OPERABLE UNIT 5 REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

VOLUME I - TEXT

Final

December 2, 2002

Submitted to:

Department of the Navy
Southwest Division Naval Facilities Engineering Command
1230 Columbia Street, Suite 1100
San Diego, California

Submitted by:

Neptune and Company, Inc.
1505 15th Street, Suite B
Los Alamos, New Mexico 87544

IT Corporation
1045 Jadwin Avenue, Suite C
Richland, Washington 99352

ENVIRON
6001 Shellmound Street, Suite 700
Emeryville, California 94608

OPERABLE UNIT 5 REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

VOLUME I - TEXT

Final

December 2, 2002

Approved by: ______________________ Date: 11/30/02

John Sciacca
IT Corporation
California Registered Geologist #4523

DEPARTMENT OF THE NAVY
SOUTHWEST DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132 - 5190

5090
Ser 06CA.RW\0213
December 2, 2002

Ms. Anna-Marie Cook
US EPA
Region 9
75 Hawthorne Street
San Francisco, CA 94105-3901

Dear Ms. Cook:

This letter transmits the Alameda Point, Final OU-5 Remedial Investigation (RI) Report. Also transmitted are Navy responses to comments on the draft final version of this document. Comments received from regulatory agencies and the public have been addressed and/or incorporated into the Final OU-5 RI Report.

Please feel free to contact me if you have questions.

Sincerely,

RICHARD C. WEISSENBORN, P.E.
Remedial Project Manager

Enclosures: *Operable Unit 5 Remedial Investigation Report, Alameda Point, Alameda, California*
DTSC Comments Draft Final Remedial Investigation Report Operable Unit 5 Alameda Point, Alameda, California
Alameda Point Restoration Advisory Board OU-5 Focus Group
United States Coast Guard Comments Draft Final Remedial Investigation Report, Operable Unit 5, Alameda Point, Alameda, California
Comments from USEPA, Operable Unit 5 Remedial Investigation Report, Draft Final

Copy to :
Ms. Marcia Liao
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, California 94710-2721

Ms. Judy Huang
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, California 94612

Table of Contents

This page intentionally left blank.

List of Tables

Follows Page No.

Follows Page No.

List of Tables (Continued)

Follows Page No.

List of Tables (Continued)

Follows Page No.

Follows Page No.

This page intentionally left blank.

List of Figures

Follows Page No.

Follows Page No.

List of Figures (Continued)

Follows Page No.

List of Figures (Continued)

Follows Page No.

List of Appendices

List of Attachments

This page intentionally left blank.

Acronyms and Abbreviations

°F	degrees Fahrenheit
μg/kg	microgram(s) per kilogram
μg/L	microgram(s) per liter
$\mu g/m^3$	microgram(s) per cubic meter
ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
BaP	benzo(a)pyrene
bgs	below ground surface
BRAC	Base Realignment and Closure
BSU	Bay Sediment Unit
BTEX	benzene, toluene, ethylbenzene, and xylenes
CalEPA	California Environmental Protection Agency
cm^2	square centimeter(s)
COPC	chemical(s) of potential concern
CSF	cancer slope factor
CSM	conceptual site model
DTSC	Department of Toxic Substances Control
EBS	Environmental Baseline Survey
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FISCO	Fleet and Industrial Supply Center Oakland
HI	hazard index
IDW	investigation-derived waste
IR	Installation Restoration
IT	IT Corporation
kg	kilogram(s)
m^3	cubic meter(s)
MCL	maximum contaminant level
mg	milligram(s)
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl tertiary butyl ether
NAS	Naval Air Station
NGVD29	National Geodetic Vertical Datum of 1929
NOEL	no-observed-effect-level
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
ppbv	part(s) per billion volume
PRG	preliminary remediation goal
QC	quality control
RfC	reference concentration

RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
SOP	Standard Operating Procedure
TCRA	time-critical removal action
TEF	toxicity equivalency factor
TPH	total petroleum hydrocarbon
TtEMI	Tetra Tech Environmental Management Inc.
UCL	upper confidence limit
VOC	volatile organic compound

Executive Summary

This Remedial Investigation Report presents the results of a remedial investigation conducted for parcels comprising Operable Unit (OU) 5, the adjacent parcels, and the adjacent Alameda Annex, located at Alameda Point, Alameda, California. The main objective of this report is to assess the potential need for remedial action to protect human health and the environment from exposure to chemical constituents present in environmental media of concern. Operable Unit 5 is a 42-acre site in the northeastern portion of Alameda Point consisting of land Parcels 181 (North Village Housing Area), 182 (Estuary Park), and 183 (Coast Guard Housing Management Office). The scope of soil sampling activities and risk assessment provided in this Remedial Investigation Report is focused on Parcel 181. However, the groundwater and soil gas sampling activities extended beyond Parcel 181 in order to investigate the boundaries and possible origins of chemical constituents in these media.

The OU-5 area is located within the National Priority List-listed portion of the former Naval Air Station Alameda, and is specifically referred to as Installation Restoration Site 25. Therefore, this Remedial Investigation Report was conducted in accordance with the requirements and guidance associated with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended by the Superfund Amendments and Reauthorization Acts.

The area encompassing OU-5 existed as marshland and tidal flats prior to development in the late 1800s and early 1900s, at which time these areas were filled with dredged material of uncertain origin to create usable land. Several historical industrial operations, including a manufactured gas plant, released oil and oil byproducts into local waterways resulting in widespread contamination of the former Oakland Inner Harbor shoreline and tidal channels. The fill events that created Alameda Point are believed to have trapped much of the contamination present in the tidal channels and marsh in place, creating a layer of polynuclear aromatic hydrocarbons (PAH) and other petroleum hydrocarbons below the fill that has been described as the "marsh crust." Additionally, the dredged fill materials are themselves suspected to have contained such petroleum-related contamination. This contamination is believed to be the origin of the widespread occurrence of PAHs observed in fill during the course of environmental investigations at Naval Air Station Alameda and OU-5.

The distribution of PAHs in near-surface soil samples collected during the 1990s and 2000 was used as the basis of a stratified random soil sampling design described in the Final Remedial Investigation Work Plan for OU-5 (Neptune and Company, 2001). During implementation of this sampling design for OU-5, PAH soil concentration data were obtained from 168 sampling locations within Parcel 181 at depth intervals of 0 to 0.5, 0.5 to 2, and 2 to 4 feet below ground surface (bgs). Sixty of these locations were also sampled for PAHs at a depth interval of 4 to 8 feet bgs. Additionally, metals, arsenic, and cyanide soil concentration data were obtained from 60 sampling locations at the 0 to 0.5 foot bgs interval and at 30 locations in the remaining three depth intervals.

Soil concentrations for the carcinogenic PAHs were expressed as benzo(a)pyrene (BaP)-equivalent concentration values, which were calculated as the sum of the concentrations of each carcinogenic PAH normalized to the carcinogenicity of BaP. Benzo(a)pyrene-equivalent soil concentrations show a general trend from higher to lower from north to south and from west to east across Parcel 181 and generally increase with depth in the northern and western portions of the parcel. A semiquantitative analysis of BaP-equivalent soil concentration data from 0 to 4 feet bgs supported stratification of Parcel 181 into seven decision areas. By contrast, metal concentrations in Parcel 181 appear relatively homogenous with only slight spatial patterns with area and depth.

Groundwater data collection for PAHs, volatile organic compounds (VOC), and methyl tertiary butyl ether (MTBE) was conducted at 19 existing monitoring wells, and 4 depth intervals at a total of 61 direct-push groundwater sampling locations in Parcel 181 and adjoining land parcels. The objective of the groundwater sampling was to investigate the spatial boundaries and possible origins of a previously observed VOC plume. Due to insufficient water and/or interference from clays and silts, fewer groundwater samples were obtained from the direct-push locations than intended. Soil gas samples were also collected and analyzed for VOCs at 32 locations in Parcel 181 and adjoining land parcels.

The extent of the VOC groundwater plume was not bounded to the west and south and its source is likewise uncertain. However, the benzene and naphthalene plumes are positioned at roughly the same locations suggesting an identical source(s). Additionally, concentrations of other petroleum-related compounds including toluene, ethylbenzene, and xylene were present with benzene and naphthalene. The Fleet and Industrial Supply Center Oakland (FISCO) Alameda Annex Scrapyard (Installation Restoration Site 25) and the historically stained area in the southwest corner of Parcel 181, were identified as potential contributors. Although the marsh crust layer of hydrocarbon contamination may also be contributing to the presence of petroleum-related compounds in groundwater. The presence of fuel additives such as MTBE and 1,2-dichloroethane, which are indicative of more recent releases than that associated with historical industries, were present in groundwater near the FISCO Annex area. Detected MTBE concentrations did not show a discernable pattern.

Human health risks were calculated for a current residential scenario and for potential future construction worker and residential scenarios using reasonable maximum exposure assumptions. Exposure pathways included incidental soil ingestion, dust inhalation, dermal absorption of chemicals from soil, and inhalation of VOCs existing in shallow groundwater and soil gas. Residential risks were calculated for each of the seven decision areas of different PAH concentrations within Parcel 181, while construction worker risks were evaluated across larger areas. Current and potential future residential cancer risks associated with PAHs in soil lie mostly within the 1×10^{-6} to 1×10^{-4} risk management range when assessing exposure to soil depths of 4 feet. If soils are mixed to depths of 8 feet, PAH cancer risks greater than 1×10^{-4} are calculated for future residents in four of the seven areas. The background cancer risk due to arsenic in soil was 1×10^{-5}. Residential hazard indices were below a value of one for PAHs, but reached two for children in the future residential scenario (0 to 8 feet bgs) due to metals concentrations in soil. Construction worker risks, and risks associated with inhalation of VOCs from soil gas or groundwater, were considerably lower than those described above for residents and soil exposure. Based on current Navy policy, the risk assessment was "dual tracked." This means that risks were calculated separately using both U.S. Environmental Protection Agency (EPA) and California Environmental Protection Agency risk assessment methodologies. Areas where the federal and state methodologies differ are noted throughout the risk assessment; however, the differences in the final risk estimates from the two methodologies were generally negligible.

A risk management decision was made by the Navy to conduct a time-critical removal action to remove soils with elevated PAH concentrations to a depth of 2 feet bgs, and backfill with clean imported fill, top soil, and sod in an area encompassing three decision areas at Parcel 181 (North Village Housing Area). The time-critical removal action was extended to include Parcels 182 (Estuary Park) and 183 (Coast Guard Housing Maintenance Office). The goal of the removal action was to substantially eliminate the potential pathways of exposure to current onsite residents, construction workers, and possible ecological receptors, in an area where initial data review suggested near-surface BaP-equivalent soil concentrations were highest. The time-critical removal actions were completed in August 2002.

This page intentionally left blank.

1.0 Introduction

This report presents the results of a remedial investigation (RI) conducted for parcels comprising Operable Unit (OU) 5, the adjacent parcels, and the adjacent Alameda Annex, located at Alameda Point, Alameda, California. Operable Unit 5 is located within the National Priority List-listed portion of the former Naval Air Station (NAS) Alameda, and is specifically referred to as Installation Restoration (IR) Site 25 (Figure 1-1, "Site Location Map").

The OU-5 area consists of a housing area with 51 multiple-housing complexes and open-space park areas. The "housing area" is a discrete area that encompasses the housing complexes, their surrounding front and back yards, and the open space between the housing complexes. Approximately 40 percent of the area is covered with structures and cement or asphalt paving, the remainder of the site is open space, covered with vegetation and soil. Operable Unit 5 is a 42-acre site that is located in the San Francisco Bay Area and lies in the northeastern corner of Alameda Point (formerly NAS Alameda) as shown in Figure 1-1. Operable Unit 5 consists of land Parcels 181 (North Village Housing Area), 182 (Estuary Park), and 183 (Coast Guard Housing Maintenance Office) (Figure 1-2, "OU-5 Site Location Map"). The Navy previously investigated Parcels 182 and 183, with the data summarized in the Final Remedial Investigation Work Plan for Operable Unit 5 (RI Work Plan) (Neptune and Company, 2001). Data indicating that polynuclear aromatic hydrocarbons (PAHs) were present at high concentrations were also presented in the *Data Summary Report Site 25 Remedial Investigation* (TtEMI, 1999a). The Navy proposed, and the Base Realignment and Closure (BRAC) Cleanup Team agreed, that remediation was required in Estuary Park and additional characterization was not warranted.

In addition to the soil investigation at Parcel 181, groundwater and soil gas were investigated during this RI within OU-5 (Parcels 181 and 182), at adjacent portions of Alameda Point (Parcels 172 through 176, 178 [Marina Village Housing Area), 179 [Miller Elementary School], 180 [Alameda Child Development Center], and 184), and at the adjacent Alameda Annex (Figure 1-2). The adjacent parcels were investigated to better understand the spatial distribution of groundwater and soil gas contamination and to support risk screening. The results of this RI Report will be used to evaluate the potential need for remedial action to protect human health and the environment from exposure to chemical constituents present in environmental media.

1.1 Scope, Purpose, and Objectives

The scope of sampling activities and risk assessment for this RI focused on Parcel 181, the North Village Housing Area. However, groundwater and soil gas sampling activities were extended beyond Parcel 181 in order to investigate the boundaries and possible origins of chemical constituents in these media.

Specific data quality objectives for this RI were presented in Tables 5-1 through 5-3 of the RI Work Plan (Neptune and Company, 2001). The data quality objectives identified three primary questions associated with the RI as follows:

- Do chemicals of potential concern (COPC) in soil and groundwater pose an unacceptable human health risk to residents and construction workers at OU-5?
- Are benzene and/or other volatile chemicals reported in groundwater migrating to ambient and indoor air?
- What volume and location of contaminated soil, and/or volume and location of contaminated groundwater, at OU-5 (outside of Estuary Park Parcel 182) should be evaluated in the feasibility study to reduce risk to acceptable levels?

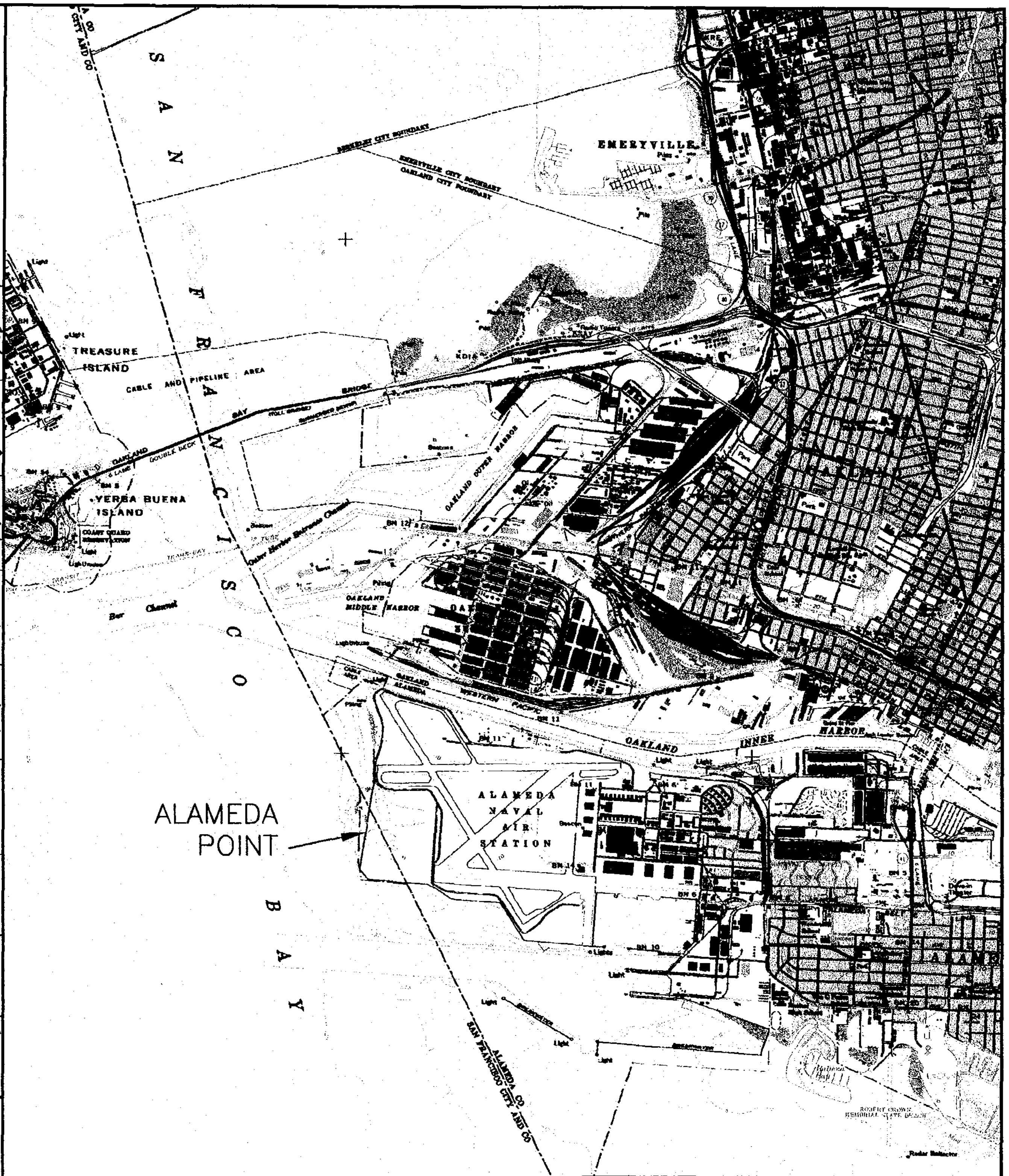
The primary questions were followed by secondary questions and/or data needs (i.e., "inputs") that provided the focus for the sampling design. As noted above, documented concentrations of PAHs in Estuary Park were high enough to lead Navy to the conclusion that remediation was needed.

