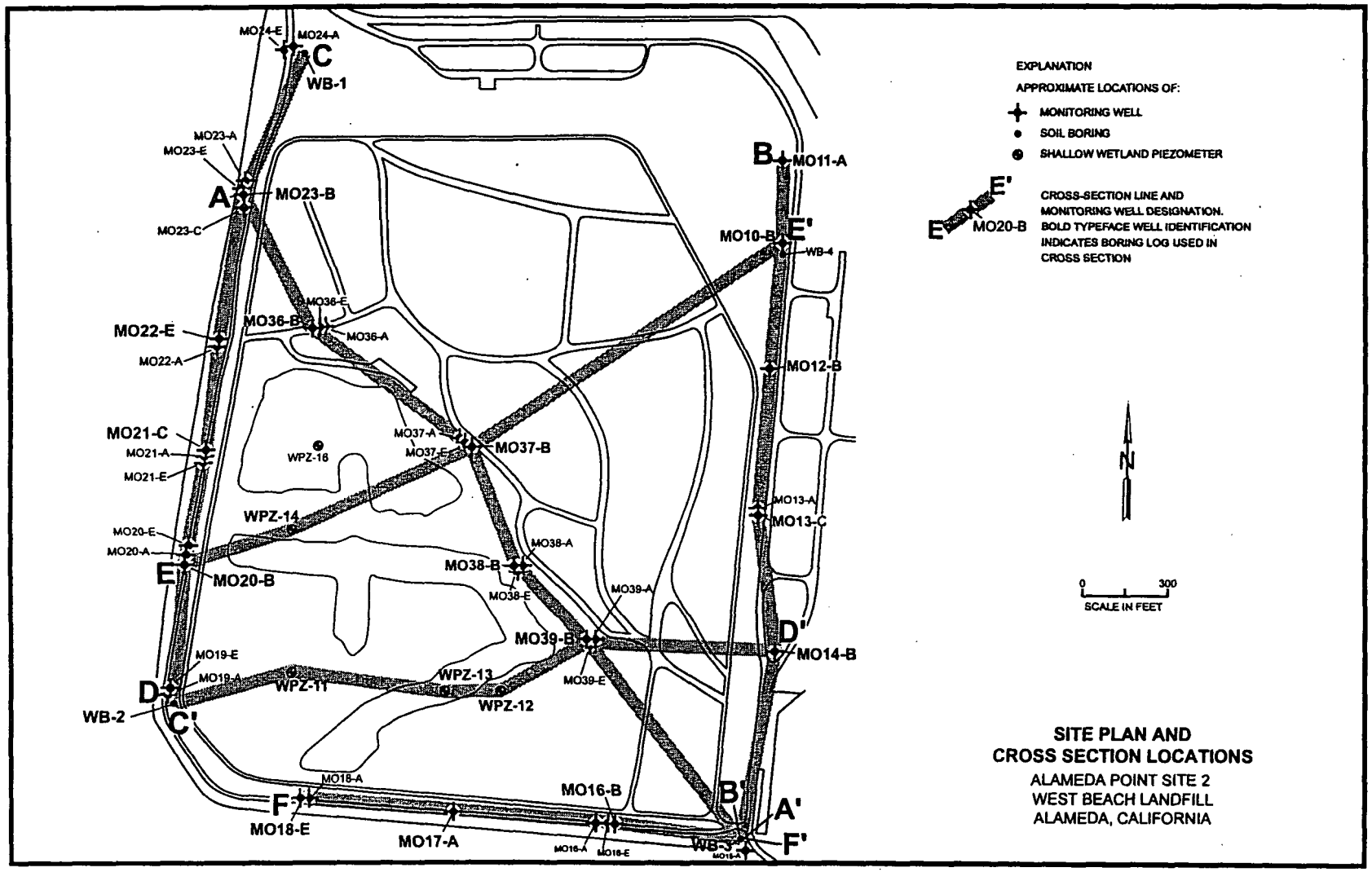

Figure 2-6. Location map for geological cross sections A-A' through F-F'.

At IR Site 2, the depth to the top of the FWBZ is 2 to 8 ft (0.6 to 2.4 m) bgs and averages 3 to 5 ft (0.9 to 1.5 m) bgs. The saturated thickness is over 30 ft (9 m) at IR Site 2. Hydraulic conductivities in Alameda Point test wells ranged from 5.2×10^{-7} meters per second (m/s) to 2.1×10^{-4} m/s for the unconfined FWBZ, and 6.1×10^{-6} m/s to 2.3×10^{-5} m/s for the SWBZ (TtEMI, 1999). The hydraulic conductivity of the semiconfining BSU was estimated by slug test to be 3.6×10^{-7} m/s. Hydraulic conductivity was also believed to vary across the depth of the unconfined aquifer because of the stratification of the fill material.

2.3.1.4.2 Conceptual Hydrologic Model of IR Site 2

A hydrologic study in 1997 and 1998 by SOMA Corporation of Emeryville, California, evaluated the hydrologic mechanisms that may facilitate contaminant transport from groundwater and soil at the landfill to the wetland and the Bay. The full report of this study is presented in Appendix D. Summaries of the results of the study follow, organized by the particular pathways investigated.

Precipitation

Groundwater and surface water elevation data show recharge effects from precipitation. The landfill and coastal groundwater elevation data show a greater response to precipitation compared with the wetland and pond groundwater elevation data. This suggests that the landfill cover now in place is permeable and that the water is being retained in the landfill and slowly dispersed. The data indicate that increases in water elevation from precipitation are greater in groundwater in the upland landfill and coastal areas than in the wetland areas and beneath the ponds. On average, surface water in the ponds shows the greatest increase in elevation, attributable to recharge from precipitation and storm water runoff. The duration of the recharge effect from precipitation in the southern pond was similar to the duration observed in groundwater, lasting approximately three to four months. In contrast, the relatively short duration of the recharge effect from precipitation in the northern pond, approximately one week, was likely due to the culvert connection with the Bay.

Groundwater Migration from the Upland Landfill

The groundwater potentiometric surface in the central upland landfill area suggests a southwest groundwater flow direction toward the wetland/pond area. The groundwater gradient north of the wetland/pond area was west, and south of the wetland/pond area was south toward the coastal margin and the Bay. The groundwater elevation beneath the upland landfill at wells M36A, M37A, and M39A was consistently above the surface water elevation in the northern and southern ponds and the wetland groundwater. This observation suggests that groundwater beneath the upland landfill was a source of recharge to the ponds and wetland. The data indicate that precipitation and tidal fluctuations did not significantly affect the groundwater gradient direction or magnitude in the upland landfill areas of the site. This suggests that the upland part of the landfill is probably not inundated with or exposed to sea water.

Groundwater and Surface Water Hydrology of the Wetland/Pond Area

The wetland/pond area consists of the northern and southern ponds and the wetland area that lies generally south and southwest of the ponds. The groundwater and surface water elevation data indicate that the predominant lateral gradient direction in the wetland/pond area was toward the coastal margin and Bay. The culvert connecting the northern pond with the Bay likely rapidly transfers surface water to the bay, reducing the effects of precipitation on surface water levels in the northern pond. When surface water in the southern pond was at an elevation of 6.6 ft (2 m), mean lower low water (MLLW) or more, it appears that the pond overflowed into the surrounding wetland and into the northern pond. Finally, variability of physical properties indicate water quality differences between surface water sampling locations within the northern pond and between the northern and southern pond.

Groundwater and Surface Water Hydrology of the Coastal Margin

The elevation of coastal margin groundwater exceeded that of the Bay surface water elevation most of the time and during the low tide portions of the tidal cycle throughout the period monitored. The electrical conductivity of the coastal margin groundwater was relatively low, as measured in well M20A (see Figure 2-6) and was affected by precipitation. These data indicated that relatively fresh groundwater discharged to the Bay during the low tide portions of the tidal cycle throughout most of the year.

Surface Water Flux Between Wetland Ponds and San Francisco Bay

The results of tidal flux calculations described in Appendix D indicate that there was a net flow from the northern pond to the Bay, except during higher spring tides during the dry months when there was a net flow from the Bay into the pond. Pond surface water levels were always higher than the mean tide level throughout the monitoring period. These data suggest that the duration and height of high tides during spring tide events in the dry season was sufficient to offset the average conditions. Based on the preceding interpretation of observations made during the study period, a conceptual model of surface water and groundwater flow was developed and is presented in Figure 2-13.

2.3.1.5 Existing Uses of Groundwater

A review of state records and readily available information found that nine state-registered wells were screened in the unconfined Merritt Sand unit and three wells were screened in the confined Alameda Formation east of Alameda Point (TtEMI, 1999). Unregistered, private irrigation wells were also screened in the unconfined Merritt Sand unit and the Alameda Formation. These wells are located in the residential community east of Alameda Point. All registered and unregistered neighborhood wells are hydraulically upgradient of Alameda Point and are far enough from IR Site 2 to ensure that they will not impact the groundwater flow direction.

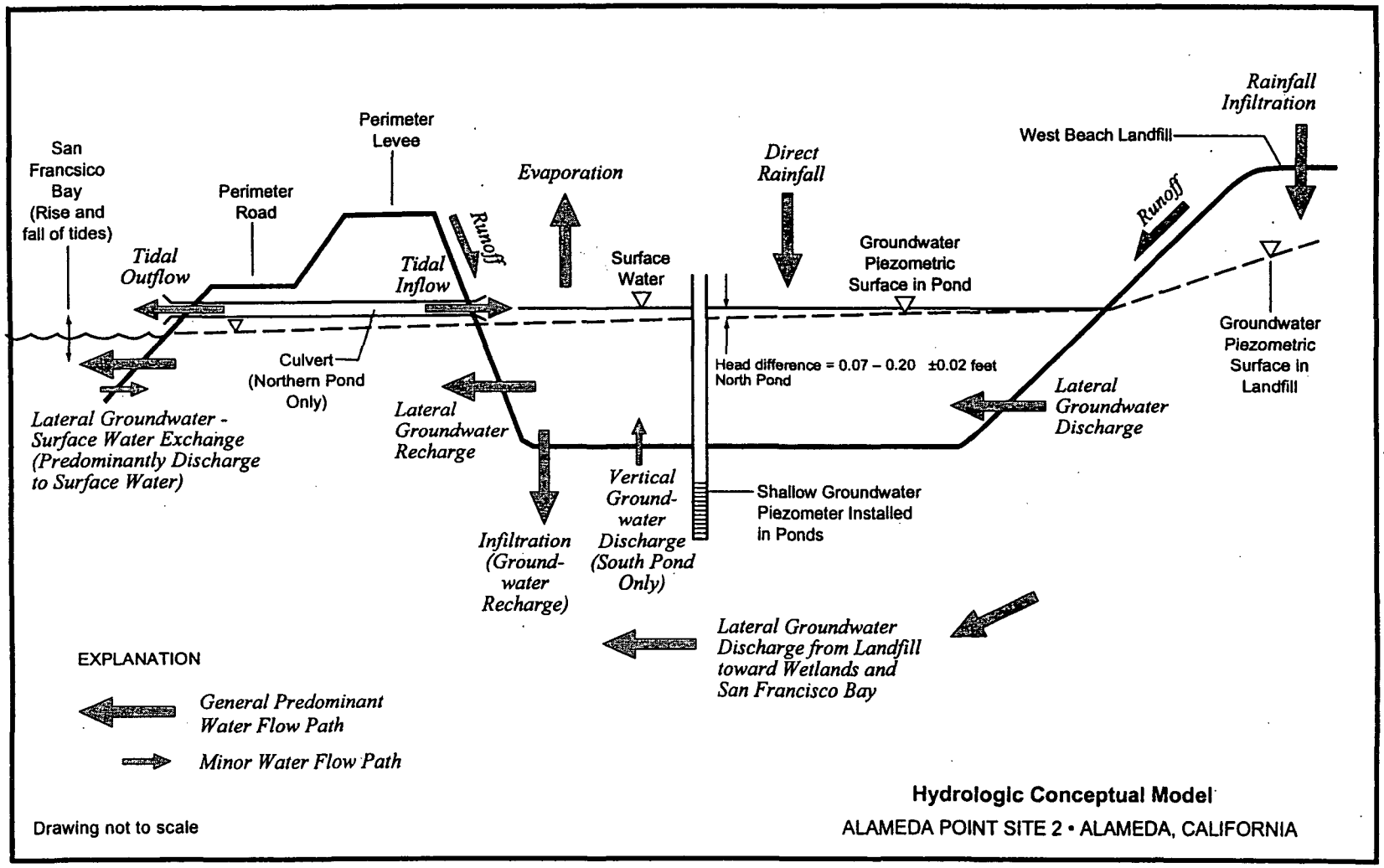

Figure 2-13. Hydrologic conceptual model for IR Site 2.

correlated with the generation of water within the landfill, since a high degree of water saturation within the landfill due to putrefaction of organic material could inhibit infiltration of surface water.

Contamination in surface soils and contaminants leached from the buried waste are transported vertically downward with water infiltrating through the vadose zone to groundwater underlying the site. The rates at which contaminants are discharged to the aquifer from the vadose zone depend upon the Darcy water velocity in the unsaturated zone, the depth to the aquifer, the sorptive and solubility characteristics of the contaminants, and vadose soil characteristics. The first two of these factors determine the groundwater travel time to the aquifer, while the sorptive properties of contaminants and soil characteristics control contaminant retardation. As the contaminant sorption capacity of soil increases for any particular contaminant, the time required for that contaminant to be discharged to groundwater also increases.

2.3.4.3 Surface Water Runoff

Chemicals deposited on the ground surface by plants and animals are available for transport via surface water runoff. Transport of soluble chemicals may occur in the liquid phase, but this mechanism is expected to function primarily via suspension of particles for most contaminants. Because the land surface of the landfill is relatively flat, surface runoff will generate relatively small flow velocities and hence will mobilize only fine-grained soil particles such as clays and silts. Buildup of fine particulates in local depressions (as seen in Figure 2-18) may result in locally elevated chemical concentrations. This is because smaller soil particles have high surface area-to-mass ratios, and therefore the contaminant concentrations may increase with decreasing particle size. The lowest points within the berm enclosing the landfill are the wetland and associated ponds. Accumulation of suspended particles from surface water runoff contributes to the generation of wetland sediments over time.

Because the ponds and wetland are more biologically active than the terrestrial environment at IR Site 2, the organic carbon content of sediments in these areas is expected to be higher than in cover soils. Hydrophobic organic compounds such as many of the substituted benzenes, PAHs, PCBs, and chemical solvents tend to adsorb onto such sediments in aqueous environments and become less bioavailable. Certain metals may also be affiliated with sediments via ionic bonds. Consequently, partitioning of organic chemicals and metals between water and sediment may result in a relatively strong association of chemicals with sediments.

The northern pond is periodically connected with the Bay via a culvert during high water tidal conditions. Following precipitation events, there may also be a hydraulic connection between the northern and southern ponds, and from the northern pond to the Bay. Therefore, contaminants associated with wetland sediments and waters in both ponds may be released to the Bay.

2.3.4.4 Groundwater Flow

The rate of contaminant transport in groundwater is controlled by similar properties as unsaturated zone flow: water velocity, the sorptive characteristics of the contaminants in the deeper soil and fill, and saturated zone soil characteristics. The direction and rate of groundwater flow at the site varies by time and location due to the effects of tidal forces and the seasonal variability in precipitation. Based on piezometric data presented in Appendix D, groundwater discharge to surface water appears to be limited to the southern pond and primarily during the winter months. Groundwater does not appear to discharge to the northern pond, since the piezometric head in the pond is consistently greater than that in the groundwater below. However, groundwater flux from the landfill toward the wetland does occur on a continual basis, resulting in discharge to the Bay.

Additional information on groundwater hydraulics is provided in Section 2.3.1.4.2 and in Appendix D.

2.3.4.5 Biological and Physical Degradation

Biological and physical degradation likely affect organic chemicals in the environment. Biodegradation generally refers to microbial breakdown of organic molecules (usually to generate energy for the microbes) under aerobic or anaerobic conditions. Physical degradation refers to the abiotic chemical breakdown of a molecule and includes processes such as hydrolysis and photolysis. An important distinction between these processes is that biotic breakdown of organic compounds can result in mineralization (i.e., converting carbon-containing molecules to carbon dioxide [CO_2]) while physical degradation yields only other organic compounds.

A common type of physical reaction is hydrolysis, where a water molecule or hydroxide ion substitutes for an atom or group of atoms in a molecule resulting in a more polar (i.e., more water soluble) compound. In addition to water, other nucleophilic (i.e., attracted by a positive charge) ions such as nitrates, sulfates, and phosphates may also attack organic chemicals via such a substitution. For polyhalogenated organic compounds (such as trichloroethylene and similar solvents), nucleophilic substitutions are not favored—instead, another type of elimination reaction called dehydrohalogenation takes precedence. Many other types of similar reactions exist that may be relevant for particular compounds and environmental conditions. A fundamentally different type of physical reaction is photolysis, wherein an organic molecule absorbs light energy and subsequently undergoes a physical transformation. Photolytic processes are only of importance in surface water and soil. Common organic pollutants that are sensitive to photolysis include certain PAHs and phenols.

Biochemical transformations of organic chemicals are particularly important for molecules whose physical degradation is limited by kinetic factors, since biological enzymes can lower the activation energy of reactions by many orders of magnitude. A common strategy is for biotic organisms to generate reactive compounds (e.g., enzymes) to facilitate oxidation or reduction

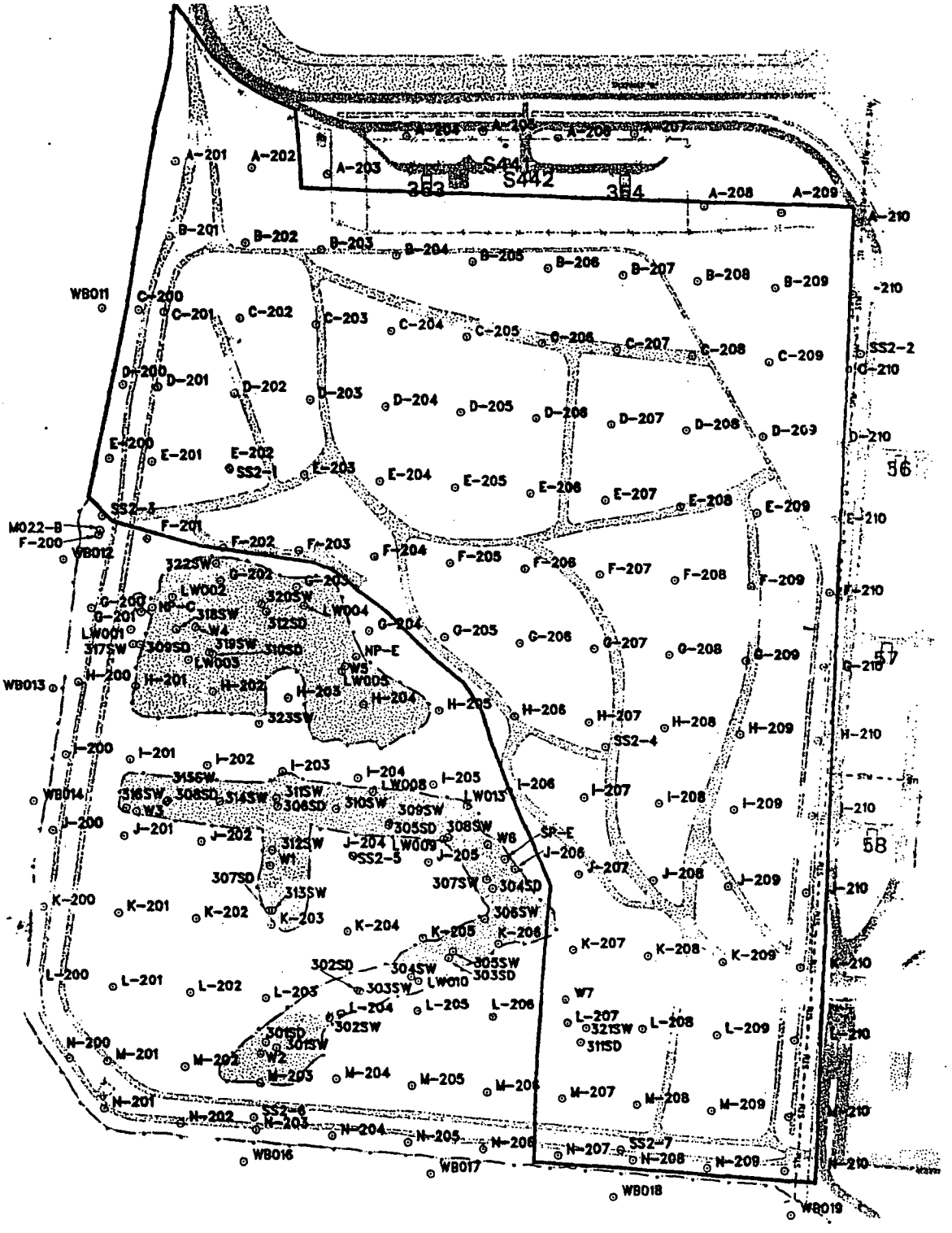

Figure 3-1. Sample locations for surface soils, surface water, and sediment

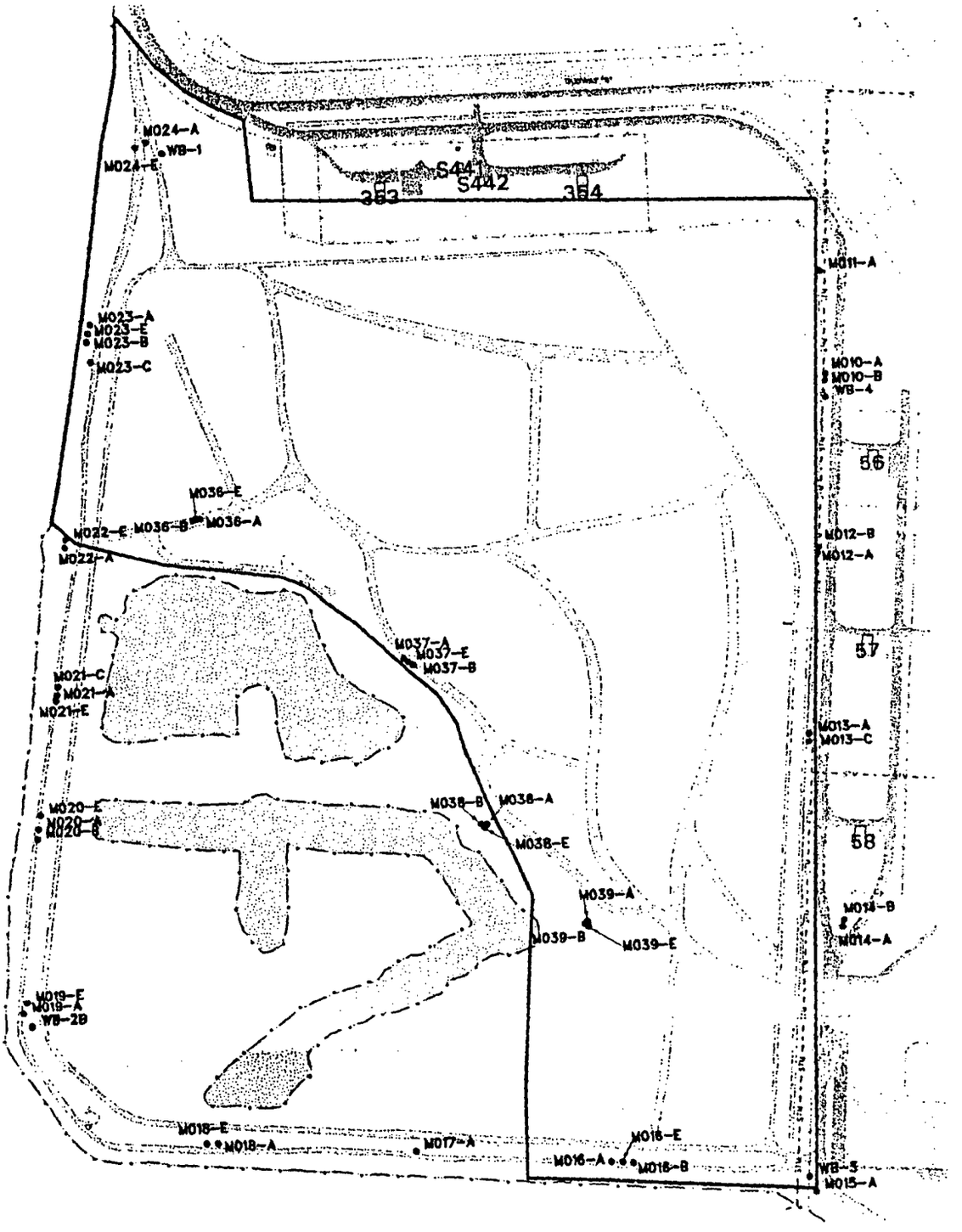

Figure 3-2. Sample locations of soil borings

During the 1990 SWAT investigation, 36 subsurface soil samples from four soil borings were collected for chemical analyses, and an additional 21 samples were collected from these borings for geotechnical analyses. During the 1991 SWAT investigation, 23 subsurface soil samples from 18 monitoring well borings were collected for chemical analyses, and an additional 26 samples were collected from the borings for geotechnical analyses. During the 1994 investigation, 6 subsurface soil samples from 3 monitoring well borings were collected for chemical analyses, and an additional 4 samples were collected from the borings for geotechnical analyses. In 1995, 20 subsurface soil samples from 12 monitoring well borings were collected for chemical analyses. Subsurface soil data are summarized in Section 4.1 and Appendix B.

3.1.2 Groundwater Sampling

The groundwater characterization at the landfill was conducted from 1991 through 1998 to determine if any chemicals present in the landfill were seeping into groundwater and potentially migrating offsite (Canonie 1990a, 1990b; PRC and MW 1993).

A total of 42 monitoring wells were installed at IR Site 2: 27 in 1991, 3 in 1994, and 12 in 1995. Table 3-4 lists the sample location, sampling date, sample type (normal or field duplicate), sample prep (filtered or unfiltered), and analyses performed. Groundwater at the landfill was sampled quarterly at monitoring wells, with additional HydroPunch™ sampling occurring during 1994 and 1995. Figure 3-3 shows the groundwater sampling locations.

During the 1991 through 1992 investigation, 132 groundwater samples were collected from 29 monitoring wells during three sampling events. Sampling events at the landfill took place during the following three time periods:

- June 1991 to August 1991,
- September 1991 to October 1991, and
- January 1992 to April 1992.

During the 1994 through 1995 investigation, 100 groundwater samples were collected from 24 monitoring wells during four quarterly sampling events. In addition, 16 HydroPunch™ groundwater samples were collected from 12 locations during this investigation. Quarterly sampling events took place during the following four time periods:

- October 1994 to December 1994,
- February 1995 to March 1995,
- May 1995 to June 1995, and
- July 1995 to October 1995.

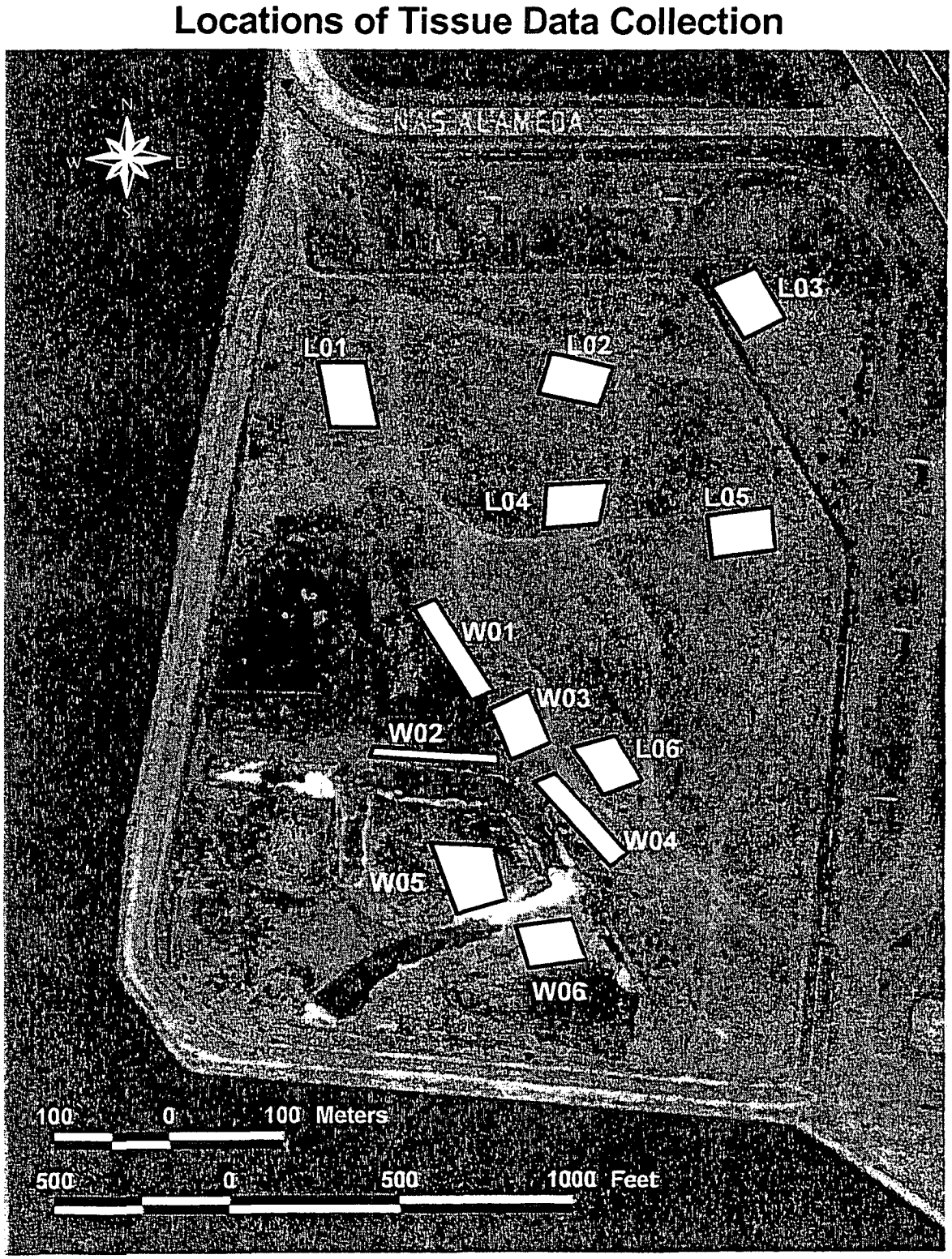

Figure 3-4. Locations of tissue sampling

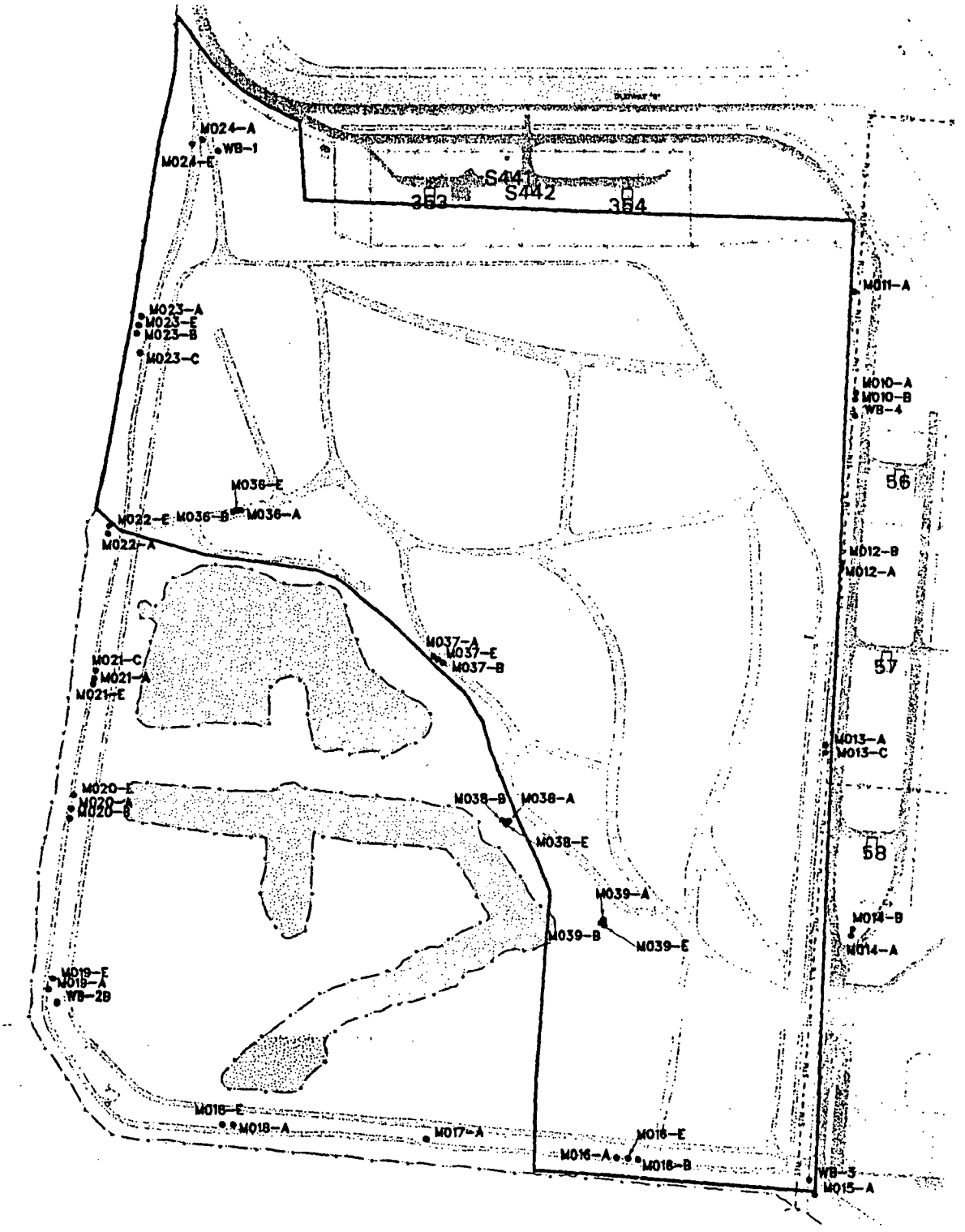

Figure 3-2. Sample locations of soil borings

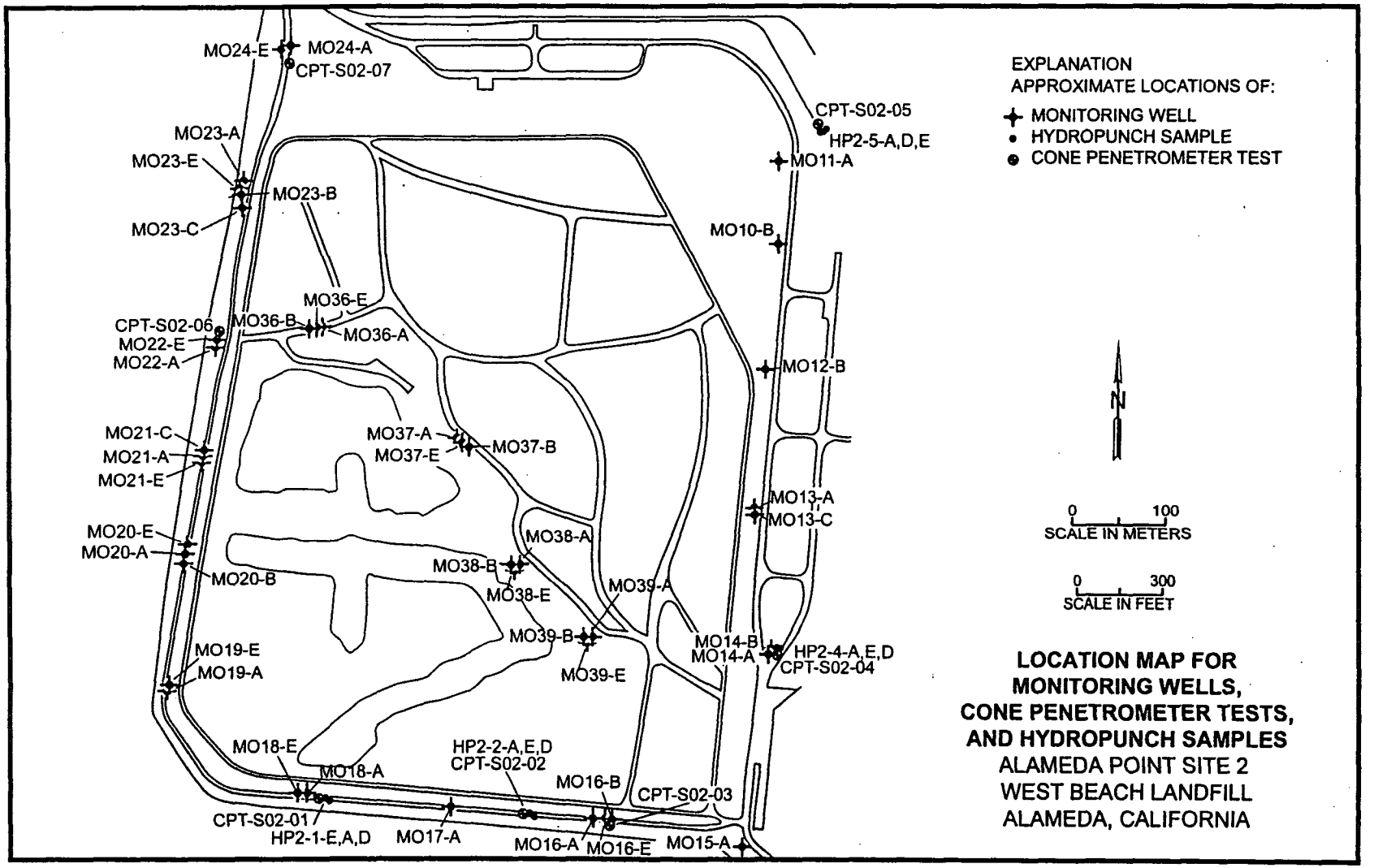

Figure 3-3. Locations of groundwater wells, cone penetrometer tests, and HydroPunch™ samples

Groundwater quality monitoring continued with 16 wells sampled from 1996 through 1998 and 72 samples collected. Sampling was conducted during the following time periods:

- January 1996,
- February 1997,
- October through November 1997,
- February 1998, and
- May 1998.

Sampling summaries for all wells were provided in Table 3-4. HydroPunch™ and monitoring well data are summarized in Section 4.3.

3.1.3 Sediment Sampling

The wetland sediments were sampled in 1991, 1993 through 1994, and 1996 through 1997. Sediment was collected from the wetland to determine if the surface soil from the landfill was being transported to the wetland via surface runoff or airborne dispersion. Sediment sampling locations were illustrated in Figure 3-1. Sediment samples were analyzed for chemical constituents and used to perform benthic-invertebrate community analyses and solid-phase and pore water benthic-invertebrate bioassays (PRC and MW, 1993; PRC and Tetra Tech Inc., 1992a, 1992b, PRC 1996c). Additional sediment samples were used to perform bioaccumulation tests as noted in Section 3.2.6. Section 4.1 and Appendix B present the results of the sediment sampling in the wetland.