The objective of this RI was to generate adequate information to develop and support responses to these questions. Among the three questions, the primary objective was to assess the risk to current and future receptors due to exposure to chemicals in the environmental media. The objective of identifying whether volatile organic compounds (VOC) are migrating to indoor or ambient air was a secondary objective within the assessment of potential health risks. The objective of determining the boundaries of the feasibility study incorporated the results of the risk assessment as the principal basis for the decision.

The purpose of this report is to present the results of data collection, evaluation, and risk assessment associated with the RI conducted for OU-5 at Alameda Point. The RI data will also support the feasibility study, where the magnitude and extent of chemical contamination are needed to support remedy development, remedy selection, and remedial cost estimates in development of a site record of decision. This RI Report:

- Documents the methods and findings of RI activities in the OU-5 vicinity
- Evaluates the nature and horizontal and vertical extent of chemicals that may be present in soil, groundwater, and soil gas

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
c-37122g3	--	CONC	SJZ 11/12/02	12/2/02	JKS 12/2/02	809155-A2



REFERENCE:
USGS 7.5' QUADRANGLE "OAKLAND WEST." DATED: 1959, PHOTOREVISED: 1980 SCALE 1:24,000

SCALE

0 4000 8000 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 1-1

ALAMEDA POINT LOCATION MAP

LEGEND

▬▬	OU5 BOUNDARY
181	PARCEL NUMBER
——	PARCEL BOUNDARY

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 1–2

OPERABLE UNIT 5 SITE MAP

- Identifies media and locations, if any, where chemicals are present at concentrations that may pose an immediate threat to human health
- Determines whether chemicals are present at concentrations that pose a potential chronic risk to human health and the environment under current and potential future land-use conditions.

1.2 Report Organization

This RI Report has been organized into seven sections as follows:

- Section 1.0 presents the purpose and objectives of the RI and the overall report organization.
- Section 2.0 provides an overview of the site history, physical characteristics, preliminary site conceptual model, site investigations, previous mitigation measures, and a summary of a time-critical removal action (TCRA).
- Section 3.0 provides a summary of the soil, groundwater, and soil gas field sampling activities conducted for the RI.
- Section 4.0 presents and evaluates the data collected, and describes the nature and extent of chemical constituents reported in the soil, groundwater, and soil gas.
- Section 5.0 presents the baseline human health risk assessment, including the statistical methods used for calculation of exposure point concentrations (EPC).
- Section 6.0 presents a summary and conclusion of RI activities and results. Additionally, remedial action objectives for soil, groundwater, and soil gas are presented.
- Section 7.0 provides a listing of the references cited in the document text.

Eleven appendices are included to support this RI Report. The list of appendices is as follows:

- Appendix A – Summary of Historical Data
- Appendix B – Data Preparation, Analysis and Calculations of Exposure Point Concentrations
- Appendix C – Risk Assessment Calculations
- Appendix D – Remedial Investigation Data Tables
- Appendix E – Core Logs and Boring Logs
- Appendix F – Field Forms (on CD-1)
- Appendix G – Laboratory Validation Forms (on CD-1)

- Appendix H – Corehole Photographs (on CD-2)
- Appendix I – Soil Boring Photographs (on CD-3)
- Appendix J – Sample Collection Summary
- Appendix K – Historic Installation Restoration Site 25 Analytical Data (on CD-1).

2.0 Site Background

The following subsections present background information used to establish the need for the scope of the remedial investigation (RI). Operable Unit (OU) 5, which is comprised of approximately 42 acres, was divided into three parcels (Parcels 181, 182, and 183) by the Environmental Baseline Survey (EBS) (TtEMI, 1999b) (see Figure 1-2). U.S. Coast Guard employees and their families are currently occupying the multi-unit housing structures within Parcel 181, under an interim use agreement with the Navy. Parcels 182 (Estuary Park) and 183 (Coast Guard Housing Maintenance Office) were previously investigated by the Navy, with the data presented in the *Data Summary Report Site 25 Remedial Investigation* (TtEMI, 1999a). Historical sampling activities were mainly focused on Estuary Park (Parcel 182). The sampling indicated that concentrations of polynuclear aromatic hydrocarbons (PAHs) were present in soil at concentrations presenting potentially excessive human health risk. To prevent exposure to contaminated soil, a fence was installed around the park in November 1998. During Base Realignment and Closure (BRAC) Cleanup Team discussions, an agreement was reached that additional characterization in Estuary Park was not warranted, but remediation was needed. The Navy initiated, and completed a time-critical removal action (TCRA) in Parcels 182 and 183. Therefore, additional sampling and assessment in Parcels 182 and 183 was not conducted in this RI.

In addition to the soil investigation at Parcel 181, the RI also included the sampling and analysis of groundwater and soil gas in parcels other than Parcel 181 (a single location within Parcel 182, numerous locations within the adjacent properties [Parcels 172 through 176, 178 through 180, and 184] to the south and southeast of OU-5, and several locations in the adjacent Fleet and Industrial Supply Center Oakland [FISCO] Alameda Facility Annex [Alameda Annex]).

Sampling and analysis of groundwater and soil gas was conducted to better understand the occurrence of groundwater and soil gas contamination in OU-5 and vicinity. The following background discussions focus on OU-5.

2.1 Site History

The area encompassing OU-5 existed as marshland and tidal flats prior to the late 1800s and early 1900s, at which time these areas were filled with dredged material of uncertain origin to create usable land. According to historical photographs and records, the OU-5 area was filled in two separate events (TtEMI, 2000a). The first fill event (1887 through 1915) covered most of the OU-5 area as shown on Figure 2-1. A later fill event (1930 through 1939) added the fill material that is now the southeast portion of OU-5.

Each of the parcels (181, 182, and 183) has somewhat different histories of usage. Parcel 181 is presently occupied by 51 residential buildings, which were constructed in 1969. Aerial photographs from 1947 and 1958, show different housing complexes that were reportedly barracks (IT, 1998). Some large structures, apparently warehouses, were also present on the eastern half of Parcel 181 in these photographs.

No chemicals are known to have been used at or stored at Parcel 181. Soil staining was evident in a 1968 aerial photograph, near the present-day intersection of Mayport and Kollmann Circles as shown on Figure 2-2. However, the soil staining was reportedly remediated during activities associated with the Zone Analysis Plans (ERM-West, 1995). There is presently no visible staining in the area indicated on Figure 2-2.

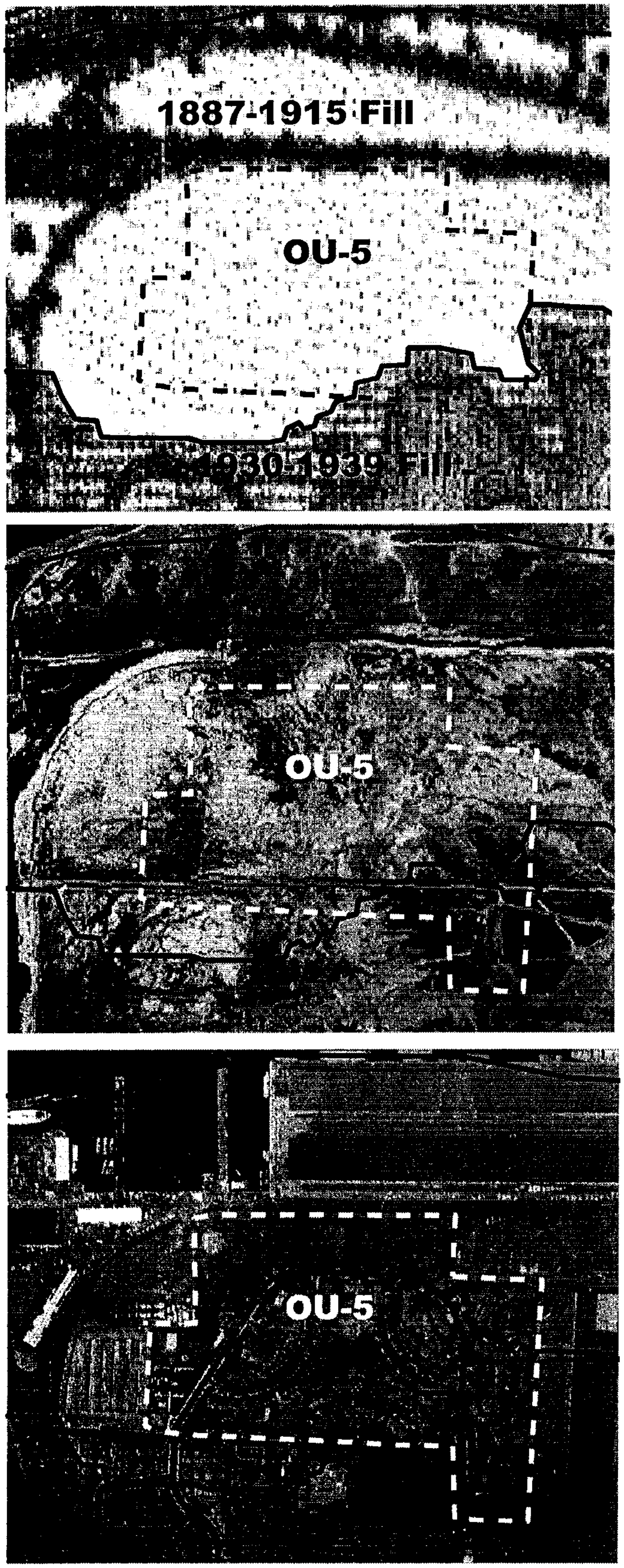
Parcel 182 is known as Estuary Park. At the start of this RI, the park included a variety of recreational parklands, including baseball and soccer fields and a physical fitness course. A sanitary sewage pump station (Facility 591) is also located in Parcel 182 near the southeast corner of Estuary Park. Between 1947 and 1966, the area was used for residential purposes and contained barracks-type housing. These buildings were reportedly demolished sometime between 1966 and 1970 (ERM-West, 1995). A housing office (Building 534) was constructed sometime between 1990 and 1992, in the southernmost portion of Parcel 182. No chemical spills or releases have been documented within Parcel 182 (ERM-West, 1995). As previously mentioned, a TCRA was performed by the Navy at Parcel 182 where the top 2 feet of contaminated soil was removed. The excavated area was backfilled with clean soil and sodded.

Parcel 183 is less than one acre in size and contains Building 545, which was constructed between 1970 and 1975 (ERM-West, 1995). Building 545 is presently used as the Coast Guard Housing Maintenance Office. Parcel 183 was historically used to house barracks and shares a similar history as Parcel 182 in this regard. No chemical spills or releases have been documented within Parcel 183 (ERM-West, 1995).

Within OU-5 there is a system of sanitary and storm water sewers, which drain from south to north. The storm sewers discharge to the Oakland Inner Harbor.

Polynuclear aromatic hydrocarbons have been detected in soil and groundwater at OU-5 during environmental investigations conducted at Naval Air Station (NAS) Alameda and vicinity. The fill material used to create portions of Alameda Island, where there were historically marshes or

Figure 2-1
Operable Unit 5 Fill History



Local fill history derived from 1915 USGS quadrangle map

Fill history superimposed over 1937 aerial photograph

Fill history superimposed over 1995 aerial photograph

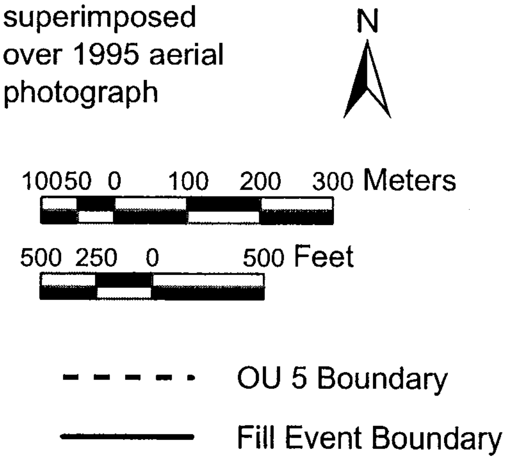
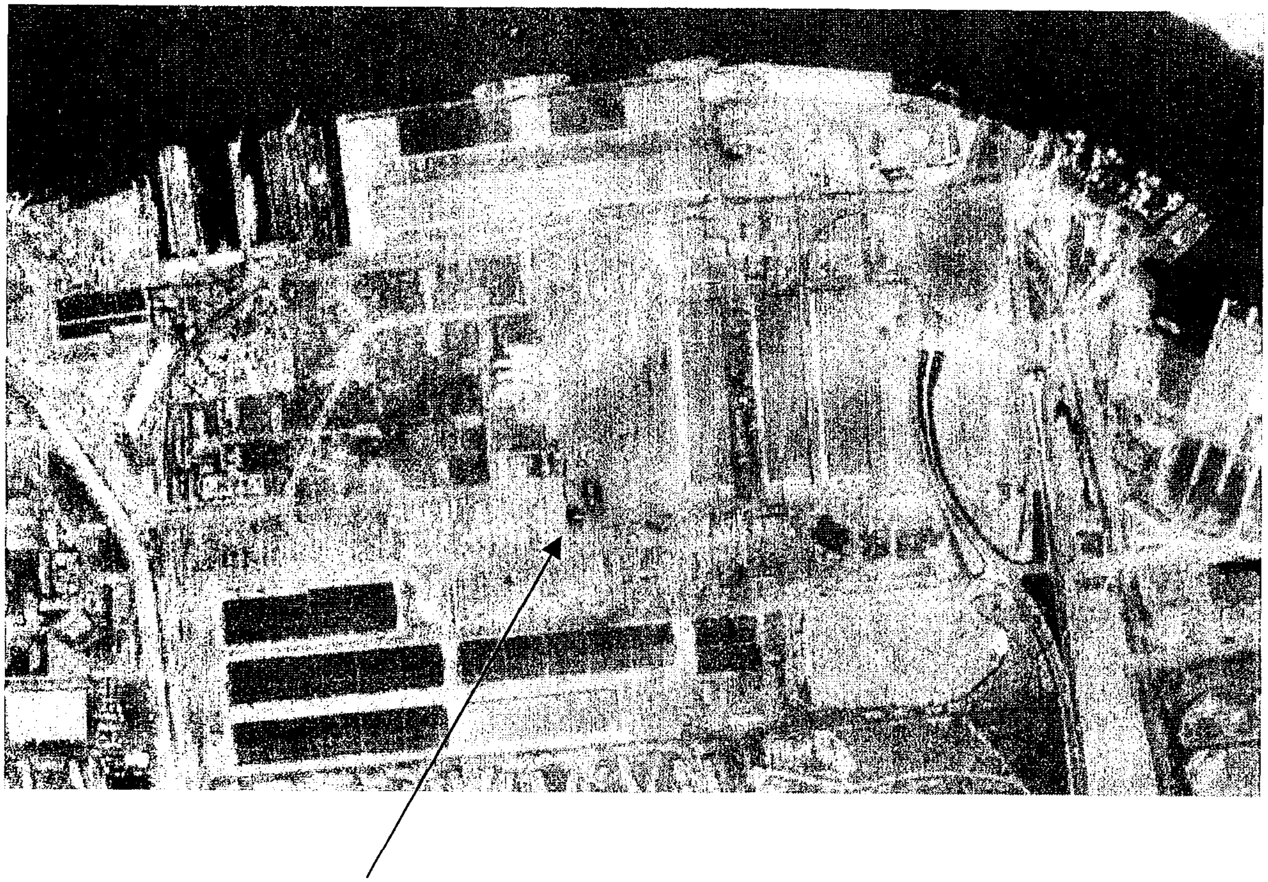


Figure 2-2
"Stained" Area in 1968 Aerial Photograph



"Stained" Area

shallow bay waters, has been identified as containing PAHs. These PAHs are believed to have originated from historical industrial activities in adjacent areas and to be ubiquitous in the fill material. In addition to the PAH contamination of soil within OU-5, groundwater in the area has been found to contain benzene and naphthalene with occasional detections of other volatile organic compounds (VOC).

Benzene, VOCs, and other petroleum hydrocarbons have been detected in groundwater in the southeastern portion of OU-5, and in adjacent properties including portions of the Alameda Annex and NAS Alameda. The source of these compounds in the groundwater is not currently known.

The Navy began its investigation of NAS Alameda (now Alameda Point) in the early 1980s, under the Naval Assessment and Control of Installation Pollutants program. The results of the Naval Assessment and Control of Installation Pollutants identified five sites that required additional investigation. The additional investigations were performed under the Installation Restoration (IR) Program. In June 1988, the California Department of Health Services, now the California Environmental Protection Agency (CalEPA) Department of Toxic Substances Control (DTSC), issued a remedial action order that required a remedial investigation/feasibility study for the IR Program sites at Alameda Point. Operable Unit 5 was not identified at that time as one of the IR Program sites because no historical spills were documented in this area.

Alameda Point was designated for closure in September 1993, and ceased all naval operations in April 1997. The property will be returned to the City of Alameda and the U.S. Fish and Wildlife Service for future use. As part of the property transfer, an EBS was performed. Environmental sampling completed as part of the EBS identified areas where environmental contaminants appeared to be present. The EBS sampling identified PAHs as being present in the soil and groundwater at OU-5.

Alameda Point was added to the National Priority List in July 1999. The listing was the result of evaluation of environmental data using the Hazard Ranking System. Since the listing, the U.S. Environmental Protection Agency (EPA) has been the primary regulatory agency. The DTSC and the Regional Water Quality Control Board are also actively involved regulatory agencies.

2.2 Physical Description

The following subsections present the physical description of OU-5. This information was used, in part, to develop the scope of the RI and the conceptual model of the site.

2.2.1 Topography

The most significant feature of the OU-5 surface topography is that the area is elevated approximately 3 to 4 feet relative to the railroad line that borders OU-5 on the north. The elevation difference is believed to be the result of fill placement without interrupting railroad service. The elevation of the OU-5 land surface is approximately 6 to 11 feet above sea level.

2.2.2 Climate

Precipitation records for Alameda Point indicate that the mean annual precipitation is 18.69 inches. Most rainfall occurs between the months of November and April. Mean yearly low and high temperatures are 50.7 degrees Fahrenheit (°F) and 64°F, respectively. The wind direction is predominantly from the west to northwest.

2.2.3 Biological/Ecological Resources

A screening level ecological risk assessment for OU-5 was conducted by Tetra Tech Environmental Management Inc. (TtEMI) and was published as part of the *Draft OU-2 Remedial Investigation Report* (which included the parcel currently identified as OU-5) (TtEMI, 1999c). The ecological risk screening concluded that chemical concentrations in OU-5 soils did not pose an unacceptable risk to ecological receptors. Based on this ecological risk screening, and due to current and planned future use of OU-5 as a residential area (which limits the habitat available for use by wildlife) no further assessment of ecological risk was proposed. Ecologically intensive land-use options, such as use of OU-5 as a wildlife refuge, have not been considered. If such options are considered in the future, further ecological risk evaluation may be required.

2.2.4 Geology

Alameda Point is located along the eastern San Francisco Bay (East Bay Margin). San Francisco Bay occupies a depression between two uplifted areas, the Berkeley Hills to the east and the Montara and other mountains to the west. The depression and the uplifted areas were formed by two sub-parallel, active faults: the San Andreas Fault west of San Francisco Bay; and the Hayward Fault east of San Francisco Bay. The San Andreas and Hayward faults are located approximately 12 miles west and 5 miles east of Alameda Point, respectively.

The geology of East San Francisco Bay has been described by Hickenbottom and Muir (1988), and the specific lithology at Alameda Point outlined by TtEMI (1999b). The sedimentary deposits represented along the East San Francisco Bay include (from youngest to oldest) the Bay Sediment Unit ("Bay Mud"), Temescal Formation, the Merritt Sand, the Posey Formation, the San Antonio Formation, and the Alameda Formation. Man-made fill overlies these units at various locations along the shoreline of the bay.

The groundwater beneficial use technical memorandum (TtEMI, 2000b), indicates that the shallow water-bearing zone consists of the shallow fill that is found in the uppermost 10 to 20 feet, and the underlying native sediment material that includes the Bay Mud and Merritt Sand Formation. These units collectively comprise the shallow water-bearing zone of the groundwater system at Alameda Point.

The fill is a heterogeneous, laterally discontinuous mixture of sand, silt, and clay (including dredged Bay Mud) with some construction debris and organic material. The thickness of the fill varies from approximately 10 to 20 feet across Alameda Point. The thickness of the fill is probably most influenced by the presence of historical tidal channels that once transected the tidal flats. A marshland layer occurs underneath the fill material. It is comprised of an organic-rich peat and grass layer about 2 to 6 inches thick at depths ranging from 15 to 20 feet below ground surface (bgs). This peat and grass layer was first recognized during previous geotechnical investigations and the term "marsh crust" was used to signify this lithologic-time stratigraphic unit. Investigations conducted at the Alameda Annex indicate that petroleum hydrocarbons released from historical industrial activities were deposited upon the surface of the tidal marsh. Hence, the marsh crust layer is presently associated with petroleum-related contamination (PRC, 1990). Underlying the marsh crust layer is Bay Mud.

Borings located near the center of Alameda Point indicate native sediment beneath the fill is Bay Mud, which consists primarily of gray to black, medium to high plasticity silty clay with occasional thin lenses of fine sand. No extensive sand layers were observed within the Bay Mud. The Bay Mud ranges in thickness from 25 to 80 feet. The Merritt Sand Formation is found below the Bay Mud, although the thickness of the Merritt Sand is unknown at the Alameda Annex and the OU-5 area. The base of the Merritt Sand is found at depths as great as 135 feet bgs across Alameda Point.

2.2.5 Hydrogeology

Two primary regional aquifers, the Merrit Sand aquifer and deeper Alameda aquifer, have been identified at Alameda Point. The Merritt Sand aquifer includes the Merritt and Posey Sands, which are considered a single hydrostratigraphic unit. The Alameda aquifer consists of coarser zones in the Alameda Formation that readily yield water. The groundwater management subarea containing the Merritt Sand and the Alameda aquifers is called the Oakland Upland and Alluvial Plain Management Subarea. The Alameda aquifer is the principal aquifer within the Oakland Upland and Alluvial Plain Management Subarea. Depth to the top of the Alameda Formation ranges from 100 feet bgs at Alameda Point to 200 feet bgs beneath the Oakland Inner Harbor (Hickenbottom and Muir, 1988). The formation thickness ranges between 200 and 800 feet

(Hickenbottom and Muir, 1988). The San Antonio aquitard, which includes the Yerba Buena Mud and a thin upper, clay rich portion of the Alameda Formation, separates the Alameda aquifer from the Merritt Sand aquifer.

The fill at Alameda Point and OU-5 is not considered a regional aquifer. The first water-bearing zone within the fill forms the upper unconfined aquifer at the site. The lateral extent of the shallow water-bearing zone is undefined at the site. Groundwater elevation data indicate that the shallow groundwater generally flows to the northwest (TtEMI, 1999b). Negative groundwater elevations occur near the Oakland Inner Harbor where groundwater appears to have significant tidal influence.

2.3 Summary of Previous Investigation Data

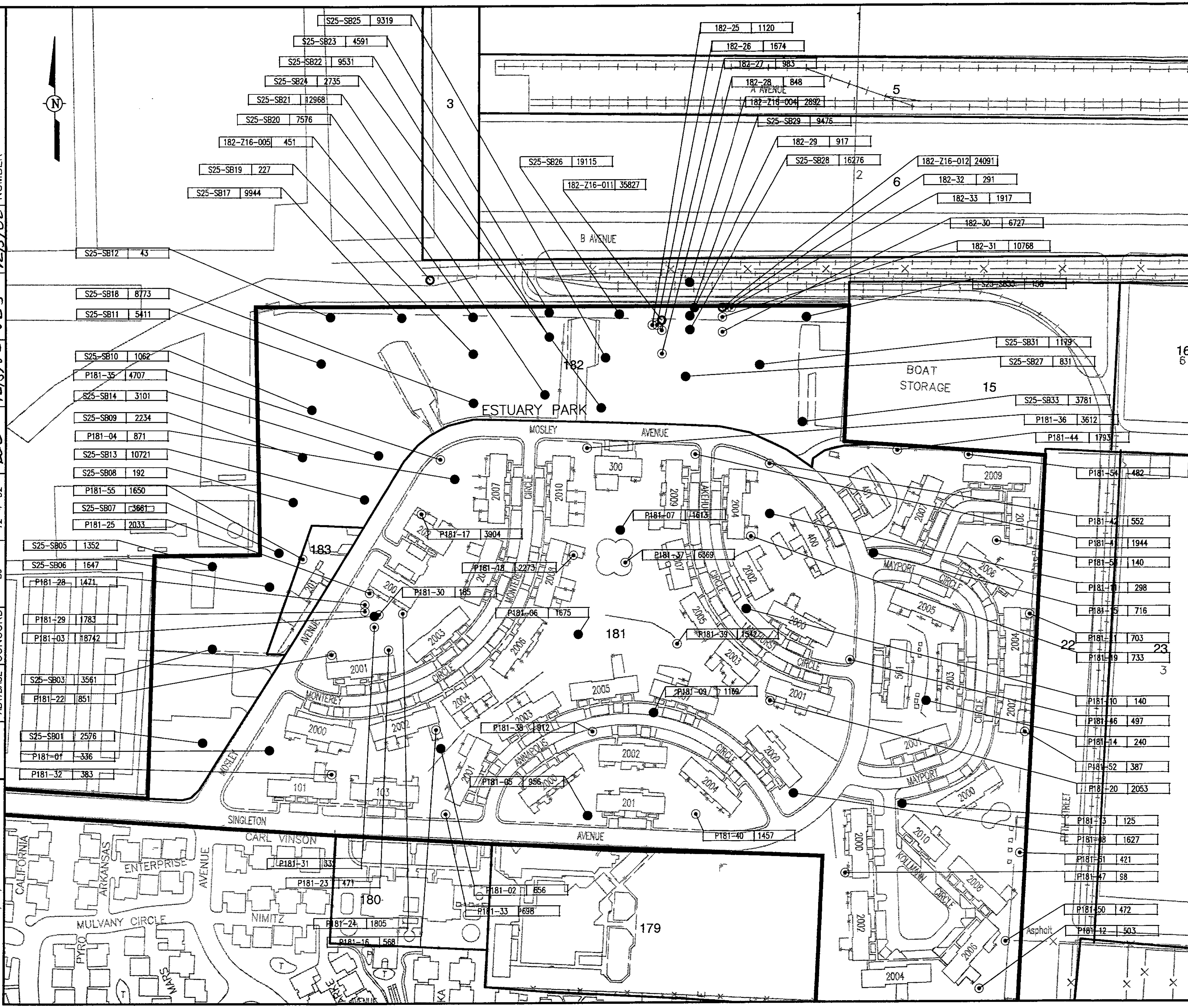
A summary review of data from previous investigations is provided in this section and in Appendix A, "Summary of Historical Data." This information was originally published in Section 3.1 of the RI Work Plan (Neptune and Company, 2001) and consists of information published in the *Final Basewide Environmental Baseline Survey* (PRC, 1996), the *Draft Supplemental Basewide Environmental Baseline Survey* (TtEMI, 1999b), and the EBS Data Evaluation Summaries (IT, 1998).

2.3.1 Polynuclear Aromatic Hydrocarbons in Soils

Prior to the current effort, samples to assess PAH concentrations in soil were collected in 1994, 1995, 1998, and 1999 in the area of OU-5. In 1994 and 1995, surface soil and soil gas samples were collected in Parcel 181 (North Village Housing Area) and Parcel 182 (Estuary Park). In 1998, groundwater samples and additional soil samples were collected at Parcels 181 and 182. In 1999, soil and groundwater direct-push samples were collected at Parcel 182, and ten groundwater monitoring wells were sampled. The majority of the 1998 soil samples were collected on a 150-foot regular grid within Parcel 182. There were also some additional discretionary samples at a location near the northern boundary of the parcel where samples collected in 1994 and 1995 indicated relatively high PAH concentrations. The 1999 samples were collected exclusively within Parcel 181, with the exception of a single sample from Parcel 183. Samples were primarily collected in the top 2 feet of soil, with most representing the top 6 inches. Very few soil samples were taken within OU-5 from the 2 to 4 foot depth interval, and even fewer from the 4 to 6 foot depth interval. However, a number of soil samples were collected from the 6 to 8 foot depth interval (most at the 6.5 to 7 foot depth) within Estuary Park, and 16 additional samples at this depth were collected in Parcel 181. Figures 2-3 through 2-6 show historical soil benzo(a)pyrene (BaP)-equivalent concentration data grouped into the four

DRAWING NUMBER	819814-B71
APPROVED BY	JES 12/5/02
CHECKED BY	BDC 12/5/02
DRAWN BY	BJ 12-4-02
OFFICE	CONCORD
X-REF	ALA1BASE
IMAGE	---

FORMAT REVISION 2/26/99



LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(line)	PARCEL BOUNDARY
●	OU5 SOIL BORING
⊙	OU5 SURFACE SOIL SAMPLE LOCATION
○	EBS SURFACE SOIL SAMPLE LOCATION

P181-53 | 0.11

- 0.11 — B(a)P EQUIVALENT (micrograms per Kilogram) (parts per billion [ppb])
- P181-53 — SAMPLE ID

SCALE

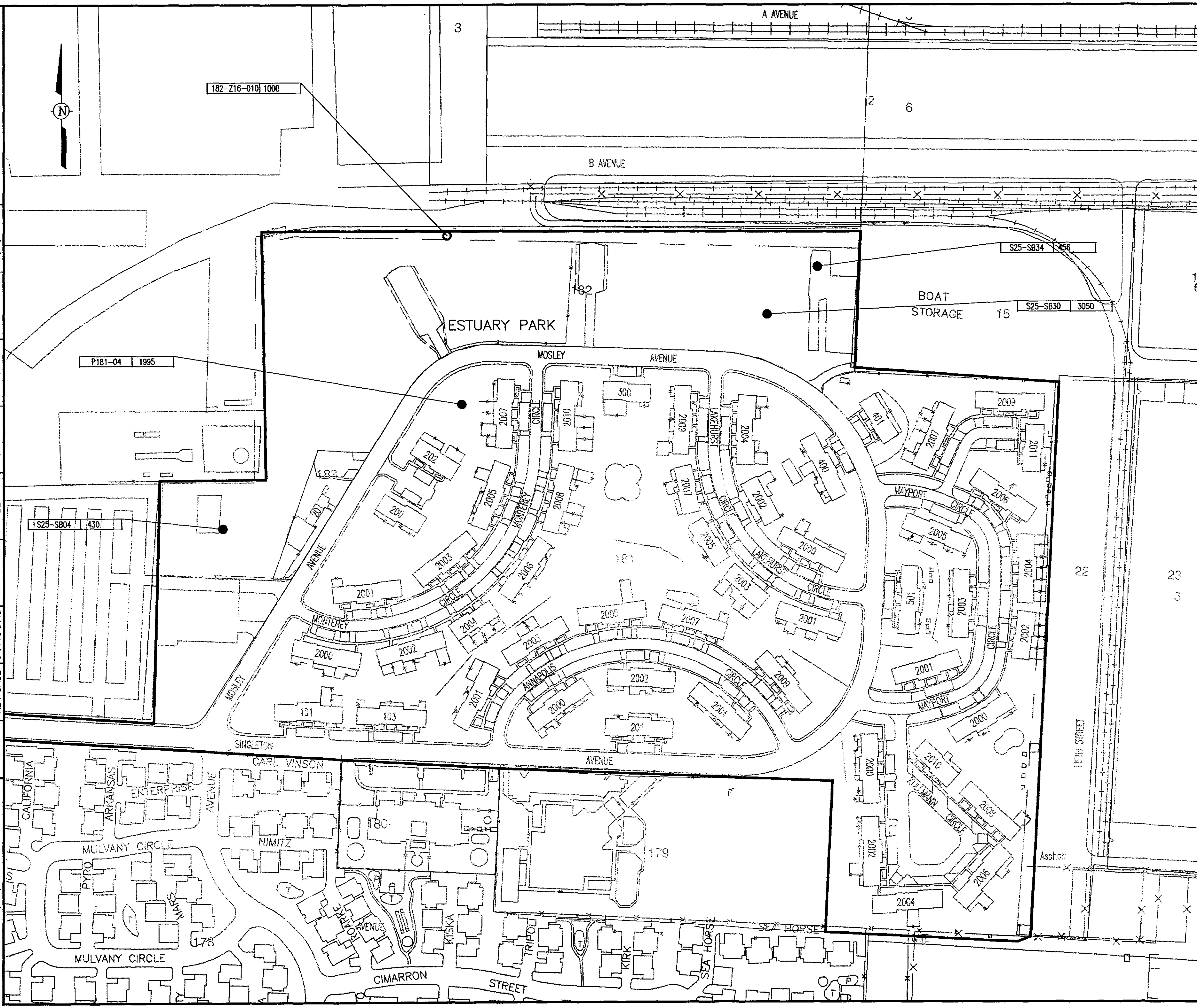
0 200 400 FT

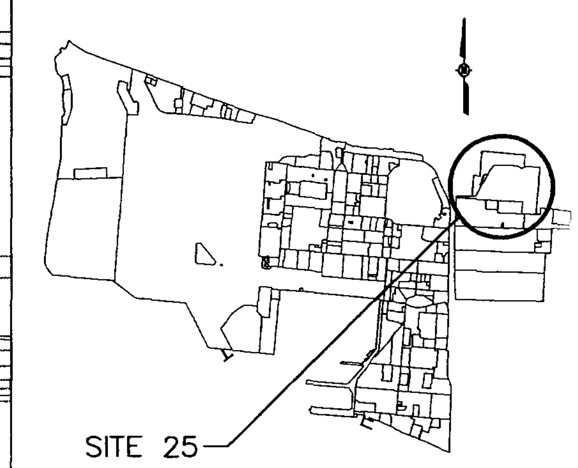
IT CORPORATION

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-3

HISTORICAL SOIL BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION RESULTS
0-0.5' DEPTH INTERVAL





LEGEND

- OU5 BOUNDARY
- PARCEL NUMBER
- PARCEL BOUNDARY
- OU5 SOIL BORING LOCATION

P181-04 | 1995

- BENZO(a)PYRENE B(a)P EQUIVALENT (micrograms per Kilogram) (parts per billion [ppb])
- SAMPLE ID