Sediment samples (13) were collected from 12 locations at the wetland in 1991. An additional 20 sediment samples were collected from 7 locations in the wetland during the 1993 ecological assessment, and 6 sediment samples were collected from 6 additional locations during the 1996 and 1997 follow-on investigation. The sediment sample locations, sampling dates, type of sample (normal or field duplicate), and analyses performed on the wetland samples were listed in Table 3-5. Sediment data is summarized in Section 4 and Appendix B. All sediment samples collected represented surface sediments.

3.1.4 Surface Water Sampling

Surface water sampling was conducted at the wetland during 1991, 1996, and 1997 (Figure 3-1) to assess if the ponds were receiving any chemicals from the adjacent fill areas via one or more of the following migration mechanisms: (1) surface water runoff, (2) direct leaching from the landfill, (3) groundwater transport, or (4) airborne dispersion and deposition of chemically affected particulates (PRC and MW 1993; PRC and Tetra Tech, 1992a, 1992b; PRC 1996c). Twenty-five surface water samples were collected from the wetland in 1991, and five surface water samples were collected in 1996 and 1997. The sample locations, sampling dates, prep method (filtered or unfiltered), and analyses performed on the surface water samples collected during this investigation are presented in Table 3-6. The results of this investigation are presented in Section 4.2.

Three of the six sampling areas at the wetland (W03, W05, and W06) were intended to be located in upland habitat with the remaining three located in the wetland habitat. However, based on vegetation types identified during the sampling effort, only two areas (W02 and W06) were considered wetland habitat. Upland plant samples consisted of wild oats (*Avena fatua*), foxtail grass (*Hordeum murinum/eporinum*), lotus (*Lotus* sp.), and wild radish (*Raphanus sativus* and *R raphanistrum*). The wetland plant samples were pickleweed (*Salicornia virginica*). The only small mammals collected at the wetland were house mice (*Mus musculus*). One composite sample of miscellaneous invertebrates was collected from all the upland areas and all the wetland areas because the number of invertebrates present in each sampling area was insufficient to constitute an individual sample

The northern pond in the wetland was randomly sampled for submerged vegetation (algae) and fish by sweeping the pond with a net. The dominant fish collected were larval silversides (Family Atherinae) that were generally less than 0.8 in. (2 cm) in length. Sufficient aquatic invertebrates were not found in the northern pond or in the sediment to constitute a complete sample for chemical analyses. The southern pond was sampled for fish and invertebrates. Sampling for invertebrates was conducted in the southern pond because sufficient numbers of invertebrates were not available for sampling from the northern pond. Additionally, the southern pond was also sampled for fish because it composes a large portion of the aquatic habitat in the wetland. Invertebrates that consisted solely of backswimmers (Corixidae) were collected by skimming the southern pond's top 4 in. (10 cm) with a 0.04-in. (1-mm) nylon mesh dipnet. The dominant fish collected in the southern pond was the threespine stickleback (*Gasterosteus aculeatus*), which ranged from 0.8 to 1.6 in. (2 to 4 cm) in length.

Tissue samples were also collected in a reference area for comparison with samples collected from the landfill, and to assist in estimating the baseline dose to ecological receptors at Alameda Point. The reference area sample locations, identification numbers, and analyses conducted are listed in Table 3-10. The seven sampling stations at the reference area were located in upland habitat and were sampled for small mammals, terrestrial vegetation, and invertebrates. The sampling stations are identified as Y01 through Y08 on Figure 3-5; Y07 is not identified on the figure because it is an area that was sampled only for small mammals for one night. No samples were collected and the sampling location subsequently was removed. Sampling of all of the reference area stations produced one composite terrestrial invertebrate sample.

3.2 Biological Surveys

3.2.1 Threatened and Endangered Species Surveys

A threatened and endangered species survey was conducted by Tetra Tech EM, Inc. (TtEMI) for the Department of the Navy at Alameda Point. The purpose of the survey was to determine the occurrence, or potential for occurrence, of threatened and endangered terrestrial and aquatic species at or near Alameda Point. The survey included both literature reviews and field surveys to identify likely potential threatened and endangered species. Results of threatened and endangered species surveys are useful in choosing appropriate assessment endpoints and must be considered when remedial alternatives are selected.

Table 3-10. Reference Area Samples

Station	Sample Type	Metals	PAH	Organotins	Pesticides	PCBs*	% Lipids	% Moisture
Y01	Terrestrial plant (grass)	X	X	X	X	X		
Y01	Mouse	X	X	X	X	X	X	X
Y02	Terrestrial plant (brome + grass)	X	X	X	X	X		
Y02	Mouse	X	X	X	X	X	X	X
Y03	Terrestrial plant (brome + sedge)	X	X	X	X	X		
Y03	Mouse	X	X	X	X	X	X	X
Y04	Terrestrial plant (brome + rush)	X	X	X	X	X		
Y04	Mouse	X	X	X	X	X	X	X
Y05	Terrestrial plant (brome + lotus)	X	X	X	X	X		
Y05	Mouse	X	X	X	X	X	X	X
Y06	Terrestrial plant (brome + sedge)	X	X	X	X	X		
Y(multi)	Terrestrial invertebrate	X	X		X	X	X	X
Y08	Mouse	X	X		X	X	X	X

*PCB = polychlorinated biphenyl.

During 1995, 1996, and 1997, field surveys were conducted to identify threatened and endangered species of plants and animals potentially present at Alameda Point. Surveys were conducted for plants, mammals, amphibians, reptiles, and birds. Field trapping surveys were conducted specifically for the endangered salt-marsh harvest mouse. Survey results are summarized in Section 4.5.

3.2.2 Plant Surveys

Plant surveys were conducted at IR Site 2 as part of the threatened and endangered species field surveys in 1997. The field surveys were performed by systematically traversing the survey area in parallel lines spaced 5 to 10 ft (1.5 to 3 m) apart. Terrestrial plant species were identified and documented to substantiate the presence or absence of any threatened, endangered, or sensitive plant species. Information from the plant surveys was used to help characterize the habitat at the landfill and the wetland. Results of the plant surveys are summarized in Section 4.6.

3.2.3 Benthic-Invertebrate Survey

Benthic-invertebrate community analyses of sediment from the wetland were conducted in 1993 and 1994. The purpose of these analyses was to determine whether chemicals present in the wetland were impacting benthic-invertebrate diversity or community structure. Four locations at the wetland were sampled to characterize the benthic-invertebrate community. Sediments were collected and sieved, and invertebrates present in the sediment were identified and catalogued as described in the workplans (PRC and Tetra Tech Inc., 1992a, 1992b). A summary of invertebrates collected and the results of the community analysis are presented in Section 4.7.

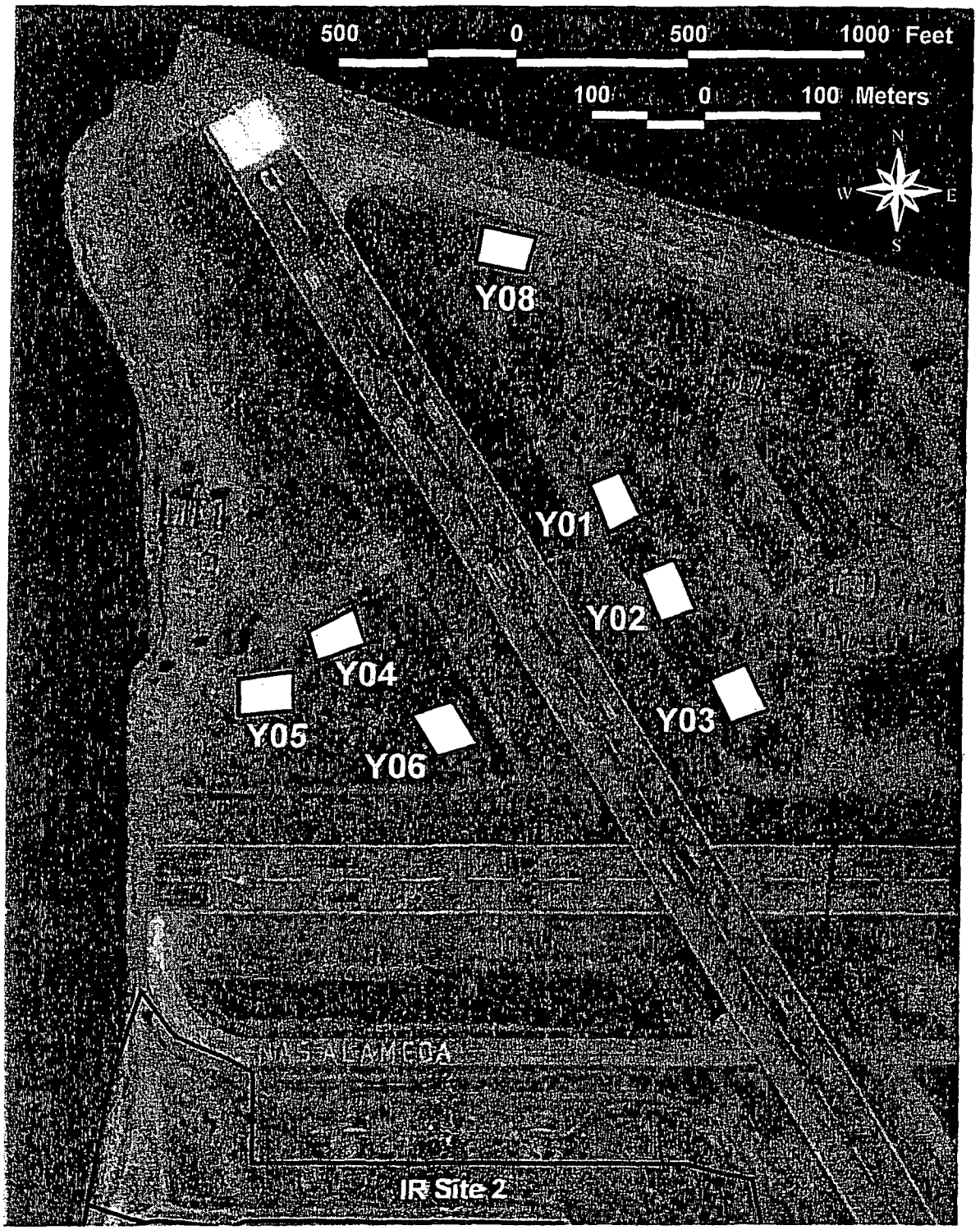

Figure 3-5. Locations of reference tissue sampling

3.2.4 Avian Survey

Between January and May 1997, avian surveys were conducted at the wetland to characterize the bird communities present at the site and to provide information for the selection of receptors for the ERA. The wetland was surveyed approximately bi-monthly. Ten individual surveys were conducted at the wetland on the following dates: January 13 and 28, February 13, March 3 and 22, April 3 and 18, and May 3, 22, and 29. A detailed description of the survey methodology and the results are presented in Appendix C.

3.2.5 Toxicity Tests

Toxicity tests were conducted on sediments collected from the wetland in 1993 and 1994 (see PRC and Tetra Tech Inc., 1992a, 1992b). Solid-phase toxicity tests were conducted on sediments from seven locations in the wetland. Sediments were collected from locations W1, W2, W3, W4, and W5 in the north pond, and stations W6 and W7 in the southern pond. (see Figure 3-4). Survival and reburial of the amphipod *Eohaustorius estuarius* and growth of the polychaete worm *Neanthes arenaceodentata* were measured in five replicate tests conducted on surface sediments from each of the seven sampling locations. The sample locations, identification numbers, methods, and dates of collection for the toxicity tests for the wetland are presented in Table 3-11. The results of the toxicity tests are presented and discussed in Section 4.8.

Table 3-11. Toxicity Test Samples

Station	Sampling Date	*Eohaustorius estuarius*	*Neanthes arenaceodentata*	Benthic-Community Analysis
Control		X[a]	X	
W1	?[b]	X	X	
W2	?	X	X	
W3	?	X	X	
W4	5 Apr 1993	X	X	X
W5	5 Apr 1993	X	X	X
W6	1 Apr 1993	X	X	X
W7	1 Apr 1993	X	X	X

[a] ? = sample collection date unknown.

[b] X = test performed.

3.2.6 Bioaccumulation Tests

Bioaccumulation studies using the clam *Macoma nasuta* and the sea-urchin *Strongylocentrotus purpuratus* were conducted on sediment samples collected from four locations in the wetland in 1993 and 1994 (Figure 3-3). These tests were conducted to determine if chemicals sorbed to

sediment were bioavailable to benthic organisms and were potentially bioaccumulating up through the food chain. The sample locations, sampling dates, and analyses performed for the bioaccumulation tests for the wetland are presented in Table 3-12. The results of the bioaccumulation studies are presented and discussed in Section 4.9.

3.3 Other Investigations

3.3.1 Radiation Survey

Because of the possibility that wastes from the radium-dial painting shop that operated at Alameda Point had been discarded in the landfill, several radiological surveys were conducted at the landfill. A near-surface radiological scoping survey of the accessible areas at the landfill was conducted in September 1995 by PRC Environmental Management (PRC, 1997a). Additional surveys were conducted by PRC from May to September 1996. These surveys identified a total of 40 radiological anomalies. A more comprehensive radiological survey of the landfill was performed in 1998 and 1999 by SSPORTS Environmental Detachment (SSPORTS, 1999a). The SSPORTS survey identified 951 points with radiation counts greater than the defined threshold of twice the background level. Radiological removal actions were conducted at 50 sites with radiation counts greater than 4 times local background (SSPORTS, 1999b).

3.3.2 Cone Penetrometer Survey

During 1994, a cone penetrometer test (CPT) survey was conducted at seven locations in the landfill (see Figure 3-3). This survey was part of a larger effort to characterize the lithology of Alameda Point. Table 3-13 lists the dates during which the CPT survey was conducted at IR Site 2 and the depths to which the cone penetrometer was driven. The information learned from this lithologic study is discussed in Section 2.3.1.3.2, Geology of Alameda IR Site 2.

3.3.3 Wetland Delineation and Wetland Evaluation Technique Analysis

Jurisdictional wetlands were delineated in February and March 1993. Results of the wetland delineation work were presented in the "Naval Air Station Alameda Preliminary Wetland Delineation" (HRG, 1993a). An analysis using WET was conducted at the jurisdictional wetland within the wetland in March 1993. Results of that work were presented in the "Naval Air Station Alameda WET Analysis" (HRG, 1993b). Results of these two analyses also are presented in detail in the draft ecological assessment report (PRC, 1994). The two analyses indicate that the amount of open water varies with season and rainfall, and the soil in the area can be classified as hydric where it occurs in depressions and in areas ponded for a long duration during the growing season. The water in the wetland appears to originate from three sources: seasonal ponding of precipitation; tidal Bay water that enters the area through a culvert on the western boundary of the wetland; and groundwater. The salinity of the wetland was found to be generally greater than 30 parts per thousand (HRG, 1993a).

Radionuclides—Radium-228 was detected infrequently and appears to be somewhat randomly distributed across the site in both surface and depth samples. Radium-226 was detected more frequently than Radium 228. However, the uniform concentrations across surface and depth samples suggest local background conditions rather than point source releases.

Summary—No pattern is evident in the distribution of detected organic constituents. There is some co-location within analyte suites, for example within the Aroclors and within the PAHs, which is to be expected for these suites. However, in general there is not enough evidence to establish a pattern of contamination.

4.2 Surface Water and Pore Water

The analysis of surface water and pore water was limited to exploratory data analysis. Surface water box plots are shown in Figures B-220 through B-264 in Appendix B. Symbols discriminate between the northern and southern ponds as well as between filtered and unfiltered samples.

Inorganics detected in greater than 5% of the surface water samples at IR Site 2 include antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, nickel, silver, vanadium and zinc. Along with the constituents commonly found in marine waters (aluminum, calcium, iron, magnesium, manganese, potassium and sodium), which are unlikely to be of concern, these constituents were found in filtered and unfiltered water samples from the wetland areas. No Aroclors were detected in wetland surface waters, and the 4,4-DDxs were detected in fewer than 5% of the samples. Heptachlor epoxide was also detected in more than 5% of the unfiltered water samples from both ponds. Bis(2-ethylhexyl)phthalate was detected in filtered water samples, but not in the unfiltered samples. The only PAH detected in surface water samples was acenaphthene, which was detected in three unfiltered samples collected in the northern pond.

In general, there does not appear to be a time trend associated with the surface waters, although the samples were not necessarily collected across a time scale that would show seasonal cycles, hence, any real trend may be obscured. Although all of the 1991 data result from filtered samples, in general, the concentration ranges cover those from other years, when either unfiltered or a combination of filtered and unfiltered analyses were performed. One might expect differences in concentrations between ponds, given the soil and sediment results from the wetland, however, no differences are apparent. The northern pond typically shows the maximum concentration in a box plot, but the concentration ranges and patterns are not sufficient to support the overall conclusion that the northern pond concentrations are elevated compared to the concentrations in the southern pond.

Only metals and 4,4-DDD and 4,4-DDE were detected in pore water samples. No VOCs, PAHs or other SVOCs, or pesticides other than 4,4-DDD and 4,4-DDT were detected in sediment pore water. Antimony, beryllium, and thallium were the only metals not detected in pore water. Surface water and pore water analyses suggest that most chemicals in the ponds are remaining bound to the sediment particles, and any that desorb are probably being flushed away by tidal action.

4.3 Groundwater

Tables 4-14 through 4-16 show summary statistics for surface and pore water data. Very few analytes were detected in 100% of the groundwater samples. As would be expected, inorganic constituents had the highest detection rates, but many of these constituents might be expected in a shallow aquifer that experiences tidal flux. Organic constituents were detected much less frequently; with the most frequently detected organic constituents detected in roughly 30% of the samples. The following constituents were detected in more than 5% of the samples. Areas of high concentration are identified for these constituents, although sampling efforts for certain constituents often focused on particular areas.

Arsenic—Arsenic had a high rate of detection across the entire site. The highest reported concentrations were for samples from stations M021-E and M038-A. Depth did not seem to be a factor in concentration.

Cadmium—Cadmium was detected in 4 of 23 unfiltered samples. Two of these detects are located at station M021-E.

Barium—Most barium samples were collected around the north and northeast perimeter of the wetland. Barium was detected in all samples with a range of approximately 40 to 1200 µg/l. Depth did not seem to be a factor in determining concentration.

Chromium—The highest concentrations were found on the northeast perimeter of the wetland area.

Cyanide—Almost all cyanide detects occurred in the northwest portion of the site at stations M022, M023, and M024. Samples closer to the surface had higher rates of detection as well as higher overall concentrations.

Lead—All three lead detects were near the surface on the northeast edge of the wetland.

Thallium—Of the five thallium detects, four were co-located (depth) with another station (stations M038-A, M038-B, M039-A, and M039-B).

Zinc—Sampling efforts for zinc focused on the northeast perimeter of the wetland as well as in the northern pond. The highest concentration occurred at station M038-A (183 µg/l). Increased depth may be slightly correlated with decreased concentration.

LMW PAHs—Samples for LMW PAHs were collected from several areas across the site. Low molecular PAHs were detected only in the landfill area and not in the coastal margin. Detection rates for the unfiltered samples in the landfill area were generally 25% to 30%. Most LMW PAHs were detected at various depths on the northeast perimeter of the wetland along the western end of the interior margin. Depth trends were not apparent and concentrations on a station-by-station basis seemed consistent across depths.

Table 4-14. Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	AROCLOR	Aroclor-1016	10	0	0			0.53	0.53
F	AROCLOR	Aroclor-1221	10	0	0			0.51	0.51
F	AROCLOR	Aroclor-1232	10	0	0			0.55	0.55
F	AROCLOR	Aroclor-1242	10	0	0			0.69	0.69
F	AROCLOR	Aroclor-1248	10	0	0			0.73	0.73
F	AROCLOR	Aroclor-1254	10	0	0			0.64	0.64
F	AROCLOR	Aroclor-1260	10	0	0			0.51	0.51
F	DDT 44	4,4'-DDD	10	1	10	0.094	0.094	0.01	0.01
F	DDT 44	4,4'-DDE	10	1	10	0.033	0.033	0.021	0.021
F	DDT 44	4,4'-DDT	10	1	10	0.2	0.2	0.013	0.013
F	METAL	Aluminum	17	17	100	62.9	666		
F	METAL	Antimony	17	6	35	3.6	193	2.4	126
F	METAL	Arsenic	17	12	71	2	14.8	1.8	3.2
F	METAL	Barium	17	13	76	35.8	141	61.5	72.7
F	METAL	Beryllium	17	0	0			0.2	1.3
F	METAL	Cadmium	17	0	0			0.2	3
F	METAL	Calcium	17	17	100	35800	580000		
F	METAL	Chromium	17	2	12	5.6	7.8	3.3	5.7
F	METAL	Cobalt	17	1	6	17.8	17.8	6.1	6.3
F	METAL	Copper	17	12	71	3.2	17.2	2.1	4.1
F	METAL	Iron	17	16	94	21.2	889	13	13
F	METAL	Lead	17	3	18	11	12.5	1	20
F	METAL	Magnesium	17	17	100	154000	2410000		
F	METAL	Manganese	17	17	100	8.5	13300		
F	METAL	Mercury	17	0	0			0.1	0.33
F	METAL	Molybdenum	10	2	20	5.4	5.5	5	5
F	METAL	Nickel	17	3	18	26.8	89	9.6	13.2
F	METAL	Potassium	17	17	100	66700	894000		
F	METAL	Selenium	17	0	0			2.2	42
F	METAL	Silver	17	7	41	5.9	9.6	1	1
F	METAL	Sodium	17	17	100	1460000	26500000		
F	METAL	Thallium	17	0	0			1.2	27
F	METAL	Vanadium	17	7	41	3.8	76	3.2	4.2
F	METAL	Zinc	17	5	29	7.2	13	2.3	11.5

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	PAH HIGH	Benzo(a)anthracene	10	0	0			1	1
F	PAH HIGH	Benzo(a)pyrene	10	0	0			1	1
F	PAH HIGH	Benzo(b)fluoranthene	10	0	0			1	1
F	PAH HIGH	Benzo(g,h,i)perylene	10	0	0			2	2
F	PAH HIGH	Benzo(k)fluoranthene	10	0	0			1	1
F	PAH HIGH	Chrysene	10	0	0			1	1
F	PAH HIGH	Dibenzo(a,h)anthracene	10	0	0			1	1
F	PAH HIGH	Fluoranthene	10	0	0			1	1
F	PAH HIGH	Indeno(1,2,3-cd)pyrene	10	0	0			1	1
F	PAH HIGH	Pyrene	10	0	0			1	1
F	PAH LOW	2-methylnaphthalene	10	0	0			1	1
F	PAH LOW	Acenaphthene	10	0	0			1	1
F	PAH LOW	Acenaphthylene	10	0	0			1	1
F	PAH LOW	Anthracene	10	0	0			1	1
F	PAH LOW	Fluorene	10	0	0			1	1
F	PAH LOW	Naphthalene	10	0	0			2	2
F	PAH LOW	Phenanthrene	10	0	0			1	1
F	PEST	Aldrin	10	0	0			0.041	0.041
F	PEST	Alpha-BHC	10	3	30	0.015	0.019	0.006	0.006
F	PEST	Alpha-chlordane	10	0	0			0.017	0.017
F	PEST	Beta-BHC	10	0	0			0.008	0.008
F	PEST	Delta-BHC	10	1	10	0.032	0.032	0.006	0.006
F	PEST	Dieldrin	10	0	0			0.015	0.015
F	PEST	Endosulfan I	10	0	0			0.005	0.005
F	PEST	Endosulfan II	10	0	0			0.021	0.021
F	PEST	Endosulfan sulfate	10	0	0			0.019	0.019
F	PEST	Endrin	10	0	0			0.013	0.013
F	PEST	Endrin aldehyde	10	0	0			0.027	0.027
F	PEST	Endrin ketone	10	0	0			0.018	0.018
F	PEST	Gamma-BHC (lindane)	10	2	20	0.008	0.009	0.004	0.004
F	PEST	Gamma-chlordane	10	0	0			0.013	0.013
F	PEST	Heptachlor	10	0	0			0.03	0.03
F	PEST	Heptachlor epoxide	10	5	50	0.023	0.039	0.006	0.006
F	PEST	Methoxychlor	10	0	0			0.046	0.046

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	PEST	Toxaphene	10	0	0			2.4	2.4
F	SVOA	1,2,4-trichlorobenzene	10	0	0			1	1
F	SVOA	1,2-dichlorobenzene	10	0	0			2	2
F	SVOA	1,3-dichlorobenzene	10	0	0			2	2
F	SVOA	1,4-dichlorobenzene	10	0	0			1	1
F	SVOA	2,2'-oxybis(1-chloropropane)	10	0	0			2	2
F	SVOA	2,4,5-trichlorophenol	10	0	0			1	1
F	SVOA	2,4,6-trichlorophenol	10	0	0			1	1
F	SVOA	2,4-dichlorophenol	10	0	0			1	1
F	SVOA	2,4-dimethylphenol	10	0	0			4	4
F	SVOA	2,4-dinitrophenol	10	0	0			2	2
F	SVOA	2,4-dinitrotoluene	10	0	0			1	1
F	SVOA	2,6-dinitrotoluene	10	0	0			1	1
F	SVOA	2-chloronaphthalene	10	0	0			1	1
F	SVOA	2-chlorophenol	10	0	0			1	1
F	SVOA	2-methylphenol	10	0	0			1	1
F	SVOA	2-nitroaniline	10	0	0			1	1
F	SVOA	2-nitrophenol	10	0	0			1	1
F	SVOA	3,3'-dichlorobenzidine	10	0	0			5	5
F	SVOA	3-nitroaniline	10	0	0			7	7
F	SVOA	4,6-dinitro-2-methylphenol	10	0	0			1	1
F	SVOA	4-bromophenyl-phenylether	10	0	0			1	1
F	SVOA	4-chloro-3-methylphenol	10	0	0			1	1
F	SVOA	4-chloroaniline	10	0	0			6	6
F	SVOA	4-chlorophenyl-phenylether	10	0	0			1	1
F	SVOA	4-methylphenol	10	0	0			1	1
F	SVOA	4-nitroaniline	10	0	0			5	5
F	SVOA	4-nitrophenol	10	0	0			1	1
F	SVOA	Bis(2-chloroethoxy)methane	10	0	0			1	1
F	SVOA	Bis(2-chloroethyl)ether	10	0	0			1	1
F	SVOA	Bis(2-ethylhexyl)phthalate	10	6	60	17	310	4	62
F	SVOA	Butylbenzylphthalate	10	0	0			1	1
F	SVOA	Carbazole	10	0	0			1	1
F	SVOA	Di-n-butylphthalate	10	0	0			1	4

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	SVOA	Di-n-octylphthalate	10	0	0			1	3
F	SVOA	Dibenzofuran	10	0	0			1	1
F	SVOA	Diethylphthalate	10	0	0			1	1
F	SVOA	Dimethylphthalate	10	0	0			1	1
F	SVOA	Hexachlorobenzene	10	0	0			2	2
F	SVOA	Hexachlorobutadiene	10	0	0			2	2
F	SVOA	Hexachlorocyclopentadiene	10	0	0			1	1
F	SVOA	Hexachloroethane	10	0	0			2	2
F	SVOA	Isophorone	10	0	0			1	1
F	SVOA	N-nitroso-di-n-propylamine	10	0	0			2	2
F	SVOA	N-nitrosodiphenylamine (1)	10	0	0			3	6
F	SVOA	Nitrobenzene	10	0	0			1	1
F	SVOA	Pentachlorophenol	10	0	0			1	1
F	SVOA	Phenol	10	0	0			1	1
U	ANION	Chloride[c]	7	7	100	5342	56950		
U	ANION	Fluoride[c]	7	7	100	0.16	0.74		
U	ANION	Nitrate/nitrite (as N)[c]	7	5	71	0.022	0.331	0.01	0.01
U	ANION	Sulfate[c]	7	6	86	2073	7625	25	25
U	AROCLOR	Aroclor-1016	20	0	0			0.2	0.53
U	AROCLOR	Aroclor-1221	20	0	0			0.4	0.51
U	AROCLOR	Aroclor-1232	20	0	0			0.2	0.55
U	AROCLOR	Aroclor-1242	20	0	0			0.2	0.69
U	AROCLOR	Aroclor-1248	20	0	0			0.2	0.73
U	AROCLOR	Aroclor-1254	20	0	0			0.2	0.64
U	AROCLOR	Aroclor-1260	20	0	0			0.2	0.51
U	DDT 44	4,4'-DDD	20	1	5	0.018	0.018	0.01	0.1
U	DDT 44	4,4'-DDE	20	0	0			0.02	0.05
U	DDT 44	4,4'-DDT	20	0	0			0.013	0.1
U	METAL	Aluminum	13	13	100	222	3340		
U	METAL	Antimony	13	5	38	2.9	3.4	2.4	16
U	METAL	Arsenic	13	2	15	5.5	12.2	3	10
U	METAL	Barium	13	13	100	15.9	100		
U	METAL	Beryllium	13	0	0			0.1	0.5
U	METAL	Cadmium	13	1	8	1	1	0.2	0.68

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	METAL	Calcium	13	13	100	87400	306000		
U	METAL	Chromium	13	4	31	2.4	16.8	1	9
U	METAL	Cobalt	13	1	8	7.5	7.5	1.2	6.3
U	METAL	Copper	13	12	92	4.3	26.5	3.8	3.8
U	METAL	Iron	13	13	100	342	9720		
U	METAL	Lead	13	3	23	4.1	10	1	5.5
U	METAL	Magnesium	13	13	100	157000	1110000		
U	METAL	Manganese	13	13	100	35.6	504		
U	METAL	Mercury	13	0	0			0.1	0.2
U	METAL	Molybdenum	13	4	31	5	16.6	5	7
U	METAL	Nickel	13	9	69	3.8	18.3	9.6	9.6
U	METAL	Potassium	13	13	100	68200	333000		
U	METAL	Selenium	13	0	0			2.2	15.5
U	METAL	Silver	13	2	15	1.3	6.6	0.6	1.5
U	METAL	Sodium	13	13	100	1430000	9190000		
U	METAL	Thallium	13	0	0			1.2	8
U	METAL	Vanadium	13	11	85	4.2	17.3	3.1	3.2
U	METAL	Zinc	13	3	23	12.2	130	9.8	84.8
U	PAH HIGH	Benzo(a)anthracene	20	0	0			1	5
U	PAH HIGH	Benzo(a)pyrene	20	0	0			1	5
U	PAH HIGH	Benzo(b)fluoranthene	20	0	0			1	5
U	PAH HIGH	Benzo(g,h,i)perylene	20	0	0			2	5
U	PAH HIGH	Benzo(k)fluoranthene	20	0	0			1	5
U	PAH HIGH	Chrysene	20	0	0			1	5
U	PAH HIGH	Dibenzo(a,h)anthracene	20	0	0			1	5
U	PAH HIGH	Fluoranthene	20	0	0			1	5
U	PAH HIGH	Indeno(1,2,3-cd)pyrene	20	0	0			1	5
U	PAH HIGH	Pyrene	20	0	0			1	5
U	PAH LOW	2-methylnaphthalene	20	0	0			1	5
U	PAH LOW	Acenaphthene	20	3	15	2	2	1	5
U	PAH LOW	Acenaphthylene	20	0	0			1	5
U	PAH LOW	Anthracene	20	0	0			1	5
U	PAH LOW	Fluorene	20	0	0			1	5
U	PAH LOW	Naphthalene	20	0	0			1	5

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	PAH LOW	Phenanthrene	20	0	0			1	5
U	PEST	Aldrin	20	0	0			0.01	0.05
U	PEST	Alpha-BHC	20	4	20	0.01	0.018	0.006	0.025
U	PEST	Alpha-chlordane	20	0	0			0.01	0.05
U	PEST	Beta-BHC	20	0	0			0.008	0.05
U	PEST	Delta-BHC	20	0	0			0.006	0.05
U	PEST	Dieldrin	20	1	5	0.022	0.022	0.015	0.05
U	PEST	Endosulfan I	20	1	5	0.009	0.009	0.005	0.05
U	PEST	Endosulfan II	20	0	0			0.02	0.1
U	PEST	Endosulfan sulfate	20	0	0			0.019	0.1
U	PEST	Endrin	20	0	0			0.013	0.05
U	PEST	Endrin aldehyde	13	0	0			0.02	0.027
U	PEST	Endrin ketone	20	0	0			0.018	0.1
U	PEST	Gamma-BHC (lindane)	20	1	5	0.012	0.012	0.004	0.025
U	PEST	Gamma-chlordane	20	0	0			0.01	0.05
U	PEST	Heptachlor	20	0	0			0.01	0.05
U	PEST	Heptachlor epoxide	20	5	25	0.025	0.057	0.006	0.05
U	PEST	Methoxychlor	20	0	0			0.046	0.5
U	PEST	Toxaphene	20	0	0			1	2.4
U	SVOA	1,2,4-trichlorobenzene	20	0	0			1	5
U	SVOA	1,2-dichlorobenzene	20	0	0			1	5
U	SVOA	1,3-dichlorobenzene	20	0	0			1	5
U	SVOA	1,4-dichlorobenzene	20	0	0			1	5
U	SVOA	2,2'-oxybis(1-chloropropane)	20	0	0			1	5
U	SVOA	2,4,5-trichlorophenol	19	0	0			1	20
U	SVOA	2,4,6-trichlorophenol	19	0	0			1	5
U	SVOA	2,4-dichlorophenol	19	0	0			1	5
U	SVOA	2,4-dimethylphenol	19	0	0			2	5
U	SVOA	2,4-dinitrophenol	19	0	0			2	30
U	SVOA	2,4-dinitrotoluene	20	0	0			1	5
U	SVOA	2,6-dinitrotoluene	20	0	0			1	5
U	SVOA	2-chloronaphthalene	20	0	0			1	5
U	SVOA	2-chlorophenol	19	0	0			1	5
U	SVOA	2-methylphenol	19	0	0			1	5

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	SVOA	2-nitroaniline	20	0	0			1	20
U	SVOA	2-nitrophenol	19	0	0			1	5
U	SVOA	3,3'-dichlorobenzidine	20	0	0			5	5
U	SVOA	3-nitroaniline	20	0	0			1	20
U	SVOA	4,6-dinitro-2-methylphenol	19	0	0			1	20
U	SVOA	4-bromophenyl-phenylether	20	0	0			1	5
U	SVOA	4-chloro-3-methylphenol	20	0	0			1	5
U	SVOA	4-chloroaniline	20	0	0			2	6
U	SVOA	4-chlorophenyl-phenylether	20	0	0			1	5
U	SVOA	4-methylphenol	19	0	0			1	5
U	SVOA	4-nitroaniline	20	0	0			2	20
U	SVOA	4-nitrophenol	19	0	0			1	20
U	SVOA	Benzoic acid	7	0	0			2.5	2.5
U	SVOA	Benzyl alcohol	7	0	0			2	2
U	SVOA	Bis(2-chloroethoxy)methane	20	0	0			1	5
U	SVOA	Bis(2-chloroethyl)ether	20	0	0			1	5
U	SVOA	Bis(2-ethylhexyl)phthalate	20	0	0			2	24
U	SVOA	Butylbenzylphthalate	20	0	0			1	5
U	SVOA	Carbazole	13	0	0			1	5
U	SVOA	Di-n-butylphthalate	20	0	0			1	5
U	SVOA	Di-n-octylphthalate	20	0	0			1	5
U	SVOA	Dibenzofuran	20	0	0			1	5
U	SVOA	Diethylphthalate	20	0	0			1	5
U	SVOA	Dimethylphthalate	20	0	0			1	5
U	SVOA	Hexachlorobenzene	20	0	0			2	5
U	SVOA	Hexachlorobutadiene	20	0	0			2	5
U	SVOA	Hexachlorocyclopentadiene	20	0	0			1	5
U	SVOA	Hexachloroethane	20	0	0			1.5	5
U	SVOA	Isophorone	20	0	0			1	5
U	SVOA	N-nitroso-di-n-propylamine	20	0	0			1	5
U	SVOA	N-nitrosodiphenylamine (1)	20	0	0			1	6
U	SVOA	Nitrobenzene	20	0	0			1	5
U	SVOA	Pentachlorophenol	19	0	0			1	20
U	SVOA	Phenol	19	0	0			1	5

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	TBT	Dibutyl tin	3	0	0			50	50
U	TBT	Monobutyl tin	3	0	0			50	50
U	TBT	Tetrabutyl tin	3	0	0			50	50
U	TBT	Tributyl tin	3	0	0			50	50
U	TPH	Diesel range organics	3	0	0			100	100
U	TPH	Gasoline range organics	3	0	0			50	50
U	TPH	Motor oil range organics	3	0	0			100	100
U	TRPH	Total recoverable petroleum hydrocarbons[c]	7	1	14	0.28	0.28	0.17	0.18
U	VOA	1,1,1-trichloroethane	7	0	0			1	1
U	VOA	1,1,2,2-tetrachloroethane	7	0	0			1	1
U	VOA	1,1,2-trichloroethane	7	0	0			1	1
U	VOA	1,1-dichloroethane	7	0	0			1	1
U	VOA	1,1-dichloroethene	7	0	0			1	1
U	VOA	1,2-dichloroethane	7	0	0			1	1
U	VOA	1,2-dichloropropane	7	0	0			1	1
U	VOA	2-butanone	7	0	0			2	2
U	VOA	2-hexanone	7	0	0			2	2
U	VOA	4-methyl-2-pentanone	7	0	0			2	2
U	VOA	Acetone	7	0	0			2	2
U	VOA	Benzene	7	0	0			1	1
U	VOA	Bromodichloromethane	7	0	0			1	1
U	VOA	Bromoform	7	0	0			1	1
U	VOA	Bromomethane	7	0	0			1	1
U	VOA	Carbon disulfide	7	0	0			1	1
U	VOA	Carbon tetrachloride	7	0	0			1	1
U	VOA	Chlorobenzene	7	0	0			1	1
U	VOA	Chloroethane	7	0	0			1	1
U	VOA	Chloroform	7	0	0			1	1
U	VOA	Chloromethane	7	1	14	2.4	2.4	1	1
U	VOA	Cis-1,3-dichloropropene	7	0	0			1	1
U	VOA	Dibromochloromethane	7	0	0			1	1
U	VOA	Ethylbenzene	7	0	0			1	1
U	VOA	Methylene chloride	7	0	0			1	1

Table 4-14 (continued). Summary Statistics for Surface Water Data, North Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	VOA	Styrene	7	0	0			1	1
U	VOA	Tetrachloroethene	7	0	0			1	1
U	VOA	Toluene	7	0	0			1	1
U	VOA	Trans-1,2-dichloroethene	7	0	0			1	1
U	VOA	Trans-1,3-dichloropropene	7	0	0			1	1
U	VOA	Trichloroethene	7	0	0			1	1
U	VOA	Vinyl acetate	7	0	0			1	1
U	VOA	Vinyl chloride	7	0	0			1	1
U	VOA	Xylene (total)	7	0	0			1	1

[a] F = filtered, U = unfiltered

[b] Values reported in micrograms per liter except as noted.

[c] Values reported in milligrams per liter.

Table 4-15. Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	AROCLOR	Aroclor-1016	5	0	0			0.53	0.53
F	AROCLOR	Aroclor-1221	5	0	0			0.51	0.51
F	AROCLOR	Aroclor-1232	5	0	0			0.55	0.55
F	AROCLOR	Aroclor-1242	5	0	0			0.69	0.69
F	AROCLOR	Aroclor-1248	5	0	0			0.73	0.73
F	AROCLOR	Aroclor-1254	5	0	0			0.64	0.64
F	AROCLOR	Aroclor-1260	5	0	0			0.51	0.51
F	DDT 44	4,4'-DDD	5	0	0			0.01	0.01
F	DDT 44	4,4'-DDE	5	0	0			0.021	0.021
F	DDT 44	4,4'-DDT	5	0	0			0.013	0.013
F	METAL	Aluminum	23	8	35	35.1	1220	31	31
F	METAL	Antimony	23	17	74	3	218	2.4	126
F	METAL	Arsenic	23	20	87	3.3	14.5	5.5	13

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	METAL	Barium	23	21	91	56.9	93.9	77.8	80.5
F	METAL	Beryllium	23	0	0			0.2	1.3
F	METAL	Cadmium	23	0	0			0.2	3
F	METAL	Calcium	23	23	100	104000	716000		
F	METAL	Chromium	23	0	0			3.3	5.7
F	METAL	Cobalt	23	0	0			6.1	6.3
F	METAL	Copper	23	21	91	2.2	37.3	2.1	2.1
F	METAL	Iron	23	6	26	36.5	1750	6.2	6.2
F	METAL	Lead	23	4	17	11.5	18.5	1	20
F	METAL	Magnesium	23	23	100	209000	1920000		
F	METAL	Manganese	23	16	70	8	206	4.5	4.5
F	METAL	Mercury	23	0	0			0.1	0.55
F	METAL	Molybdenum	5	0	0			5	5
F	METAL	Nickel	23	21	91	13.6	23.3	13.2	13.2
F	METAL	Potassium	23	23	100	86100	629000		
F	METAL	Selenium	23	3	13	10.5	30.5	2.2	21
F	METAL	Silver	23	18	78	5.5	10.2	1	1
F	METAL	Sodium	23	23	100	1920000	17700000		
F	METAL	Thallium	23	0	0			1.2	13.5
F	METAL	Vanadium	23	19	83	5.7	73	3.2	3.2
F	METAL	Zinc	23	4	17	13.2	31.8	6.8	11.5
F	PAH HIGH	Benzo(a)anthracene	5	0	0			1	1
F	PAH HIGH	Benzo(a)pyrene	5	0	0			1	1
F	PAH HIGH	Benzo(b)fluoranthene	5	0	0			1	1
F	PAH HIGH	Benzo(g,h,i)perylene	5	0	0			2	2
F	PAH HIGH	Benzo(k)fluoranthene	5	0	0			1	1
F	PAH HIGH	Chrysene	5	0	0			1	1
F	PAH HIGH	Dibenzo(a,h)anthracene	5	0	0			1	1
F	PAH HIGH	Fluoranthene	5	0	0			1	1
F	PAH HIGH	Indeno(1,2,3-cd)pyrene	5	0	0			1	1
F	PAH HIGH	Pyrene	5	0	0			1	1
F	PAH LOW	2-methylnaphthalene	5	0	0			1	1
F	PAH LOW	Acenaphthene	5	0	0			1	1
F	PAH LOW	Acenaphthylene	5	0	0			1	1

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	PAH LOW	Anthracene	5	0	0			1	1
F	PAH LOW	Fluorene	5	0	0			1	1
F	PAH LOW	Naphthalene	5	0	0			2	2
F	PAH LOW	Phenanthrene	5	0	0			1	1
F	PEST	Aldrin	5	0	0			0.041	0.041
F	PEST	Alpha-BHC	5	2	40	0.014	0.015	0.006	0.006
F	PEST	Alpha-chlordane	5	0	0			0.017	0.017
F	PEST	Beta-BHC	5	0	0			0.008	0.008
F	PEST	Delta-BHC	5	0	0			0.006	0.006
F	PEST	Dieldrin	5	0	0			0.01	0.015
F	PEST	Endosulfan I	5	0	0			0.005	0.005
F	PEST	Endosulfan II	5	0	0			0.021	0.027
F	PEST	Endosulfan sulfate	5	0	0			0.019	0.019
F	PEST	Endrin	5	0	0			0.013	0.013
F	PEST	Endrin aldehyde	5	0	0			0.027	0.027
F	PEST	Endrin ketone	5	0	0			0.018	0.018
F	PEST	Gamma-bhc (lindane)	5	1	20	0.007	0.007	0.004	0.004
F	PEST	Gamma-chlordane	5	0	0			0.013	0.013
F	PEST	Heptachlor	5	0	0			0.03	0.03
F	PEST	Heptachlor epoxide	5	4	80	0.008	0.011	0.006	0.006
F	PEST	Methoxychlor	5	0	0			0.046	0.046
F	PEST	Toxaphene	5	0	0			2.4	2.4
F	SVOA	1,2,4-trichlorobenzene	5	0	0			1	1
F	SVOA	1,2-dichlorobenzene	5	0	0			2	2
F	SVOA	1,3-dichlorobenzene	5	0	0			2	2
F	SVOA	1,4-dichlorobenzene	5	0	0			1	1
F	SVOA	2,2'-oxybis(1-chloropropane)	5	0	0			2	2
F	SVOA	2,4,5-trichlorophenol	5	0	0			1	1
F	SVOA	2,4,6-trichlorophenol	5	0	0			1	1
F	SVOA	2,4-dichlorophenol	5	0	0			1	1
F	SVOA	2,4-dimethylphenol	5	0	0			4	4
F	SVOA	2,4-dinitrophenol	5	0	0			2	2
F	SVOA	2,4-dinitrotoluene	5	0	0			1	1
F	SVOA	2,6-dinitrotoluene	5	0	0			1	1

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	SVOA	2-chloronaphthalene	5	0	0			1	1
F	SVOA	2-chlorophenol	5	0	0			1	1
F	SVOA	2-methylphenol	5	0	0			1	1
F	SVOA	2-nitroaniline	5	0	0			1	1
F	SVOA	2-nitrophenol	5	0	0			1	1
F	SVOA	3,3'-dichlorobenzidine	5	0	0			5	5
F	SVOA	3-nitroaniline	5	0	0			7	7
F	SVOA	4,6-dinitro-2-methylphenol	5	0	0			1	1
F	SVOA	4-bromophenyl-phenylether	5	0	0			1	1
F	SVOA	4-chloro-3-methylphenol	5	0	0			1	1
F	SVOA	4-chloroaniline	5	0	0			6	6
F	SVOA	4-chlorophenyl-phenylether	5	0	0			1	1
F	SVOA	4-methylphenol	5	0	0			1	1
F	SVOA	4-nitroaniline	5	0	0			5	5
F	SVOA	4-nitrophenol	5	0	0			1	1
F	SVOA	Bis(2-chloroethoxy)methane	5	0	0			1	1
F	SVOA	Bis(2-chloroethyl)ether	5	0	0			1	1
F	SVOA	Bis(2-ethylhexyl)phthalate	5	1	20	18	18	2	47
F	SVOA	Butylbenzylphthalate	5	0	0			1	1
F	SVOA	Carbazole	5	0	0			1	1
F	SVOA	Di-n-butylphthalate	5	0	0			1	2
F	SVOA	Di-n-octylphthalate	5	0	0			1	3
F	SVOA	Dibenzofuran	5	0	0			1	1
F	SVOA	Diethylphthalate	5	0	0			1	1
F	SVOA	Dimethylphthalate	5	0	0			1	1
F	SVOA	Hexachlorobenzene	5	0	0			2	2
F	SVOA	Hexachlorobutadiene	5	0	0			2	2
F	SVOA	Hexachlorocyclopentadiene	5	0	0			1	1
F	SVOA	Hexachloroethane	5	0	0			2	2
F	SVOA	Isophorone	5	0	0			1	1
F	SVOA	N-nitroso-di-n-propylamine	5	0	0			2	2
F	SVOA	N-nitrosodiphenylamine (1)	5	0	0			3	6
F	SVOA	Nitrobenzene	5	0	0			1	1
F	SVOA	Pentachlorophenol	5	0	0			1	1

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
F	SVOA	Phenol	5	0	0			1	1
U	ANION	Chloride[c]	18	18	100	24970	32020		
U	ANION	Fluoride[c]	18	18	100	0.13	0.15		
U	ANION	Nitrate/nitrite (as N)[c]	18	18	100	0.03	433		
U	ANION	Sulfate[c]	18	18	100	5795	7597		
U	AROCLOR	Aroclor-1016	24	0	0			0.2	0.53
U	AROCLOR	Aroclor-1221	24	0	0			0.2	0.515
U	AROCLOR	Aroclor-1232	24	0	0			0.2	0.55
U	AROCLOR	Aroclor-1242	24	0	0			0.2	0.69
U	AROCLOR	Aroclor-1248	24	0	0			0.2	0.73
U	AROCLOR	Aroclor-1254	24	0	0			0.2	0.64
U	AROCLOR	Aroclor-1260	24	0	0			0.2	0.515
U	DDT 44	4,4'-DDD	24	0	0			0.01	0.103
U	DDT 44	4,4'-DDE	24	0	0			0.02	0.052
U	DDT 44	4,4'-DDT	24	0	0			0.013	0.103
U	METAL	Aluminum	6	5	83	251	3330	61.1	61.1
U	METAL	Antimony	6	1	17	15.5	15.5	2.1	2.4
U	METAL	Arsenic	6	2	33	7.6	7.6	6.7	8
U	METAL	Barium	6	6	100	46.3	72.1		
U	METAL	Beryllium	6	0	0			0.04	0.2
U	METAL	Cadmium	6	0	0			0.2	1.2
U	METAL	Calcium	6	6	100	106000	130000		
U	METAL	Chromium	6	1	17	1.1	1.1	3.3	8.4
U	METAL	Cobalt	6	1	17	1.2	1.2	6.3	6.3
U	METAL	Copper	6	6	100	8.5	39.7		
U	METAL	Iron	6	6	100	210	4160		
U	METAL	Lead	6	2	33	1.9	5.6	1	3.8
U	METAL	Magnesium	6	6	100	204000	439000		
U	METAL	Manganese	6	6	100	137	199		
U	METAL	Mercury	6	0	0			0.1	0.26
U	METAL	Molybdenum	6	0	0			1.4	5
U	METAL	Nickel	6	4	67	14.3	27	9.6	9.6
U	METAL	Potassium	6	6	100	80500	138000		
U	METAL	Selenium	6	0	0			2.1	4.6

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	METAL	Silver	6	0	0			0.5	1.5
U	METAL	Sodium	6	6	100	1910000	3430000		
U	METAL	Thallium	6	0	0			1.2	2.4
U	METAL	Vanadium	6	5	83	1.8	10.6	3.2	3.2
U	METAL	Zinc	6	1	17	8.5	8.5	20.1	43.1
U	PAH HIGH	Benzo(a)anthracene	24	0	0			1	5
U	PAH HIGH	Benzo(a)pyrene	24	0	0			1	5
U	PAH HIGH	Benzo(b)fluoranthene	24	0	0			1	5
U	PAH HIGH	Benzo(g,h,i)perylene	24	0	0			2	5
U	PAH HIGH	Benzo(k)fluoranthene	24	0	0			1	5
U	PAH HIGH	Chrysene	24	0	0			1	5
U	PAH HIGH	Dibenzo(a,h)anthracene	24	0	0			1	5
U	PAH HIGH	Fluoranthene	24	0	0			1	5
U	PAH HIGH	Indeno(1,2,3-cd)pyrene	24	0	0			1	5
U	PAH HIGH	Pyrene	24	0	0			1	5
U	PAH LOW	2-methylnaphthalene	24	0	0			1	5
U	PAH LOW	Acenaphthene	24	0	0			1	5
U	PAH LOW	Acenaphthylene	24	0	0			1	5
U	PAH LOW	Anthracene	24	0	0			1	5
U	PAH LOW	Fluorene	24	0	0			1	5
U	PAH LOW	Naphthalene	24	0	0			1	5
U	PAH LOW	Phenanthrene	24	0	0			1	5
U	PEST	Aldrin	24	0	0			0.01	0.052
U	PEST	Alpha-BHC	24	0	0			0.006	0.026
U	PEST	Alpha-chlordane	24	0	0			0.01	0.052
U	PEST	Beta-BHC	24	0	0			0.008	0.052
U	PEST	Delta-BHC	24	0	0			0.006	0.052
U	PEST	Dieldrin	24	0	0			0.015	0.052
U	PEST	Endosulfan I	24	0	0			0.005	0.052
U	PEST	Endosulfan II	24	0	0			0.02	0.103
U	PEST	Endosulfan sulfate	24	0	0			0.019	0.103
U	PEST	Endrin	24	0	0			0.013	0.052
U	PEST	Endrin aldehyde	6	0	0			0.02	0.027
U	PEST	Endrin ketone	24	0	0			0.018	0.103

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	PEST	Gamma-BHC (lindane)	24	1	4	0.005	0.005	0.004	0.026
U	PEST	Gamma-chlordane	24	0	0			0.01	0.052
U	PEST	Heptachlor	24	0	0			0.01	0.052
U	PEST	Heptachlor epoxide	24	4	17	0.006	0.096	0.006	0.052
U	PEST	Methoxychlor	24	0	0			0.046	0.515
U	PEST	Toxaphene	24	0	0			1	2.4
U	SVOA	1,2,4-trichlorobenzene	24	0	0			1	5
U	SVOA	1,2-dichlorobenzene	24	0	0			1	5
U	SVOA	1,3-dichlorobenzene	24	0	0			1	5
U	SVOA	1,4-dichlorobenzene	24	0	0			1	5
U	SVOA	2,2'-oxybis(1-chloropropane)	24	0	0			1	5
U	SVOA	2,4,5-trichlorophenol	24	0	0			1	20
U	SVOA	2,4,6-trichlorophenol	24	0	0			1	5
U	SVOA	2,4-dichlorophenol	24	0	0			1	5
U	SVOA	2,4-dimethylphenol	24	0	0			2	5
U	SVOA	2,4-dinitrophenol	24	0	0			2	30
U	SVOA	2,4-dinitrotoluene	24	0	0			1	5
U	SVOA	2,6-dinitrotoluene	24	0	0			1	5
U	SVOA	2-chloronaphthalene	24	0	0			1	5
U	SVOA	2-chlorophenol	24	0	0			1	5
U	SVOA	2-methylphenol	24	0	0			1	5
U	SVOA	2-nitroaniline	24	0	0			1	20
U	SVOA	2-nitrophenol	24	0	0			1	5
U	SVOA	3,3'-dichlorobenzidine	24	0	0			5	5
U	SVOA	3-nitroaniline	24	0	0			1	20
U	SVOA	4,6-dinitro-2-methylphenol	24	0	0			1	20
U	SVOA	4-bromophenyl-phenylether	24	0	0			1	5
U	SVOA	4-chloro-3-methylphenol	24	0	0			1	5
U	SVOA	4-chloroaniline	24	0	0			2	6
U	SVOA	4-chlorophenyl-phenylether	24	0	0			1	5
U	SVOA	4-methylphenol	24	0	0			1	5
U	SVOA	4-nitroaniline	24	0	0			2	20
U	SVOA	4-nitrophenol	24	0	0			1	20
U	SVOA	Benzoic acid	18	0	0			2.5	2.5

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	SVOA	Benzyl alcohol	18	0	0			2	2
U	SVOA	Bis(2-chloroethoxy)methane	24	0	0			1	5
U	SVOA	Bis(2-chloroethyl)ether	24	0	0			1	5
U	SVOA	Bis(2-ethylhexyl)phthalate	24	0	0			2	12
U	SVOA	Butylbenzylphthalate	24	0	0			1	5
U	SVOA	Carbazole	6	0	0			1	5
U	SVOA	Di-n-butylphthalate	24	0	0			1	5
U	SVOA	Di-n-octylphthalate	24	0	0			1	5
U	SVOA	Dibenzofuran	24	0	0			1	5
U	SVOA	Diethylphthalate	24	0	0			1	5
U	SVOA	Dimethylphthalate	24	0	0			1	5
U	SVOA	Hexachlorobenzene	24	0	0			2	5
U	SVOA	Hexachlorobutadiene	24	0	0			2	5
U	SVOA	Hexachlorocyclopentadiene	24	0	0			1	5
U	SVOA	Hexachloroethane	24	0	0			1.5	5
U	SVOA	Isophorone	24	0	0			1	5
U	SVOA	N-nitroso-di-n-propylamine	24	0	0			1	5
U	SVOA	N-nitrosodiphenylamine (1)	24	0	0			1	6
U	SVOA	Nitrobenzene	24	0	0			1	5
U	SVOA	Pentachlorophenol	24	0	0			1	20
U	SVOA	Phenol	24	0	0			1	5
U	TBT	Dibutyl tin	1	0	0			38	38
U	TBT	Monobutyl tin	1	0	0			31	31
U	TBT	Tetrabutyl tin	1	0	0			50	50
U	TBT	Tributyl tin	1	0	0			44	44
U	TPH	Diesel range organics	1	0	0			100	100
U	TPH	Gasoline range organics	1	0	0			50	50
U	TPH	Motor oil range organics	1	1	100	410	410		
U	TRPH	Total recoverable petroleum hydrocarbons[c]	18	0	0			0.17	0.2
U	VOA	1,1,1-trichloroethane	18	0	0			1	1
U	VOA	1,1,2,2-tetrachloroethane	18	0	0			1	1
U	VOA	1,1,2-trichloroethane	18	0	0			1	1
U	VOA	1,1-dichloroethane	18	0	0			1	1

Table 4-15 (continued). Summary Statistics for Surface Water Data, South Pond

Sample Prep[a]	Suite	Analyte[b]	Number of Samples			Detects		Nondetects	
			Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
U	VOA	1,1-dichloroethene	18	0	0			1	1
U	VOA	1,2-dichloroethane	18	0	0			1	1
U	VOA	1,2-dichloropropane	18	0	0			1	1
U	VOA	2-butanone	18	0	0			2	2
U	VOA	2-hexanone	18	0	0			2	2
U	VOA	4-methyl-2-pentanone	18	0	0			2	2
U	VOA	Acetone	18	0	0			2	5.2
U	VOA	Benzene	18	0	0			1	1
U	VOA	Bromodichloromethane	18	0	0			1	1
U	VOA	Bromoform	18	0	0			1	1
U	VOA	Bromomethane	18	0	0			1	1
U	VOA	Carbon disulfide	18	0	0			1	1
U	VOA	Carbon tetrachloride	18	0	0			1	1
U	VOA	Chlorobenzene	18	0	0			1	1
U	VOA	Chloroethane	18	0	0			1	1
U	VOA	Chloroform	18	0	0			1	1
U	VOA	Chloromethane	18	0	0			1	1
U	VOA	Cis-1,3-dichloropropene	18	0	0			1	1
U	VOA	Dibromochloromethane	18	0	0			1	1
U	VOA	Ethylbenzene	18	0	0			1	1
U	VOA	Methylene chloride	18	0	0			1	2
U	VOA	Styrene	18	0	0			1	1
U	VOA	Tetrachloroethene	18	0	0			1	1
U	VOA	Toluene	18	0	0			1	1
U	VOA	Trans-1,2-dichloroethene	18	0	0			1	1
U	VOA	Trans-1,3-dichloropropene	18	0	0			1	1
U	VOA	Trichloroethene	18	0	0			1	1
U	VOA	Vinyl acetate	18	0	0			1	1
U	VOA	Vinyl chloride	18	0	0			1	1
U	VOA	Xylene (total)	18	0	0			1	1

[a] F = filtered, U = unfiltered

[b] Values reported in micrograms per liter except as noted.

[c] Values reported in milligrams per liter.

Table 4-16. Summary Statistics for Pore Water Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
AMMONIA	Ammonia[b]	3	3	100	0.63	1.1		
AROCLOR	Aroclor-1016	6	0	0			0.2	2
AROCLOR	Aroclor-1221	6	0	0			0.4	2
AROCLOR	Aroclor-1232	6	0	0			0.2	2
AROCLOR	Aroclor-1242	6	0	0			0.2	2
AROCLOR	Aroclor-1248	6	0	0			0.2	2
AROCLOR	Aroclor-1254	6	0	0			0.2	2
AROCLOR	Aroclor-1260	6	0	0			0.2	2
DDT 44	4,4'-DDD	6	1	17	0.064	0.064	0.02	0.2
DDT 44	4,4'-DDE	6	1	17	0.012	0.012	0.02	0.2
DDT 44	4,4'-DDT	6	0	0			0.02	0.2
METAL	Aluminum	6	3	50	1580	7420	20.3	114
METAL	Antimony	6	0	0			2.1	16
METAL	Arsenic	6	6	100	6.5	126		
METAL	Barium	6	6	100	26.8	125		
METAL	Beryllium	6	0	0			0.1	0.5
METAL	Cadmium	6	3	50	5.6	15.1	0.2	1
METAL	Calcium	6	6	100	271000	377000		
METAL	Chromium	6	3	50	14.3	41.7	1	6.7
METAL	Cobalt	6	4	67	7.5	45.8	0.5	0.56
METAL	Copper	6	3	50	41.8	156	1	5
METAL	Iron	6	6	100	230	21200		
METAL	Lead	6	3	50	11.5	38.2	1.1	5.5
METAL	Magnesium	6	6	100	1030000	3650000		
METAL	Manganese	6	6	100	372	1670		
METAL	Mercury	6	3	50	1.3	4.9	0.1	0.1
METAL	Molybdenum	6	6	100	3.5	34.3		
METAL	Nickel	6	4	67	11.8	172	2.1	2.5
METAL	Potassium	6	6	100	316000	883000		
METAL	Selenium	3	3	100	3.4	8.7		
METAL	Silver	6	4	67	1.2	7.6	0.6	0.6
METAL	Sodium	6	6	100	8050000	27500000		
METAL	Thallium	6	0	0			1.3	8
METAL	Vanadium	6	4	67	9.6	38	1.1	1.1

Table 4-16 (continued). Summary Statistics for Pore Water Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
METAL	Zinc	6	3	50	118	335	27.4	58.8
PAH HIGH	Benzo(a)anthracene	6	0	0			5	50
PAH HIGH	Benzo(a)pyrene	6	0	0			5	50
PAH HIGH	Benzo(b)fluoranthene	6	0	0			5	50
PAH HIGH	Benzo(g,h,i)perylene	6	0	0			5	50
PAH HIGH	Benzo(k)fluoranthene	6	0	0			5	50
PAH HIGH	Chrysene	6	0	0			5	50
PAH HIGH	Dibenzo(a,h)anthracene	6	0	0			5	50
PAH HIGH	Fluoranthene	6	0	0			5	50
PAH HIGH	Indeno(1,2,3-cd)pyrene	6	0	0			5	50
PAH HIGH	Pyrene	6	0	0			5	50
PAH LOW	2-methylnaphthalene	6	0	0			5	50
PAH LOW	Acenaphthene	6	0	0			5	50
PAH LOW	Acenaphthylene	6	0	0			5	50
PAH LOW	Anthracene	6	0	0			5	50
PAH LOW	Fluorene	6	0	0			5	50
PAH LOW	Naphthalene	6	0	0			5	50
PAH LOW	Phenanthrene	6	0	0			5	50
PEST	Aldrin	6	0	0			0.01	0.1
PEST	Alpha-BHC	6	0	0			0.01	0.1
PEST	Alpha-chlordane	6	0	0			0.01	0.1
PEST	Beta-BHC	6	0	0			0.01	0.1
PEST	Delta-BHC	6	0	0			0.01	0.1
PEST	Dieldrin	6	0	0			0.02	0.2
PEST	Endosulfan I	6	0	0			0.01	0.1
PEST	Endosulfan II	6	0	0			0.02	0.2
PEST	Endosulfan sulfate	6	0	0			0.02	0.2
PEST	Endrin	6	0	0			0.02	0.2
PEST	Endrin aldehyde	6	0	0			0.02	0.2
PEST	Endrin ketone	6	0	0			0.02	0.2
PEST	Gamma-BHC (lindane)	6	0	0			0.01	0.1
PEST	Gamma-chlordane	6	0	0			0.01	0.1
PEST	Heptachlor	6	0	0			0.01	0.1
PEST	Heptachlor epoxide	6	0	0			0.01	0.1

Table 4-16 (continued). Summary Statistics for Pore Water Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
PEST	Methoxychlor	6	0	0			0.1	1
PEST	Toxaphene	6	0	0			1	10
SVOA	1,2,4-trichlorobenzene	6	0	0			5	50
SVOA	1,2-dichlorobenzene	6	0	0			5	50
SVOA	1,3-dichlorobenzene	6	0	0			5	50
SVOA	1,4-dichlorobenzene	6	0	0			5	50
SVOA	2,2'-oxybis(1-chloropropane)	6	0	0			5	50
SVOA	2,4,5-trichlorophenol	6	0	0			20	200
SVOA	2,4,6-trichlorophenol	6	0	0			5	50
SVOA	2,4-dichlorophenol	6	0	0			5	50
SVOA	2,4-dimethylphenol	6	0	0			5	50
SVOA	2,4-dinitrophenol	6	0	0			20	200
SVOA	2,4-dinitrotoluene	6	0	0			5	50
SVOA	2,6-dinitrotoluene	6	0	0			5	50
SVOA	2-chloronaphthalene	6	0	0			5	50
SVOA	2-chlorophenol	6	0	0			5	50
SVOA	2-methylphenol	6	0	0			5	50
SVOA	2-nitroaniline	6	0	0			20	200
SVOA	2-nitrophenol	6	0	0			5	50
SVOA	3,3'-dichlorobenzidine	6	0	0			5	50
SVOA	3-nitroaniline	6	0	0			20	200
SVOA	4,6-dinitro-2-methylphenol	6	0	0			20	200
SVOA	4-bromophenyl-phenylether	6	0	0			5	50
SVOA	4-chloro-3-methylphenol	6	0	0			5	50
SVOA	4-chloroaniline	6	0	0			5	50
SVOA	4-chlorophenyl-phenylether	6	0	0			5	50
SVOA	4-methylphenol	6	0	0			5	50
SVOA	4-nitroaniline	6	0	0			20	200
SVOA	4-nitrophenol	6	0	0			20	200
SVOA	Bis(2-chloroethoxy)methane	6	0	0			5	50
SVOA	Bis(2-chloroethyl)ether	6	0	0			5	50
SVOA	Bis(2-ethylhexyl)phthalate	6	0	0			4	40
SVOA	Butylbenzylphthalate	6	0	0			5	50
SVOA	Carbazole	6	0	0			5	50

Table 4-16 (continued). Summary Statistics for Pore Water Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
SVOA	Di-n-butylphthalate	6	0	0			5	50
SVOA	Di-n-octylphthalate	6	0	0			5	50
SVOA	Dibenzofuran	6	0	0			5	50
SVOA	Diethylphthalate	6	0	0			5	50
SVOA	Dimethylphthalate	6	0	0			5	50
SVOA	Hexachlorobenzene	6	0	0			5	50
SVOA	Hexachlorobutadiene	6	0	0			5	50
SVOA	Hexachlorocyclopentadiene	6	0	0			5	50
SVOA	Hexachloroethane	6	0	0			5	50
SVOA	Isophorone	6	0	0			5	50
SVOA	N-nitroso-di-n-propylamine	6	0	0			5	50
SVOA	N-nitrosodiphenylamine (1)	6	0	0			5	50
SVOA	Nitrobenzene	6	0	0			5	50
SVOA	Pentachlorophenol	6	0	0			20	200
SVOA	Phenol	6	0	0			5	50
TBT	Dibutyl tin	6	0	0			38	50
TBT	Monobutyl tin	6	0	0			31	50
TBT	Tetrabutyl tin	6	0	0			50	50
TBT	Tributyl tin	6	2	33	61	120	44	50
TPH	Diesel range organics	6	0	0			100	100
TPH	Gasoline range organics	6	0	0			50	50000
TPH	Motor oil range organics	6	5	83	150	270	100	100

[a] Values reported in micrograms per liter except as noted.

[b] Values reported in milligrams per liter.

1,4-Dichlorobenzene—Dichlorobenzene was one of the most frequently detected organic analytes. The highest concentrations were at station M-024A, which is located in the northwest corner of the site. Depth did not seem to be a significant factor.

Chlorobenzene—The detects for chlorobenzene tended to be co-located with naphthalene detects on the eastern perimeter of the wetland as well as the northern portion of the coastal margin. Depth did not seem to be a significant factor.

Ethylbenzene—Detects for ethylbenzene were confined to the northeast corner of the wetland area (stations M037, M038, and M039 at various depths). Detected surface concentrations seemed slightly elevated over detected subsurface concentrations.

Dimethylphthalate—Dimethylphthalate detects occurred across the site with no evident pattern of distribution. The largest detected concentration (470 µg/l) occurred at station M022-E in the coastal margin, near the northwest corner of wetland.

Gasoline and diesel range organics—These organics were detected at most stations for which samples existed. Samples were collected along the eastern perimeter of the wetland area. Depth did not seem to be a factor in determining concentration.

In summary, no depth trend is evident for most analytes. Because the data sets are too small to allow a formal statistical trend analysis, conclusions were based on qualitative assessments. Few constituents, such as cyanide, lead, zinc, and naphthalene, had somewhat higher concentrations at the surface than at subsurface. There is no other evidence of a depth trend. Considering organics with detection frequencies that exceeded 10%, most maximum detected values occurred in wells along the wetland boundary with the landfill. An exception to this general statement is well M024, where many detected organics were found. This well is located at the northwest corner of the site, where groundwater flow is in a westerly direction. Groundwater elevations and potentiometric maps are provided in Appendix D. The groundwater flow direction at the location of this well suggests that only a very small portion of the landfill could be impacting this well, and that a source outside the IR Site 2 boundary may be responsible for the organic constituents observed at this location.

Summary statistics for groundwater data are presented in Tables 4-17 and 4-18.

4.4 Tissue Analyses

Field-collected animal, plant, invertebrate, and fish tissues from the landfill and the wetland were analyzed for organic and inorganic constituents to assist in determining whether bioavailable chemicals were bioaccumulating in ecological receptors at the site. A summary of the tissue concentrations is presented in Tables 4-19 through 4-23.

4.4.1 Plant Tissues

All metals except antimony, mercury, and vanadium were detected in 100% of the terrestrial plant tissues collected from the landfill. Both antimony and mercury were detected in 4 of 6 samples, while vanadium was detected in 5 of 6 samples. Detection frequencies of inorganics in wetland plant tissues were more variable, ranging from a low of 14% detects (silver) to a high of 100% detects (13 different constituents). PAHs and PCBs were detected in all landfill- and wetland-plant tissues. The following pesticides were detected in landfill plant tissues: alpha-chlordane (4 of 6 samples), gamma-chlordane (2 of 6 samples), gamma-BHC (1 of 6 samples), and heptachlor (1 of 6 samples). Alpha-chlordane and endosulfan I were detected in wetland-plant tissues (3 of 7 samples and 1 of 7 samples, respectively).

Table 4-21. Summary Statistics for Fish Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
AROCLOR	Aroclor-1016	6	0	0			15	16
AROCLOR	Aroclor-1221	6	0	0			30	34
AROCLOR	Aroclor-1232	6	0	0			15	16
AROCLOR	Aroclor-1242	6	0	0			15	16
AROCLOR	Aroclor-1248	6	0	0			15	16
AROCLOR	Aroclor-1254	6	6	100	64	120		
AROCLOR	Aroclor-1260	6	6	100	52	160		
CON	PCB101	1	0	0			20	20
CON	PCB105	1	1	100	16.8	16.8		
CON	PCB118	1	1	100	47.5	47.5		
CON	PCB128	1	1	100	14.5	14.5		
CON	PCB138	1	1	100	103	103		
CON	PCB153	1	1	100	124.9	124.9		
CON	PCB170	1	1	100	14	14		
CON	PCB18	1	1	100	10.7	10.7		
CON	PCB180	1	1	100	16.2	16.2		
CON	PCB187	1	1	100	37.1	37.1		
CON	PCB195	1	1	100	1.8	1.8		
CON	PCB206	1	1	100	1.3	1.3		
CON	PCB209	1	1	100	1.5	1.5		
CON	PCB28	1	0	0			13	13
CON	PCB44	1	1	100	8	8		
CON	PCB52	1	1	100	21.6	21.6		
CON	PCB66	1	1	100	29.2	29.2		
CON	PCB8	1	1	100	6.6	6.6		
DDT 24	2,4'-DDD	1	1	100	65.5	65.5		
DDT 24	2,4'-DDE	1	0	0			23.6	23.6
DDT 24	2,4'-DDT	1	0	0			1.3	1.3
DDT 44	4,4'-DDD	7	7	100	3	22.1		
DDT 44	4,4'-DDE	7	7	100	13	44.2		
DDT 44	4,4'-DDT	7	6	86	9	26	6.3	6.3
METAL	Aluminum[b]	7	7	100	6.3	401		
METAL	Antimony[b]	7	0	0			0.05	0.26
METAL	Arsenic[b]	7	1	14	3	3	0.58	1

Table 4-20 (continued). Summary Statistics for Mouse Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
PAH LOW	Acenaphthene	12	0	0			30	2439
PAH LOW	Acenaphthylene	12	0	0			30	2439
PAH LOW	Anthracene	12	0	0			30	2439
PAH LOW	Fluorene	12	0	0			30	2439
PAH LOW	Naphthalene	11	0	0			30	2439
PAH LOW	Phenanthrene	12	0	0			30	2439
PEST	Aldrin	12	0	0			1.6	4
PEST	Alpha-BHC	12	0	0			1.6	4
PEST	Alpha-chlordane	12	0	0			1.6	4
PEST	Beta-BHC	12	1	8	18.6	18.6	1.6	4
PEST	Chlordane	12	0	0			75	155
PEST	Delta-BHC	12	0	0			1.6	4
PEST	Dieldrin	12	4	33	7	9.6	2.2	13
PEST	Endosulfan I	12	0	0			1.6	6
PEST	Endosulfan II	12	0	0			1.6	7
PEST	Endosulfan sulfate	12	1	8	11.4	11.4	1.6	18
PEST	Endrin	12	2	17	5.5	7	2.2	9
PEST	Endrin aldehyde	12	0	0			1.6	6
PEST	Endrin ketone	12	1	8	2.5	2.5	1.6	18
PEST	Gamma-BHC (lindane)	12	1	8	0.9	0.9	1.6	12
PEST	Gamma-chlordane	12	0	0			1.6	4
PEST	Heptachlor	12	0	0			1.6	6
PEST	Heptachlor epoxide	12	2	17	5.8	7.1	2.8	14
PEST	Methoxychlor	12	0	0			1.6	4
PEST	Mirex	12	0	0			1.6	4
PEST	Toxaphene	12	0	0			150	176
PEST	Trans-nonachlor	12	1	8	3	3	1.6	4
SVOA	Hexachlorobenzene	12	2	17	0.9	1	1.6	4
TBT	Dibutyl tin	12	0	0			15	42
TBT	N-butyltin	12	0	0			15	464
TBT	Tetrabutyl tin	12	0	0			15	42
TBT	Tributyl tin	12	0	0			15	42

[a] Values reported in micrograms per kilogram except as noted.

[b] Values reported in milligrams per kilogram.