SCALE

0 200 400 FT

IT CORPORATION

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-4

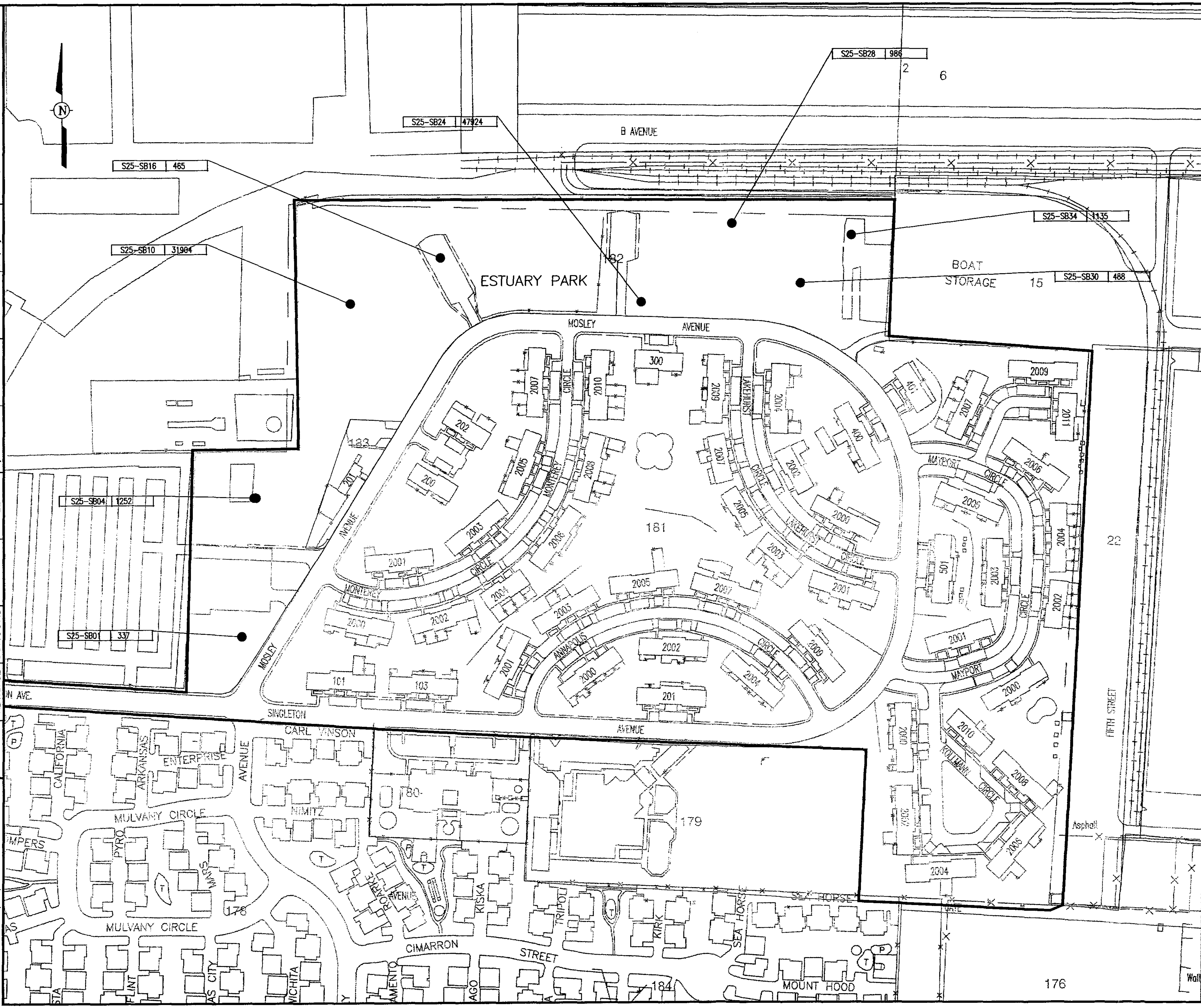
HISTORICAL SOIL
BENZO(a)PYRENE (BaP)
EQUIVALENT CONCENTRATION RESULTS
0.5–2.0' DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-22-02	RDC 12/2/02	JES 12/2/02	819814-B72

FORMAT REVISION 2/26/99

DRAWING NUMBER	819814-B73
APPROVED BY	JES 12/2/02
CHECKED BY	12/2/02
DRAWN BY	BJ 11-22-02
OFFICE	CONCORD
X-REF	ALA1BASE
IMAGE	---

FORMAT REVISION 2/26/99



LEGEND

- OU5 BOUNDARY
- PARCEL NUMBER
- PARCEL BOUNDARY
- OU5 SOIL BORING LOCATION

P181-53 | 0.11
- BENZO(a)PYRENE B(a)P EQUIVALENT (micrograms per Kilogram) (parts per billion [ppb])
- SAMPLE ID

SCALE

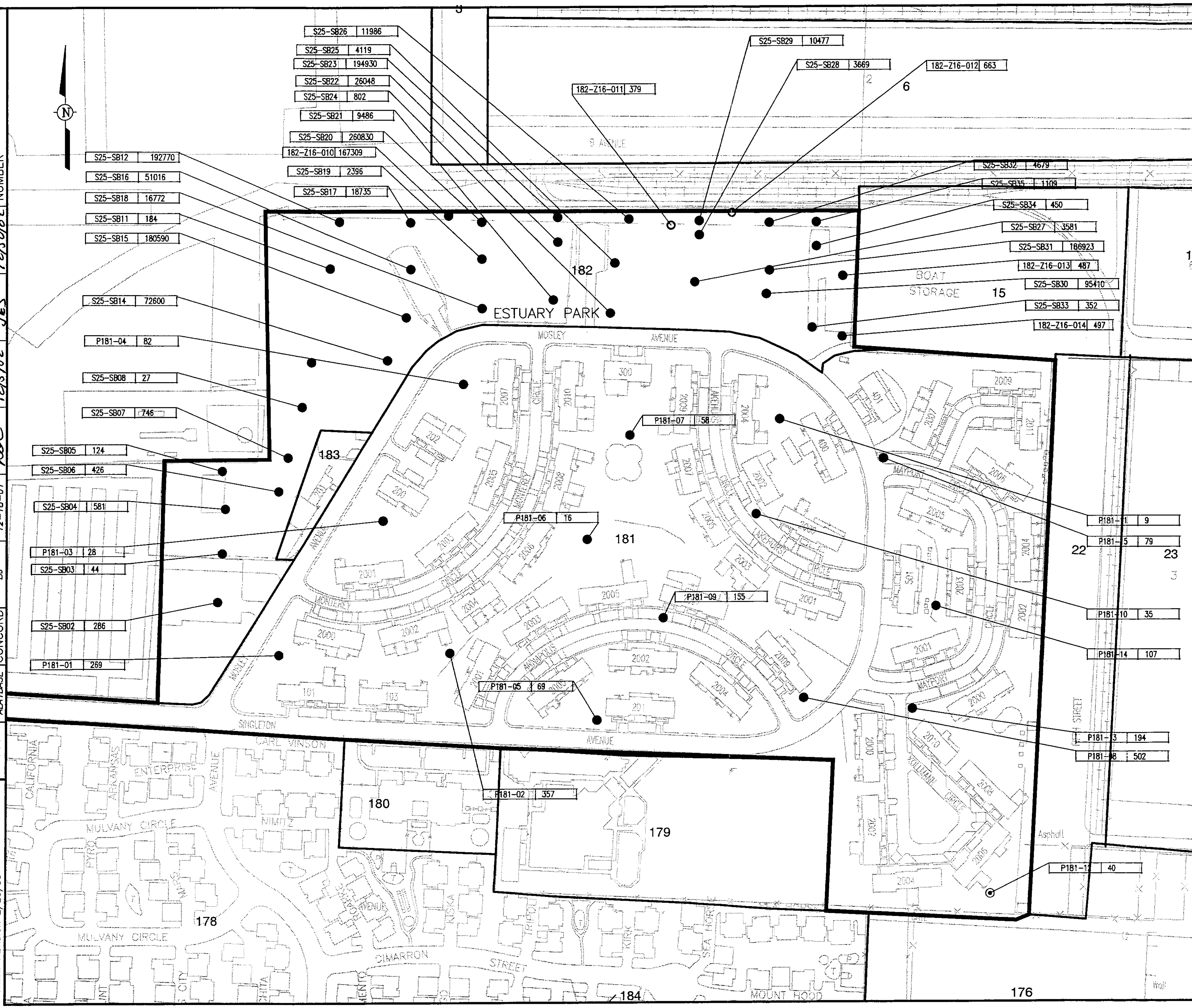
0 200 400 FT

IT CORPORATION

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-5

HISTORICAL SOIL
BENZO(a)PYRENE (BaP)
EQUIVALENT CONCENTRATION RESULTS
2.0-4.0' DEPTH INTERVAL



DRAWING NUMBER 819814-B74

APPROVED BY JES 12/30/02

CHECKED BY 12/5/02

DRAWN BY BJ 12-18-01

OFFICE CONCORD

X-REF ALA1BASE

IMAGE ---

FORMAT REVISION 2/26/99

IT CORPORATION

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-6
HISTORICAL SOIL Benzo(a)Pyrene (BaP) EQUIVALENT CONCENTRATION RESULTS
4.0-8.0' DEPTH INTERVAL

sampling depth intervals used in this RI. These depth intervals were 0 to 0.5 feet bgs, 0.5 to 2 feet bgs, 2 to 4 feet bgs, and 4 to 8 feet bgs, respectively.

Though individual PAHs were reported in the analytical data from the previous investigations, the evaluation and risk assessment focused on the carcinogenic (cancer-causing) PAHs using BaP-equivalent concentrations. The BaP-equivalent concentrations were calculated for each sample by normalizing the concentration of each carcinogenic PAH to the carcinogenicity of BaP, for which both EPA and CalEPA have published separate cancer slope factors (CSF). The risk assessment calculations were conducted using EPA and CalEPA toxicity equivalency factors (TEF) as follows (differences between the two methods are noted in parenthesis):

- Benz(a)anthracene (0.1)
- BaP (1.0)
- Benzo(b)fluoranthene (0.1)
- Benzo(k)fluoranthene (EPA 0.01; CalEPA 0.1)
- Chrysene (EPA 0.001; CalEPA 0.01)
- Dibenz(a,h)anthracene (EPA 1.0; CalEPA 4.1/12)
- Indeno(1,2,3-cd)pyrene (0.1).

As further discussed in Section 5.7, the CalEPA TEF value for dibenz(a,h)anthracene is actually based on the ratio of two slope factors rather than a TEF value. For ease of presentation, all figures presented in this report are based on the EPA BaP-equivalent concentrations.

Approximately 9 percent of the historical samples did not have detectable analytical data for one or more of the seven PAHs needed to calculate BaP-equivalent concentrations. Dibenz(a,h)anthracene was the most common PAH that was not detected during laboratory analyses. The reporting limits for dibenz(a,h)anthracene were variable, likely due to matrix interferences that required samples to be diluted. The reporting limits ranged from 0.003 to 18 milligrams per kilogram (mg/kg). Because a protocol of using one half the reporting limit for non-detect PAHs was employed in calculation of the BaP-equivalent concentration, this variability resulted in some high values of calculated BaP-equivalent concentrations even when concentrations of detected PAHs were relatively low.

Despite the limitations of the historical data, there were two general trends apparent in the BaP-equivalent concentration data. Benzo(a)pyrene-equivalent concentrations in surface soil were clearly elevated in the northwest portion of OU-5, in the area of Estuary Park, and decreased in easterly and southeasterly directions toward the Alameda Annex. At Alameda Annex IR Site 02, BaP-equivalent concentrations in surface soil increased, but were generally lower than those in the northwest portion of OU-5 (see Figure 2-3). The second noticeable trend was that BaP-equivalent soil concentrations were significantly higher between 4 to 8 feet bgs than at 0 to 0.5 feet bgs in Estuary Park.

2.3.2 Other Historic Chemicals of Potential Concern at Operable Unit 5

No widespread evidence of soil contamination by organic constituents other than PAHs was evident in the historical data. A summary of the historical data is presented in the RI Work Plan (Neptune and Company, 2001). Methyl tertiary butyl ether (MTBE) was identified in 4 of 43 soil samples collected at a depth of 2 to 7 feet bgs and 2 of 10 soil samples collected in Estuary Park at a depth of 7 to 10 feet bgs. The MTBE detections were limited to an area in the eastern portion of Estuary Park and might be an indication of a more recent fuel spill, possibly from an adjacent parking lot. All but one of the MTBE detections were reported as estimated values.

Data from the few surface soil samples that were analyzed for metals during historical sampling events indicated that the majority of metals were present at higher concentrations in samples collected near Estuary Park than in samples from the southeastern portion of OU-5. Data from subsurface soils were not available to assess trends in metals concentrations as a function of depth.

Concentrations of metals in the majority of the housing areas (Parcel 181) were unknown prior to this RI. While it is unlikely that there is a significant metals contamination problem at OU-5, certain metals are known to be associated with gas manufacturing (a historic industry), and therefore the nature and extent of metals in soils was identified as a data gap in the RI Work Plan (Neptune and Company, 2001).

Historical data indicated that benzene and other petroleum-related constituents (e.g., acenaphthene, diesel-range total petroleum hydrocarbons [TPH], naphthalene, and phenanthrene) were present in groundwater. The highest observed levels were located in the southeastern portion of the housing areas and adjacent properties. The source and extent of chemical constituents in groundwater was not well understood.

Groundwater samples collected prior to this RI were collected from the shallow water-bearing zone. Analytes reported included:

- 16 PAHs
- Semivolatile organic compounds, not including PAHs
- Benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds
- MTBE

- 29 VOCs, not including BTEX and MTBE
- 2 categories of TPH (diesel-range and gasoline-range).

Polynuclear aromatic hydrocarbons were detected in as many as 60 percent of the sample locations. Benzene was reported in 13 of 35 historic samples; ethylbenzene and xylenes (total) were reported in 12 of 35 samples, and toluene was reported in 9 of 35 samples. Methyl tertiary butyl ether was reported in 2 of 30 historic samples. 1,4-Dichlorobenzene, 2,4-dichlorophenol, carbon disulfide, and dibenzofuran were detected once, while carbazole was detected in three samples. Diesel-range and gasoline-range TPH were reported in 16 of 30 samples and 11 of 40 samples, respectively.

Spatial and temporal patterns for benzene and other frequently detected organic chemicals in groundwater (acenaphthene, diesel range TPH, naphthalene, and phenanthrene) were reviewed. The data suggest that there may be multiple sources of PAHs and benzene in groundwater.

2.4 Preliminary Site Conceptual Model

A physical model of PAH contamination is presented to provide an interpretation of the historic PAH soil results. Several historical industrial operations that were likely to have released petroleum hydrocarbons to the environment were located in the vicinity of present-day Alameda Point. In particular a manufactured gas plant that used oil (most active from 1903 through 1930) existed on the waterfront in Oakland (Figure 2-7). Releases of oil and oil byproducts associated with manufacturing operations from large industries are believed to have resulted in widespread contamination of the former Oakland Inner Harbor shoreline, marshland, and tidal channels (Figure 2-7). This layer of petroleum-related contamination on the historic shoreline, marshland, and tidal channels is today referred to as the "marsh crust." Recent efforts to "fingerprint" ten OU-5 soil samples indicate that the PAHs in the OU-5 soil came from Monterey Crude, the petroleum used for the manufactured gas plant (Battelle, 2000).

Dredge and fill events starting as early as 1887, are believed to have removed sediments from portions of Oakland Inner Harbor and San Francisco Bay that contained contaminants from the nearby industries. In addition, sediments containing contaminants from elsewhere in San Francisco Bay may also have been reused. Spoils from the dredging operations were used as fill material to create the majority of the landmass now occupied by OU-5 at Alameda Point (see Figure 2-1). In addition, historical photographs of early industrial operations show large piles of waste materials that suggest heavily contaminated waste. The waste materials might have been directly used as fill (IT, 1998). Subsequent dredge and fill operations conducted in the 1930s, contributed additional fill material to the southeastern portion of OU-5 (see Figure 2-1).