Table 4-21 (continued). Summary Statistics for Fish Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
METAL	Barium[b]	7	7	100	0.58	6.3		
METAL	Beryllium[b]	7	0	0			0.004	0.05
METAL	Cadmium[b]	7	1	14	0.15	0.15	0.012	0.05
METAL	Calcium[b]	7	7	100	5590	26142		
METAL	Chromium[b]	7	7	100	0.35	1.5		
METAL	Cobaltv	7	6	86	0.057	0.36	0.057	0.057
METAL	Copper[b]	7	7	100	2.1	26.6		
METAL	Ironv	7	7	100	55.7	486		
METAL	Lead[b]	7	5	71	0.25	0.59	0.053	0.1
METAL	Magnesium[b]	7	7	100	579	2160		
METAL	Manganese[b]	7	7	100	7.1	55.1		
METAL	Mercury[b]	7	7	100	0.011	0.13		
METAL	Molybdenum[b]	7	1	14	0.13	0.13	0.04	0.2
METAL	Nickel[b]	7	7	100	0.12	4.8		
METAL	Potassium[b]	7	7	100	2200	7640		
METAL	Selenium[b]	7	0	0			0.42	3
METAL	Silver[b]	7	1	14	0.15	0.15	0.036	0.39
METAL	Sodium[b]	7	7	100	2290	7563		
METAL	Thallium[b]	7	0	0			0.05	0.18
METAL	Tin[b]	1	0	0			3	3
METAL	Vanadium[b]	7	6	86	0.089	1.3	0.46	0.46
METAL	Zinc[b]	7	7	100	24.4	89		
PAH	1-methylnaphthalene	1	0	0			25	25
PAH	1-methylphenanthrene	1	0	0			25	25
PAH	2,3,5-trimethylnaphthalene	1	0	0			25	25
PAH	2,6-dimethylnaphthalene	1	0	0			25	25
PAH	Biphenyl	1	0	0			25	25
PAH	Dibenzothiophene	1	0	0			25	25
PAH HIGH	Benzo(a)anthracene	7	0	0			25	2600
PAH HIGH	Benzo(a)pyrene	7	0	0			25	2600
PAH HIGH	Benzo(b)fluoranthene	7	0	0			25	2600
PAH HIGH	Benzo(e)pyrene	1	0	0			25	25
PAH HIGH	Benzo(g,h,i)perylene	7	1	14	41	41	2500	2600
PAH HIGH	Benzo(k)fluoranthene	7	0	0			25	2600

Table 4-21 (continued). Summary Statistics for Fish Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
PAH HIGH	Chrysene	7	0	0			25	2600
PAH HIGH	Dibenzo(a,h)anthracene	7	0	0			25	2600
PAH HIGH	Fluoranthene	7	0	0			25	2600
PAH HIGH	Indeno(1,2,3-cd)pyrene	7	0	0			25	2600
PAH HIGH	Perylene	1	0	0			25	25
PAH HIGH	Pyrene	7	0	0			25	2600
PAH LOW	2-methylnaphthalene	7	1	14	20	20	2500	2600
PAH LOW	Acenaphthene	7	1	14	23	23	2500	2600
PAH LOW	Acenaphthylene	7	0	0			25	2600
PAH LOW	Anthracene	7	0	0			25	2600
PAH LOW	Fluorene	7	1	14	18	18	2500	2600
PAH LOW	Naphthalene	7	1	14	10	10	2500	2600
PAH LOW	Phenanthrene	7	1	14	15	15	2500	2600
PEST	Aldrin	7	6	86	2	3	1.3	1.3
PEST	Alpha-BHC	7	1	14	0.6	0.6	0.8	1.3
PEST	Alpha-chlordane	7	6	86	2	4	4.8	4.8
PEST	Beta-BHC	7	5	71	0.6	3	0.8	1.3
PEST	Chlordane	1	0	0			127	127
PEST	Delta-BHC	7	0	0			0.8	1.3
PEST	Dieldrin	7	6	86	2	8	12.2	12.2
PEST	Endosulfan I	7	6	86	0.5	4	5.3	5.3
PEST	Endosulfan II	7	5	71	2	4	2	11.2
PEST	Endosulfan sulfate	7	0	0			1.3	2
PEST	Endrin	7	6	86	6	26	1.3	1.3
PEST	Endrin aldehyde	7	6	86	5	14	1.3	1.3
PEST	Endrin ketone	7	0	0			2	5.3
PEST	Gamma-BHC (lindane)	7	1	14	0.6	0.6	0.8	1.3
PEST	Gamma-chlordane	7	6	86	0.7	2	1.3	1.3
PEST	Heptachlor	7	0	0			0.8	1.3
PEST	Heptachlor epoxide	7	6	86	0.5	3	18.8	18.8
PEST	Methoxychlor	7	2	29	15	18	1.3	8
PEST	Mirex	1	0	0			1.3	1.3
PEST	Toxaphene	7	0	0			75	381
PEST	Trans-nonachlor	1	0	0			2	2

Table 4-21 (continued). Summary Statistics for Fish Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
SVOA	1,2,4-trichlorobenzene	6	0	0			2500	2600
SVOA	1,2-dichlorobenzene	6	0	0			2500	2600
SVOA	1,3-dichlorobenzene	6	0	0			2500	2600
SVOA	1,4-dichlorobenzene	6	0	0			2500	2600
SVOA	2,2'-oxybis(1-chloropropane)	6	0	0			2500	2600
SVOA	2,4,5-trichlorophenol	6	0	0			6000	6400
SVOA	2,4,6-trichlorophenol	6	0	0			2500	2600
SVOA	2,4-dichlorophenol	6	0	0			2500	2600
SVOA	2,4-dimethylphenol	6	0	0			2500	2600
SVOA	2,4-dinitrophenol	6	0	0			6000	6400
SVOA	2,4-dinitrotoluene	6	0	0			2500	2600
SVOA	2,6-dinitrotoluene	6	0	0			2500	2600
SVOA	2-chloronaphthalene	6	0	0			2500	2600
SVOA	2-chlorophenol	6	0	0			2500	2600
SVOA	2-methylphenol	6	0	0			2500	2600
SVOA	2-nitroaniline	6	0	0			6000	6400
SVOA	2-nitrophenol	6	0	0			2500	2600
SVOA	3,3'-dichlorobenzidine	6	0	0			2500	2600
SVOA	3-nitroaniline	6	0	0			6000	6400
SVOA	4,6-dinitro-2-methylphenol	6	0	0			6000	6400
SVOA	4-bromophenyl-phenylether	6	0	0			2500	2600
SVOA	4-chloro-3-methylphenol	6	0	0			2500	2600
SVOA	4-chloroaniline	6	0	0			2500	2600
SVOA	4-chlorophenyl-phenylether	6	0	0			2500	2600
SVOA	4-methylphenol	6	0	0			2500	2600
SVOA	4-nitroaniline	6	0	0			6000	6400
SVOA	4-nitrophenol	6	0	0			6000	6400
SVOA	Bis(2-chloroethoxy)methane	6	0	0			2500	2600
SVOA	Bis(2-chloroethyl)ether	6	0	0			2500	2600
SVOA	Bis(2-ethylhexyl)phthalate	6	0	0			2500	2600
SVOA	Butylbenzylphthalate	6	0	0			2500	2600
SVOA	Carbazole	6	0	0			2500	2600
SVOA	Di-n-butylphthalate	6	0	0			2500	2600
SVOA	Di-n-octylphthalate	6	0	0			2500	2600

Table 4-21 (continued). Summary Statistics for Fish Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
SVOA	Dibenzofuran	6	0	0			2500	2600
SVOA	Diethylphthalate	6	0	0			2500	2600
SVOA	Dimethylphthalate	6	0	0			2500	2600
SVOA	Hexachlorobenzene	7	0	0			1.3	2600
SVOA	Hexachlorobutadiene	6	0	0			2500	2600
SVOA	Hexachlorocyclopentadiene	6	0	0			2500	2600
SVOA	Hexachloroethane	6	0	0			2500	2600
SVOA	Isophorone	6	0	0			2500	2600
SVOA	N-nitroso-di-n-propylamine	6	0	0			2500	2600
SVOA	N-nitrosodiphenylamine (1)	6	0	0			2500	2600
SVOA	Nitrobenzene	6	0	0			2500	2600
SVOA	Pentachlorophenol	1	0	0			6400	6400
SVOA	Phenol	6	0	0			2500	2600
TBT	Dibutyltin	7	1	14	5	5	2	2
TBT	N-butyltin	1	0	0			63	63
TBT	Tetrabutyltin	7	0	0			2	63
TBT	Tributyltin	7	4	57	2	18	2	2

[a] Values reported in micrograms per kilogram except as noted.

[b] Values reported in milligrams per kilogram.

Table 4-22. Summary Statistics for Crab Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
AROCLOR	Aroclor-1016	2	0	0			14	16
AROCLOR	Aroclor-1221	2	0	0			29	34
AROCLOR	Aroclor-1232	2	0	0			14	16
AROCLOR	Aroclor-1242	2	0	0			14	16
AROCLOR	Aroclor-1248	2	0	0			14	16
AROCLOR	Aroclor-1254	2	2	100	51	110		

Table 4-23 (continued). Summary Statistics for Macoma Tissue Data

Suite	Analyte[a]	Number of Samples			Detects		Nondetects	
		Total	Detects	% Detects	Min	Max	Min Detection Limit	Max Detection Limit
SVOA	4-chlorophenyl-phenylether	4	0	0			610	670
SVOA	4-methylphenol	4	3	75	800	2100	670	670
SVOA	4-nitroaniline	4	0	0			3000	3300
SVOA	4-nitrophenol	4	0	0			3000	3300
SVOA	Benzidine	4	0	0			6100	6700
SVOA	Benzoic acid	4	4	100	19000	54000		
SVOA	Benzyl alcohol	4	0	0			3000	3300
SVOA	Bis(2-chloroethoxy)methane	4	0	0			610	670
SVOA	Bis(2-chloroethyl)ether	4	0	0			610	670
SVOA	Bis(2-ethylhexyl)phthalate	4	1	25	130000	130000	6100	6700
SVOA	Butylbenzylphthalate	4	0	0			31000	34000
SVOA	Di-n-butylphthalate	4	3	75	2900	7200	2500	2500
SVOA	Di-n-octylphthalate	4	0	0			610	670
SVOA	Dibenzofuran	4	0	0			610	670
SVOA	Diethylphthalate	4	0	0			610	670
SVOA	Dimethylphthalate	4	0	0			610	670
SVOA	Hexachlorobenzene	4	0	0			610	670
SVOA	Hexachlorobutadiene	4	0	0			1200	1300
SVOA	Hexachlorocyclopentadiene	4	0	0			3000	3300
SVOA	Hexachloroethane	4	0	0			1200	1300
SVOA	Isophorone	4	0	0			610	670
SVOA	N-nitroso-di-n-propylamine	4	0	0			610	670
SVOA	N-nitrosodiphenylamine (1)	4	0	0			610	670
SVOA	Nitrobenzene	4	0	0			610	670
SVOA	Pentachlorophenol	4	0	0			3000	3300
SVOA	Phenol	4	0	0			1200	1300
TBT	Dibutyltin	4	2	50	160	270	5	5

4.4.2 Mammal Tissues

As with plant tissues, inorganics and PCBs were detected in most mammalian (mouse) tissues collected from both the landfill and wetland areas. PAHs were not detected in any mouse tissues from either area. Dieldrin was detected in 2 of 6 samples from the wetland area, while beta-BHC,

gamma-BHC, endrin, and heptachlor epoxide were each detected in 1 of 6 wetland mammal samples. Dieldrin and 4,4-DDE were detected in 2 of 6 landfill mammal samples, while endosulfan sulfate, endrin, endrin ketone, and heptachlor epoxide were each detected in 1 of 6 mammal samples collected from the landfill.

4.4.3 Fish and Crab Tissues

Inorganic constituents were commonly detected in both fish and crab tissues. Arsenic, cadmium, molybdenum, and silver were the least-frequently detected inorganics in fish tissue; each was detected in only one sample. Benzo(g,h,i)perylene, 2-methylnaphthalene, acenaphthene, fluorene, naphthalene, and phenanthrene were each detected in one fish tissue sample. No other PAHs were detected in fish or crab tissue. Aroclor-1254, Aroclor-1260, 4,4-DDD, and 4,4-DDE were detected in all fish and crab samples, while 4,4-DDT was detected in all crab samples and 6 of 7 fish samples. The list of other pesticides detected in fish and crab tissues is more extensive and the percentage of detects is greater than those observed in plant and mammalian tissues. Tables 4-19 and 4-23 provide a list of the pesticides detected.

4.5 Threatened and Endangered Species Survey Results

The literature search and field surveys conducted for Alameda Point show that the occurrence of threatened and endangered species is limited to the wetland areas that occur in the southwest quadrant of the facility, specifically at West Beach Landfill Wetland and Runway Wetland. Although the literature search identified several species of plants, invertebrates, fishes, amphibians, reptiles, and mammals that could potentially occur, the industrial nature of Alameda Point and the isolated and disturbed nature of these areas may preclude using these areas as animal habitats.

In contrast a number of threatened and endangered bird species have been observed at Alameda Point, mainly in the wetland areas but also flying over the area or using offshore habitat in the Bay adjacent to the wetland. Threatened and endangered bird species known to occur at Alameda Point include American peregrine falcon (*Falco peregrinus anatum*), western snowy plover (*Charadrius alexandrinus nivosus*), California least tern (*Sterna antillarum browni*), saltmarsh common yellowthroat (*Geothlypis trychas sinuosa*), Alameda song sparrow (*Melospiza melodia pusillula*), and California brown pelican (*Pelicanus occidentalis californicus*). All of these species except the pelican could potentially forage at IR Site 2. Observations of these species were reported by Feeney and Collins (1993) or were made during the 1997 avian surveys conducted for the wetland areas (TtEMI, 1998).

Given the industrial nature of most of Alameda Point and the site-specific surveys conducted to characterize plant, mammal, and bird communities in the limited areas that provide habitat, no additional threatened and endangered species surveys are needed at this time.

Table 7-3. Cumulative Area Summary of Sediment COPECs at IR Site 2

Detected Constituents with Concentrations > Screening Benchmarks	Detected Constituents without Screening Benchmarks	Detected Constituents < Screening Benchmarks which Bioaccumulate	Constituents with Detection Limits > Screening Benchmarks
Arsenic	Aluminum	Fluoranthene	Benz(a)anthracene
Cadmium	Barium	Pyrene	Benzo(a)pyrene
Chromium	Beryllium		Benzo(k)fluoranthene
Copper	Cobalt		Chrysene
Lead	Iron		Dibenz(a,h)anthracene
Mercury	Manganese		Acenaphthene
Nickel	Molybdenum		Acenaphthylene
Silver	Thallium		Anthracene
Zinc	Vanadium		Fluorene
Benzo(g,h,i)perylene	Benzo(b)fluoranthene		Naphthalene
Indeno(1,2,3-cd)pyrene	2-methylnaphthalene		Phenanthrene
Alpha-chlordane	Endrin Aldehyde		Phenol
Dieldrin	Bis(2-ethylhexyl)phthalate		Gamma-BHC
Gamma-chlordane			
4,4'-DDD	Butylbenzylphthalate		
4,4'-DDE	Diethylphthalate		
4,4'-DDT	Acetone		
Total Aroclors	N-nitrosodiphenyl-amine		
Di-n-butylphthalate	4-chlorophenyl-phenylether		
Tributyltin			

Table 7-4. Cumulative Area Summary of Ground Water COPECs at IR Site 2

Detected Constituents with Concentrations > Screening Benchmarks	Detected Constituents without Screening Benchmarks	Detected Constituents < Screening Benchmarks which Bioaccumulate	Constituents with Detection Limits > Screening Benchmarks
Barium	Aluminum	Chromium	Cobalt*
Cobalt	Manganese		Copper*
Cyanide	Fluorene		Benz(a)anthracene*
Lead	1,3-dichlorobenzene		Benzo(a)pyrene*
Silver	2,4-dimethylphenol		Fluoranthene*
Thallium	N-nitroso-diphenylamine		Anthracene*
Zinc			Phenanthrene
2-methylnaphthalene	Ethylbenzene		Dieldrin*
Naphthalene			Endosulfan I*
Chlorobenzene			Endosulfan II*
Dimethylphthalate			Endrin*
			Gamma-BHC*
			Heptachlor*
			Heptachlor epoxide*
			Methoxychlor*
			Toxaphene*
			4,4'-DDD*
			4,4'-DDT*
			Total Aroclors*
			4-chloro-3-methylphenol*
			Butylbenzylphthalate*
			Di-n-butylphthalate*
			Di-n-octylphthalate*
			Pentachlorophenol*

* Data are all nondetects.

Table 7-5. Cumulative Area Summary of Surface Water COPECs at IR Site 2

Detected Constituents with Concentrations > Screening Benchmarks	Detected Constituents without Screening Benchmarks	Detected Constituents < Screening Benchmarks which Bioaccumulate	Constituents with Detection Limits > Screening Benchmarks
Barium	Aluminum	Arsenic	Aroclor-1016*
Cobalt	Iron	Cadmium	Aroclor-1221*
Copper	Manganese	Chromium	Aroclor-1232*
Lead			Aroclor-1242*
Nickel			Aroclor-1248*
Silver			Aroclor-1254*
Zinc			Aroclor-1260*
Heptachlor epoxide			4,4'-DDD*
			4,4'-DDT*
			Benz(a)anthracene*
			Benzo(a)pyrene*
			Dieldrin*
			Endosulfan I*
			Endosulfan II*
			Endrin*
			Gamma BHC*
			Heptachlor*
			Methoxychlor*
			Toxaphene*
			4-chloro-3-methylphenol*
			Pentachlorophenol*

* Data are all nondetects.

7.3 Baseline ERA

Chemicals that failed COPEC screening were carried forward to the Baseline ERA, with the exception of those for groundwater. There is not a pathway that can be reasonably identified from groundwater to ecological receptors on IR Site 2 (Section 5). This is an important recognition for the baseline assessment, as the baseline ERA hinges on three major lines of evidence: (1) potential dose to ecological receptors (assessment endpoints, Appendix C) via ingestion pathways; (2) laboratory toxicity bioassays; and (3) comparison of biotic tissues collected at IR Site 2 in comparison with a reference site deemed appropriate for such purpose by the Natural Resource Trustees (TtEMI, 1999). Other potential pathways including inhalation and dermal contact with potential contaminants were not considered for the baseline ERA. This is simply because for suspension of soil particles and gaseous dispersion (which were discussed in Section 2.3.4.6 and 2.3.4.7, respectively) no relevant data pertaining to these processes are available.

7.3.2.2 Bioassay Results

Bioassay results were presented in Section 4. Results of the *Eohaustorius estuarius* bioassay show mortality exceeding the San Francisco Bay reference envelope UTL at three of the seven locations. Two of these locations (W4, W5) in the northern pond had means of 34.0% and 49.2% survival respectively across the five replicates, while the third location (W6), located in the southern pond had a mean of 51.0% survival across the five replicates. *Eohaustorius* reburial percentages fell within reference envelope UTLs. The three locations showing unacceptable mortality also showed the highest variability among replicates, indicating this mortality was not consistent between replicates. Locations W4 and W5 correspond to the two sampling locations in the northern pond having the highest COPEC concentrations. The following constituents had their highest detected northern pond concentrations at locations W4 or W5: cadmium, chromium, lead, mercury, selenium, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i) perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, total

PCBs, 4,4'-DDD, 4,4'-DDT, alpha-chlordane, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-butylphthalate, and phenol. Three of these constituents, mercury, total PCBs, and 4,4'-DDD had concentrations in the northern pond exceeding their respective ER-Ms. The highest concentration of mercury in the northern pond (0.79 µg/kg) was above the ER-M of 0.71 µg/kg. The highest concentration of 4,4'-DDD (27 µg/kg) exceeded the ER-M of 20 µg/kg, while total PCBs (480 µg/kg) were approximately two and a half times the ER-M of 180 µg/kg. Nickel was also recorded in the northern pond at a level twice its ER-M (119 µg/kg vs. ER-M of 51.6 µg/kg), however this detect was not at one of the two bioassay locations. In the southern pond, seven constituents nickel, selenium, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, alpha-chlordane, and total PCBs) were detected above ER-Ms. 4,4'-DDD and 4,4'-DDT had detected concentrations 14x and 80x their respective ER-Ms.

These bioassays were conducted as part of a larger effort to assess sediment toxicity at areas offshore of Alameda Point, including the areas immediately offshore of the landfill. Laboratory benchsheets or other documentation detailing handling protocols for the organisms used in the wetland bioassays were not available for this RI report, so it is unknown whether results may have been confounded by other factors. However, in the absence of such documentation, it must be concluded that the results of the *Eohaustoius* bioassays indicate that sediment COPEC concentrations may be problematic at certain locations in the wetland ponds.

Results of the *Neanthes arenaceodentata* bioassay show that growth was not different from the reference envelope UTL at any of the sampling stations. *Neanthes* mortality was not significantly different from laboratory controls at any sampling location. Results of the *Neanthes* bioassays are not indicative that sediment COPEC concentrations are a problem.

7.3.2.3 Plant and Animal Tissue Comparisons

An analysis of tissues from various biota was performed in order to consider the potential for biotic uptake of contaminants. The analysis served two purposes: (1) determine if contaminants

are entering the biota on IR Site 2 in excess of that which might be occurring on a reference site and (2) determine if there may be patterns of chemical uptake that indicate particular constituents or classes thereof that are of particular concern.

A reference site for tissue collection was chosen in the area north of IR Site 2 (see Figure 3-5), and corresponds to the area from which ambient soil samples were collected. This site was considered an appropriate reference site since it was not in geographic or topographical position to receive contaminants from the landfill operations of IR Site 2, either directly or indirectly; it was also deemed to be representative of ambient biotic conditions in the western portion of Alameda Point (TtEMI, 1999). Although the entire western land area of Alameda Point is artificial, the reference area was considered "typical" of those areas that sustained biota with a modicum of similarity to that of IR Site 2.

Sampling for tissues from the reference area occurred for animals on 10 September 1998 and for plants on 02 September 1998. Sampling for tissues from IR Site 2 occurred for animals from 08 September to 10 September 1998 and for plants from 01 September to 03 September 1998. Plant sampling was primarily for grasses with the collection of some forbs, while animal sampling was primarily for mice *(Mus domesticus)* with one incidental collection of a black rat (*Rattus rattus*t) (Table 7-20). Plant sampling was nearly always composite sampling, and tissues from mouse samples include carcasses only.

Table 7-20. Plant and Animal Species Collected at the Reference Site and IR Site 2 for Comparison of Contaminants in Tissues

Reference Site	IR Site 2
Mus domesticus (house mouse) and one rat (pr. *Rattus rattus*)	*Mus domesticus* (house mouse)
Various dry grasses: probably *Avena sp.* (oats) and *Hordeum sp.* (foxtail)	Various dry grasses: probably *Avena sp.* (oats) and *Hordeum sp.* (foxtail)
Bromus sp. (pr. *B. diandrus*, ripgut brome)	*Brassica sp.* (pr. *B. nigra*, black mustard)
Lotus sp. (pr. *Lotus formosissimus*, seaside birdsfoot trefoil)	*Lotus sp.* (pr. *Lotus formosissimus*, seaside birdsfoot trefoil)
Sedge (pr. *Carex hassei*, salt sedge)	Pickleweed (pr. *Salicornia virginica*).
Spikerush (pr. common spikerush, *Eleocharis macrostachya*)	

Data were evaluated in broad categories: plants and mice. This composite was done since the data were inadequate for species by species comparisons (except for mice) across the reference site and IR Site 2. A broad comparison of tissue data is made in order to gain general insights into the level of contaminants that may be entering the food chain at the level of vascular producers in generally terrestrial environs. Indeed, from Table 7-20 the plant species sampled at IR Site 2 were different (although not exclusive) from those sampled at the reference site. It was felt that by being more inclusive of plant species at large in both the reference site and IR Site 2,

a better comparison of contaminant concentrations between potentially impacted (by waste disposal operations) and unimpacted areas could be made.

Comparisons were made for analytes of either tissue category (plant, mouse) that were passed from the screening-level ERA to the baseline ERA, as long as data for each sufficiently addressed the rigors of the tests for which comparisons could be made. Only when the constituents were detected in *both* populations (reference site and IR Site 2) were comparisons made.

Results from these comparisons are summarized in Tables 7-21 and 7-22, and are limited to select metals and PCBs for reasons outlined below. Note that the reference to PCBs is to congener by number, and not more generally by Aroclor. This is because 1998 tissue analyses were conducted for PCB congeners, not individual Aroclors.

Table 7-21. Results for Distributional Tests Comparing Analytes in IR Site 2 Mouse Tissues Versus Reference Site Mouse Tissues

Analyte	Number of Samples	Number of Detects	Number of Samples	Number of Detects	Site 2 > Reference?	Gehan p-value	Quantile p-value	Slippage p-value	t-test p-value
PCB153	11	9	6	3	No	0.7046	0.9706	1.0000	0.8682
PCB170	11	8	6	5	No	0.5997	0.9706	1.0000	0.7719
PCB180	11	9	6	3	No	0.6928	0.9706	1.0000	0.8814
PCB187	11	10	6	3	No	0.7593	0.9706	1.0000	0.8965
PCB206	11	7	6	3	Yes	0.1390	0.2426	0.5385	0.0052
Aluminum	12	12	6	6	Yes	0.0415	0.2696	0.1618	0.0165
Barium	12	12	6	6	No	0.9984	0.9755	0.6667	0.9955
Cadmium	12	12	6	5	Yes	0.0006	0.2696	0.0004	0.0002
Chromium	12	11	6	5	No	0.3191	0.7549	0.7059	0.6111
Cobalt	12	12	6	6	Yes	0.0063	0.2696	0.0249	0.0054
Copper	12	12	6	6	No	0.5000	0.7549	0.6667	0.5635
Iron	12	12	6	6	Yes	0.0024	0.2696	0.0249	0.0532
Lead	12	12	6	6	No	0.9976	0.9755	0.6667	0.9974
Manganese	12	12	6	6	Yes	0.1026	0.2696	0.1618	0.0431
Mercury	12	9	6	4	No	0.4622	0.7549	1.0000	0.6896
Molybdenum	12	12	6	6	Yes	0.0546	0.2696	0.1618	0.0301
Nickel	12	12	6	6	No	0.3366	0.7549	0.4314	0.3545
Thallium	12	6	6	4	Yes	0.1885	0.2696	0.0238	0.1373
Zinc	12	12	6	6	No	0.9862	0.9755	1.0000	0.9749

Table 7-22. Results for Distributional Tests Comparing Analytes in IR Site 2 Plant Tissues Versus Reference Site Plant Tissues

Analyte	Number of Samples	Number of Detects	Number of Samples	Number of Detects	Site 2 > Reference?	Gehan p-value	Quantile p-value	Slippage p-value	t-test p-value
Aluminum	12	10	6	6	No	0.9755	0.9755	1.0000	0.9313
Antimony	12	8	6	4	No	0.7759	0.9755	0.6250	0.7388
Arsenic	12	12	6	6	Yes	0.0729	0.2696	0.0249	0.0218
Barium	12	11	6	6	No	0.5900	0.7549	0.6667	0.7311
Cadmium	12	12	6	5	Yes	0.0010	0.2696	0.0113	0.0075
Chromium	12	8	6	6	No	0.9566	0.9755	1.0000	0.9194
Cobalt	12	12	6	6	No	0.4813	0.7549	1.0000	0.6670
Copper	12	12	6	6	No	0.7288	0.7549	0.4314	0.6729
Iron	12	12	6	6	No	0.8793	0.9755	1.0000	0.9202
Lead	12	12	6	6	No	0.9976	1.0000	1.0000	0.9756
Manganese	12	12	6	6	No	0.8752	0.7549	0.4314	0.6741
Mercury	12	7	6	3	No	0.6126	0.7549	1.0000	0.5268
Molybdenum	12	11	6	6	No	0.3751	0.9755	1.0000	0.5958
Nickel	12	12	6	6	No	0.6462	0.7549	1.0000	0.6887
Vanadium	12	7	6	3	No	0.8617	0.9755	1.0000	0.8105
Zinc	12	12	6	6	Yes	0.0084	0.2696	0.0113	0.0026
PCB101	11	10	6	6	No	0.9158	0.7279	1.0000	0.7738
PCB105	10	8	6	5	No	0.9888	1.0000	1.0000	0.9582
PCB118	11	10	6	6	No	0.9318	0.7279	1.0000	0.8616
PCB138	9	8	6	5	No	0.4526	0.6593	1.0000	0.4525
PCB153	11	10	6	6	No	0.5407	0.7279	1.0000	0.5359
PCB52	10	8	6	6	No	0.9570	0.9643	1.0000	0.8843
PCB66	11	10	6	5	No	0.5000	0.7279	1.0000	0.5058

Data resulting from the analysis of mouse tissue collected at IR Site 2 were compared statistically with mouse tissue data from the selected ambient locations to assess differences between their distributions. The distribution shift tests run for this analysis were the Gehan, Slippage, Quantile and t-tests. Descriptions of these tests are summarized in Appendix B-1.

4-chloro-3-methylphenol, 4-chlorophenyl-phenylether, acetone, bis(2-ethylhexyl) phthalate, butylbenzylphthalate, diethylphthalate, di-n-butylphthalate, motor oil range organics, naphthalene, n-nitrosodiphenylamine, pentachlorophenol, phenol, and total recoverable hydrocarbons were not included in this analysis either because they were not included in the

analytical suites requested of the laboratory for tissue samples or because they were only requested for the site or the reference site tissue samples, but not both.

Distribution shift tests perform reasonably well if the detection rate in both data sets is at least 50%. For mice, analytes with detection rates below 50% were excluded from the analysis. The excluded analytes were: PCB congeners 8, 18, 28, 44, 52, 66, 101, 105, 118, 128, 138, 195, 209; antimony; arsenic; beryllium; selenium; silver; vanadium; all non-PCB organics.

Table 7-21 summarized the statistical test results for mice, for analytes that satisfied the requirements of the tests relating to detection rates. The Gehan and/or t-tests led to the conclusion that the median/mean of site mouse tissue concentrations of aluminum, cadmium, cobalt, iron, manganese and molybdenum exceeded those found in ambient tissue. In most cases, the Gehan and t-test led to the same conclusion. These tests gave different results for manganese. Given that the detection rate for this analyte is 100% and the site and reference site data are fairly normally distributed, one would rely more on the t-test results because of its increased statistical power compared to the Gehan test. The slippage test results for cadmium, cobalt, and iron indicated that a high proportion of the maximum values for these analytes occurred in the site data as compared to the reference site data.

Although the t-test indicated for mice that the mean PCB206 concentration in site tissue was greater that the mean concentration in the reference site tissue, this was an artifact of four very high non-detected results being included as the detection limits in the analysis. These detection limits exceeded all other results, both detected and non-detected. Under these circumstances, the t-test does not give reliable results. When the tests were re-run with these data removed, none indicated a difference between site mouse tissue and reference site mouse tissue PCB206 concentrations.

The slippage test indicated a difference for mice between thallium concentrations in site and reference site tissue, but an examination of the distributions showed that there were elevated non-detected values in the upper tail of the site tissue data distribution. Under these circumstances, the slippage test gives unreliable results.

In mouse tissue, the mean and/or median concentrations of aluminum, cadmium, cobalt, iron, manganese and molybdenum were greater than those in the reference site mouse tissue.

As with mouse tissue data, plant analytes with detection rates below 50% were excluded from the analysis. Excluded analytes were PCB congeners 8, 18, 28, 44, 128, 170, 180, 187, 195, 206, 209; beryllium; selenium; silver; thallium; all non-PCB organics.

Table 7-22 summarized the statistical test results for plants, for analytes that satisfied the requirements of the tests relating to detection rates. The Gehan, slippage and t-test all indicated distribution shifts between site plant tissue and reference site tissue for arsenic, cadmium and

zinc concentrations. Not only were mean and median values greater at the site than in the reference site, more of the extreme values occurred in the site tissue data than would be expected.

For plants, the mean and median concentration of arsenic, cadmium and zinc were greater in site tissues than those in the reference site.

7.3.2.4 Food Chain Dose Calculations and TRV Comparisons

In this section, the results from the dose calculations for each receptor are presented. These results are directly compared with the low and high toxicity reference values (TRV) for any given constituent (Navy 1998).

TRVs are divided into high and low categories as characterized in the Navy guidance for TRV development (Navy 1998):

"TRVs for birds and mammals were derived from published toxicological data for 20 chemicals found at San Francisco Bay area naval installations. Rather than a single point estimate associated with adverse biological effects, high and low TRVs were derived for each chemical to reflect the variability of parameters within an ecological risk context. Specifically, a low TRV is consistent with a chronic no effect level. A no effect level is a dose within a study at which no effect to the test organism was observed. A high TRV is consistent with an effect level. An effect level is a dose at which a specific biological effect was seen in the laboratory test organism. High TRVs were selected from approximately the middle of the range of all sublethal effect levels for a particular chemical. Hence, the high TRV is a value at which adverse effects have been demonstrated in at least one laboratory study and are assumed likely to occur in the field."

If a dose exceeds either TRV for a given receptor, then that constituent is considered further in the IR Site 2 ERA uncertainty section (Sections 7.3.4.2). TRV comparisons are provided in Tables 7-23 through 7-32. Note that two hazard quotients are calculated: HQ_{low} and HQ_{high}. These are, respectively, the hazard quotient calculated as the dose divided by the low TRV and the dose divided by the high TRV. As is clear from the tables, not all of the constituents passed from screening have associated Navy TRVs. Other published TRVs for certain inorganic COPECs are discussed in the uncertainty section (7.3.4). However, if a TRV (high or low) was exceeded for any receptor, then this information and the associated HQs are summarized in Table 7-33.

An evaluation of the HQ analysis shows that HQ_{high} values never exceeded one for any constituent for any receptor. All receptors had some exceedances of HQ_{lows}, with cadmium, lead and zinc being the most common exceedances.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions from Data Review and the Conceptual Site Model

The conclusions presented in this section were based upon evaluation of soils data collected in 1990, 1991, 1994 and 1995; sediment data collected in 1993, 1994, 1996 and 1997; surface water data collected in 1991 and 1994 through 1997; groundwater data collected in 1991 through 1998; and biological tissue data collected in 1996 through 1998.

The results of data analysis (Section 4) indicate that there is little or no evidence that chemical constituents associated with the landfill are present in surrounding environmental media. These analytical results are not consistent with *a priori* expectations of detectable chemical migration from the landfill based on historical descriptions of waste deposition activities at the landfill (Section 2). The Navy has concluded that there are four possible explanations for the absence of obvious chemical migration from the landfill. These explanations, which rest on data interpretation provided in the conceptual site model in Section 5, are presented below in order of plausibility.

1. All or most of the chemical constituents have already decomposed or migrated from the landfill. The plausibility of this scenario rests on two premises: (1) conditions at the landfill were ideal for waste biodegradation and (2) given the landfill environment, bulk transport and dissolution processes were likely to have removed contaminants from the landfill. As described in Section 5.2, the landfill experiences frequent ponding of surface water following precipitation which should lead to infiltration and leaching of chemical constituents from the waste. The landfill is also in tidal communication with the bay and is subject to tidal washing of disposed wastes. This was particularly true during the waste deposition process.

2. Assumptions regarding the amount and type of hazardous chemical constituents disposed in the landfill are incorrect. There are relatively few records documenting the quantity of hazardous substances disposed of in the waste. Much of the information regarding waste type is descriptive and estimates of the amount of hazardous chemicals are based on these descriptive records. The landfill may have received only a small quantity of hazardous chemicals. The plausibility of the first hypothesis for the absence of obvious chemical migration from the landfill is enhanced if this second hypothesis is also true.

3. No or few chemical constituents have yet migrated from the landfill. The landfill is known to have used dredge spoils or similar material as a daily cover on the waste. Such material is extremely fine and may contain high quantities of organic material. It is possible that much of the waste has been contained within a matrix of this material, and that the high organic carbon content and large surface area per unit mass of the material has effectively inhibited chemical migration. Chemical uptake by plants is also known to be inhibited when chemicals are present in a soil matrix that is high in organic content.

The plausibility of this hypothesis is weakened by historical and current observations that the landfill is well-connected with the surrounding environment via tidal surges, a groundwater table that partially submerges the buried waste, and surface depressions that enhance local ponding and in infiltration of precipitation. The absence of linings or leachate collection systems further reduces the credibility of this hypothesis.

4. The analytical data do not accurately reflect chemical constituent concentrations in the environmental media. The majority of the data used in this assessment have been published in reports of previous investigations and most data were validated according to the protocols established for those investigations. The adequacy of these data quality assurance measures for use of the data in this installation restoration report has not been specifically evaluated. However, the data sets evaluated in this report are uniformly consistent in showing little evidence of environmental contamination, and data analyses did not reveal significant differences in chemical concentrations among the various sampling campaigns. Therefore, it is highly unlikely that systematic errors in reported concentrations could exist.

8.2 Conclusions from Risk Assessment Results

Human Health Risk Assessment: Human health risks were evaluated assuming future land uses consistent with an ecological preserve. Visitors to the preserve and workers were evaluated as potential receptors. Uncertainty in land use intensity under these scenarios was addressed by calculating risks for both reasonable maximum (RME) and central tendency (CTE) exposure assumptions. The results of the human health risk assessment indicate that chemical hazards are well below the threshold criterion (hazard quotient of 1) for all combinations of land use exposure intensity. Predicted excess cancer risks for chemicals are equal to or less than the lower end of the US Environmental Protection Agency's (EPA's) risk range of 10^{-4} to 10^{-6} for all combinations of land use and exposure intensity. Generally speaking, most sources of uncertainty in the calculated risk values tend to bias the results towards higher values (see Section 6.5.5). Therefore, it is highly unlikely that unacceptable chemical hazard or risk will be realized under the future land use conditions evaluated in this assessment.

Excess cancer risks associated with exposure to radium isotopes under occupational land use conditions were estimated to be approximately 10^{-5} and 10^{-6} using RME and CTE exposure assumptions, respectively. Estimated risks for recreational land use conditions were approximately 10^{-6} and 10^{-7} using RME and CTE exposure assumptions, respectively. Potentially unacceptable risks were therefore identified for only one of the four combinations of land use and exposure intensity. As discussed in Section 6.5.5, the radium isotope data are inadequate to determine whether radium concentrations in soil at IR Site 2 are indicative of releases from Naval activities and, if so, what percentage of the measured activity concentrations are due to such releases. However, estimated risks are still well within EPA's risk range even under RME exposure conditions. The number of potentially exposed occupational receptors are also likely to

be few. Therefore, remedial action to mitigate potential cancer risks associated with exposure to radium under future land use conditions is not recommended.

As discussed in Section 6.5.2.3, differences in the derivation of chemical and radionuclide cancer slope factors prohibit simple summing of cancer risk across chemicals and radionuclides. However, radionuclide cancer risks were approximately tenfold higher than chemical risks for the same land use scenario and exposure assumptions. Because of this relatively large difference, and because cancer risk estimates are reported with only one significant figure (EPA 1989), adding chemical cancer risk to radionuclide risk would not substantially affect the radionuclide risk estimates in this assessment.

Ecological Risk Assessment: The ecological risk assessment utilized a qualitative weight-of-evidence approach, which included the following lines of evidence:

- comparison of chemical concentrations in soil to plant soil screening levels;
- comparison of chemical concentrations in IR Site 2 plant and animal tissues to tissues collected at a reference area;
- invertebrate bioassays using wetland sediment; and,
- food-chain modeling to nine upper-trophic-level receptors.

Results of the ecological risk assessment were mostly equivocal (Section 7.3.3). As summarized in Section 7.4, the ambiguity of the results was due mainly to concentrations of nine metals in surface soils at IR Site 2. These nine metals drove the uncertainty associated with food-chain modeling results, as each had modeled daily doses to some ecological receptors that exceeded low toxicity reference values (TRVs), but not high TRVs. Despite this ambiguity, a recommendation of no action at this time is warranted based on the following facts:

- The nine metals responsible for the ambiguity of the results are distributed site-wide and do not appear to originate from a discrete source (i.e., the landfill).
- Food chain doses to ecological receptors only exceeded low TRVs; no high TRVs were exceeded. Exceedances of only low TRVs are not definitive indications of risk..

A valued ecosystem is currently in place at IR Site 2, with no evidence that it is being impacted by chemical constituents (see Ecological Scoping Checklist in Appendix C).

8.3 Identification of Remedial Action Objectives

The results of the human health risk assessment indicate that risks associated with current chemical concentrations in environmental media do not warrant remedial action. However, the Navy has determined that follow-up activities are desirable to reduce uncertainties in the

conceptual site model and ecological risk assessment and to confirm that future impacts will remain insignificant.

A Feasibility Study (FS) will be conducted to evaluate the efficacy of selected remedies to further reduce uncertainties regarding the future migration of chemical constituents from the landfill to the surrounding environment. The FS will focus on resolving which of the four alternatives described in Section 8.1 best explains why there is little or no evidence of chemical migration from the landfill in current environmental data. Information collected via implementation of the FS also be used to reduce uncertainty in the conclusions of the ecological risk assessment.

The scope of the remedial action objectives for IR Site 2 are also dependent upon the results of an ongoing investigation of possible unexploded ordnance (UXO) at IR Site 2. Results of the UXO investigation will be published as an addendum to this report.

Table B-31 (continued). Statistics and UCL Calculation Methods for Exposure Point Concentrations for all constituents in Terrestrial Invertebrate Tissue, Entire Site

Analyte	Number of Samples	Standard Mean	Range	Max Detected Value (Recommended EPC)	Units
ACENAPHTHENE	2	35	40	55	ug/kg
ANTHRACENE	2	28	26	41	ug/kg
FLUORENE	2	21.5	13	28	ug/kg
NAPHTHALENE	2	40.5	57	69	ug/kg
PHENANTHRENE	2	232	433	448	ug/kg
ENDOSULFAN I	2	1.3	0.8	1.7	ug/kg
DIBUTYL TIN	3	10.3	9	15	ug/kg
N-BUTYLTIN	3	14	16	23	ug/kg
TRIBUTYL TIN	3	84	170	179	ug/kg

NA = not available. If the number of samples is less than 4, a UCL is not calculated.