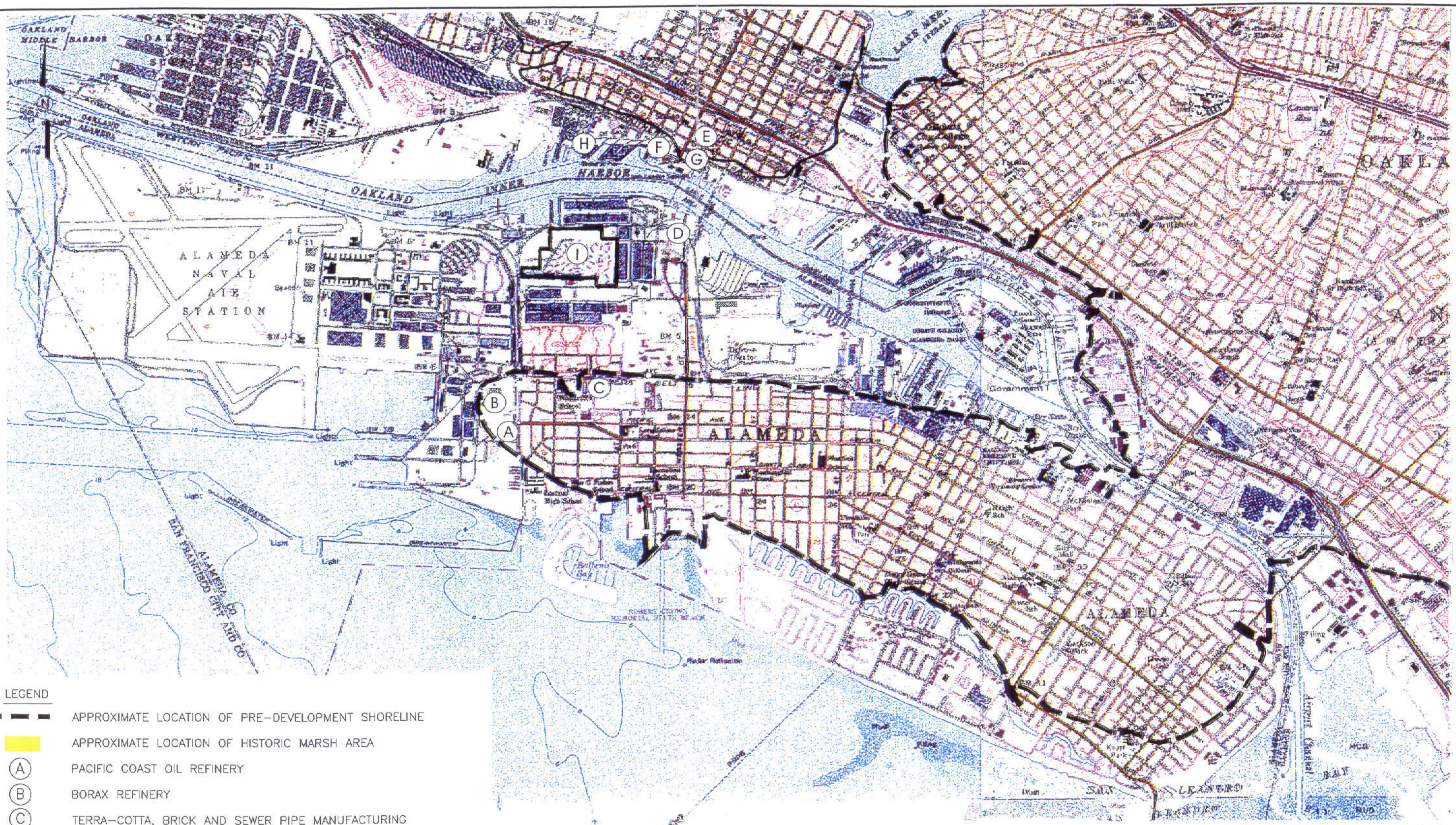
Investigations at Alameda Point have indicated that the fill material was deposited upon the marsh surface during filling operations. As described above, the fill material contained some chemical constituents that resulted from historical industrial waste disposal practices and the marsh surface itself contained high concentrations of PAHs and petroleum hydrocarbons (termed the "marsh crust"). The precise details of how the filling operation was conducted, remains unknown. However, it is likely that fill material was pumped over the old railroad mole, filling the area in the northern part of OU-5 (Parcel 182) followed by a gradual filling of the area now referred to as Parcel 181. Given that historical data indicate that PAH concentrations tend to increase at depth, it is apparent that the earlier fill material was more highly contaminated. The distribution of PAHs observed today would be explained by the earlier fill material coming from either the industrial waste piles and/or the old surface sediments dredged from the Oakland Inner Harbor (that presumably contained higher levels of PAHs from the gas manufacturing operations). In general, concentrations of PAHs in fill within the boundaries of OU-5 decrease from north to south-southeast and increase from the surface to depths approaching the surface of the historical marsh.

The mode of fill placement, as well as the differences in PAH concentrations in different fill materials, also contribute to observed patterns of PAH soil concentrations. As discussed above, higher concentrations of PAHs at depth at some locations reflect the fact that fill sources with higher levels of petroleum contamination were placed first, and then covered with fill from less contaminated areas. Small-scale spatial heterogeneity in historical PAH concentrations might be related to the presence of discrete pockets of petroleum-containing materials in the fill.

Based upon this model of the origin and placement of PAH-contaminated fill materials at OU-5, variability in the spatial concentrations of PAHs related to the origin of fill material was expected primarily at relatively large spatial scales. This expectation was based on the assumption that fill placement would result in mixing within each source of fill material and was substantiated by spatial patterns observed in the historical PAH data. However, within the large-scale patterns of PAH concentrations, sample-to-sample and within-sample variability in PAH concentrations was expected because the PAH content of a soil sample might be associated with relatively few discrete particles that are difficult to homogenize.

Sources other than the historic dredge and fill operations may also have contributed to the contamination observed at OU-5. For example:

- Historical information suggests that waste material from nearby early industrial operations could have been used directly as fill material for Alameda Point. This waste material would likely have been contaminated.



LEGEND

APPROXIMATE LOCATION OF PRE-DEVELOPMENT SHORELINE

APPROXIMATE LOCATION OF HISTORIC MARSH AREA

(A) PACIFIC COAST OIL REFINERY

(B) BORAX REFINERY

(C) TERRA-COTTA, BRICK AND SEWER PIPE MANUFACTURING

(D) ELECTRIC CAR MANUFACTURING

(E) MANUFACTURED GAS PLANT

(F) MALTHINE MANUFACTURING

(G) COAL BULK STORAGE

(H) NAIL MANUFACTURING

(I) OPERABLE UNIT 5 LOCATION

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 FEET

NOTE:
1. FIGURE COMPILED FROM U.S.G.S. TOPOGRAPHIC MAP OF OAKLAND EAST AND OAKLAND WEST QUANDRANGLES DATED 1959, PHOTOREVISED 1980 AND MISCELLANEOUS GEOLOGIC INVESTIGATIONS MAP I-298-"SHORELINE FEATURES ALONG THE EAST SIDE OF SAN FRANCISCO BAY "DATED 1959.
2. DIGITAL TOPO FROM TOPO @ 1996 WILDFLOWER PRODUCTIONS (www.topo.com)

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-7

HISTORIC FEATURES AND INDUSTRIES

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	---	Concord	BJ 11-11-02	12/4/02	JES 12/6/02	819814-B79

- A historic spill or release identified as a "stained" area in Figure 2-2 may be a potential source of localized contamination near the present-day intersection of Mayport Circle and Kollmann Circle. It has been reported that the "stain" was remediated (ERM-West, 1995); however, this has yet to be confirmed. If remediation was conducted, the timeframe between discovery of the release and initiation of the remediation, and the details of the remediation activities remains unclear. There is presently no visible staining in the area indicated on Figure 2-2.
- The identification of MTBE and certain chlorinated hydrocarbons present in some environmental samples indicates the potential for a recent spill or release that is not associated with historic industrial activities in the OU-5 area. This is based on the fact that these chemicals are of more recent manufacture than the fill events that created the portion of Alameda Point occupied by OU-5.

Although these additional sources may have contributed to contamination at OU-5, historic dredging operations and fill materials used to create the Alameda Point land surface are considered to be the principal origin of soil contamination at OU-5. As mentioned above, the source of groundwater contamination at OU-5 is unknown.

2.5 Historical Response Actions

Response actions have been performed in OU-5 to reduce the potential for exposure to PAHs in the soil. The responses included the installation of a fence around Estuary Park in November 1998 and a removal action that was performed in October 2000 to eliminate the potential for exposure of children using the play area to PAHs. Consensus with the need for the removal action was reached at an October 18, 2000, BRAC Cleanup Team meeting. Clover Park is located near the geographical center of the North Village Housing Area within OU-5 (Parcel 181) (Figure 2-8). The play area is 45 feet by 45 feet square, with 22.5-foot radius semicircles on each side. The play area is edged by a concrete berm and filled with imported sand.

Soil samples collected from the turf-covered area near Clover Park and within the play area itself, contained PAHs at concentrations exceeding a screening level suggested by DTSC of 0.62 mg/kg BaP-equivalent concentration for PAHs. This level corresponds to an excess lifetime cancer risk of 10^{-5} under a residential land-use scenario. Benzo(a)pyrene-equivalent concentrations in the area surrounding Clover Park were generally in the range of 1.7 to 5.6 mg/kg. Polynuclear aromatic hydrocarbons were detected in discrete soil samples collected from 0 to 0.5 feet bgs (with the turf or paving material and subgrade removed to establish "ground surface"), 1.5 to 2 feet bgs, 3.5 to 4 feet bgs, and 7.5 to 8 feet bgs. Based upon the presence of elevated PAH concentrations in soils at Clover Park and regular digging by children within the play area, the Navy determined that a potential threat to public health and welfare existed and that a removal action pursuant to Comprehensive Environmental Response, Compensation, and Liability Act Section 104(a) was appropriate in order to mitigate these threats.

In October 2000, soil within the play area was excavated to a depth of 4 feet, placed directly into trucks, covered, and transported off site to an approved landfill. An estimated 900 cubic yards of soil was removed. A high-density polyethylene liner was placed in the bottom of the excavation. Clean imported fill was placed from 4 feet bgs to 1.25 feet bgs, and compacted to 90 percent relative compaction. Pea gravel was then placed from 1.25 to 1 feet bgs. Fall zone material was placed from 1 foot bgs to final grade, by the Coast Guard, following installation of the new play structure.

2.6 Time-Critical Removal Action Activities

A risk management decision was made by the Navy to conduct a TCRA at Parcel 181 (North Village Housing Area) (Figure 2-9) during winter 2001 and spring 2002. The TCRA activities removed soils with elevated levels of PAHs to a depth of 2 feet bgs. The area was then backfilled with clean imported fill, top soil, and sod, and the excavated soils were disposed of at an off site disposal facility. The goal of the TCRA was to substantially eliminate the potential pathways of exposure to current onsite residents, construction workers, and possible ecological receptors. The area included in the TCRA and shown on Figure 2-9, was defined by identifying all contiguous housing complex areas where at least one near-surface sample was determine to have BaP-equivalent concentrations of 1.8 mg/kg or greater. The TCRA was expanded to include Parcels 182 and 183. The TCRA was completed in August 2002.

LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(thin line)	PARCEL BOUNDARY

SCALE

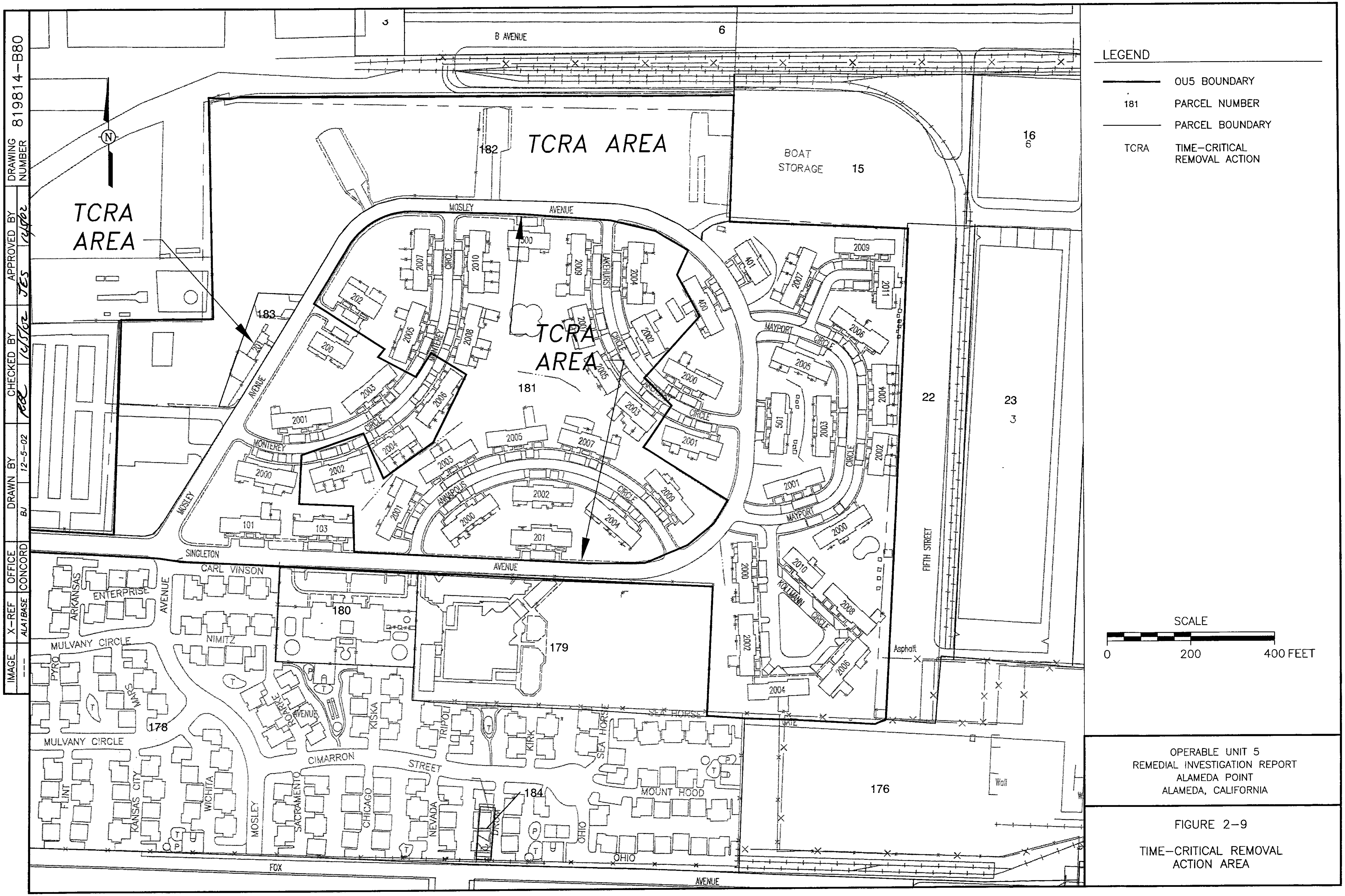
0 300 600 FEET

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-2-02	RA 12/2/02	JES 12/2/02	819814-B97

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-8

CLOVER PARK LOCATION MAP



OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 2-9

TIME-CRITICAL REMOVAL ACTION AREA

3.0 Remedial Investigation Field Activities

This section describes the procedures and protocol followed by IT Corporation (IT) and its subcontractors during implementation of the remedial investigation (RI) field activities. The main activities included:

- Plans and notification
- Mobilization activities
- Underground utility clearance
- Field sampling activities
  - Surface soil sampling
  - Soil boring drilling and sampling
  - Direct-push groundwater sampling
  - Groundwater monitoring well sampling
  - Soil gas sampling
- Decontamination procedures
- Boring abandonment
- Surveying
- Field documentation
- Field Quality Control (QC) Sampling and Data Validation
- Demobilization
- Investigation-derived waste (IDW) management and disposal.

Initial field activities started on May 17, 2001, with sample location marking, and concluded on June 19, 2001. Additional supplemental soil sampling activities were also conducted and included collecting confirmation samples near sample location OU5-178 and collecting samples at the Miller Elementary School (Parcel 179) and Alameda Child Development Center (Parcel 180). The supplemental activities were conducted on September 26, 2001 and October 13, 2001, respectively.

The activities performed as part of this RI were conducted in accordance with the RI Work Plan (Neptune and Company, 2001) and the IT Standard Quality Procedures and Standard Operating Procedures (SOP) Manual (IT, 2000), which were provided in Appendix H of the RI Work Plan

(Neptune and Company, 2001). Remedial Investigation field activities are described in detail in the following subsections.

3.1 Plans and Notification

Planning and agency notification were key steps in preparing for field activities. Planning activities for the RI consisted of meetings with the regulatory agencies, Restoration Advisory Board, and the Navy. Additionally, the Alameda County Public Works Agency, Water Resources Section, and Alameda Unified School District were notified prior to starting the sampling activities.

3.2 Mobilization Activities

Mobilization activities included:

- Obtaining equipment and materials
- Procuring the services of subcontractors
- Conducting an initial and preparatory phase inspection with the Navy
- Conducting preparatory phase inspections with the subcontractors
- Marking boring locations.

The preparatory phase inspections were held to discuss equipment inspection, project scope, health and safety requirements, field procedures, submittals, and QC protocols.

Equipment inspections were performed and documented by IT personnel prior to onsite use to verify that the subcontractor's equipment and tools were in good working order, were not chemically contaminated, and that no equipment leaked oil, grease, or hydraulic fluid.