Table B-32. Statistics and UCL Calculation Methods for Exposure Point Concentrations for all constituents in Fish Tissue, Wetland Area

Suite	Analyte	Number of Samples	LogN MVUE Mean	Standard Mean	LogN 95% UCL	Norm 95% UCL	S-W test for LogN (p-value):	S-W test for Norm (p-value):	Max Detected Value	Units	Recommended EPC	Type
AROCLOR	AROCLOR-1254	6	84.3	84.3	108	102	0.401	0.295	120	ug/kg	108	Lognormal UCL
AROCLOR	AROCLOR-1260	6	89.7	90.2	149	124	0.570	0.236	160	ug/kg	149	Lognormal UCL
DDT 44	4,4'-DDD	7	12.2	11.9	27.5	16.5	0.578	0.990	22.1	ug/kg	16.5	Normal UCL
DDT 44	4,4'-DDE	7	20.9	21.2	31.7	29.1	0.230	0.017	44.2	ug/kg	31.7	Lognormal UCL
DDT 44	4,4'-DDT	7	16.3	15.6	40.8	21.4	0.170	0.955	26	ug/kg	21.4	Normal UCL
METAL	ALUMINUM	7	159	140	2925	249	0.630	0.070	401	mg/kg	401	Max Detect
METAL	ARSENIC	7	0.674	0.766	1.97	1.49	0.002	0.000	3	mg/kg	1.97	Lognormal UCL

Table B-32 (continued). Statistics and UCL Calculation Methods for Exposure Point Concentrations for all constituents in Fish Tissue, Wetland Area

Suite	Analyte	Number of Samples	LogN MVUE Mean	Standard Mean	LogN 95% UCL	Norm 95% UCL	S-W test for LogN (p-value):	S-W test for Norm (p-value):	Max Detected Value	Units	Recommended EPC	Type
METAL	BARIUM	7	1.40	1.59	4.21	3.12	0.003	0.000	6.3	mg/kg	4.21	Lognormal UCL
METAL	CADMIUM	7	0.024	0.031	0.195	0.070	0.018	0.000	0.15	mg/kg	0.150	Max Detect
METAL	CALCIUM	7	13405	13440	22748	18602	0.747	0.222	26142	mg/kg	22748	Lognormal UCL
METAL	CHROMIUM	7	0.758	0.764	1.59	1.13	0.122	0.046	1.5	mg/kg	1.5	Max Detect
METAL	COBALT	7	0.151	0.148	0.545	0.235	0.910	0.332	0.36	mg/kg	0.36	Max Detect
METAL	COPPER	7	6.19	6.91	21.5	13.4	0.076	0.000	26.6	mg/kg	21.5	Lognormal UCL
METAL	IRON	7	254	250	691	374	0.590	0.156	486	mg/kg	486	Max Detect
METAL	LEAD	7	0.407	0.340	4.78	0.512	0.040	0.256	0.59	mg/kg	0.512	Normal UCL
METAL	MAGNESIUM	7	888	908	1381	1317	0.004	0.000	2160	mg/kg	1381	Lognormal UCL
METAL	MANGANESE	7	22.4	22.5	45.9	33.8	0.602	0.027	55.1	mg/kg	45.9	Lognormal UCL
METAL	MERCURY	7	0.045	0.046	0.164	0.076	0.805	0.069	0.13	mg/kg	0.130	Max Detect
METAL	MOLYBDENUM	7	0.054	0.055	0.126	0.086	0.240	0.025	0.13	mg/kg	0.126	Lognormal UCL
METAL	NICKEL	7	0.866	1.04	7.99	2.27	0.332	0.000	4.8	mg/kg	4.8	Max Detect
METAL	POTASSIUM	7	3796	3827	5432	5117	0.145	0.007	7640	mg/kg	5432	Lognormal UCL
METAL	SILVER	7	0.070	0.073	0.245	0.124	0.180	0.011	0.15	mg/kg	0.15	Max Detect
METAL	SODIUM	7	3857	3886	5979	5301	0.324	0.081	7563	mg/kg	5979	Lognormal UCL
METAL	VANADIUM	7	0.464	0.467	2.69	0.811	0.452	0.060	1.3	mg/kg	1.3	Max Detect
METAL	ZINC	7	48.9	49.1	74.7	65.4	0.661	0.208	89	mg/kg	74.7	Lognormal UCL
PAH HIGH	BENZO(G,H,I)PERYLENE	7	1522	1099	20539	1442	0.000	0.000	41	ug/kg	41	Max Detect
PAH LOW	2-METHYLNAPHTHALENE	7	1815	1096	77199	1445	0.000	0.000	20	ug/kg	20	Max Detect
PAH LOW	ACENAPHTHENE	7	1749	1096	58364	1444	0.000	0.000	23	ug/kg	23	Max Detect
PAH LOW	FLUORENE	7	1868	1095	95942	1445	0.000	0.000	18	ug/kg	18	Max Detect

Table B-32 (continued). Statistics and UCL Calculation Methods for Exposure Point Concentrations for all constituents in Fish Tissue, Wetland Area

Suite	Analyte	Number of Samples	LogN MVUE Mean	Standard Mean	LogN 95% UCL	Norm 95% UCL	S-W test for LogN (p-value):	S-W test for Norm (p-value):	Max Detected Value	Units	Recommended EPC	Type
PAH LOW	NAPHTHALENE	7	2222	1094	358500	1446	0.000	0.000	10	ug/kg	10	Max Detect
PAH LOW	PHENANTHRENE	7	1967	1095	141616	1445	0.000	0.000	15	ug/kg	15	Max Detect
PEST	ALDRIN	7	1.99	1.95	3.23	2.45	0.002	0.018	3	ug/kg	2.45	Normal UCL
PEST	ALPHA-BHC	7	0.464	0.464	0.557	0.546	0.001	0.001	0.6	ug/kg	0.546	Normal UCL
PEST	ALPHA-CHLORDANE	7	2.77	2.77	3.44	3.29	0.333	0.283	4	ug/kg	3.44	Lognormal UCL
PEST	BETA-BHC	7	1.01	1.05	2.12	1.70	0.270	0.002	3	ug/kg	2.12	Lognormal UCL
PEST	DIELDRIN	7	3.98	4.01	6.53	5.61	0.089	0.021	8	ug/kg	6.53	Lognormal UCL
PEST	ENDOSULFAN I	7	2.74	2.59	6.46	3.40	0.005	0.274	4	ug/kg	3.40	Normal UCL
PEST	ENDOSULFAN II	7	3.13	3.09	5.67	4.15	0.458	0.719	4	ug/kg	4	Max Detect
PEST	ENDRIN	7	19.0	14.7	244	21.0	0.008	0.685	26	ug/kg	21.0	Normal UCL
PEST	ENDRIN ALDEHYDE	7	9.87	8.38	58.1	11.7	0.010	0.812	14	ug/kg	11.7	Normal UCL
PEST	GAMMA-BHC (LINDANE)	7	0.464	0.464	0.557	0.546	0.001	0.001	0.6	ug/kg	0.546	Normal UCL
PEST	GAMMA-CHLORDANE	7	1.34	1.34	2.27	1.80	0.067	0.027	2	ug/kg	2	Max Detect
PEST	HEPTACHLOR EPOXIDE	7	2.76	2.84	10.7	5.05	0.654	0.004	3	ug/kg	3	Max Detect
PEST	METHOXYCHLOR	7	7.49	7.09	49.3	11.9	0.127	0.018	18	ug/kg	18	Max Detect
TBT	DIBUTYL TIN	7	1.47	1.57	2.96	2.68	0.000	0.000	5	ug/kg	2.96	Lognormal UCL
TBT	TRIBUTYL TIN	7	3.74	4.29	22.0	8.81	0.104	0.000	18	ug/kg	18	Max Detect

NA = not available. If the number of samples is less than 4, a UCL is not calculated.
LogN = LogNormal. MVUE = Minimum Variance Unbiased Estimate S-W = Shapiro Wilk (see B.6.1.2)

Figure B-221. Boxplot of Arsenic Concentrations in IR Site 2 Surface Water – by Date

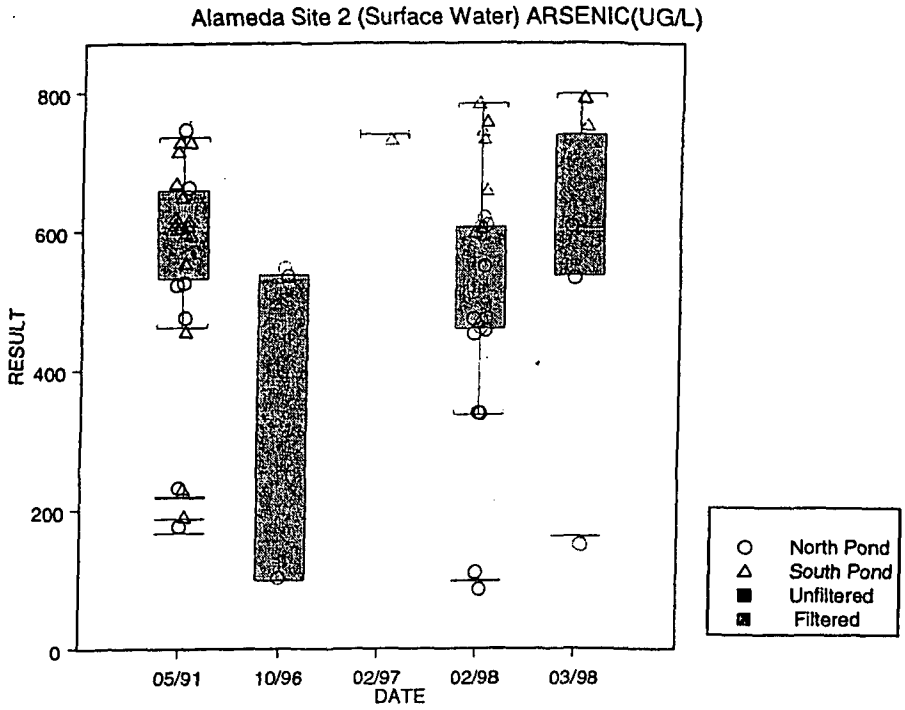

Figure B-222. Boxplot of Barium Concentrations in IR Site 2 Surface Water – by Date

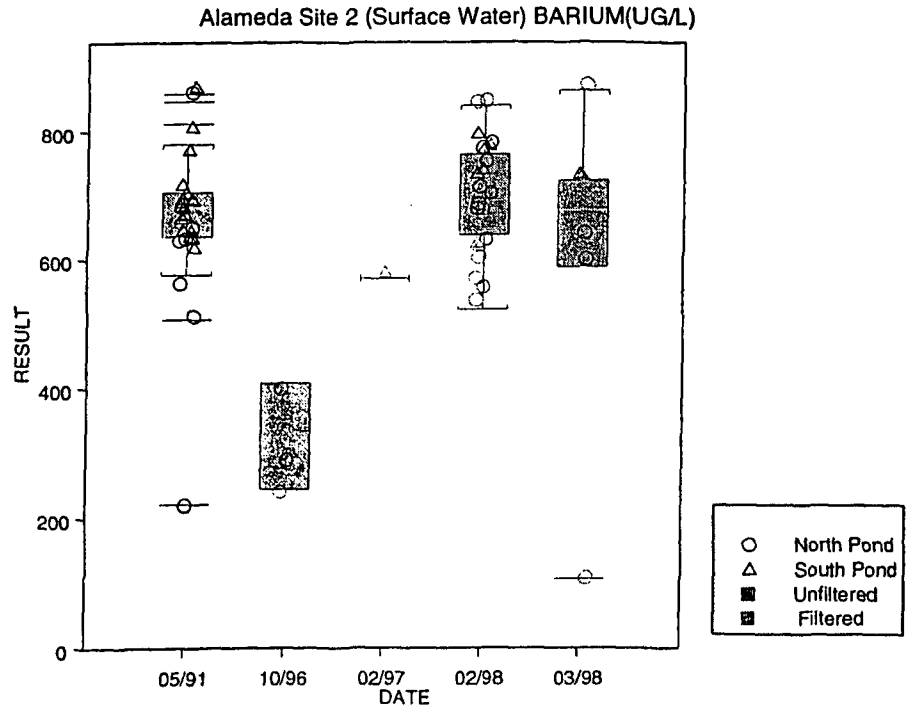

Figure B-223. Boxplot of Beryllium Concentrations in IR Site 2 Surface Water – by Date

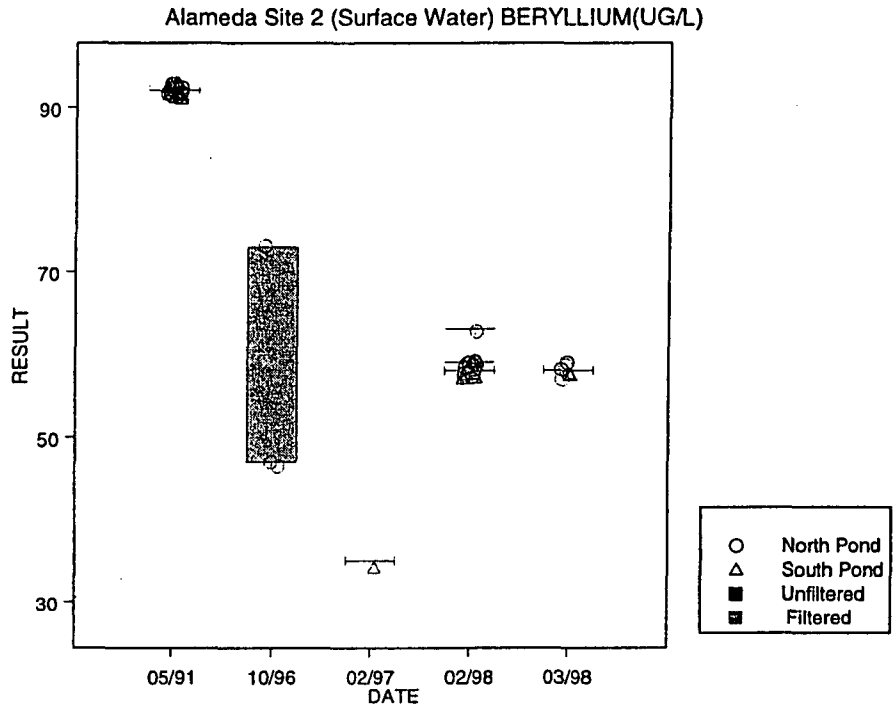

Figure B-224. Boxplot of Cadmium Concentrations in IR Site 2 Surface Water – by Date

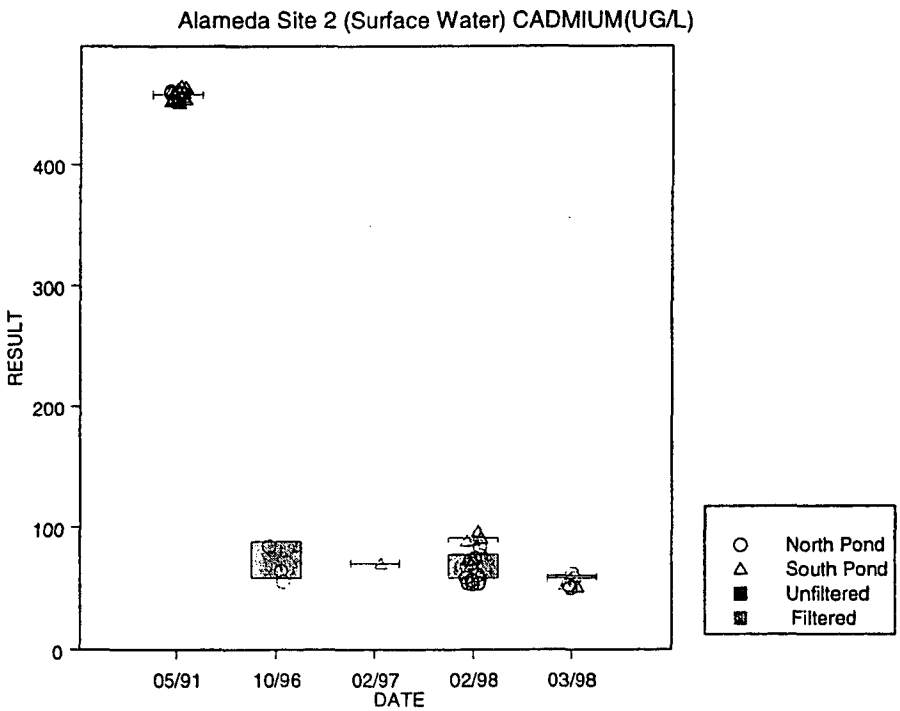

Figure B-225. Boxplot of Calcium Concentrations in IR Site 2 Surface Water – by Date

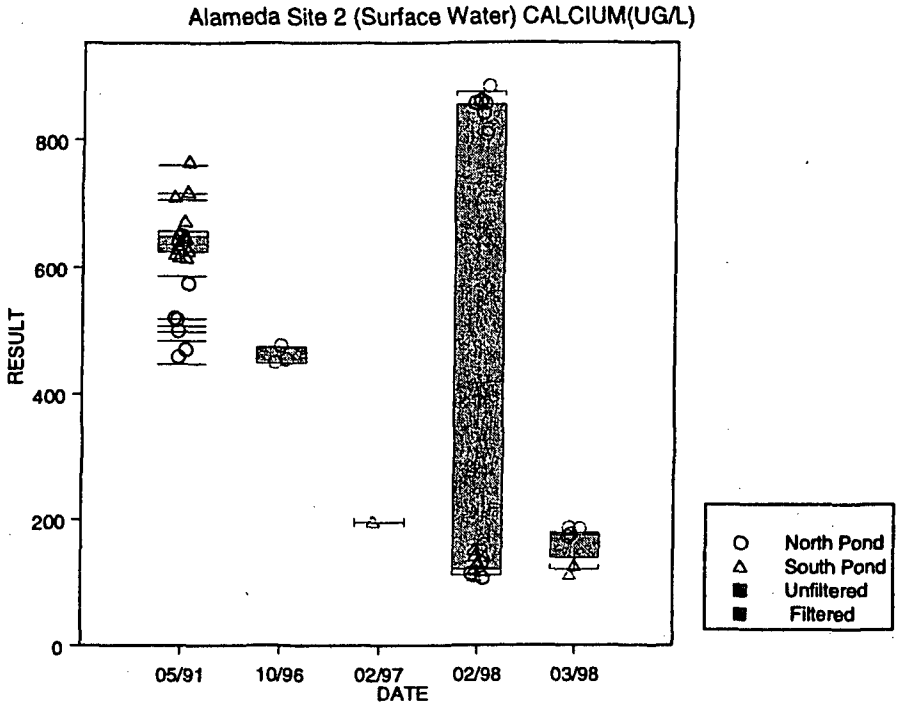

Figure B-226. Boxplot of Chromium Concentrations in IR Site 2 Surface Water – by Date

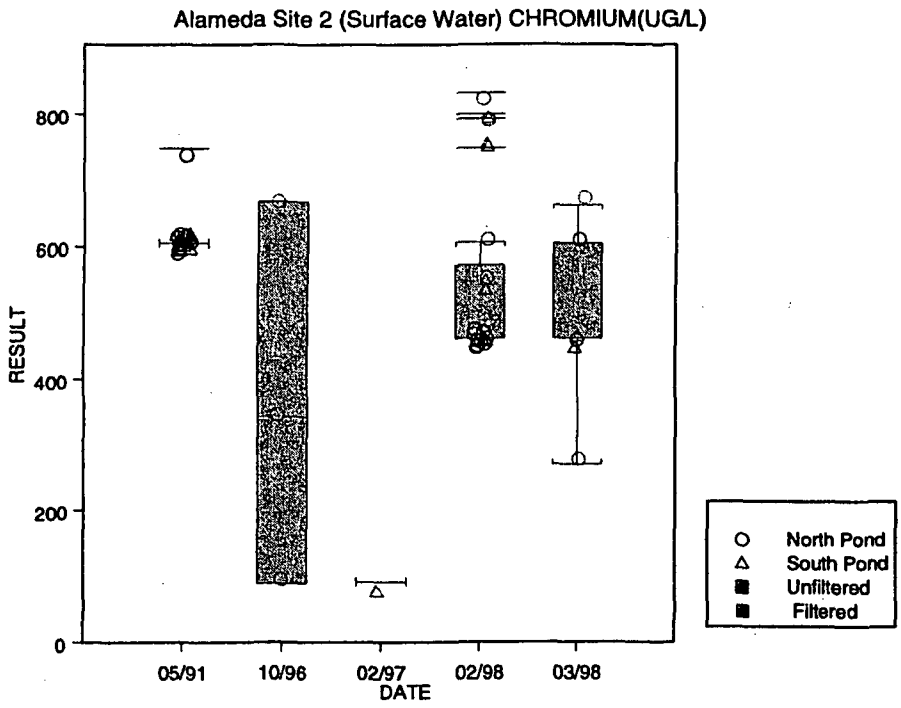

Figure B-227. Boxplot of Cobalt Concentrations in IR Site 2 Surface Water – by Date

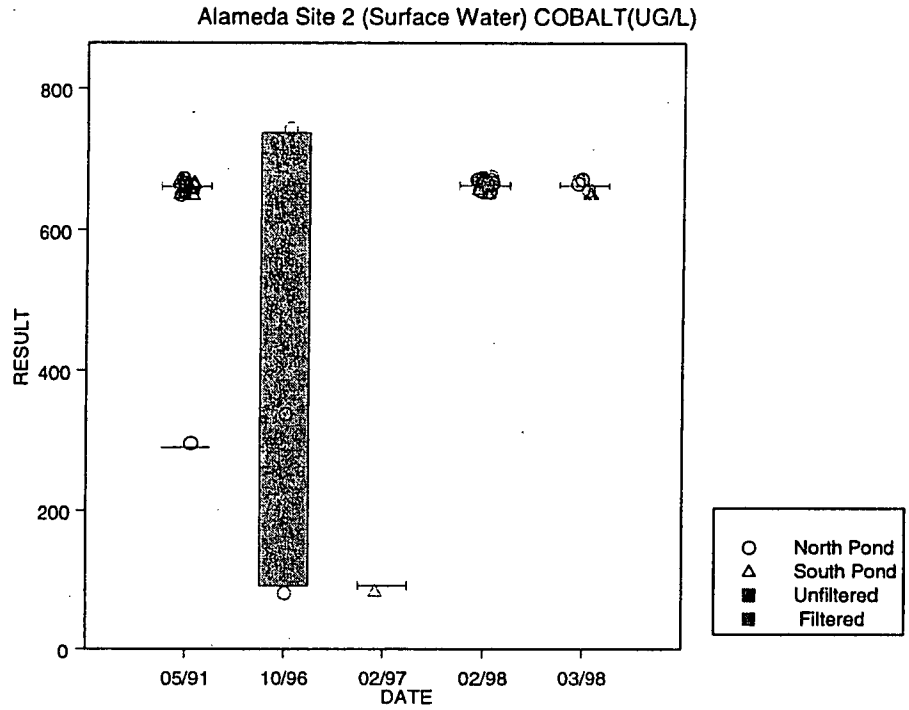

Figure B-228. Boxplot of Copper Concentrations in IR Site 2 Surface Water – by Date

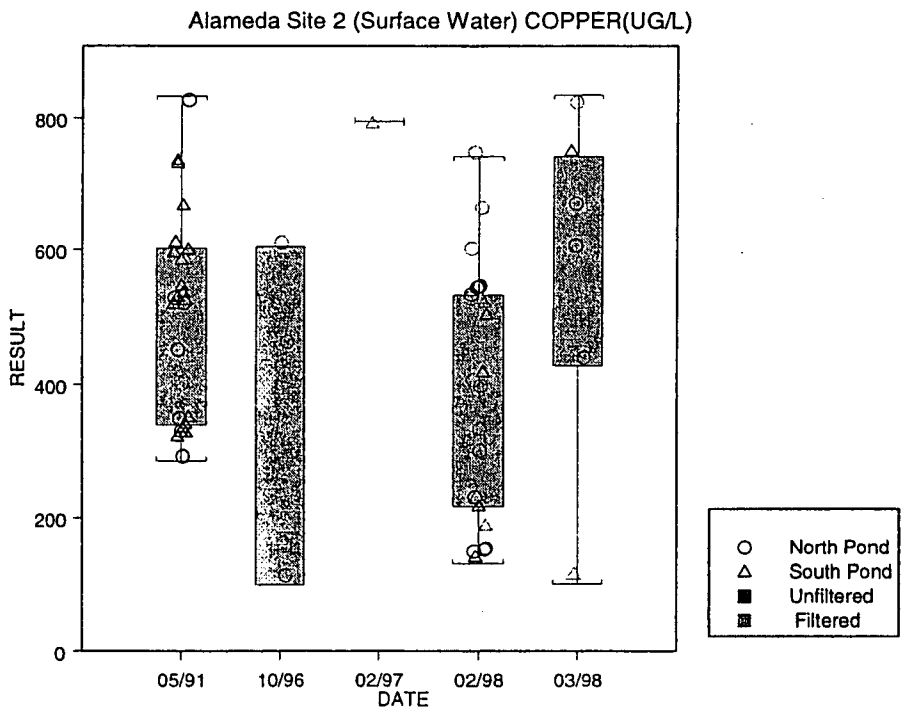

Figure B-229. Boxplot of Iron Concentrations in IR Site 2 Surface Water – by Date

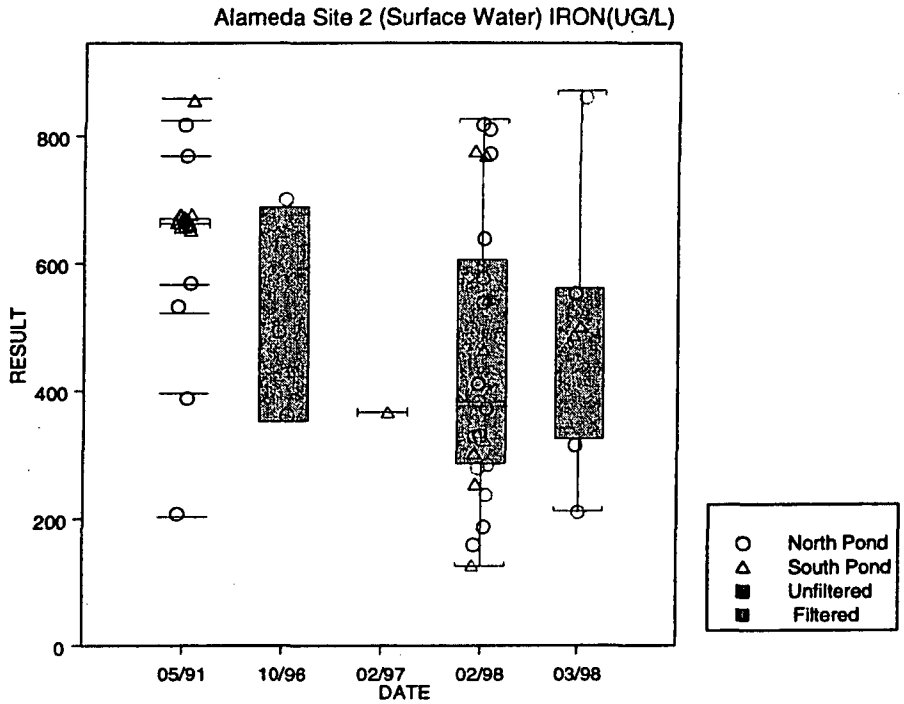

Figure B-230. Boxplot of Lead Concentrations in IR Site 2 Surface Water – by Date

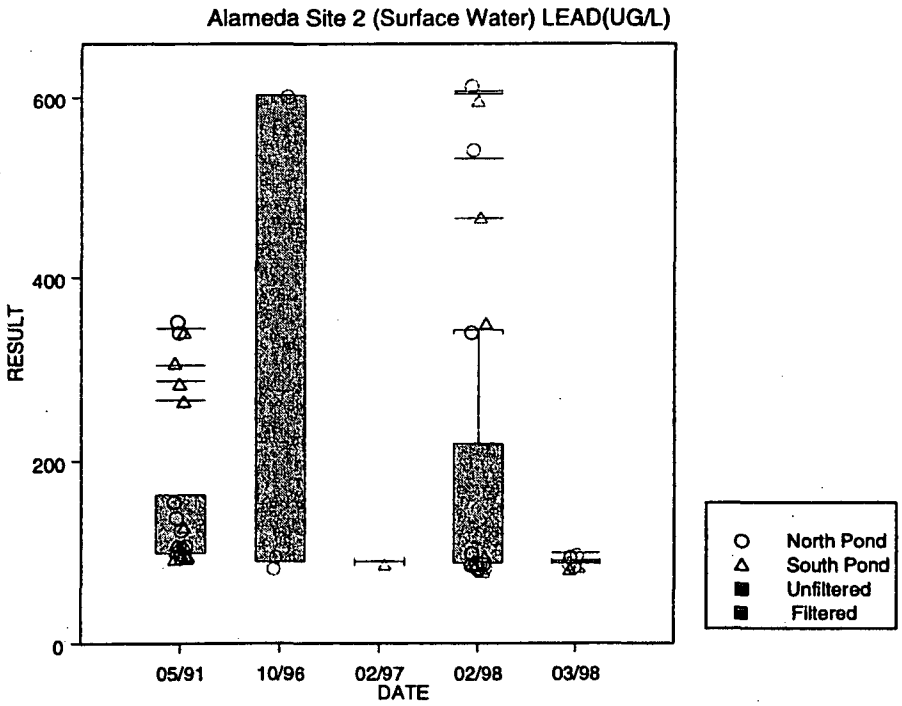

Figure B-231. Boxplot of Magnesium Concentrations in IR Site 2 Surface Water – by Date

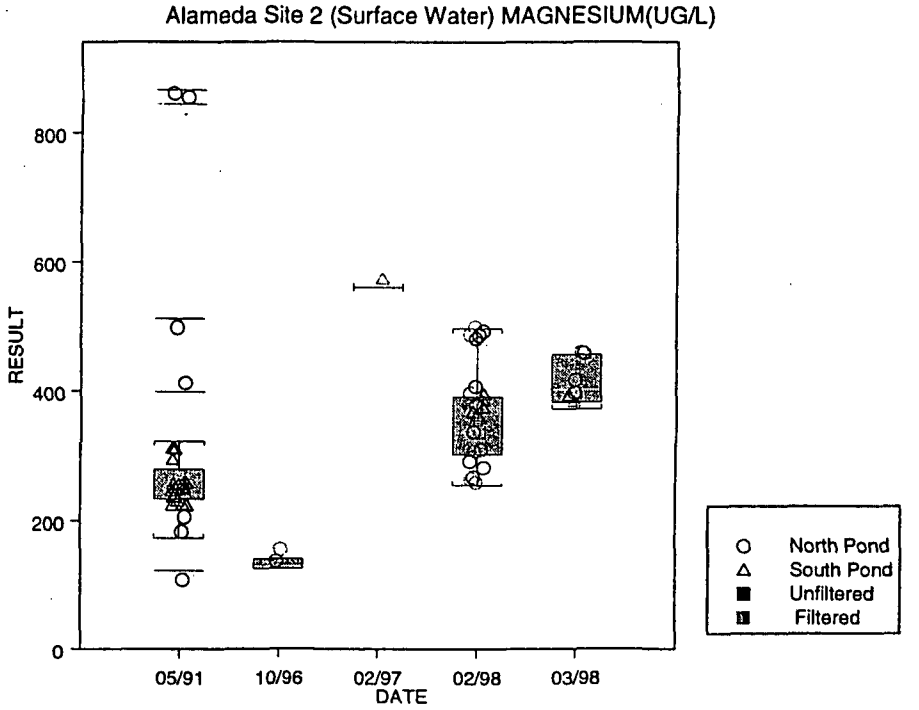

Figure B-232. Boxplot of Manganese Concentrations in IR Site 2 Surface Water – by Date

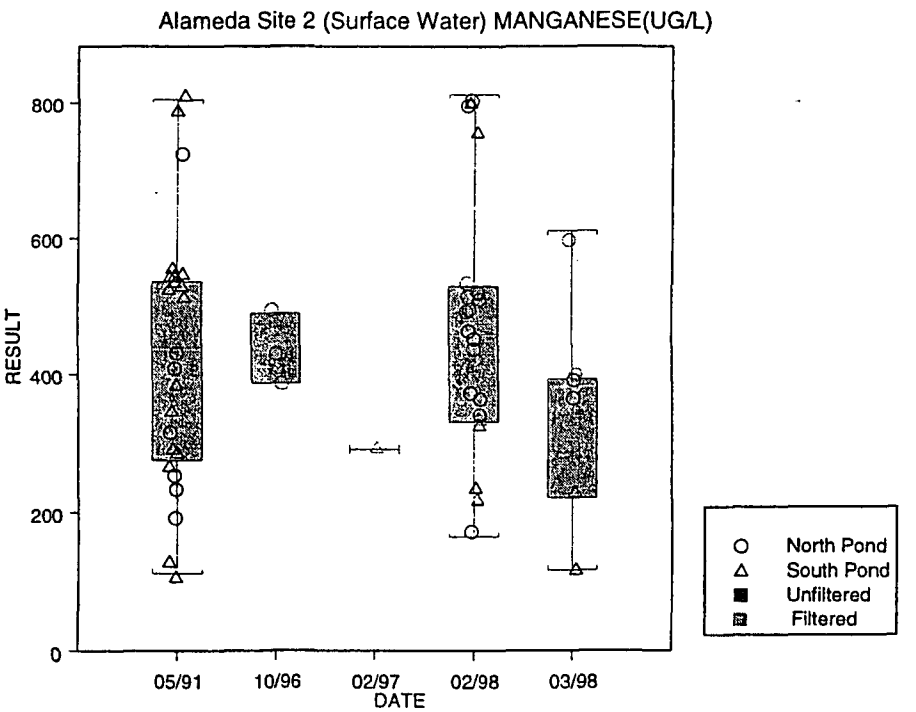

Figure B-233. Boxplot of Mercury Concentrations in IR Site 2 Surface Water – by Date

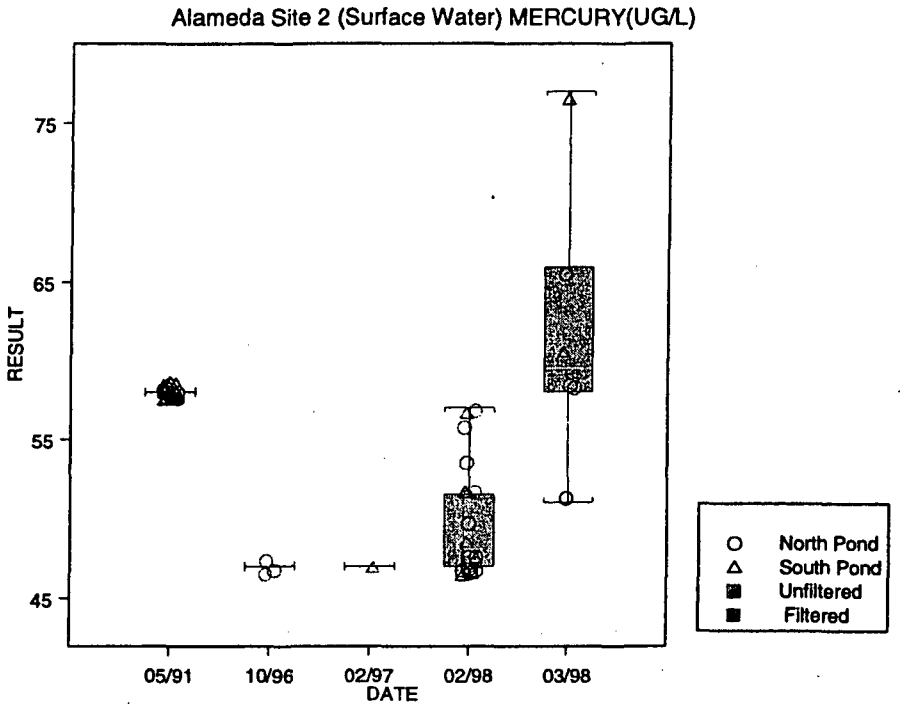

Figure B-234. Boxplot of MolybdenumConcentrations in IR Site 2 Surface Water – by Date

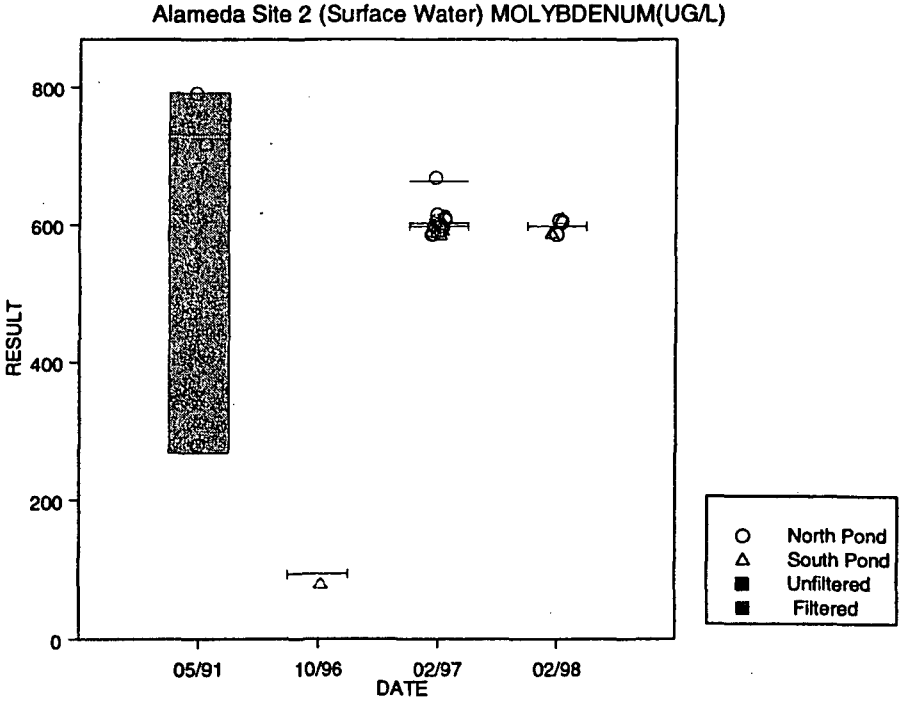

Figure B-235. Boxplot of Nickel Concentrations in IR Site 2 Surface Water – by Date

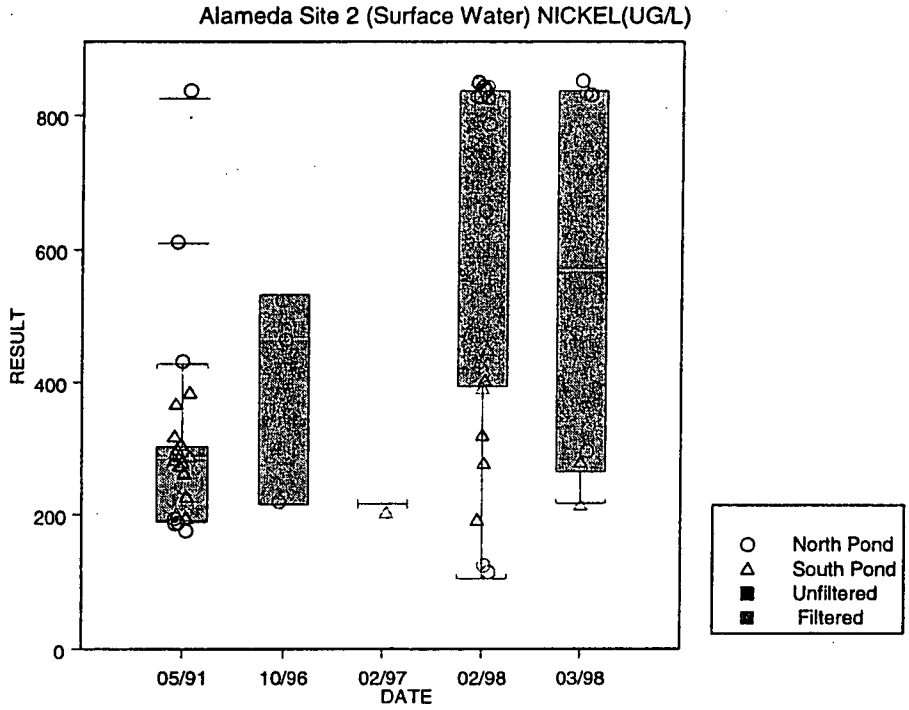

Figure B-236. Boxplot of Potassium Concentrations in IR Site 2 Surface Water – by Date