3.3 Underground Utility Clearance

On May 17 and 18, 2001, proposed soil, groundwater, soil gas, and corehole boring locations for the field activities were marked by IT representatives on the ground using water-resistant paint. Representatives from the U.S. Environmental Protection Agency (EPA) and Department of Toxic Substances Control (DTSC) were present during the marking activities and aided in revising some of the sample locations. Once the sampling locations were marked, Underground Services Alert was notified and they marked the street and sidewalk prior to starting intrusive activities.

On May 22, 2001, land-surface utility clearances were started by an IT subcontractor, Subtronic Corporation, to locate subsurface drilling hazards in the vicinity of the proposed sample locations. A 10-foot radius was cleared around each of the proposed sampling location. The subcontractor marked each cleared sampling location with paint immediately upon clearing it. All suspected underground utilities, conduits, and structures were also marked at the surface with color-coded marking paint. When the locator determined there was a potential for interference from an underground utility, the proposed boring location was moved to a nearby location and cleared. Utility clearance was completed on May 29, 2001 and prior to intrusive activities. During drilling activities, no underground utilities were encountered.

3.4 Field Sampling Activities

Field sampling activities consisted of collecting subsurface soil, groundwater, and soil gas samples at Parcels 172 through 176, 178 through 182, and 184, and the Alameda Annex area. The sampling design for collection of soil, groundwater, and soil gas samples is described in Section 5.2 of the RI Work Plan (Neptune and Company, 2001). The design for soil sampling included sampling each housing area by collecting soil from three depth intervals (0 to 0.5, 0.5 to 2, and 2 to 4 feet below ground surface [bgs]) where exposure to current residents was considered most probable. The "housing area" was a discrete area that encompassed housing complexes (the actual residences), their surrounding front and back yards, and the open space between the housing complexes. The sampling design also included soil sample collection from the 4 to 8 foot bgs depth interval, at a lower sampling density. Sampling and analysis results from this depth interval were to be used to support the evaluation of risk due to future redevelopment of the area that might involve digging and mixing soils from this deeper interval. Soil samples were not collected at depths greater than 8 feet bgs because groundwater is present at that depth.

During RI planning, a decision was made to obtain metals analyses on a subset of samples collected during the RI. The metals data would be used to confirm the assumption that metals in soils were generally not elevated across Operable Unit (OU) 5.

Analysis of historical groundwater data indicated the presence of a plume of volatile organic compounds (VOC) and semivolatile organic compounds, including benzene, in the southern portion of OU-5. To better define the extent of contaminated groundwater, and to support the evaluation of exposure to VOCs in indoor air, collection of groundwater and soil gas samples was planned at locations that were intended to bound the plume. Soil gas data were also intended to provide an indication of whether VOCs in groundwater were migrating into soil gas and potentially affecting indoor air.

3.4.1 Soil Remedial Investigation Activities

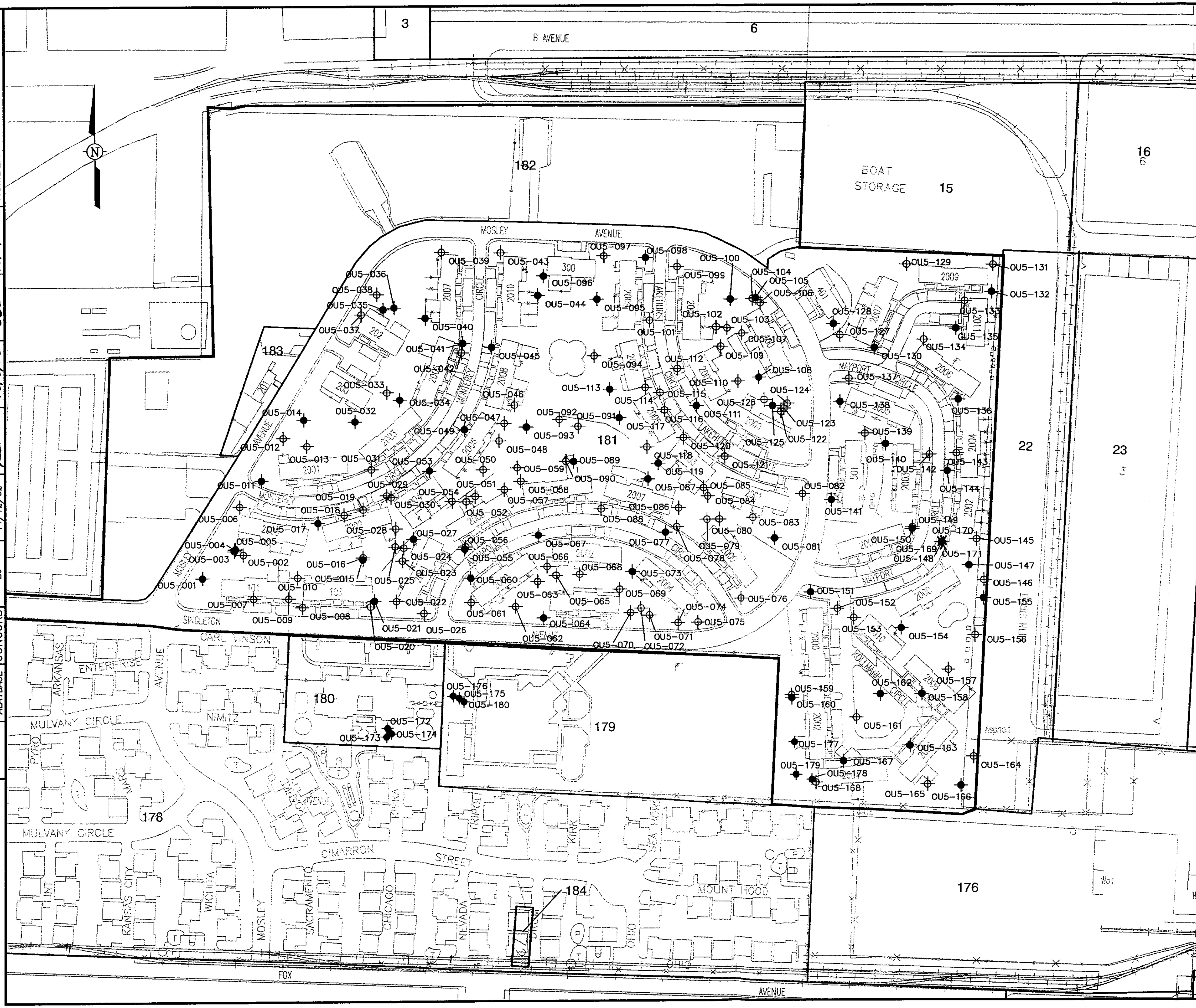
The following sections discuss the soil RI activities. The results of the soil sampling and analysis are presented in Section 4.1.

3.4.1.1 Soil Characterization Activities

One hundred sixty-eight soil boring locations on Parcel 181 (Figure 3-1) were drilled using direct-push drilling techniques. Soil samples were collected into a soil sampler comprised of a 2-inch outside diameter and 48-inch long acetate liner. The direct-push drilling method primarily used the weight of the drill rig to push the sampling tool into the soil. When the weight of the drilling rig could not advance the sampling tool, the sampling tool was then driven using a hammer. Once the required sampling depth was reached, the sampler was retrieved and the acetate sleeve containing the soil sample removed. Samples were collected from 0 to 0.5 feet bgs, 0.5 to 2 feet bgs, 2 to 4 feet bgs, and 4 to 8 feet bgs. The samples were obtained by removing the appropriate soil intervals from the 48-inch sampler liners and homogenizing the soil using the method described in Appendix C of the RI Work Plan (Neptune and Company, 2001). A summary of the process is as follows:

- The drive tube was advanced into the subsurface, forcing soil into the attached acetate liner. Following sampling of the zone of interest, the drive tube with the soil sample was pulled out of the borehole.
- The acetate liner was removed from the drive tube and cut open. The soil within the liner was examined and described, thereby generating a boring log for each boring. Copies of the boring logs are provided in Appendix E. Additionally, photographs of the corehole and soil boring cores were taken and are included in Appendices H and I on compact disk.
- Grass, roots, and slough at the top of the liner were removed, and the soil from the applicable sample depths was transferred to a decontaminated stainless-steel bowl. The start of the sample or "zero" depth was below the discarded grass and root zone. Rocks, debris, and plant material were removed from the sample.
- The sample material was homogenized by thoroughly mixing the soil in the decontaminated stainless-steel bowl. The soil was then divided into four equal portions, and the two opposite portions were discarded into U.S. Department of Transportation-approved 55-gallon steel drums. Contents of these drums were appropriately characterized and disposed. The remaining portions were further homogenized and then placed in prelabeled glass sample jars.
- The glass sample jars were completely filled to provide the maximum amount of material for laboratory usage.

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11/12/02	12/2/02	JES 12/2/02	819814-B40



LEGEND

- OU5 BOUNDARY
- 181 PARCEL NUMBER
- PARCEL BOUNDARY
- X OU5-169 SOIL SURFACE LOCATION (0-0.5 FT. BGS)
- OU5-139 SOIL BORING LOCATION (0-4 FT. BGS)
- OU5-138 SOIL BORING LOCATION (0-8 FT. BGS)

SCALE

0 200 400 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 3-1

SOIL BORING LOCATIONS

- The samples were then packaged, prepared, and shipped to the laboratory in accordance with IT SOP 1.1 "Chain of Custody," IT SOP 2.1 "Sample Handling, Packaging, and Shipping," and Appendix C of the RI Work Plan (Neptune and Company, 2001).

Five hundred fifty-nine samples composited over each of the four depth intervals described above were collected from the 168 borings (Appendix J) and analyzed for polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8310. Five hundred sixty-four samples were planned. Two samples were not collected because there was no soil recovered from the depth interval and three samples were incorrectly sent to archive.

One hundred forty-three samples were collected from 60 borings and analyzed for metals by EPA Method 6010B, arsenic by EPA Method 7060A, and cyanide by EPA Method 9010. There were 150 samples planned (60 samples from the 0 to 0.5 foot bgs interval and 30 samples each from the 0.5 to 2, 2 to 4, and 4 to 8 foot bgs intervals). Two samples were not analyzed because the request for metals analysis was inadvertently left off of the chain-of-custody record, and five samples were mistakenly archived rather than analyzed.

Samples for geotechnical analysis were collected from soil borings in which a continuous soil core was retrieved as described in Section 3.4.2. Samples were collected from coreholes CH-1 through CH-6 and coreholes CH-8 through CH-10 (Figure 3-2). Samples were collected at approximately 2 feet and 7 feet bgs, to correspond with the depth interval of the collected soil gas samples (Section 3.4.3). A sample of the collected soil was obtained by cutting an approximate 0.5 feet-long section of the acetate liner and sealing the ends with Teflon®, plastic caps, and tape. The samples were labeled, packaged, and prepared for shipment to the laboratory in accordance with IT SOP 1.1 "Chain of Custody," IT SOP 2.1 "Sample Handling, Packaging, and Shipping," and Appendix C of the RI Work Plan (Neptune and Company, 2001). Samples were sent to the IT San Jose, California geotechnical testing laboratory for analysis. Analyses performed were permeability by American Society for Testing and Materials (ASTM) Method D5084, density by ASTM D1557, moisture content by ASTM D2216, and grain size by ASTM D2487. The ASTM Method D5084 for permeability was substituted for ASTM Method D6539. American Society for Testing and Materials Method D1556 for density was specified in the RI Work Plan (Neptune and Company, 2001); however, this was a field measurement method using a sand cone and was an inappropriate method for this study. Therefore, ASTM Method D1557 for laboratory determination of density was used.

Samples for total organic carbon analysis were collected from soil obtained immediately above the geotechnical sampling depth intervals and were placed in labeled 8-ounce glass jars. The samples were packaged and shipped to the laboratory in accordance with IT SOP 1.1 "Chain of Custody," IT SOP 2.1 "Sample Handling, Packaging, and Shipping," and Appendix C of the RI Work Plan (Neptune and Company, 2001). Samples were analyzed for total organic carbon using EPA Method 9060.

Following completion of the initial RI soil sampling activities in June 2001, supplementary sampling activities were conducted east of the asphalt parking lot (east of Miller Elementary School), at the Miller Elementary School, and at the Alameda Child Development Center (Figure 3-3). These samples were not planned in the RI Work Plan (Neptune and Company, 2001) but were deemed necessary after review of the data and to provide information about PAH concentrations in soil in the unpaved portions of the Alameda Unified School District Facilities. Three surface soil samples (OU5-169, -170, and -171) were collected for PAH analysis by EPA Method 8310 from 0 to 0.5 feet bgs near soil boring OU5-148 (see Figure 3-1). These samples were collected to evaluate the small-scale heterogeneity of PAH concentrations. These samples were collected approximately 5, 7.5, and 10 feet laterally from boring OU5-148.

Soil samples for PAH analysis were collected at nine locations at and near the vicinity of the Miller Elementary School (Parcel 179) and Alameda Child Development Center (Parcel 180). Sampling was attempted at the 0 to 0.5-foot bgs, 0.5 to 2-foot bgs, 2 to 4 foot bgs, and 4 to 8 foot bgs depth intervals using hand-augering sampling methods. However, it was not possible to collect samples from every interval due to sampler refusal upon encountering hard soils. Table 3-1, "Sampling Intervals for Soil Samples Collected at Miller Elementary School and Alameda Child Development Center," lists the sampling depth intervals for each boring completed for this additional sampling. The soils were placed in 8-ounce glass jars and labeled, packaged, and shipped to the laboratory in accordance with IT SOP 1.1 "Chain of Custody" and IT SOP 2.1 "Sample Handling, Packaging, and Shipping." Samples were analyzed for PAHs using EPA Method 8310.

3.4.2 Groundwater Remedial Investigation Activities

The following discusses the groundwater RI activities. The results of the groundwater RI activities are presented in Section 4.2.

Fourteen continuous coreholes were drilled in Parcel 181 and 15 continuous coreholes were drilled in Parcels 172 through 176, 178, and 182 (see Figure 3-2). The coreholes were advanced to total depths of between 20 and 24 feet bgs using direct-push drilling methods. Thirty coreholes were originally planned; however; corehole CH-7, located within the Miller Elementary School schoolyard, was not drilled to minimize intrusive activities at the schoolyard.

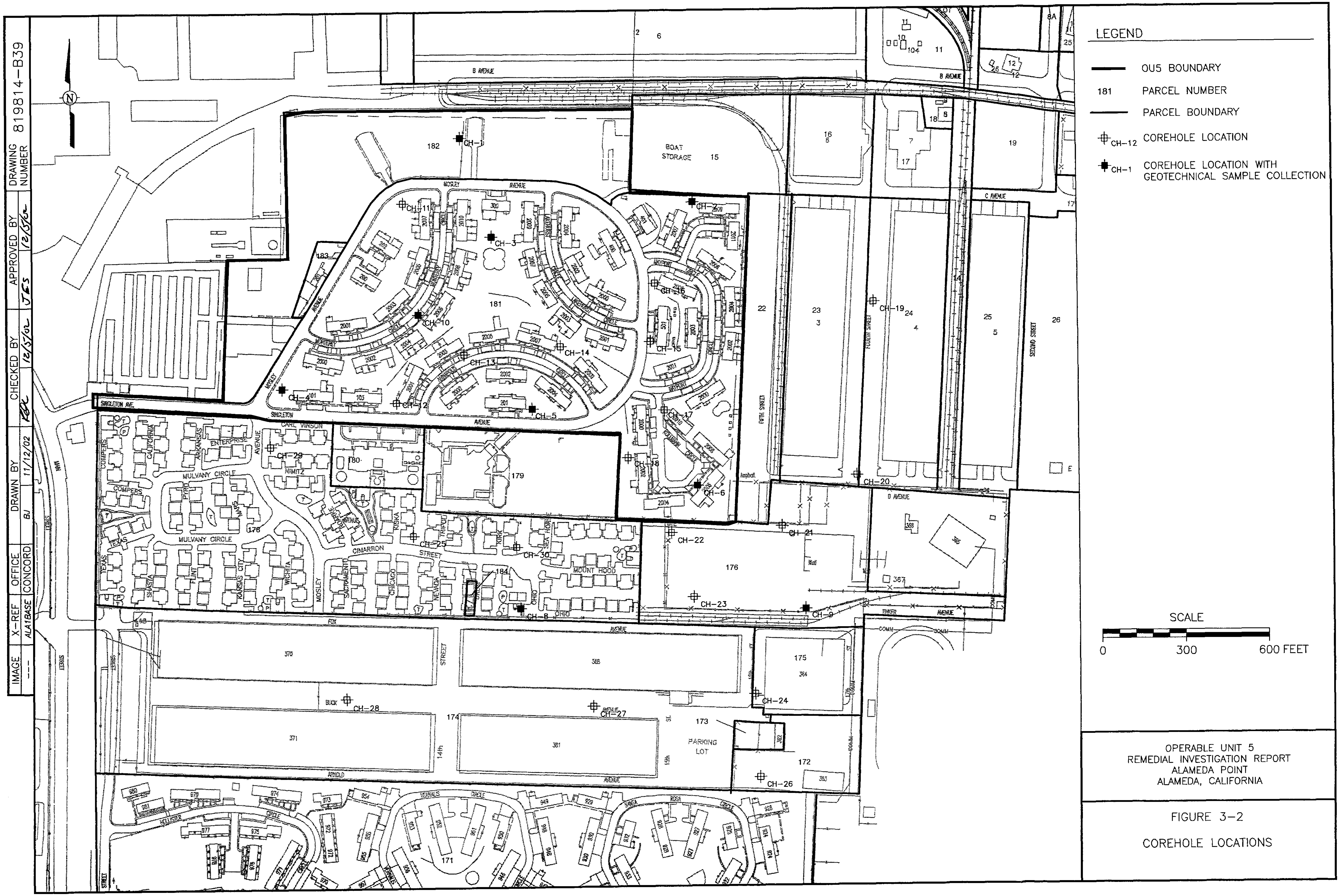
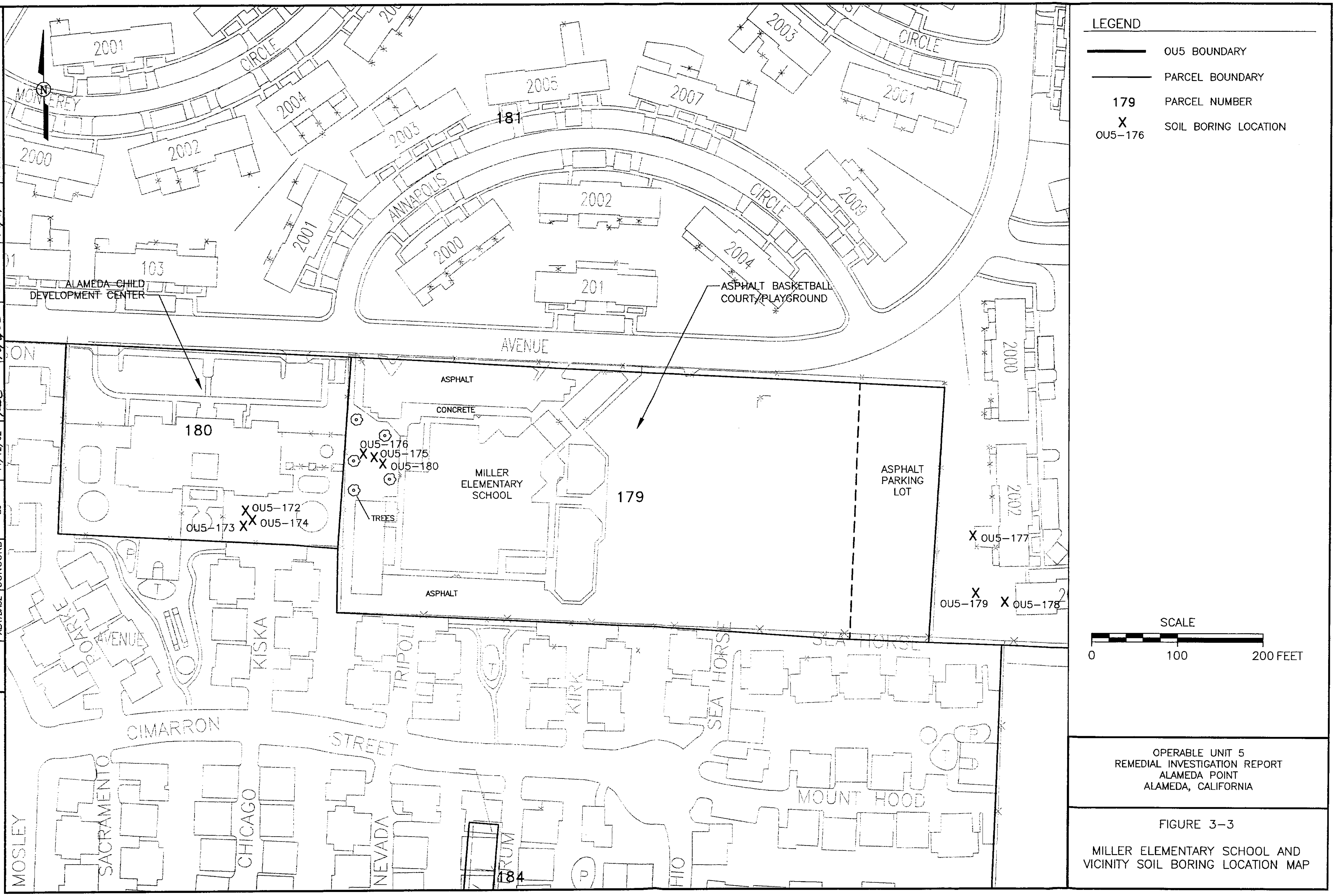


FIGURE 3-2

COREHOLE LOCATIONS



OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 3-3

MILLER ELEMENTARY SCHOOL AND VICINITY SOIL BORING LOCATION MAP

DRAWING NUMBER 819814-B63
APPROVED BY
CHECKED BY
DRAWN BY BJ 11/12/02
OFFICE CONCORD
X-REF ALA1BASE
IMAGE ---

Table 3-1
Sampling Intervals for Soil Samples Collected at Miller Elementary School and Alameda Child Development Center

Boring	Sample Depth Intervals (feet below ground surface)			
	0 to 0.5	0.5 to 2	2 to 4	4 to 8
OU5-172	X	X	No Sample	No Sample
OU5-173	X	X	X	X
OU5-174	X	X	X	No Sample
OU5-175	X	No Sample	No Sample	No Sample
OU5-176	X	No Sample	No Sample	No Sample
OU5-180	X	No Sample	No Sample	No Sample

X denotes soil sample collected from this depth interval.

The lithologic and stratigraphic information from other nearby coreholes (see Figure 3-2) was similar. Therefore, it was determined that data from corehole CH-7 was not required.

Twenty-three direct-push groundwater locations were drilled and sampled (or attempted to be sampled) in Parcel 181 and 38 locations in Parcels 172 through 176, 178 through 180, and 182 and the Annex area (Figure 3-4). Based on the lithologic and stratigraphic correlations, and the depth to groundwater observed in the coreholes, four 4-foot long sampling intervals were targeted for sample collection. The sample intervals were to target the capillary fringe, an intermediate zone, the top of the marsh crust, and the top of the Bay Sediment Unit (BSU). The four intervals were approximately 8 to 12 feet bgs, 12 to 16 feet bgs, 16 to 20 feet bgs, and 20 to 24 feet bgs. However, many of the intervals were not sampled due to lack of water or very low productivity because of an abundance of fine-grained material in the target interval.

Groundwater samples from the direct-push sampling locations were obtained using the method described in Appendix C of the RI Work Plan (Neptune and Company, 2001). A summary of the process is as follows:

- The sampler was advanced into the targeted water zone and the drive rods were retracted to partially expose the sampler screen.
- The groundwater sample was collected using a peristaltic pump attached to new, clean Teflon® tubing, which was lowered through the drive rods into the sampler screen. As the groundwater infiltrated the sampler screen, the peristaltic pump moved the groundwater to the surface.
- Prior to collecting the sample, a minimum of three sample tubing volumes of groundwater were removed to attempt to remove as much silt as possible from the water to reduce sample turbidity.
- The samples were then collected directly into sample bottles. The sample bottles were completely filled in the following order for analysis, VOCs, methane, PAHs, sulfate, nitrate, total sulfide, and alkalinity.
- The remaining depth intervals in the boring were sampled in a similar manner following advancement of the drive rods to the depth of interest.
- The samples were labeled, packaged, and shipped to the laboratory in accordance with IT SOP 1.1 "Chain of Custody," IT SOP 2.1 "Sample Handling, Packaging, and Shipping," and Appendix C of the RI Work Plan (Neptune and Company, 2001).

In general, a sufficient volume of water for sampling was available only from the two middle intervals (12 to 16 feet bgs and 16 to 20 feet bgs), which were predominantly fine-grained to silty sands. In some cases, in the southern portion of the study area, no samples could be collected due to a predominance of silt and clay at all sample intervals.

The objective of the groundwater investigation was to sample the groundwater in the shallow water-bearing zone (i.e., Fill Unit), which consisted of medium to very fine-grained sands, silts, and clays. The shallow water-bearing zone is not considered a regional aquifer. Samples were not obtained from the BSU or Marsh Crust. Groundwater was first encountered between 6 and 8 feet bgs.

Nine of 11 existing groundwater monitoring wells in the OU-5 area were sampled.
Well PW-10A could not be sampled due to an obstruction in the well casing, which prevented the pump from being lowered into the well. In addition, Well S-2 was not sampled because it was not completed in the first water-bearing zone. When initial water-level measurements were collected, the bottom of Well S-2 could not be tagged using a 100 foot long measuring tape. Upon reviewing well logs, the bottom of the well was found to be 115 feet bgs and the well was completed in the Merritt Sand Formation (i.e., the second water-bearing zone).

Groundwater samples were collected from monitoring wells using the methods described in Appendix C of the RI Work Plan (Neptune and Company, 2001). A summary of the process is as follows:

- Depth to water was measured prior to placing the pump in the well.
- A decontaminated submersible pump was then lowered into the well and the base of the pump was set approximately 2 feet above the bottom of the well.
- Three well volumes were purged from the well, during which pH, specific conductivity, temperature, turbidity, dissolved oxygen, and oxidation-reduction potential were monitored (using a flow-through cell) and recorded. Purging was considered complete following the removal of three well volumes of water or the stabilization of the field measured parameters.
- The samples were then collected directly into glass sample bottles. The sample bottles were completely filled in the following order for analysis, VOCs, methane, PAHs, sulfate, nitrate, total sulfide, and alkalinity.
- The samples were labeled, packaged, and shipped to the laboratory in accordance with IT SOP 1.1 "Chain of Custody," IT SOP 2.1 "Sample Handling, Packaging, and Shipping," and Appendix C of the RI Work Plan (Neptune and Company, 2001).

LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(line)	PARCEL BOUNDARY
+ OS-HP24	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
△ S-35	MONITORING WELL LOCATION
⊕ OS-HP24	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION SAMPLED FOR NATURAL ATTENUATION PARAMETERS

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 3–4

GROUNDWATER SAMPLING LOCATIONS

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALATBASE	CONCORD	BJ 11/13/02	12/5/02	JES 12/5/02	819814-B36

Appendix J provides a summary of the monitoring wells sampled and the analyses completed. Complete discussions of the Hydropunch® and monitoring well groundwater analytical results are provided in Section 4.0.

3.4.3 Soil Gas Remedial Investigation Activities

The following sections discuss the soil gas RI activities. The results of the soil gas investigation are presented in Section 4.3.

3.4.3.1 Soil Gas Characterization Activities

Forty-two soil gas samples (Appendix J) were collected from two sampling intervals at 32 soil gas sampling locations shown on Figure 3-5. All soil gas sampling locations, except OU-5-SG8 and OU5-SG15, were located adjacent (within 5 feet) to a groundwater sampling location (Table 3-2, "Co-Located Direct-Push Groundwater Sampling Locations and Soil Gas Locations"). Samples were collected at 2 feet bgs and at approximately 5 to 7 feet bgs. The RI Work Plan called for sampling at the capillary fringe (approximately 8 feet bgs); however, saturated soil conditions were encountered at this depth. Several attempts to collect samples from 6 and 7 feet bgs were made; however, only one attempt was successful due to saturated soil conditions. Limited soil gas sampling success was obtained at 5 feet bgs.

Soil gas samples from the 2 foot bgs sampling horizon were obtained at 31 of 32 sampling locations. Of the 31 samples collected, one sample (OU5-SG10) could not be analyzed. An obstruction in the canister valve prevented extraction of the sample. Soil gas samples from the deeper sampling horizon were obtained from 11 of the 32 locations (Appendix J). The primary factor preventing sample collection was wet soil conditions. In particular, this occurred within Parcel 181 where the lawns are heavily watered, and much of the excess water infiltrates through the soil column.

Soil gas samples were collected using the methods described in Appendix C of the RI Work Plan (Neptune and Company, 2001). A summary of the process is as follows:

- Sampler was advanced to each selected sampling depth and the probe rods were retracted by pulling up the drive pipe, thereby exposing the sampling screen.
- A Tygon® sampling tube was inserted in to the drill string and set at the screen.
- The tubing was secured properly and checked for leakage to ensure no dilution of samples occurred.
- A peristaltic sample pump was used to purge the sample tubing of approximately three volumes prior to collecting a soil gas sample.

- The sample tubing was connected to a 6-liter Summa® canister, and the regulator valve was opened.
- The vacuum of the Summa® canisters was recorded before sampling to ensure no dilution was caused by leakage in transit to the site.
- An approximate 5-inch mercury vacuum was maintained in the canister after sampling. The exact vacuum remaining was recorded on the chain-of-custody form.

Following collection of a vapor sample, the drive tube was advanced to the next deeper sampling depth, where the sampling procedure was repeated. All samples were submitted to the laboratory for VOCs and naphthalene analysis by EPA Method TO-15. The RI Work Plan specified that soil gas be analyzed by EPA Method TO-14A (Neptune and Company, 2001). However, EPA Method TO-15 was used because it is an update of the TO-14A method. Soil gas analytical results are presented in Appendix D.

3.5 Decontamination Procedures

Decontamination of non-disposable sampling equipment that came in contact with samples (i.e., stainless-steel bowls or hand trowels, Hydropunch® well screen, submersible pump) was performed according to IT SOP 6.1 "Sampling Equipment and Well Material Decontamination" (IT, 2000) to prevent the introduction of extraneous material into samples, and to maintain sample integrity.

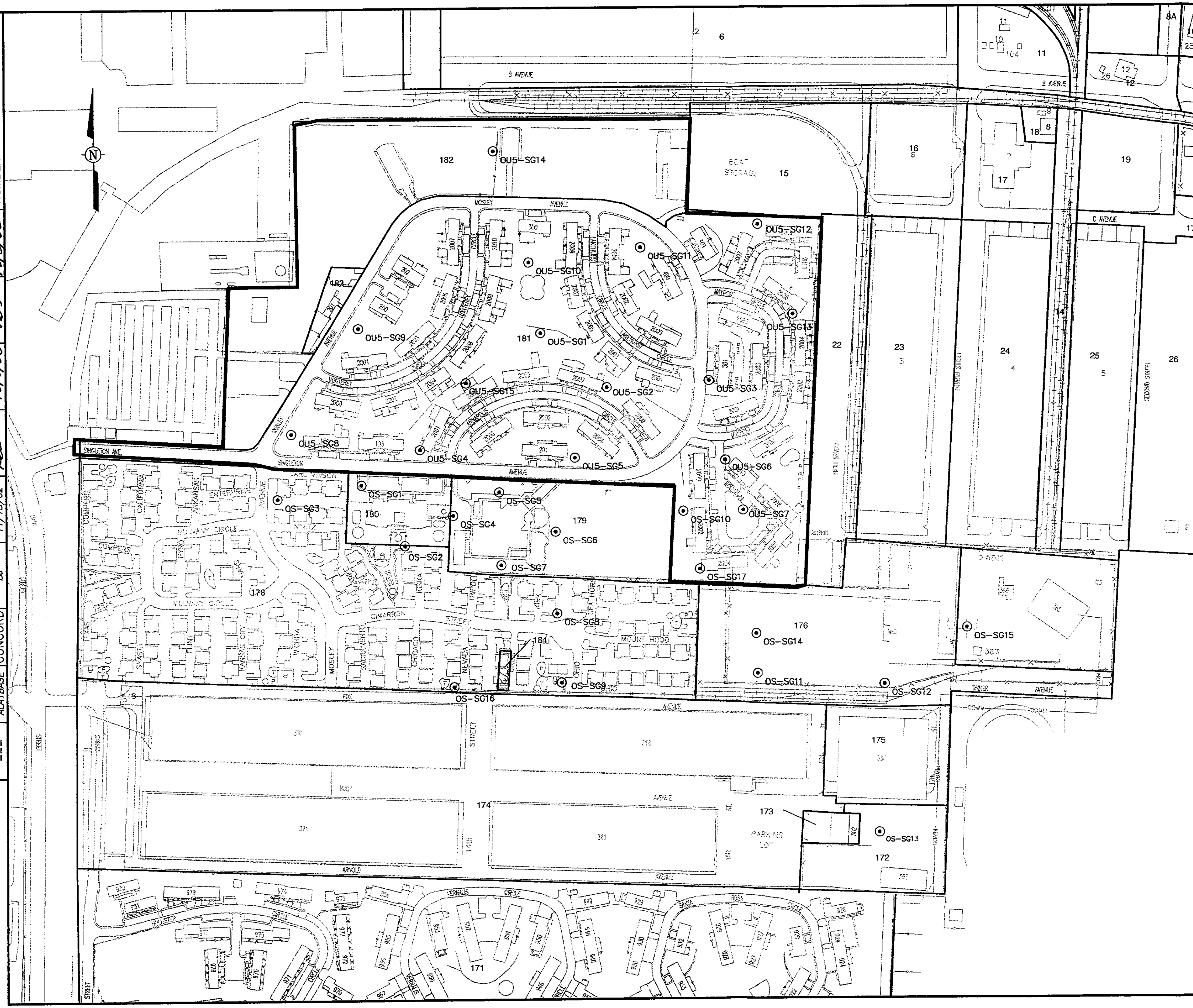
The following steps were followed for decontamination of non-disposable sampling equipment that came in direct contact of the samples:

- Rinse with potable water
- Wash with the nonphosphate detergent and water solution
- Rinse with potable water to remove detergent
- Rinse with analyte-free deionized water to remove residues in potable water
- Air dry.