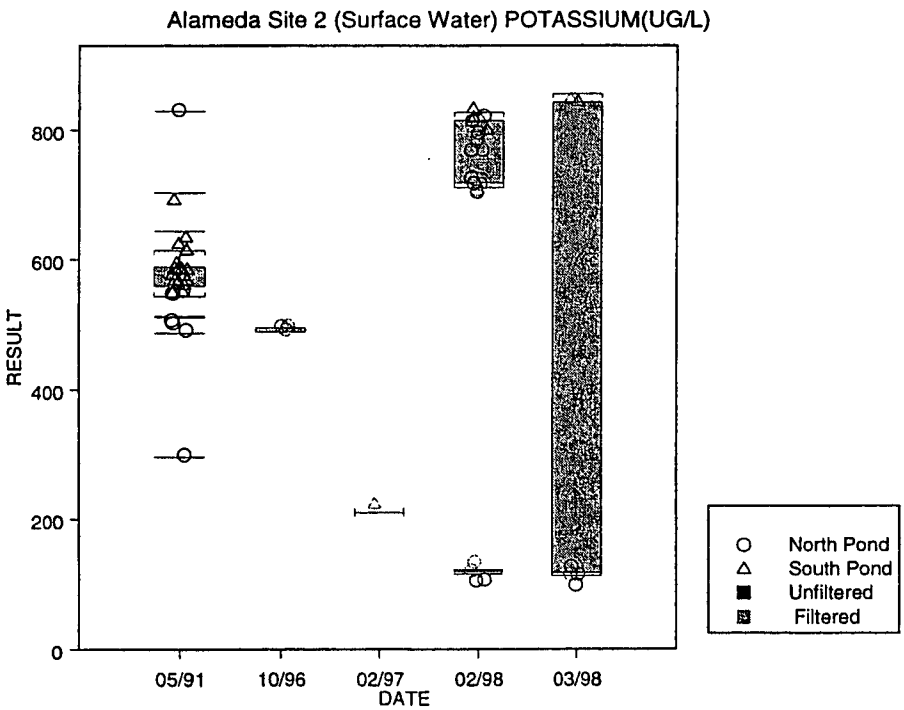

Figure B-237. Boxplot of Selenium Concentrations in IR Site 2 Surface Water – by Date

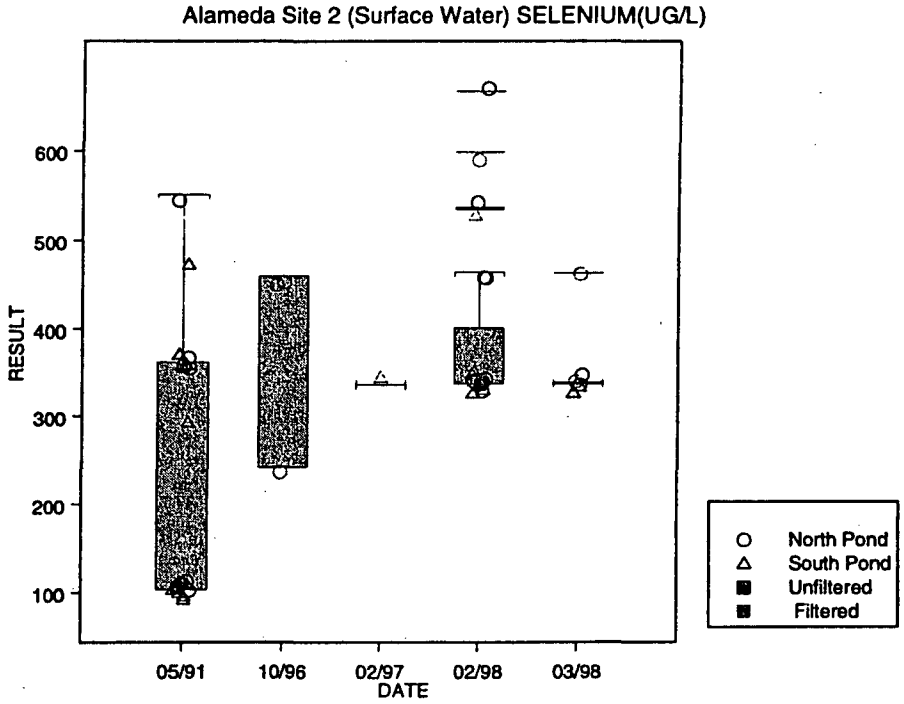

Figure B-238. Boxplot of Silver Concentrations in IR Site 2 Surface Water – by Date

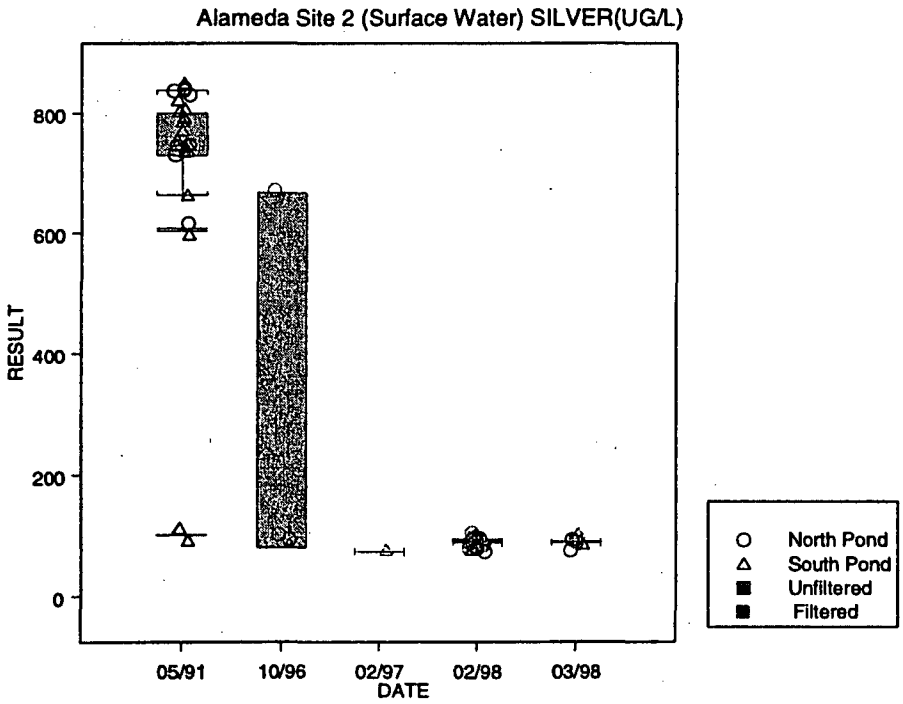

Figure B-239. Boxplot of Sodium Concentrations in IR Site 2 Surface Water – by Date

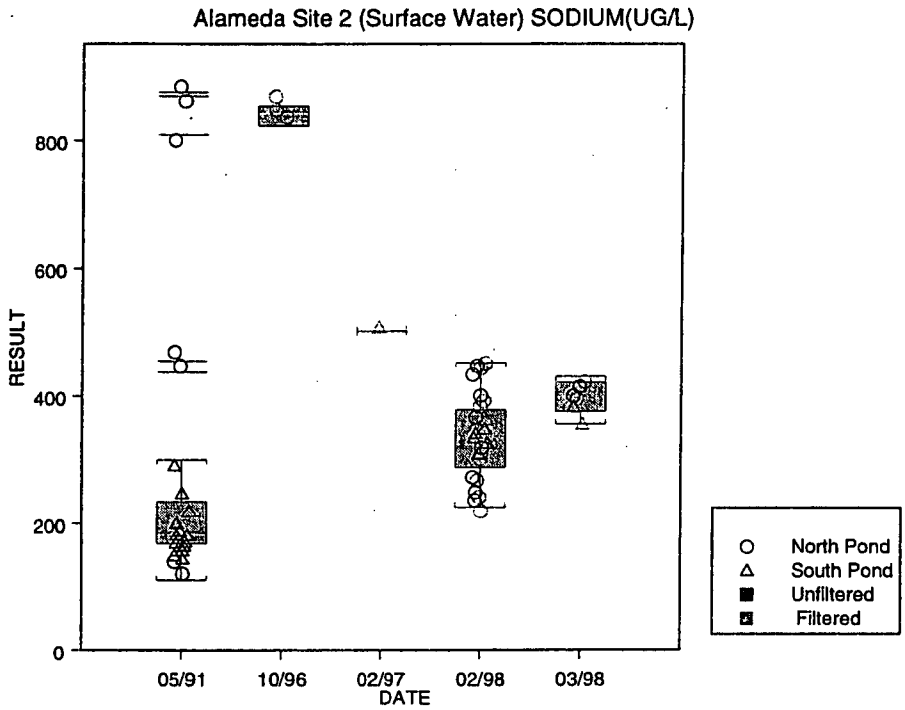

Figure B-240. Boxplot of Thallium Concentrations in IR Site 2 Surface Water – by Date

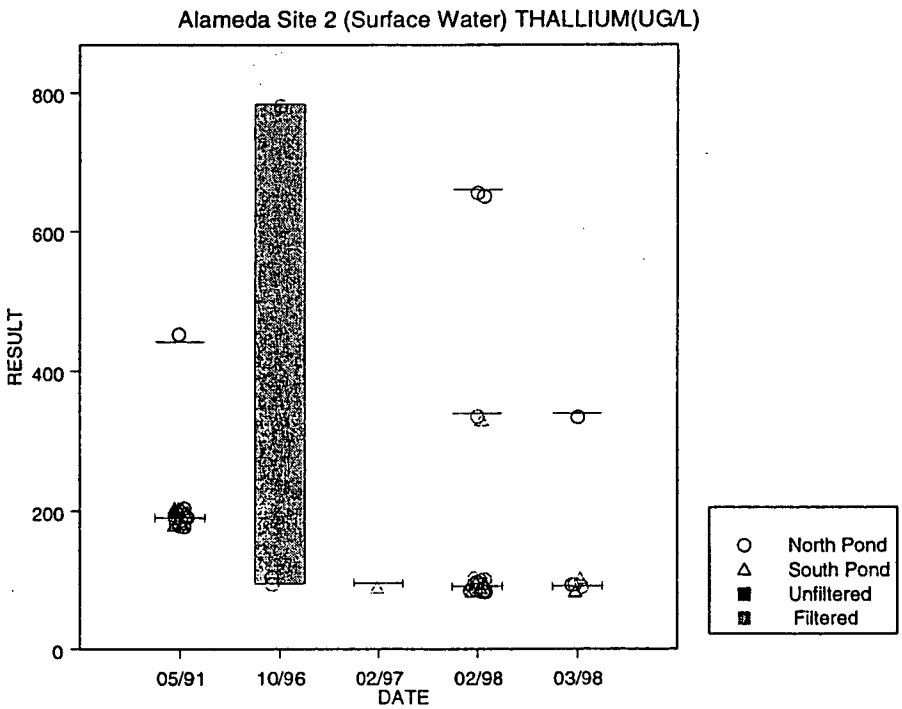

Figure B-241. Boxplot of Vanadium Concentrations in IR Site 2 Surface Water – by Date

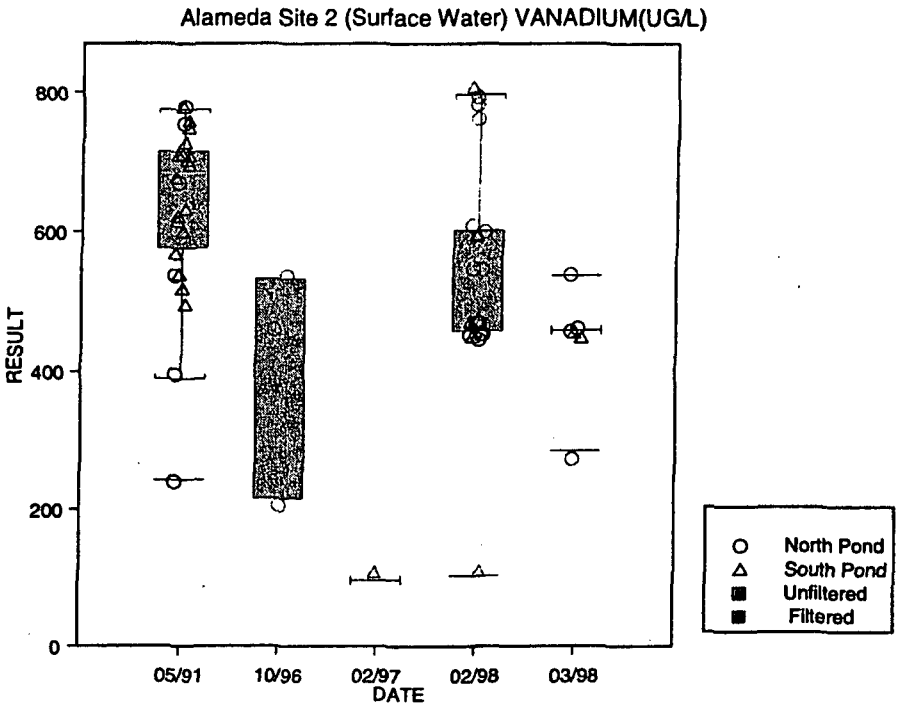

Figure B-242. Boxplot of Zinc Concentrations in IR Site 2 Surface Water – by Date

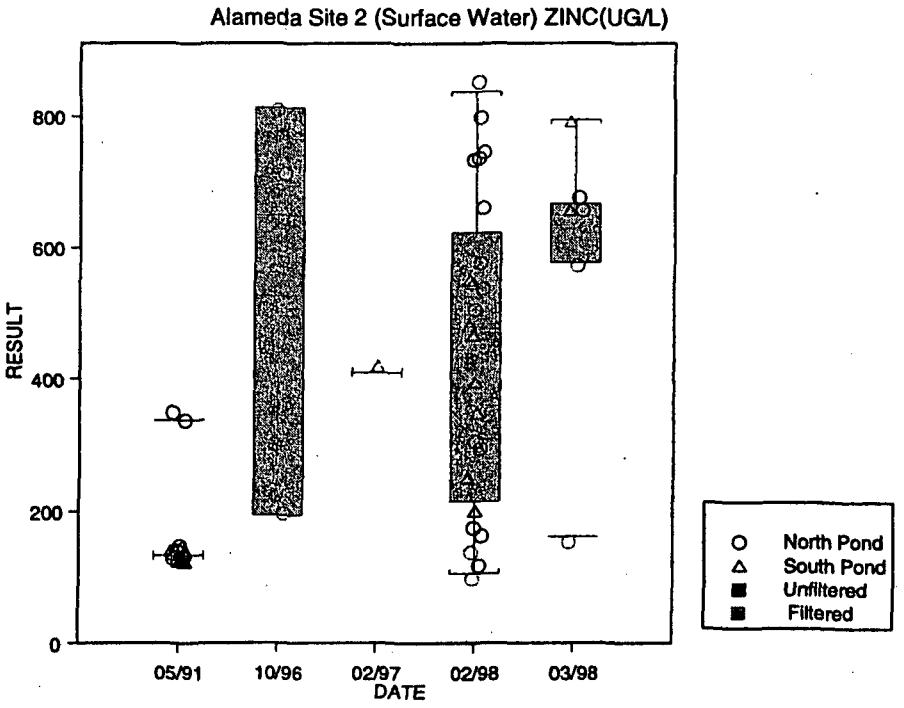

Figure B-243. Boxplot of Benzo(a)anthracene Concentrations in IR Site 2 Surface Water – by Date

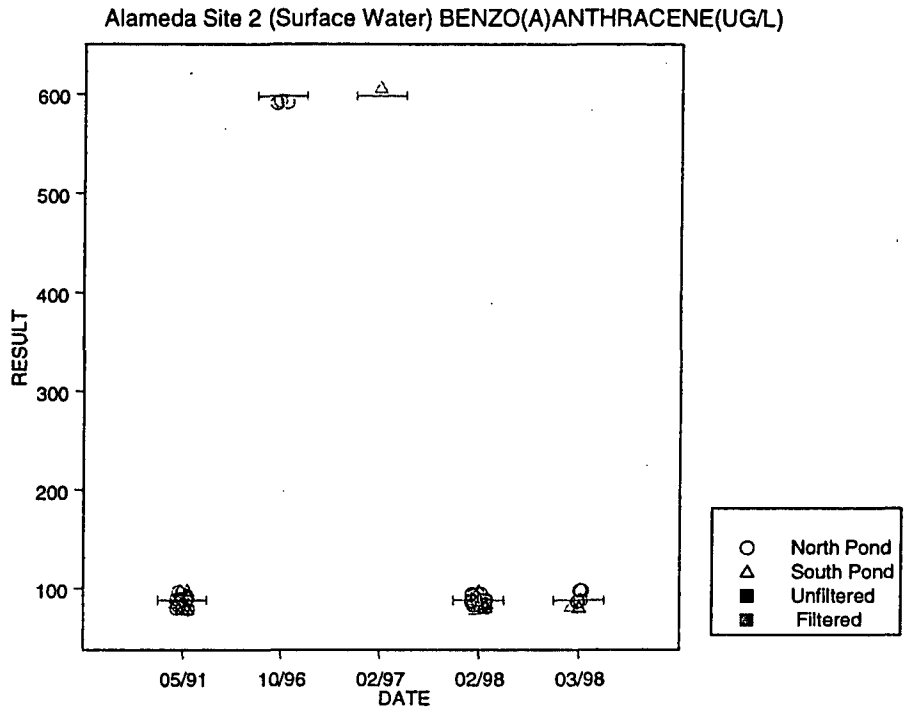

Figure B-244. Boxplot of Benzo(a)pyrene Concentrations in IR Site 2 Surface Water – by Date

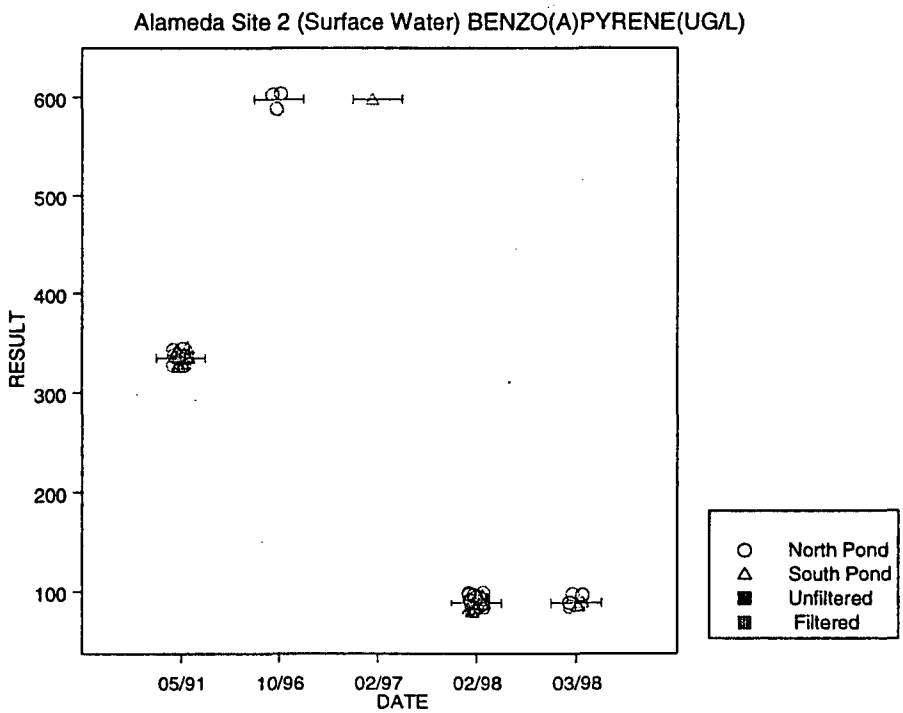

Figure B-245. Boxplot of 2-Methylnaphthalene Concentrations in IR Site 2 Surface Water – by Date

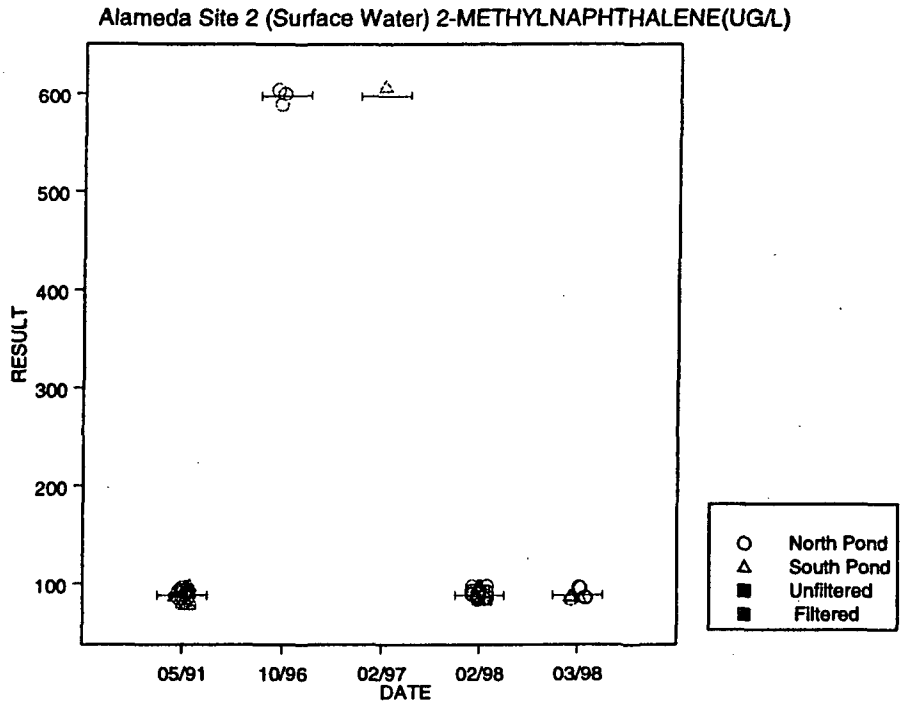

Figure B-246. Boxplot of Acenaphthene Concentrations in IR Site 2 Surface Water – by Date

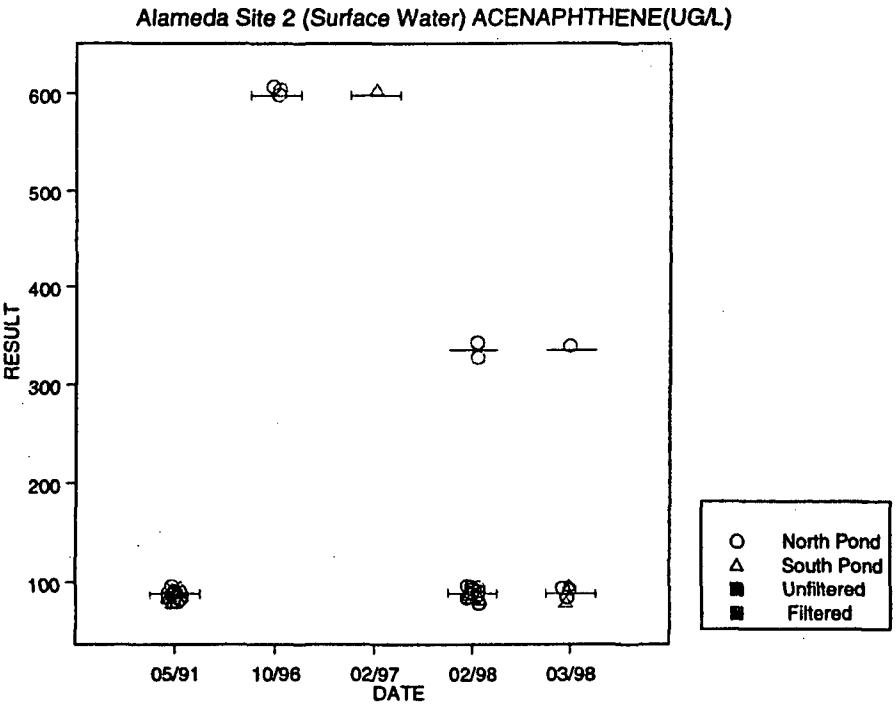

Figure B-247. Boxplot of Anthracene Concentrations in IR Site 2 Surface Water – by Date

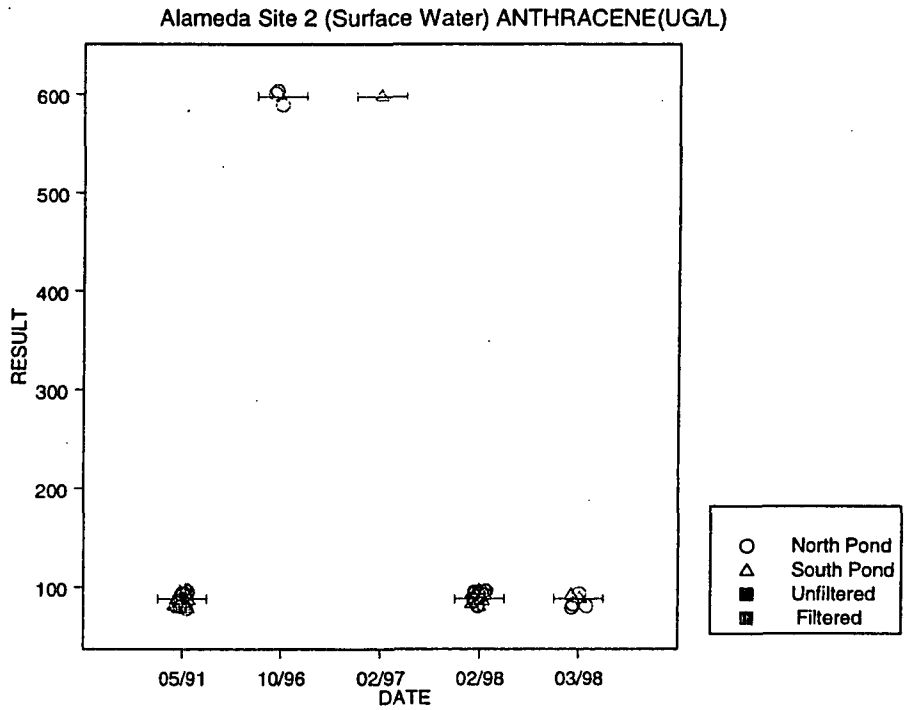

Figure B-248. Boxplot of Naphthalene Concentrations in IR Site 2 Surface Water – by Date

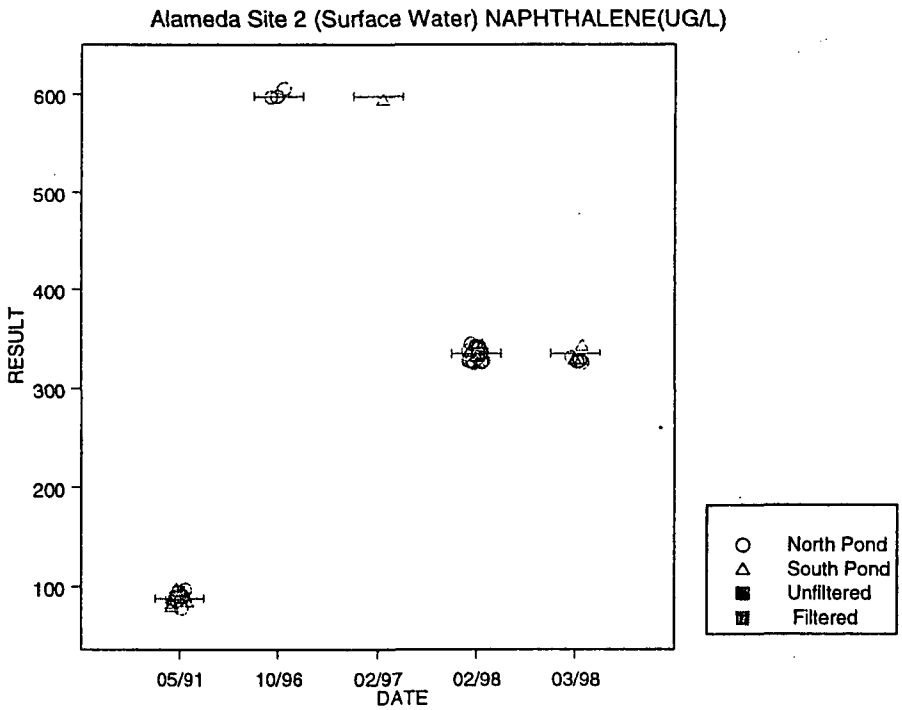

Figure B-249. Boxplot of Aroclor-1254 Concentrations in IR Site 2 Surface Water – by Date

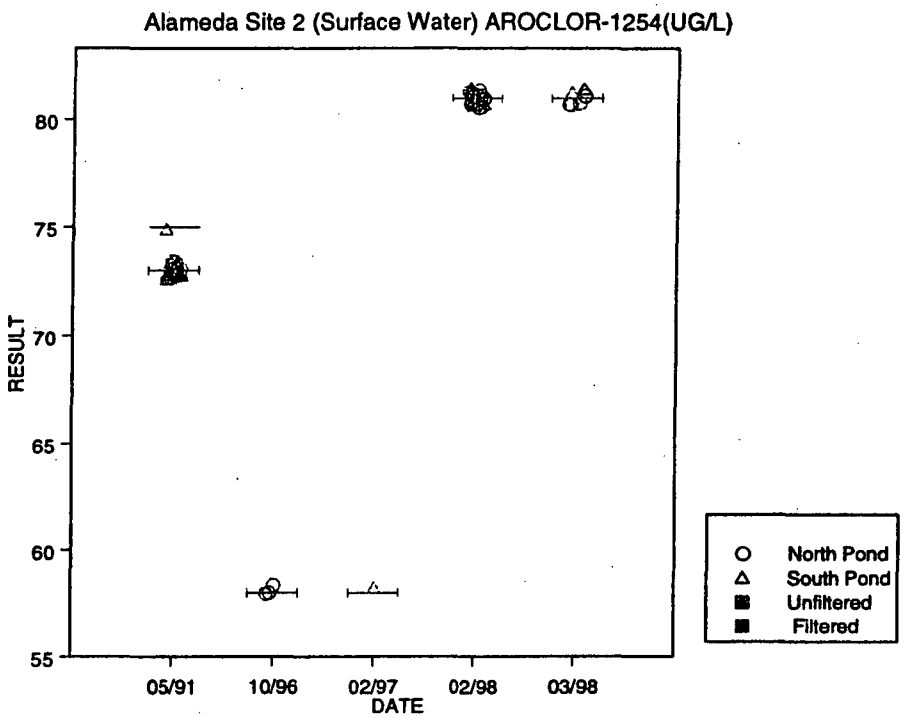

Figure B-250. Boxplot of Aroclor-1260 Concentrations in IR Site 2 Surface Water – by Date

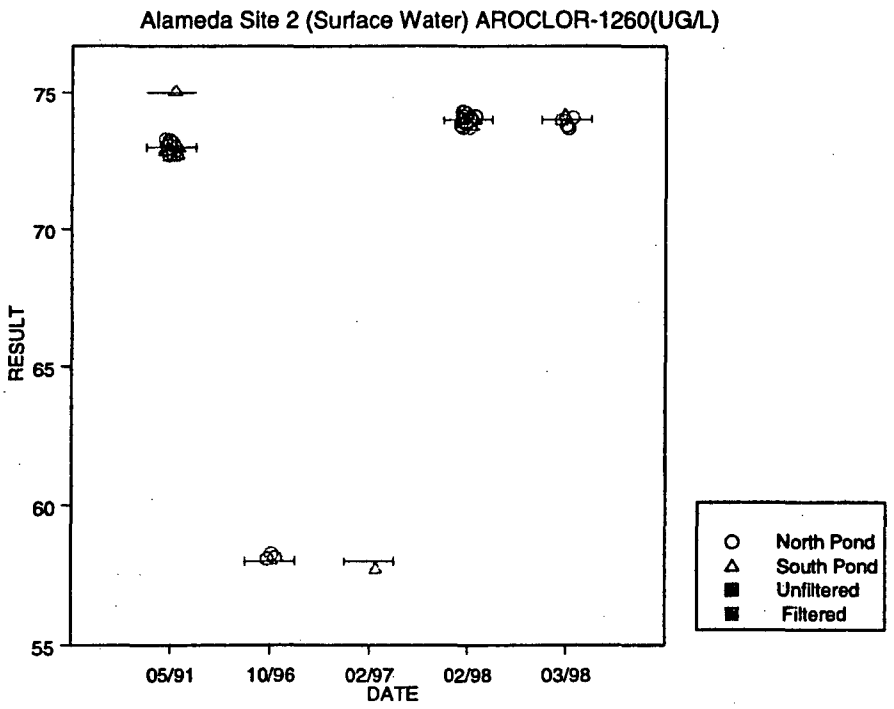

Figure B-251. Boxplot of Aldrin Concentrations in IR Site 2 Surface Water – by Date

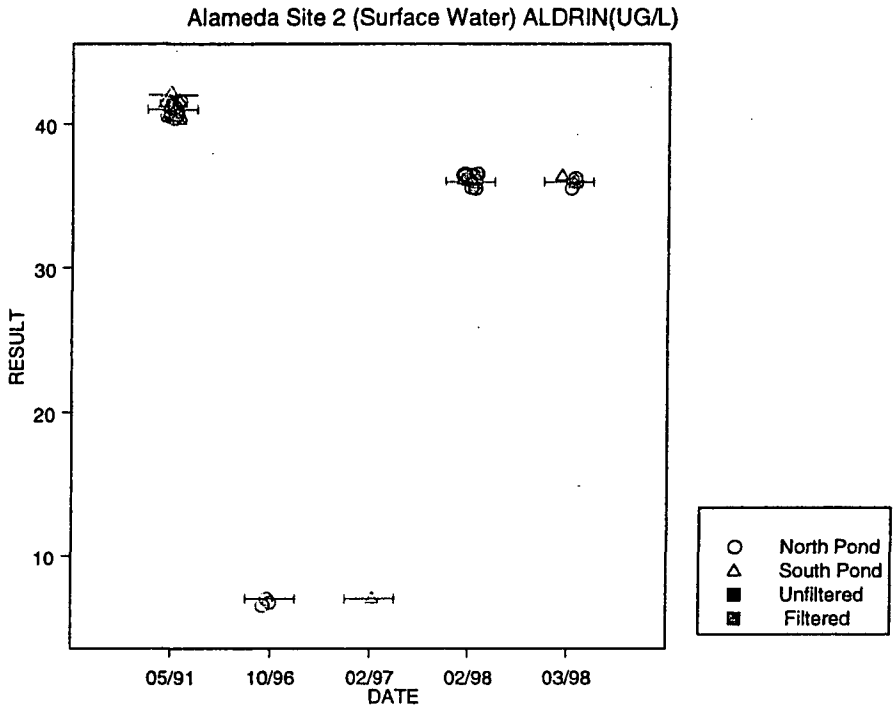

Figure B-252. Boxplot of Alpha-BHC Concentrations in IR Site 2 Surface Water – by Date

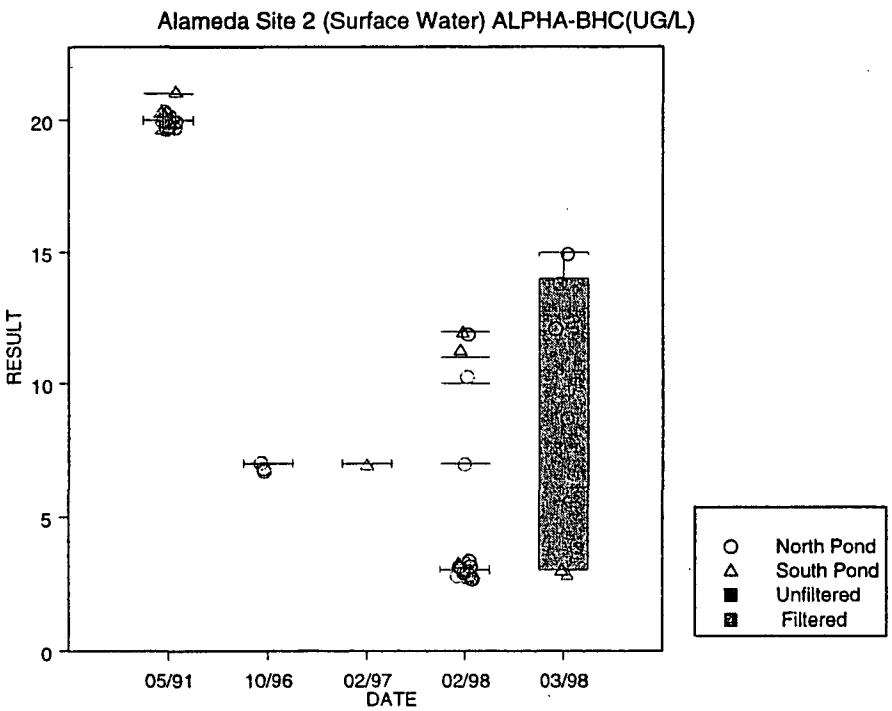

Figure B-253. Boxplot of Alpha-Chlordane Concentrations in IR Site 2 Surface Water – by Date

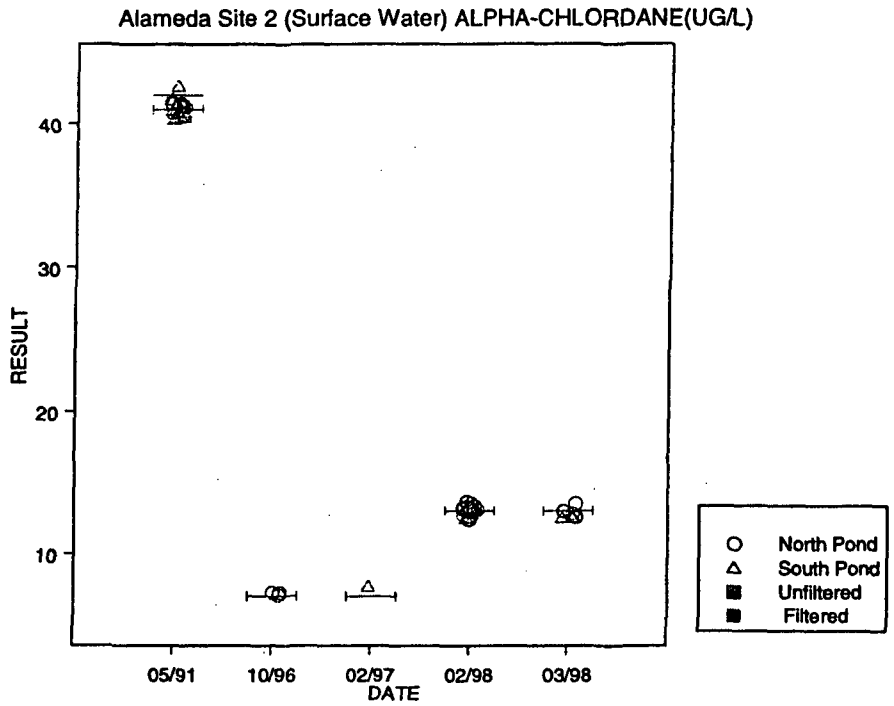

Figure B-254. Boxplot of Beta-BHC Concentrations in IR Site 2 Surface Water – by Date

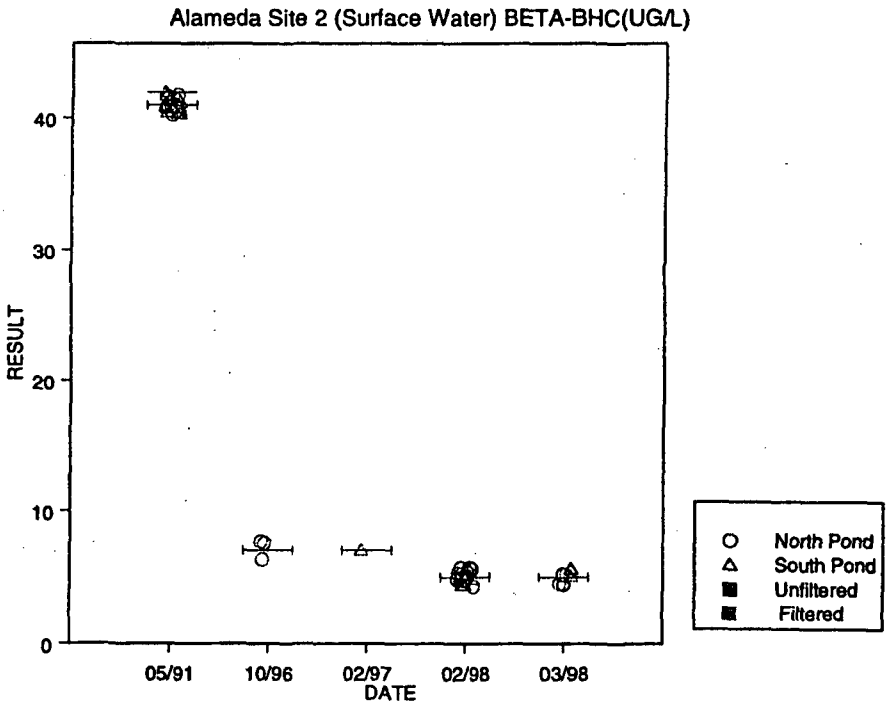

Figure B-255. Boxplot of Delta-BHC Concentrations in IR Site 2 Surface Water – by Date

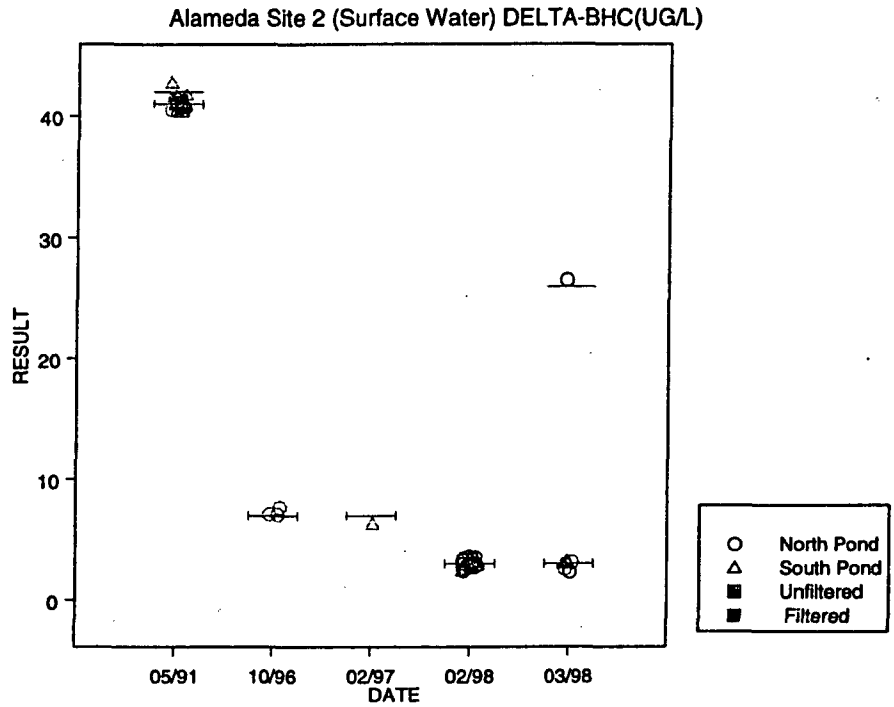

Figure B-256. Boxplot of Dieldrin Concentrations in IR Site 2 Surface Water – by Date

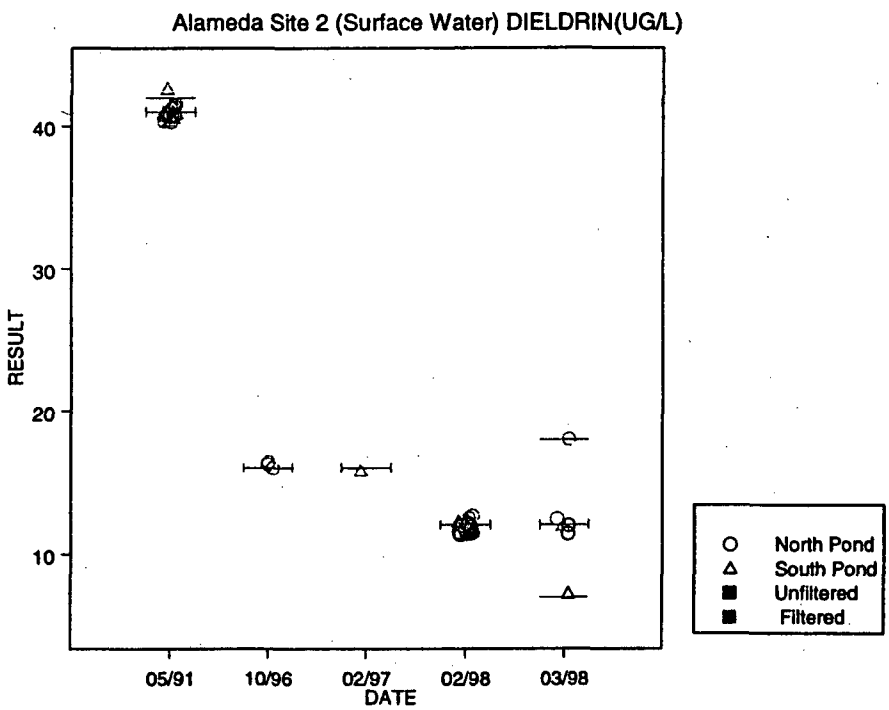

Figure B-257. Boxplot of Endosulfan I Concentrations in IR Site 2 Surface Water – by Date

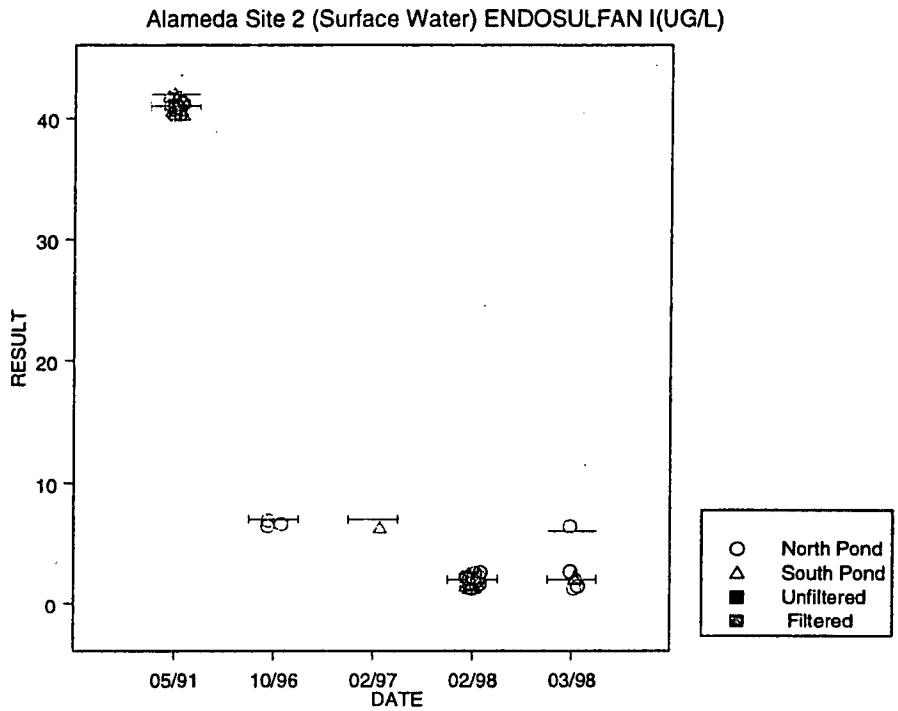

Figure B-258. Boxplot of Endosulfan II Concentrations in IR Site 2 Surface Water – by Date

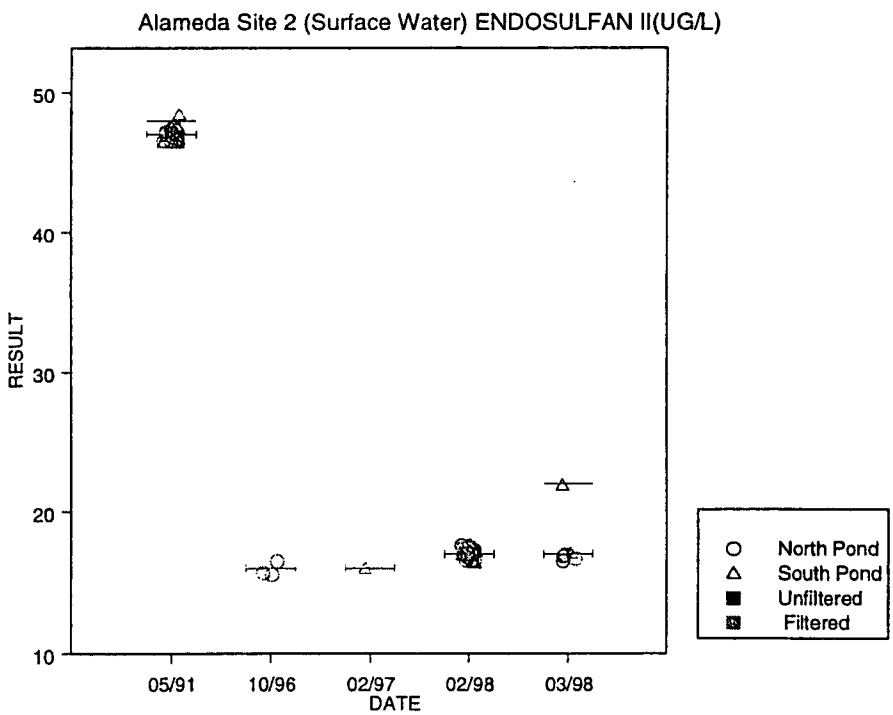

Figure B-259. Boxplot of Endrin Concentrations in IR Site 2 Surface Water – by Date

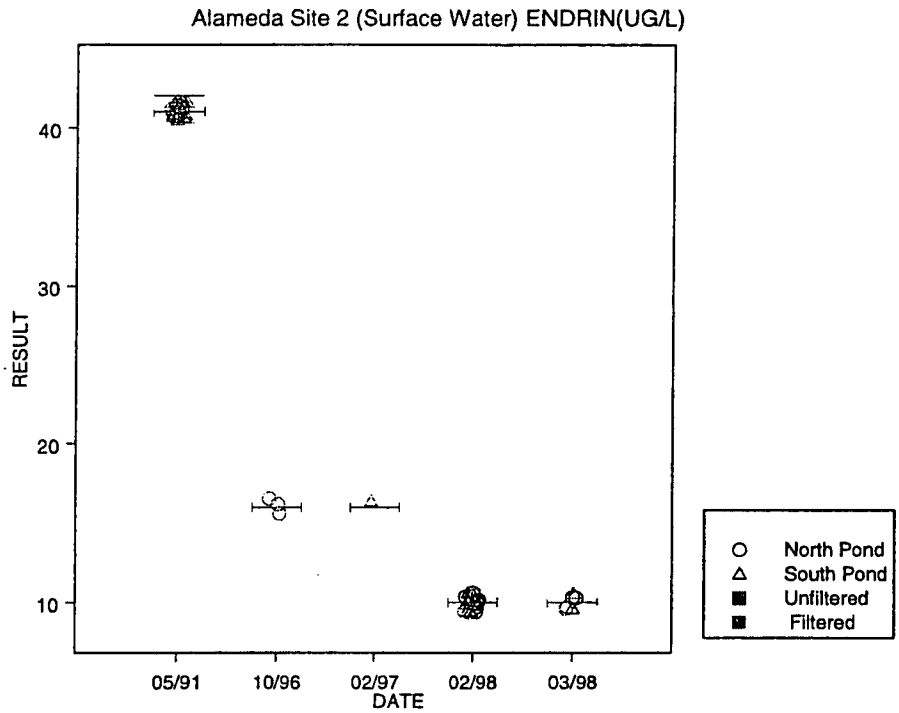

Figure B-260. Boxplot of Endrin Aldehyde Concentrations in IR Site 2 Surface Water – by Date

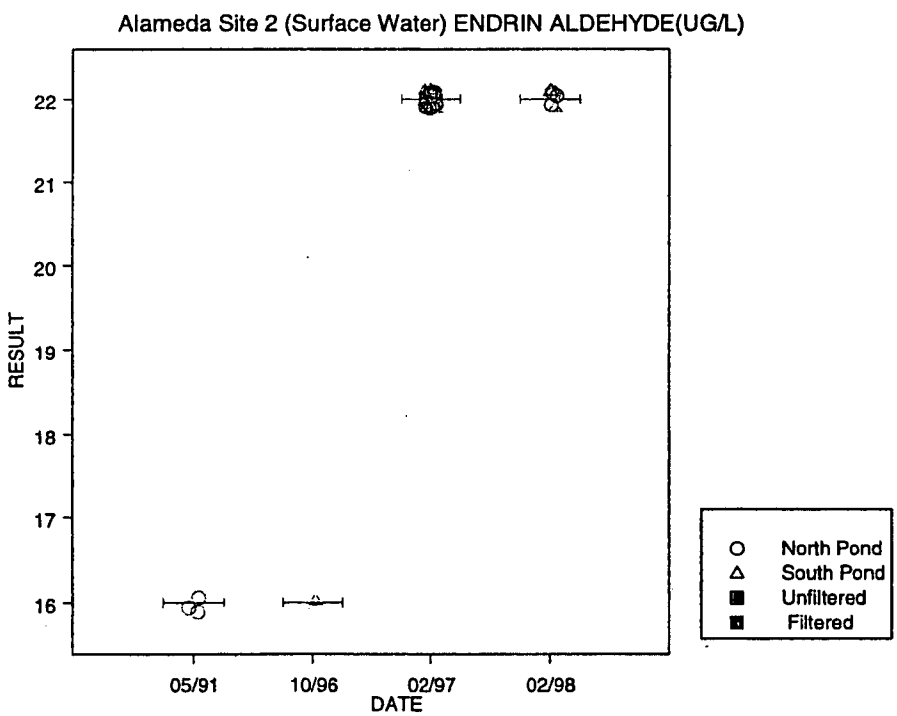

Figure B-261. Boxplot of Endrin Ketone Concentrations in IR Site 2 Surface Water – by Date

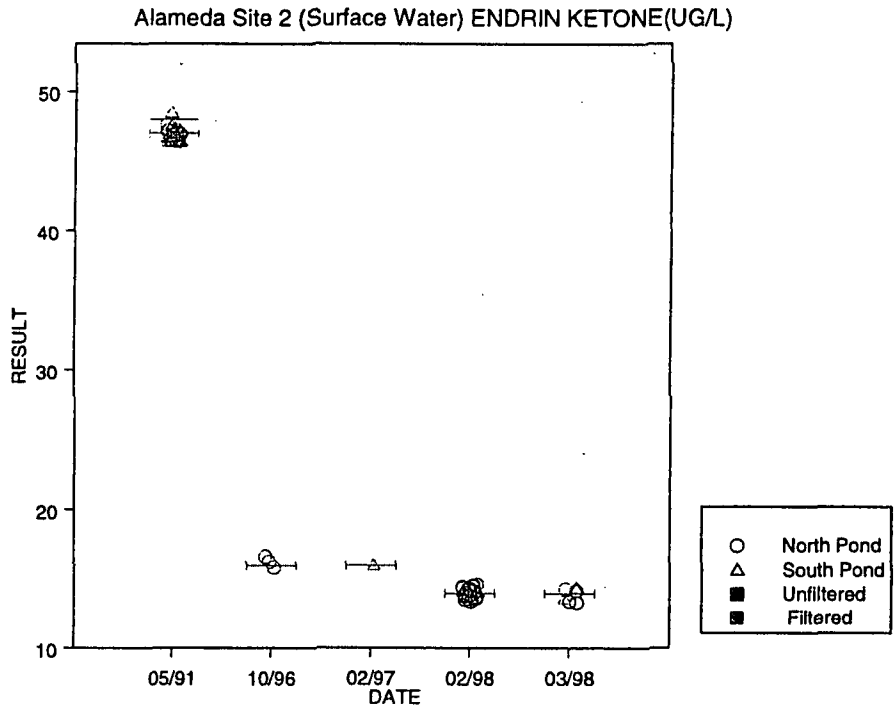

Figure B-262. Boxplot of Gamma-BHC Concentrations in IR Site 2 Surface Water – by Date

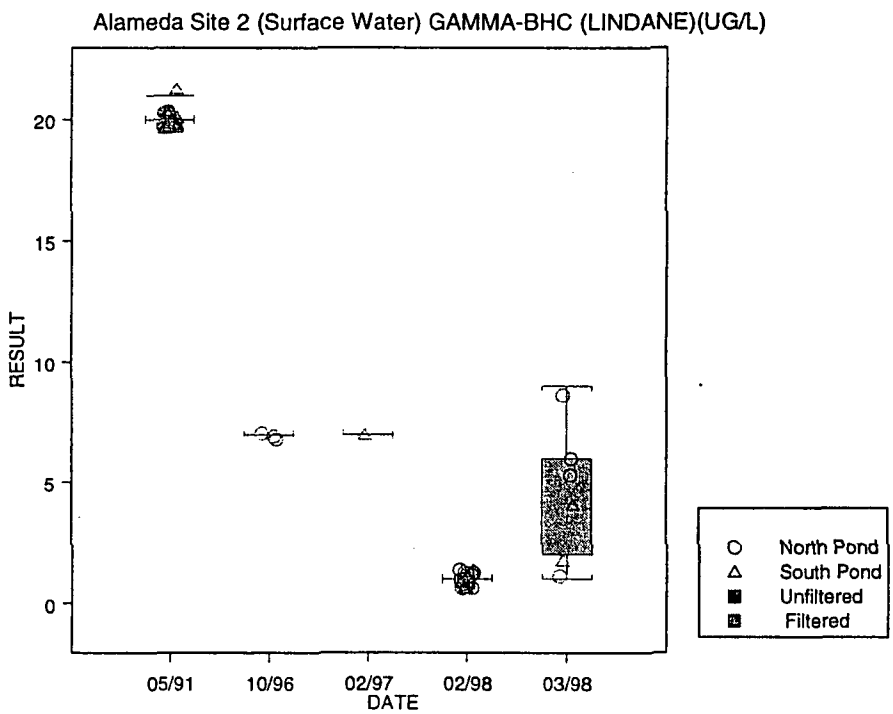

Figure B-263. Boxplot of Heptachlor Concentrations in IR Site 2 Surface Water – by Date

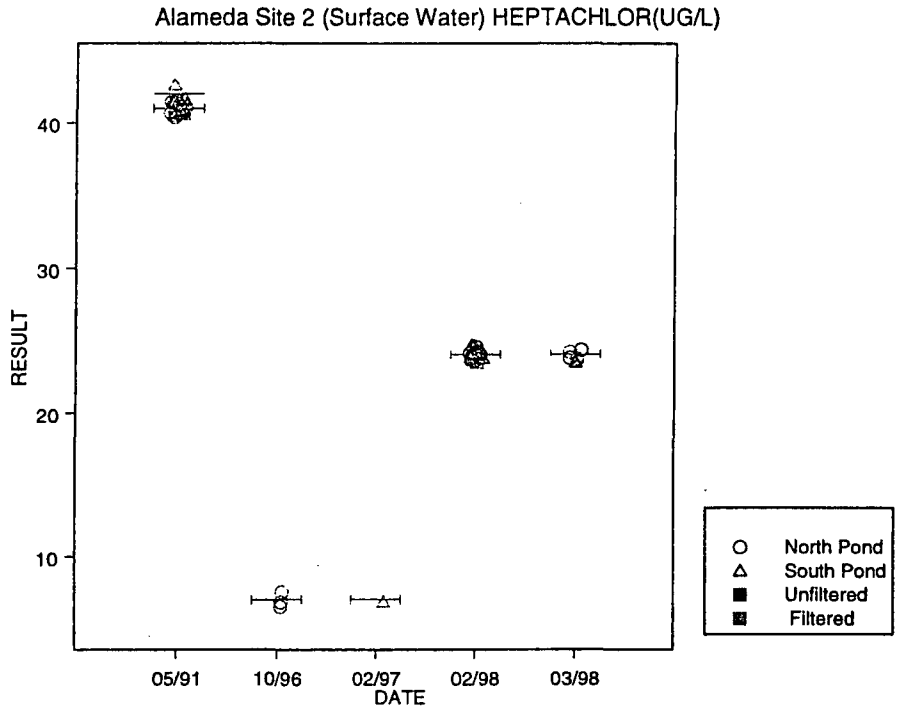

Figure B-264. Boxplot of Heptachlor Epoxide Concentrations in IR Site 2 Surface Water – by Date

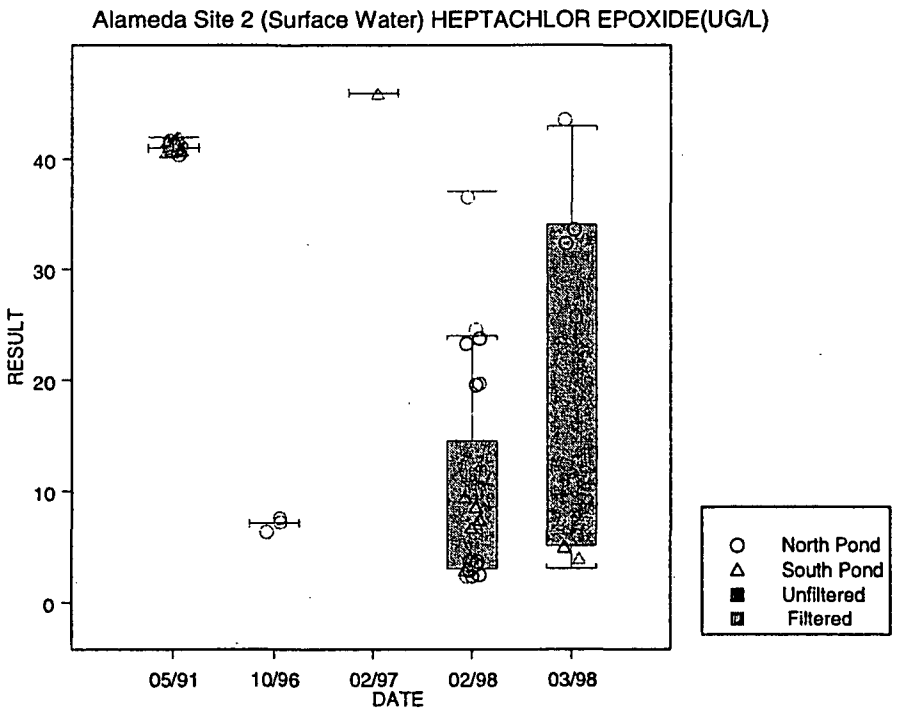

Figure B-265. Boxplot of Methoxychlor Concentrations in IR Site 2 Surface Water – by Date

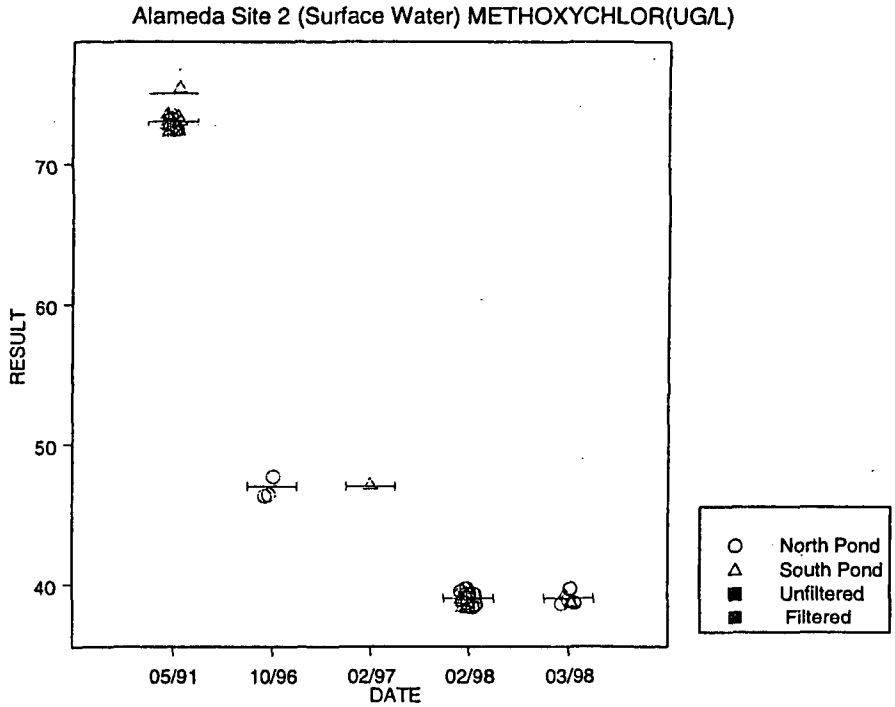

Figure B-266. Boxplot of Toxaphene Concentrations in IR Site 2 Surface Water – by Date

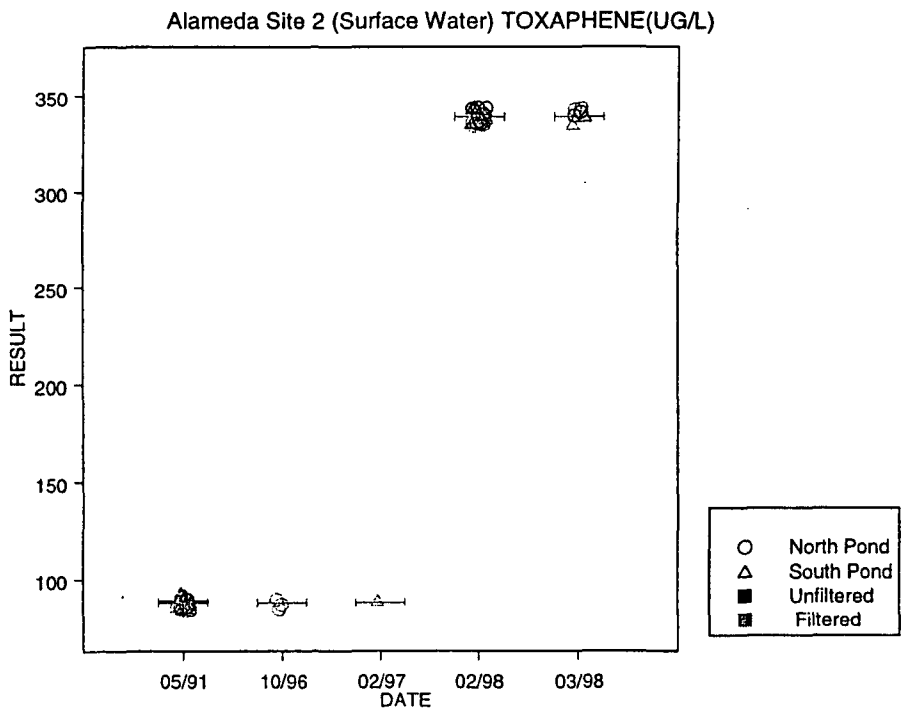

Figure B-267. Boxplot of 4,4'-DDD Concentrations in IR Site 2 Surface Water – by Date

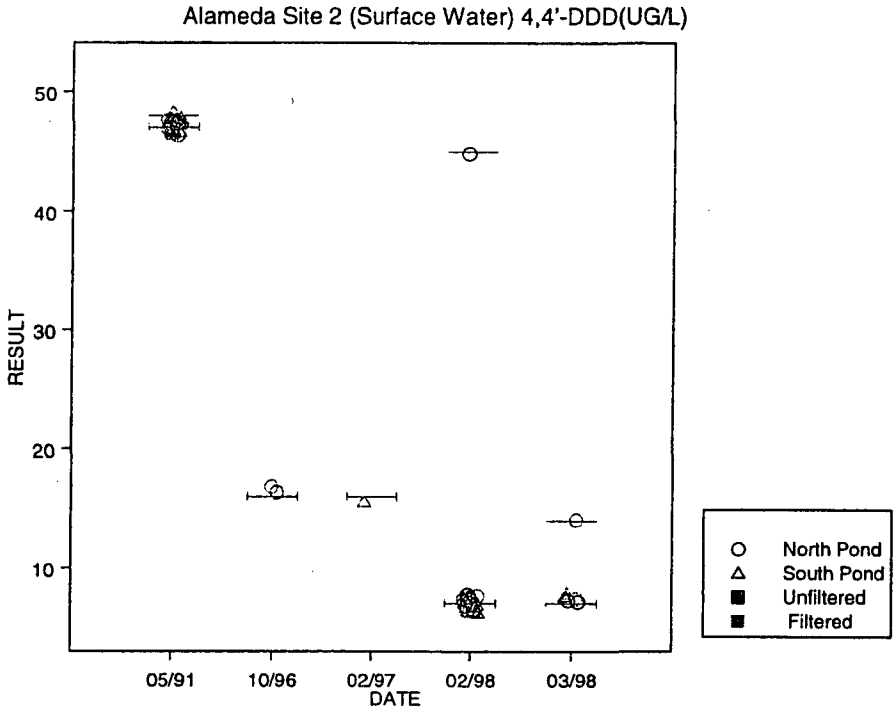

Figure B-268. Boxplot of 4,4'-DDE Concentrations in IR Site 2 Surface Water – by Date

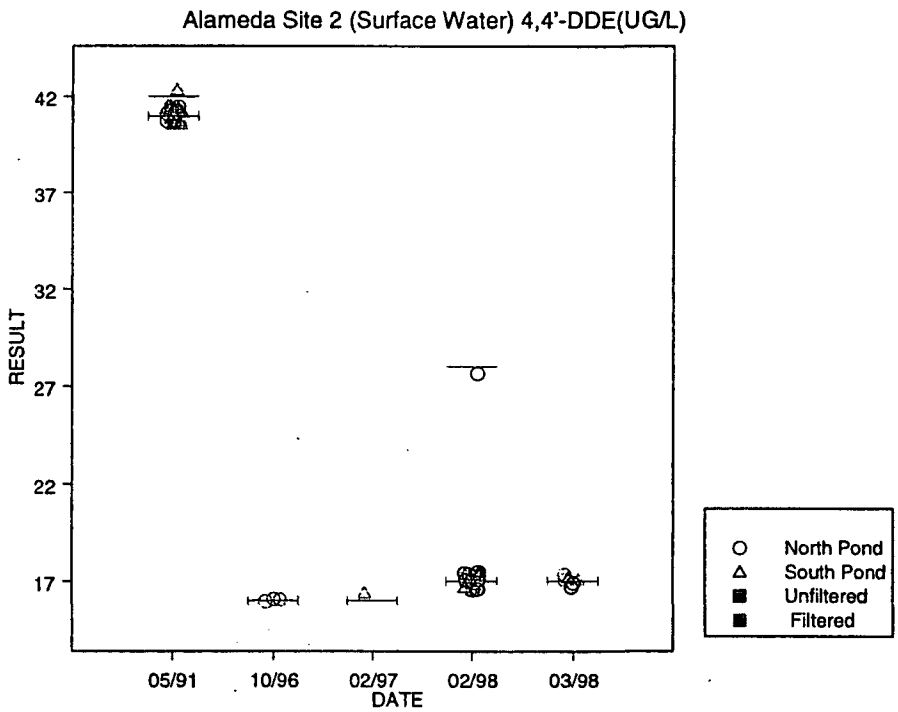

Figure B-269. Boxplot of 4,4'-DDT Concentrations in IR Site 2 Surface Water – by Date

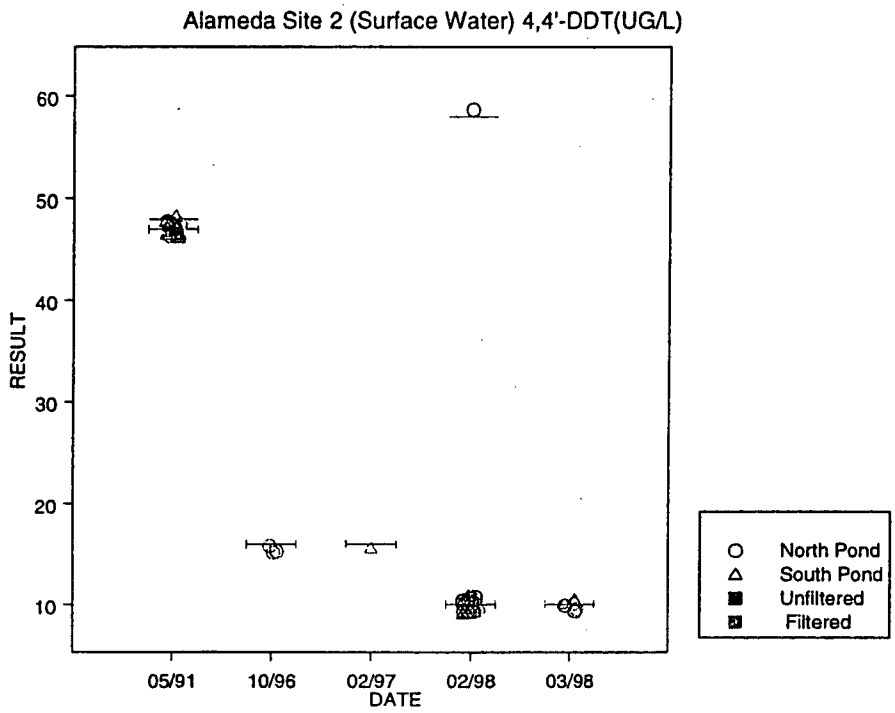

Figure B-270. Boxplot of 1,2,4-Trichlorobenzene Concentrations in IR Site 2 Surface Water – by Date

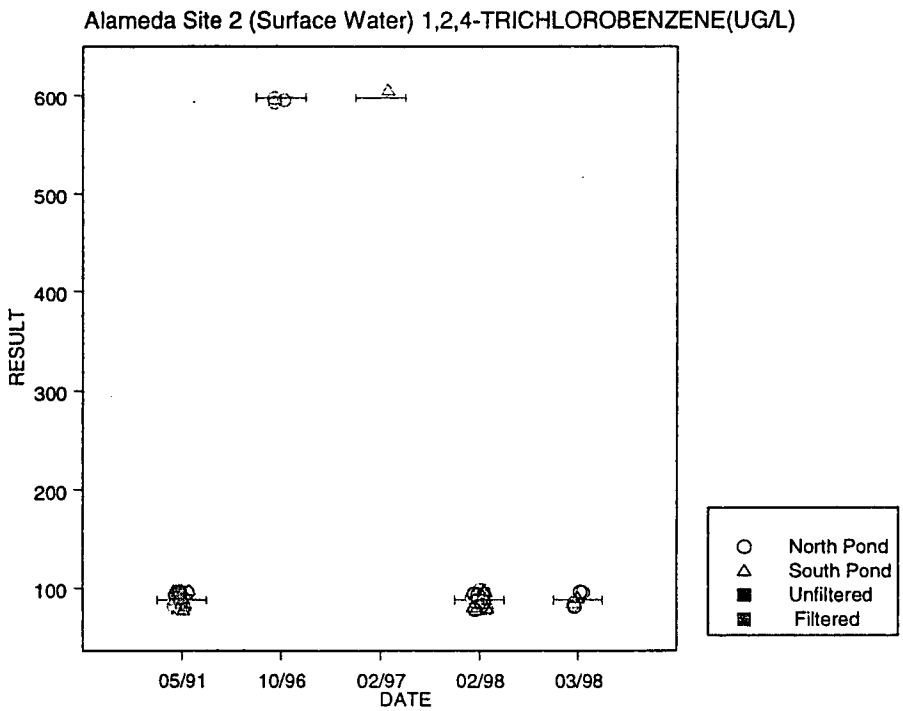

Figure B-271. Boxplot of 1,2-Dichlorobenzene Concentrations in IR Site 2 Surface Water – by Date

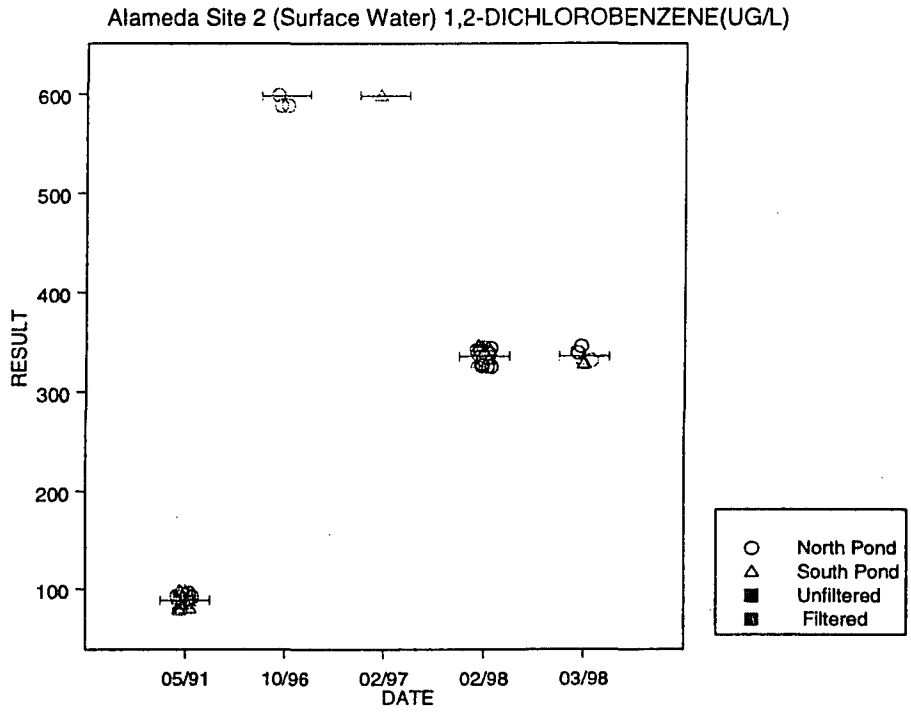

Figure B-272. Boxplot of 2,4,5-Trichlorophenol Concentrations in IR Site 2 Surface Water – by Date

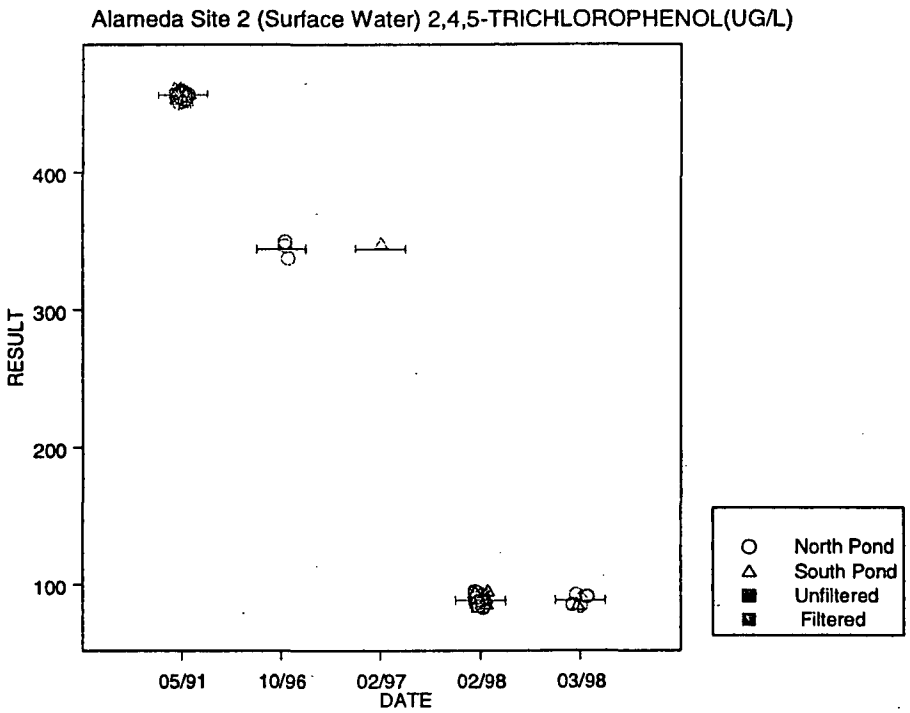

Figure B-273. Boxplot of 2,4-Dichlorophenol Concentrations in IR Site 2 Surface Water – by Date

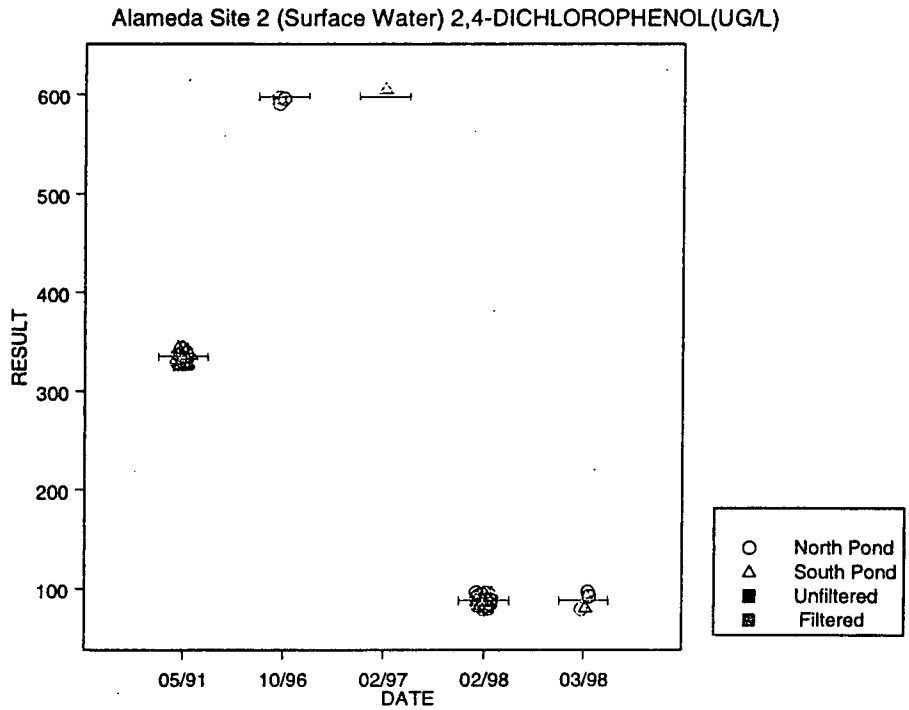

Figure B-274. Boxplot of 3-Nitroaniline Concentrations in IR Site 2 Surface Water – by Date

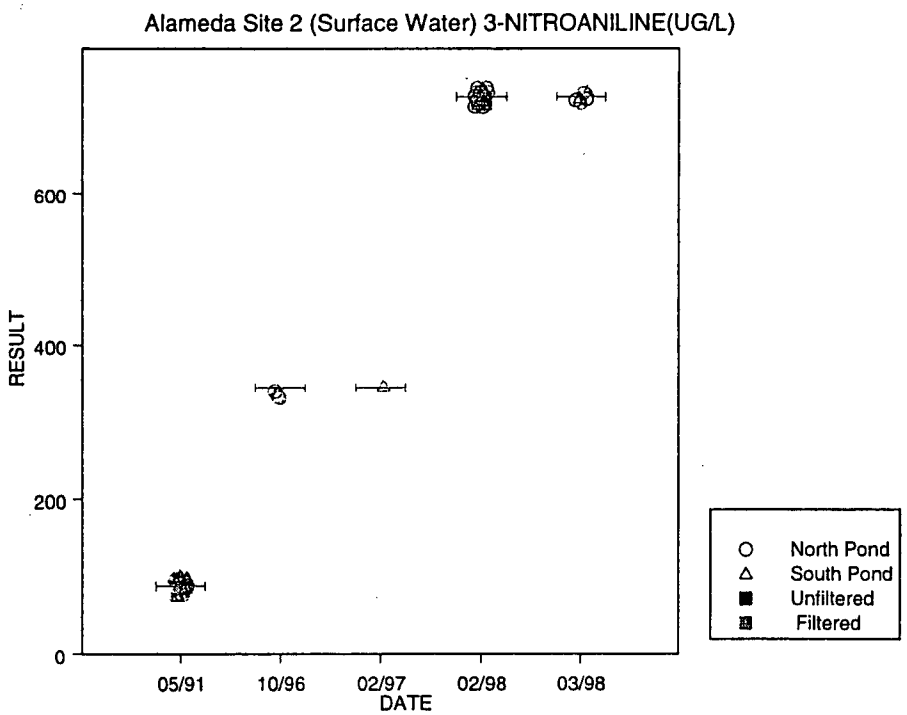

Figure B-275. Boxplot of 4-Chloro-3-Methylphenol Concentrations in IR Site 2 Surface Water – by Date

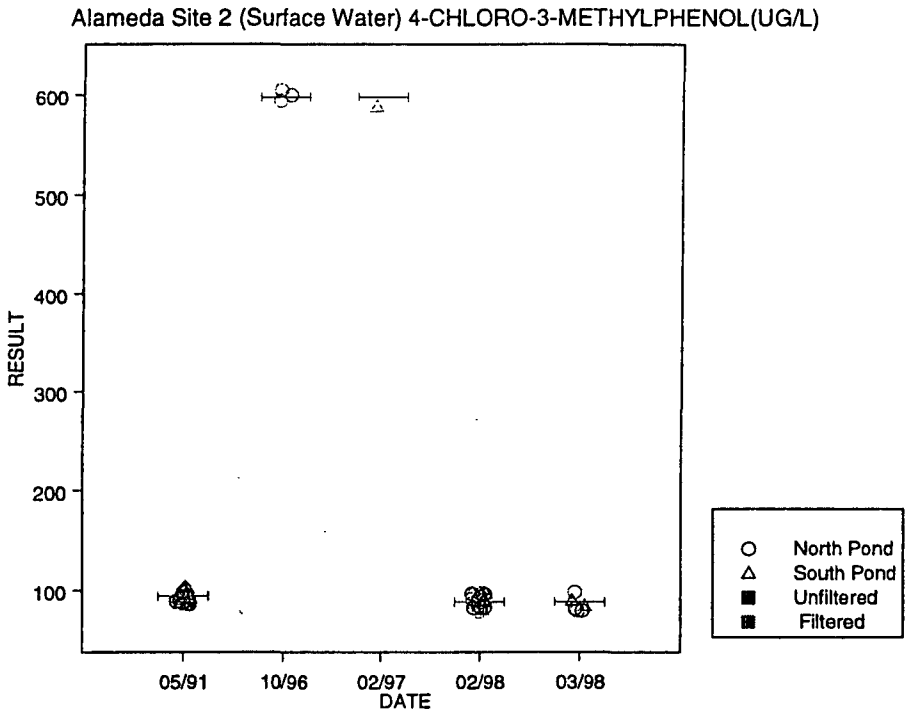

Figure B-276. Boxplot of 4-Chloroaniline Concentrations in IR Site 2 Surface Water – by Date

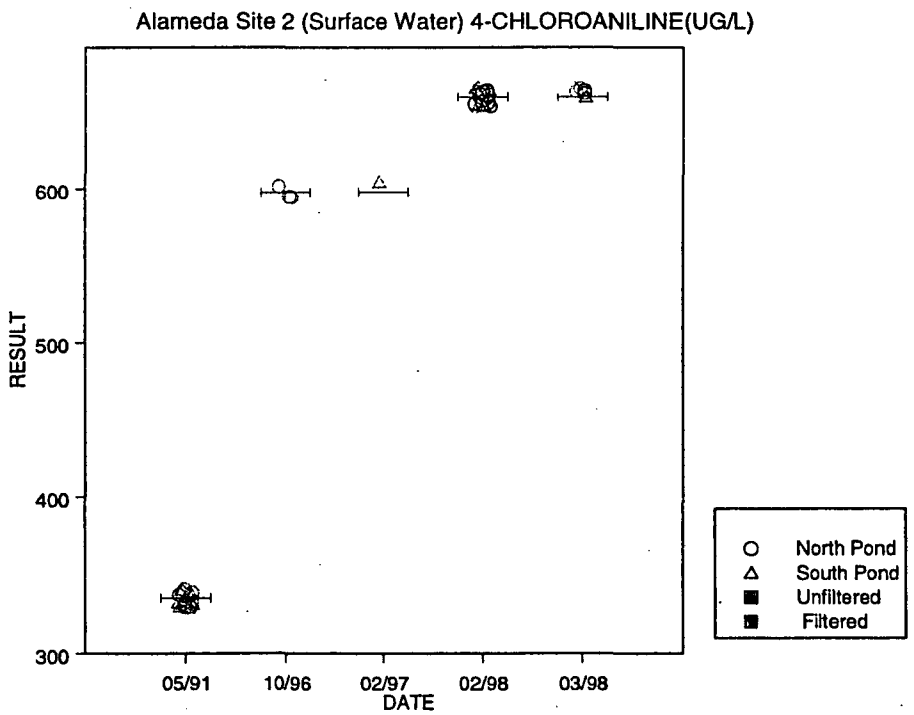

Figure B-277. Boxplot of Bis(2-ethylhexyl)phthalate Concentrations in IR Site 2 Surface Water – by Date

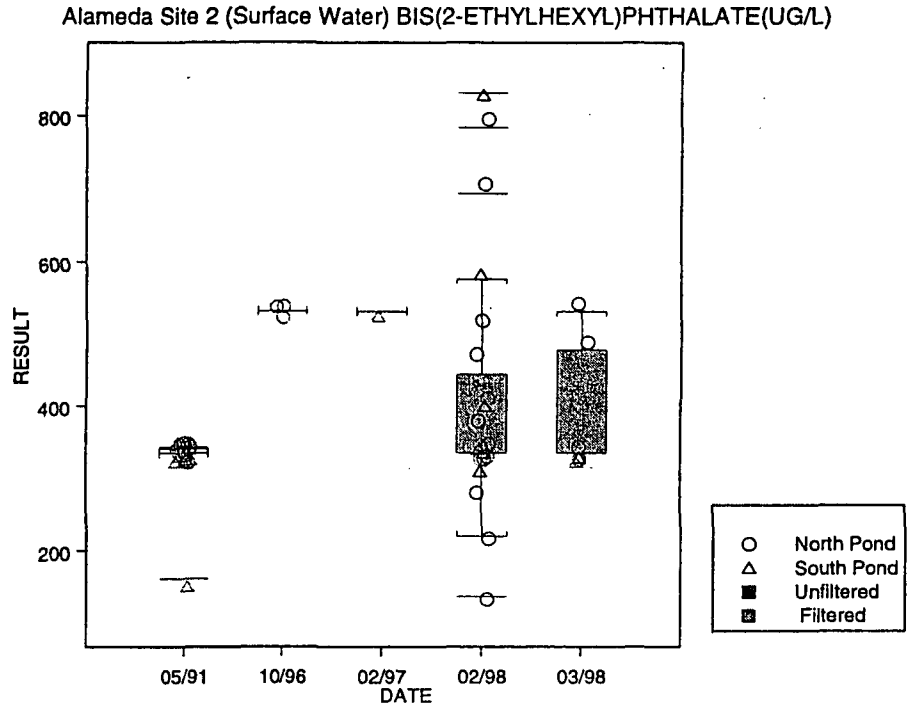

Figure B-278. Boxplot of Butylbenzylphthalate Concentrations in IR Site 2 Surface Water – by Date

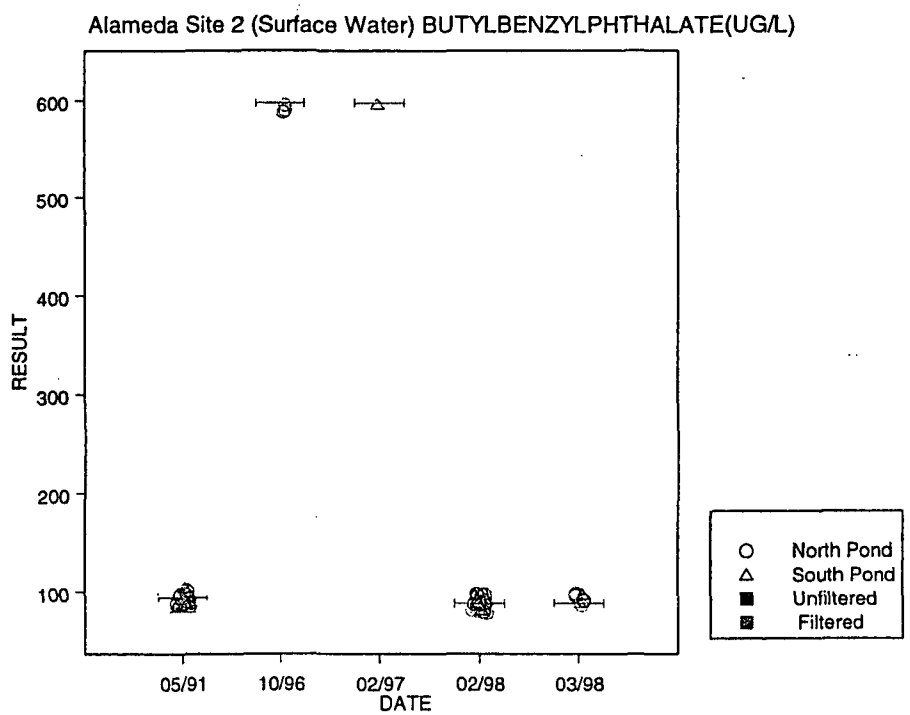

Figure B-279. Boxplot of Di-n-butylphthalate Concentrations in IR Site 2 Surface Water – by Date

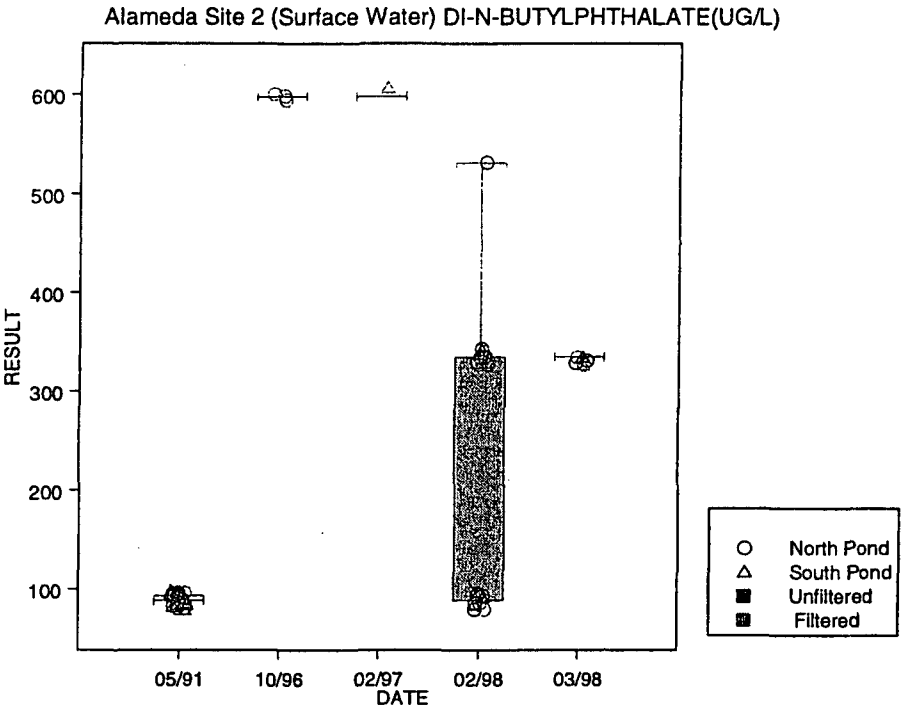

Figure B-280. Boxplot of Di-n-octylphthalate Concentrations in IR Site 2 Surface Water – by Date

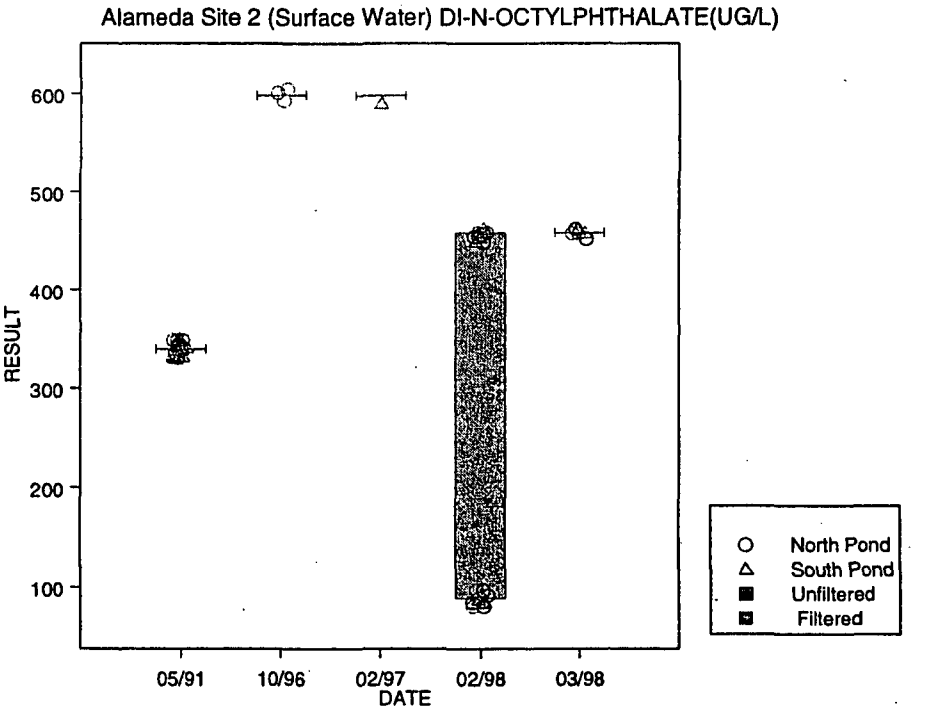

Figure B-281. Boxplot of Dimethylphthalate Concentrations in IR Site 2 Surface Water – by Date

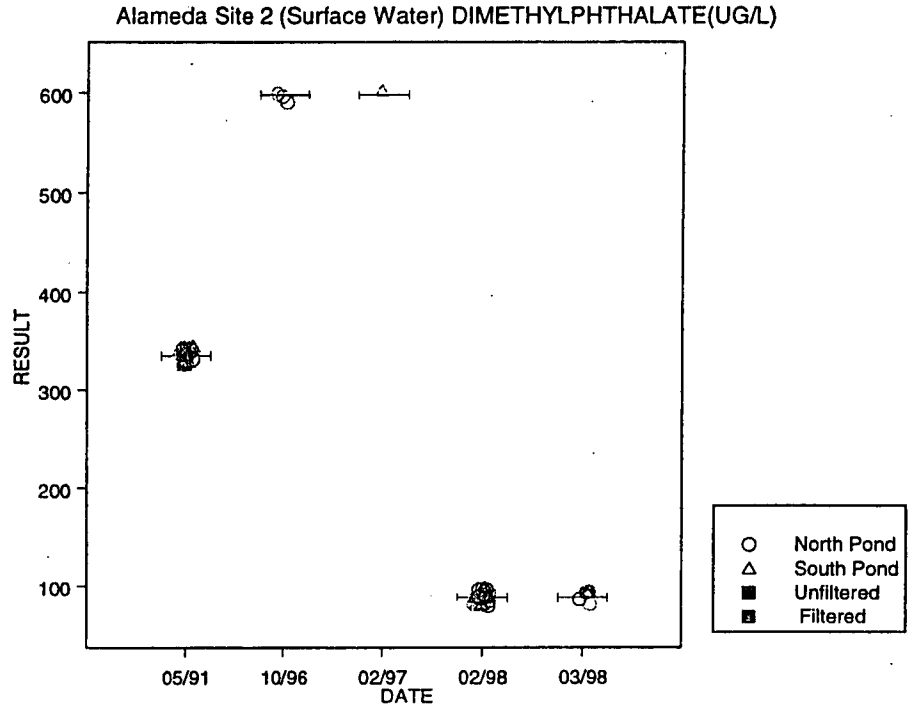

Figure B-282. Boxplot of N-Nitrosodiphenylamine Concentrations in IR Site 2 Surface Water – by Date

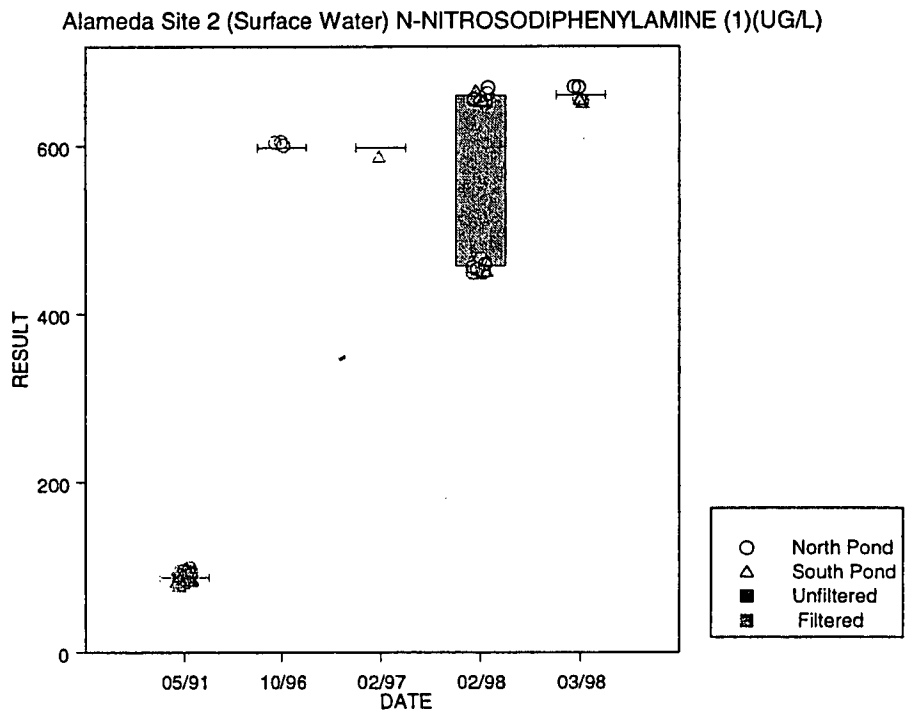

Figure B-283. Boxplot of Pentachlorophenol Concentrations in IR Site 2 Surface Water – by Date

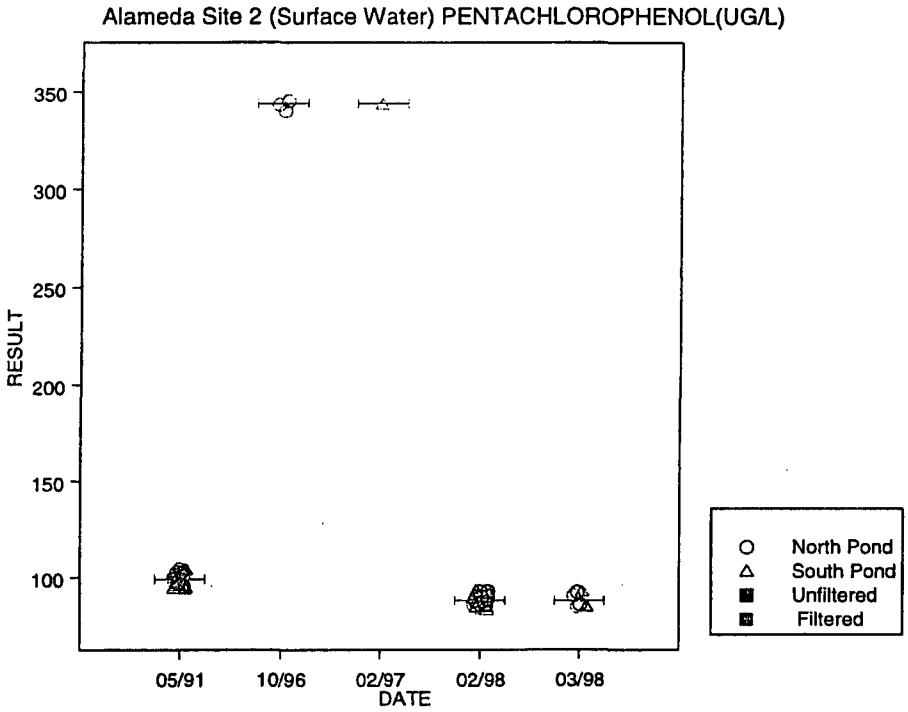

Figure B-284. Boxplot of Tributyl Tin Concentrations in IR Site 2 Surface Water – by Date

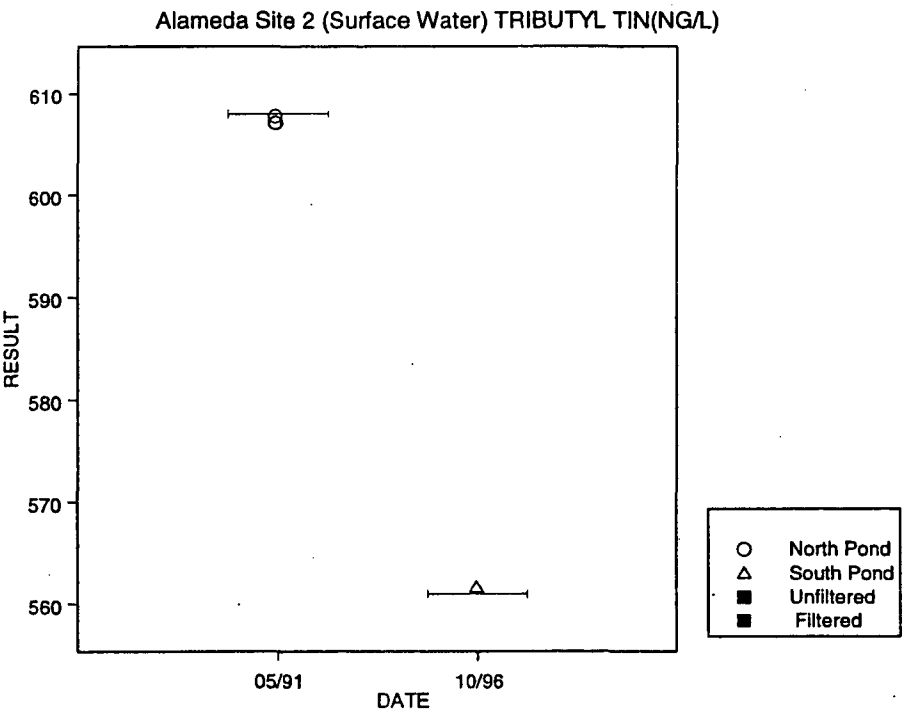

Figure B-285. Boxplot of Motor Oil Range Organics Concentrations in IR Site 2 Surface Water – by Date

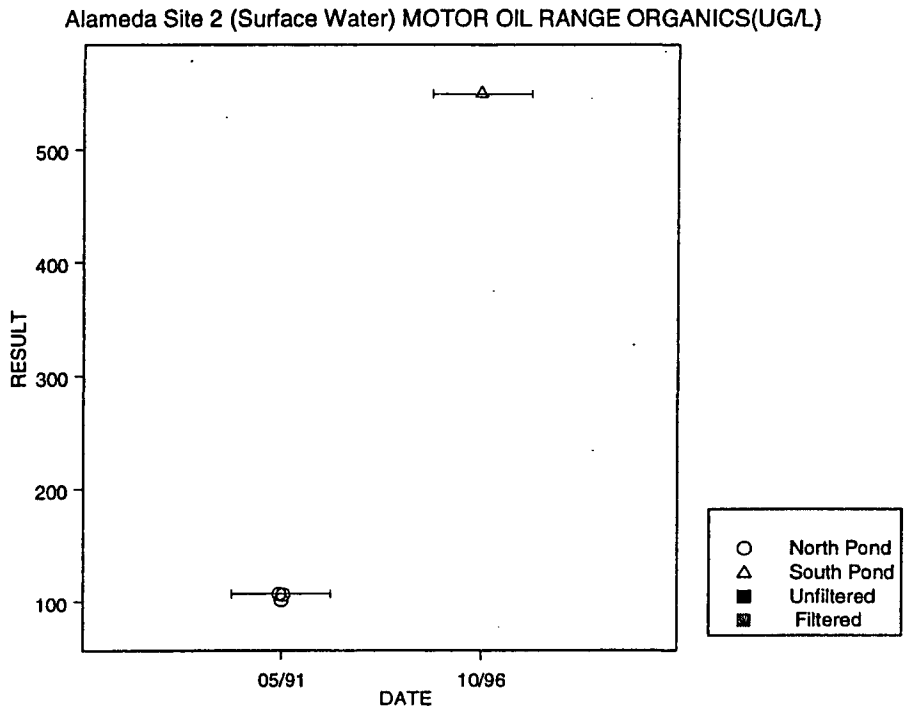

Figure B-286. Boxplot of Total Recoverable Petroleum Hydrocarbons Concentrations in IR Site 2 Surface Water – by Date

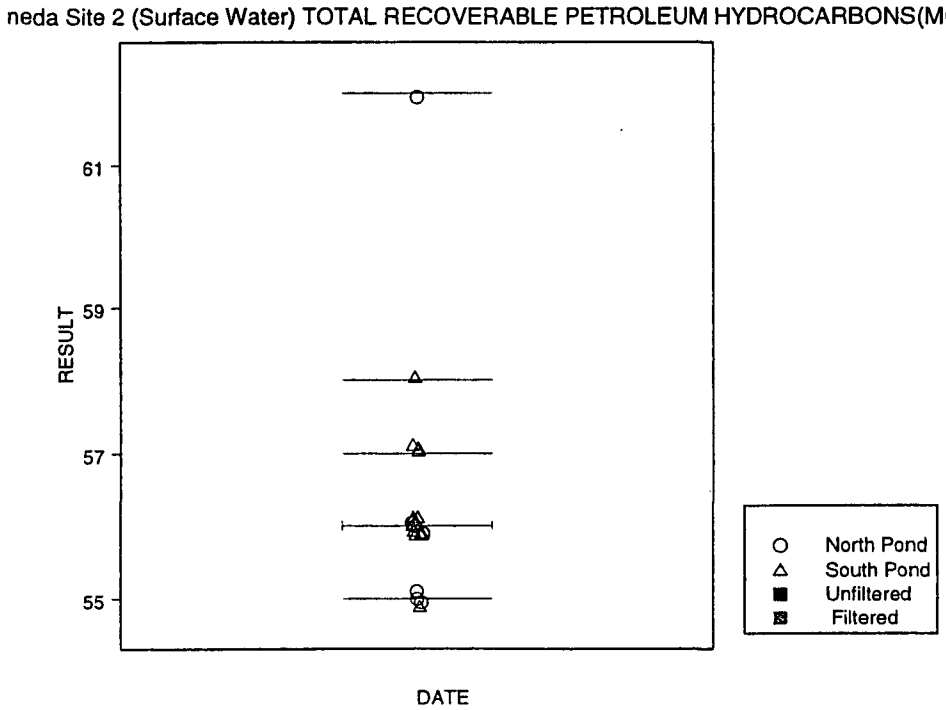

Figure B-287. Boxplot of 1,1,1-Trichloroethane Concentrations in IR Site 2 Surface Water – by Date

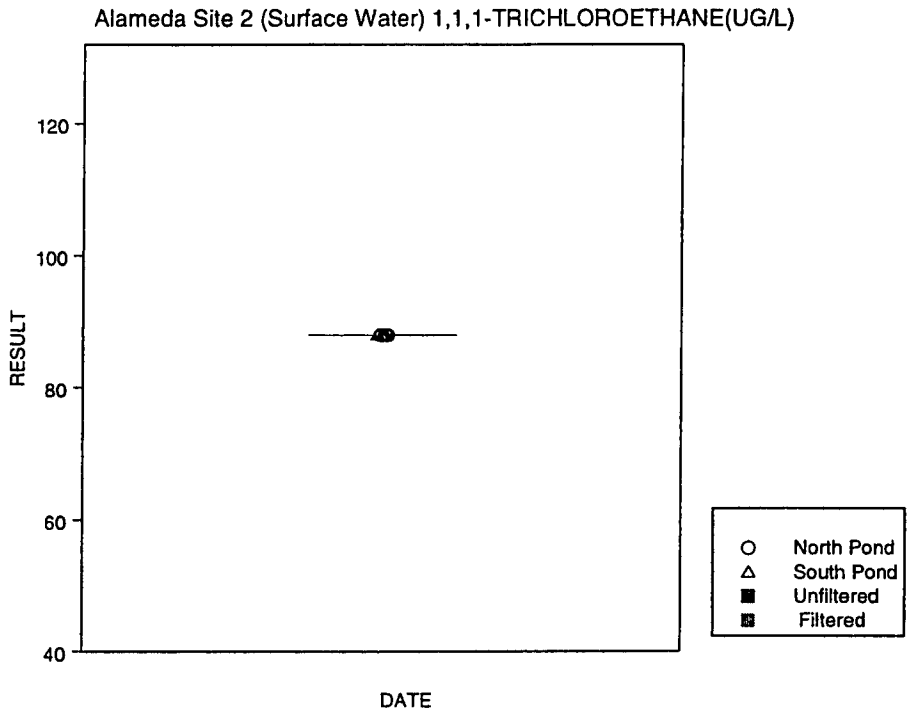

Figure B-288. Boxplot of Acetone Concentrations in IR Site 2 Surface Water – by Date

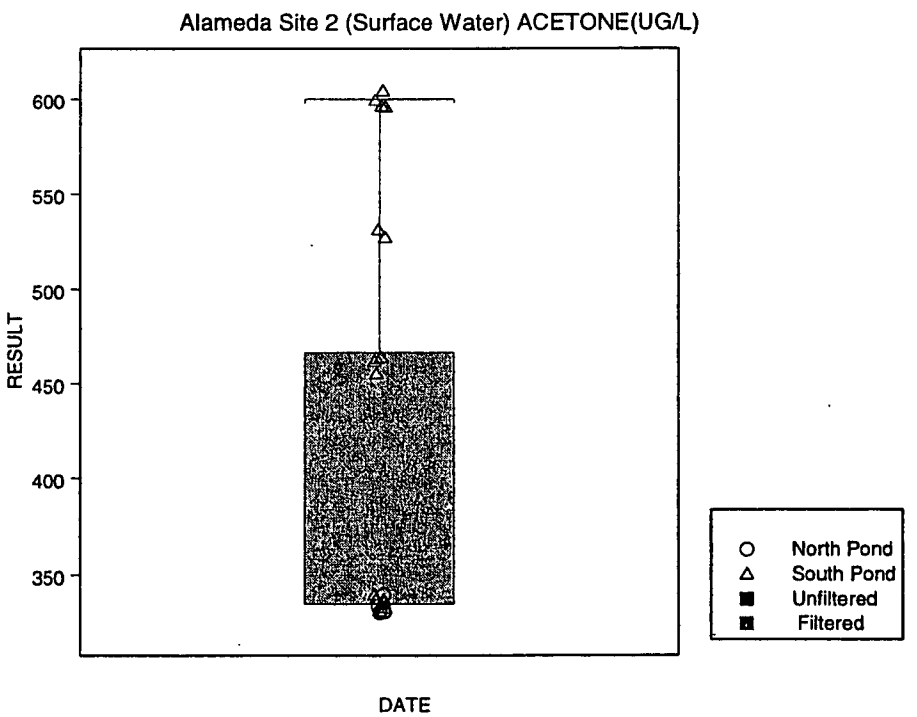

Figure B-289. Boxplot of Chloromethane Concentrations in IR Site 2 Surface Water – by Date

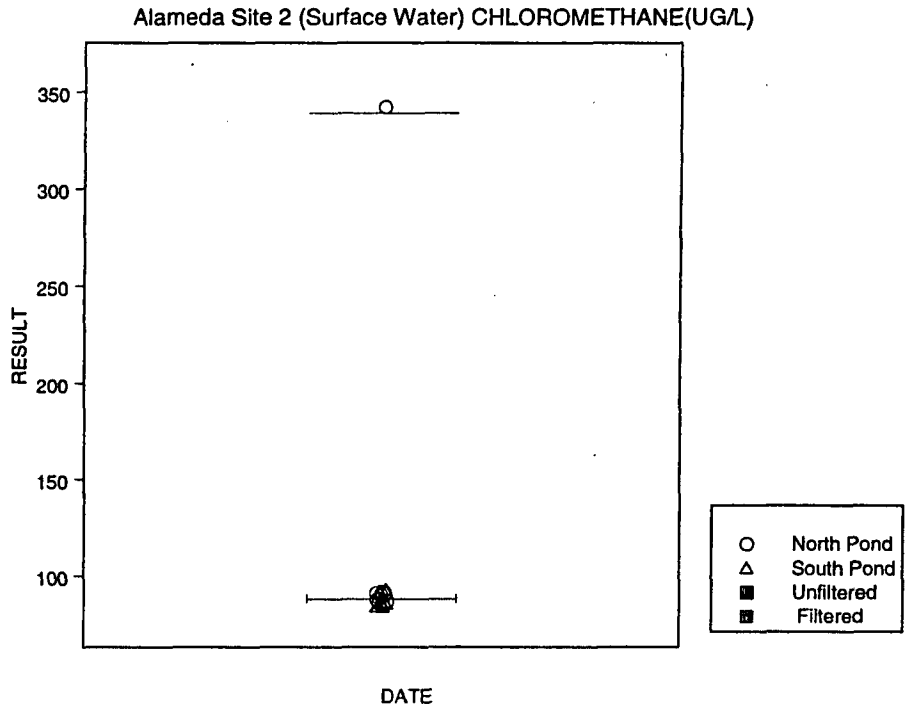

Figure B-290. Boxplot of Methylene Chloride Concentrations in IR Site 2 Surface Water – by Date