All non-disposable sampling equipment that did not come in direct contact with the samples and drill rods were decontaminated by washing with a nonphosphate detergent (Liquinox™) and rinsing with distilled water.

Decontamination water was collected in U.S. Department of Transportation-approved containers and stored at Building 112 pending sample collection for waste profiling and subsequent disposal (Section 3.11).

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11/13/02	RA 12/4/02	JES 12/3/02	819814-B35



LEGEND

OU5 BOUNDARY

181 PARCEL NUMBER

PARCEL BOUNDARY

⊙ OU5-SG3 SOIL GAS SAMPLING LOCATION

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 3-5

SOIL GAS
SAMPLING LOCATIONS

Table 3-2
Co-Located Direct-Push Groundwater Sampling Locations and Soil Gas Sampling Locations

Direct-Push Groundwater Sample Location	Soil Gas Sample Location
OU5-HP1	OU5-SG1
OU5-HP9	OU5-SG2
OU5-HP11	OU5-SG3
OU5-HP4	OU5-SG4
OU5-HP8	OU5-SG5
OU5-HP12	OU5-SG6
OU5-HP13	OU5-SG7
OU5-HP14	OU5-SG9
OU5-HP17	OU5-SG10
OU5-HP18	OU5-SG11
OU5-HP20	OU5-SG12
OU5-HP21	OU5-SG13
OU5-HP22	OU5-SG14
OS-HP2	OS-SG1
OS-HP3	OS-SG2
OS-HP1	OS-SG3
OS-HP6	OS-SG4
OS-HP7	OS-SG5
OS-HP8	OS-SG6
OS-HP9	OS-SG7
OS-HP21	OS-SG8
OS-HP20	OS-SG9
OS-HP10	OS-SG10
OS-HP17	OS-SG-11
OS-HP14	OS-SG12
OS-HP39	OS-SG13
OS-HP35	OS-SG-14
OS-HP4	OS-SG15
OS-HP22	OS-SG16
OS-HP37	OS-SG17

Note: No soil gas and hydropunch samples were collected from the same boring. Co-located means the soil gas and direct-push locations were laterally within 5 feet of each other.

3.6 Boring Abandonment

All drilled coreholes, soil borings, direct-push groundwater borings, and soil gas borings were abandoned after sampling. Abandonment activities were conducted per applicable State of California procedures (CDWR, 1990). On a daily basis, all borings were grouted to the surface with a 5 percent bentonite-cement slurry. Grout was slowly poured by hand into the hole according to procedures described in the RI Work Plan (Neptune and Company, 2001). The grout was allowed to settle a minimum of 24 hours, then checked and topped off if required.

3.7 Surveying

Each corehole, soil boring, direct-push groundwater borings, and soil gas boring location was surveyed following sampling under the supervision or direction of a State of California Registered Land Surveyor. Ground surface elevations for each point were determined to the nearest 0.01 foot. The horizontal coordinates of each survey point were also surveyed to the nearest 0.1 foot and referenced to the North American Datum 83, California State Plane Coordinate System Zone 3. Vertical elevations were based on the National Geodetic Vertical Datum of 1929 (NGVD29) as adjusted by the National Geodetic Survey in June 1991 and converted to NGVD29. The horizontal and vertical measurements were referenced to established permanent control monuments.

3.8 Field Documentation

Field documentation was prepared daily and maintained on site. Field documentation consisted of Daily Contractor Production Logs, Field Activity Daily Logs, Daily QC Reports, Chains of Custody, Sample Collection Forms, and Equipment Inspection Logs. Copies of completed field documentation are provided on compact disk as Appendix F.

Boring logs were prepared for each boring and corehole and are provided in Appendix E. Munsell soil color charts were also added to the soil descriptions. Digital color photographs were taken of the soil boring and corehole cores. These photographs are provided as Appendices H and I on compact disk.

3.9 Field Quality Control Sampling and Data Validation

Field QC samples were collected and analyzed during the project to assess the consistency and performance of the sampling program. Field QC samples for this project included field duplicates, matrix spike/matrix spike duplicates (MS/MSD), trip blanks for VOC analyses, rinsate blanks, and temperature blanks.

Field duplicate pairs consisted of two samples of the same matrix (a primary and a duplicate) collected at the same time and location (to the extent possible), using the same sampling techniques. The purpose of the field duplicate samples was to evaluate the precision of the overall sample collection and analysis process. Field duplicate samples were only obtained for the soil borings and groundwater monitoring wells. No field duplicates were collected for the direct-push groundwater samples. Fifty-five field duplicate samples for the subsurface soils and two duplicate samples for the groundwater monitoring well samples were collected and were analyzed for the same analytes as the corresponding original samples. Note that only 54 of the 55 field duplicate samples for the subsurface soils were analyzed, as one sample was lost.

In addition to field duplicates, 27 MS/MSD samples of the subsurface soils and one MS/MSD sample from the groundwater monitoring well sampling were analyzed. Two equipment rinsate samples from the soil sampling and one from the monitoring well sampling were analyzed for the same analytes as the corresponding original samples. The field duplicate, MS/MSD, and equipment rinse blank sample numbers are provided in Appendix J for the soil and monitoring well samples. The analytical results of these samples are provided on the respective analytical table in Appendix D.

Soil and groundwater data were validated using EPA Level III data validation protocols. The soil gas data and geotechnical data were not validated. The results of the data validation were incorporated into the data tables provided in Appendix D. Copies of the laboratory validation reports are provided as Appendix G on compact disk.

3.10 Demobilization

Demobilization consisted of the subcontractors and IT cleaning up work areas after completion of sampling activities. The work areas were left in a condition similar to that existing before the work commenced. Additionally, IT completed a survey to verify that the subcontractor's equipment had not leaked any oil, grease, or hydraulic fluid during site activities and that all borings, coreholes, direct-push groundwater sampling points, and soil gas points were properly abandoned.

3.11 Investigation-Derived Waste Management and Disposal

All IDW, soil and water, were containerized in 55-gallon drums at the Building 112 storage yard pending results of analyses for waste profiling. Analytical results determined that the soil was a non-hazardous solid waste. Other solid materials, which consisted of gloves, sampling materials, liners, and sample tubing were also determined to be non-hazardous solid waste. One drum of liquid decontamination water possessed a high pH resulting in its classification as a corrosive under State of California, but not under EPA, regulations. Therefore, it was determined to be a California-only hazardous waste – unspecified alkaline liquid and was transported under a signed hazardous waste manifest to Chemical Waste Management, Inc.'s Kettleman Hills Facility in Kettleman City, California. The remaining water was determined to be non-hazardous. All non-hazardous solid waste and non-hazardous, non-sewerable water was transported under a signed non-hazardous waste manifest to Altamont Landfill. All manifests were signed, copied, and filed by the Navy's Caretaker Site Office representative. Table 3-3, "Investigation-Derived Waste Disposition," presents the disposition of the IDW.

This page intentionally left blank.

Table 3-3
Investigation-Derived Waste Disposition

Waste Stream	Number of Drums	Analysis Performed	Quantity	Transportation, Storage, and Disposal Facility	Profile Number
Caustic water drum	1	TPH (EPA Method 8015) VOC (EPA Method 8260) CAM 17 Metals (EPA Method 6010B) SVOC (EPA Method 8270) Reactivity (EPA SW-846, Chapter 7) Corrosivity (EPA Method 9045C) Ignitability (EPA Method 1010/1020)	22 gallons	Chemical Waste Management, Kettleman Hills	EB-3175
Non-hazardous, non-sewerable water	23		1,035 gallons	Altamont Landfill	54996900
Soil cuttings	5	TPH (EPA Method 8015) VOC (EPA Method 8260) PCB (EPA Method 8082) PAH (EPA Method 8310) CAM 17 Metals (EPA Method 6010B) Reactivity (EPA SW-846, Chapter 7) Corrosivity (EPA Method 9045C) Ignitability (EPA Method 1010/1020)	2,400 pounds	Altamont Landfill	54985800
IDW Debris	17	Analysis Performed	1,400 pounds	Altamont Landfill	54985900

IDW denotes Investigation-Derived Waste
CAM denotes California Assessment Manual
PCB denotes polychlorinated biphenyls
SVOC denotes semivolatile organic compounds
TPH denotes total petroleum hydrocarbons
VOC denotes volatile organic compounds
PAH denotes polynuclear aromatic hydrocarbons
EPA denotes U.S. Environmental Protection Agency

4.0 Nature and Extent of Contamination

This section provides an evaluation of the data collected during the remedial investigation (RI). This includes a description of the geology and the subsurface distribution of chemical constituents in soil and groundwater at the site.

Subsurface soils consist of heterogeneous mixtures of fine sand, silt, and clay with sporadic occurrences of angular crushed rock in the upper few feet. Five cross sections were prepared based on boring logs from the 29 coreholes drilled during the RI (Figure 4-1). The five cross sections (Figures 4-2 through 4-6) illustrate the general lithology of the subsurface soils. The upper 20 feet are dominated by fill consisting of poorly to well graded sands and silty sands with silt and clay lenses and some correlatable silt and clay beds. Across much of the study area, a zone of discontinuous silty clay to clay (CL, OH, CH, and OH) lenses is found at approximately 4 feet to 6 feet below ground surface (bgs) (Figure 4-2). Below this is a predominantly sandy zone down to 20 feet bgs across much of the study area. However, in the southern portion of the study area, such as in Parcels 172 through 175 and the western portion of Parcel 176, the soils are predominantly silts and clays with a few sand lenses (Figures 4-5 and 4-6). This distribution is indicative of the dredge and fill source of these upper soils. Soil boring logs are provided in Appendix E.

The marsh crust was identified in some coreholes with observed dark staining as a thin zone of organic material consisting of grasses and reeds or decaying vegetation. Depths of the marsh crust ranged from between 15 and 22 feet bgs. The position of the marsh crust, based on the corehole logs, is identified on the cross sections (Figures 4-2 through 4-6). The marsh crust was not identified in all coreholes. In some coreholes, an organic, rich clay was observed near the expected position of the marsh crust. However, the Site Geologist concluded that this alone was insufficient evidence for identifying the marsh crust. There typically was an odor of decaying vegetation and occasionally of petroleum products, associated with this horizon. The decaying vegetation odor was also observed during direct-push groundwater sampling. This odor became stronger with depth, with the strongest odor coincident with the occurrence of the marsh crust. Bay mud was generally found under the fill and marsh crust.

Groundwater sampled at Operable Unit (OU) 5 and the adjacent parcels occur in the first water-bearing zone, which consists of the medium to fine-grained sands, silty sands, silts, and clays comprising the fill unit. The first water-bearing zone is not considered a regional aquifer. Groundwater was first encountered between 6 and 8 feet bgs and was sampled to depths of

24 feet bgs. However, sufficient groundwater volume for sampling was found only in materials containing sand and at depths below 10 feet bgs. During corehole logging, soil moisture content was recorded; however, it was found that this was not necessarily a good indicator of sufficient water for sampling. Efforts to sample the zones containing silts and clays were not successful and did not yield sufficient water for complete sample collection. In some cases, there was sufficient water volume to fill only the volatile organic compound (VOC) sample containers, but not enough for the polynuclear aromatic hydrocarbon (PAH) sample containers.

Attempts to collect groundwater samples in clay-dominated intervals, such as in Parcels 172 through 176, were generally unsuccessful. Most sampling attempts resulted in insufficient water volume for sample collection. Elsewhere in the study area, few samples were collected above 10 feet bgs and below 20 feet bgs due to insufficient water volume. This was due in part to the predominance of silts and clays at the depths of interest.

During direct-push groundwater sampling at all parcels, gas bubbles were sometimes observed in the sample tubing in many wells. The occurrence of the bubbles increased with the deeper direct-push sampling intervals. In addition, upon opening the well cap of the monitoring wells, gas bubbling could be seen on the water surface in the well casing. These bubbles are assumed to be methane gas that was either in a dissolved-phase in the groundwater or occurred as a trapped gas in the water-bearing zone. Methane was detected at a maximum concentration of 10 milligrams per liter (mg/L) in direct-push boring OU5-HP20 at a depth of 15 to 19 feet bgs. The maximum methane concentration detected in a groundwater monitoring well was 32 mg/L in Well EW-2.

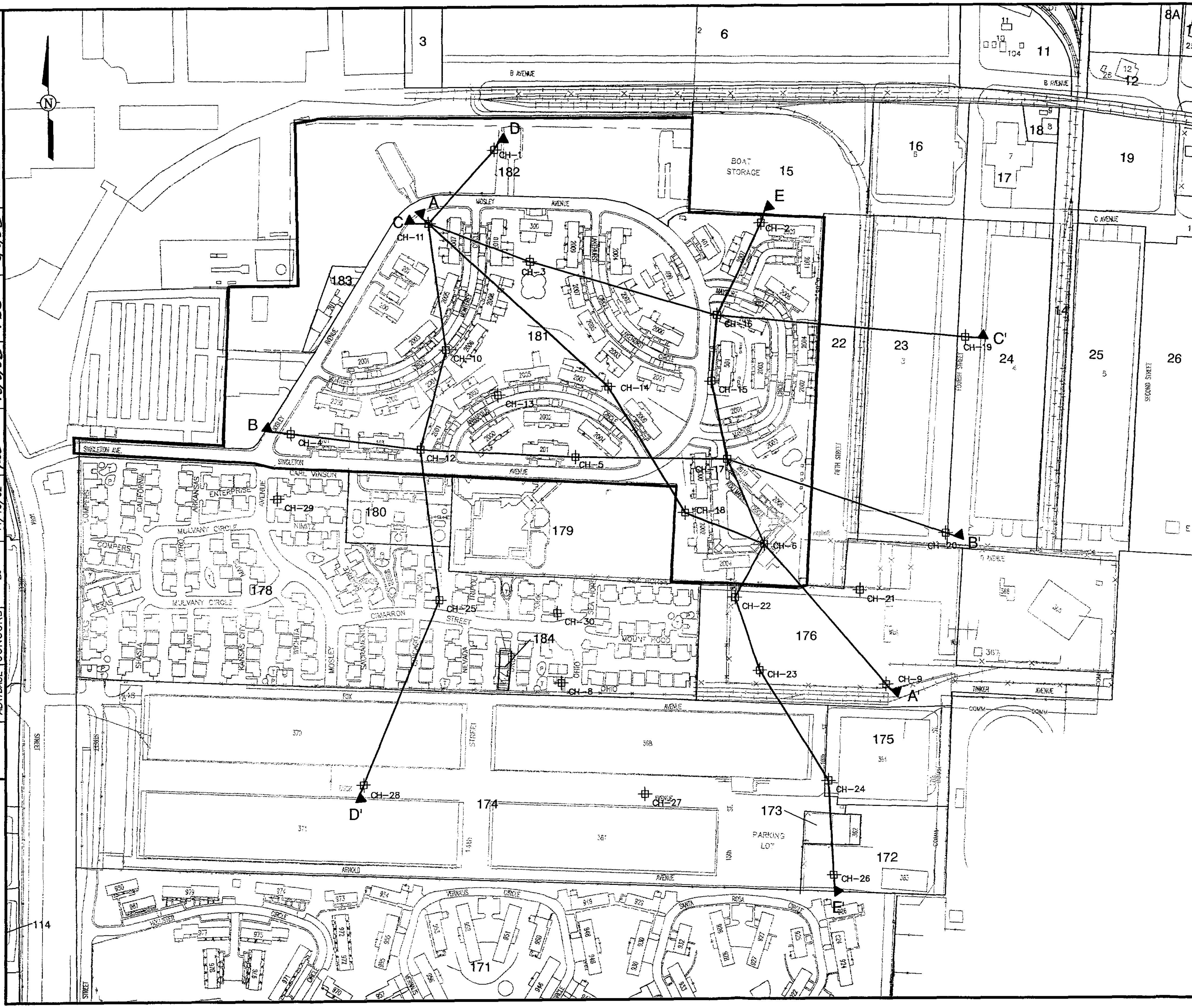
4.1 Spatial Distribution of Chemicals in Soil

This section discusses the spatial distribution of organic and inorganic chemicals detected in the RI soil samples collected at Parcel 181. Additional analyses of these data, including comparisons to background concentrations, are presented in Appendix B.

4.1.1 Organic Chemicals

Polynuclear aromatic hydrocarbons were detected throughout the OU-5 area. All 16 PAH compounds analyzed for U.S. Environmental Protection Agency (EPA) were detected in at least some of the samples. Table 4-1, "Summary Statistics of the Polynuclear Aromatic Hydrocarbons Soil Data by Depth" lists the individual PAH compounds and provides summary statistics for each sampling depth interval. The evaluation of the data and use in the risk assessment (Section 5.0) focused on the carcinogenic (cancer-causing) PAHs and calculation of the benzo(a)pyrene (BaP)-equivalent concentration. The BaP-equivalent concentrations were

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11/13/02	12/3/02	JES 12/4/02	819814-B75



LEGEND

Symbol	Description
(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(thin line)	PARCEL BOUNDARY
CH-19	COREHOLE LOCATION
A — A'	GEOLOGIC CROSS SECTION LOCATION

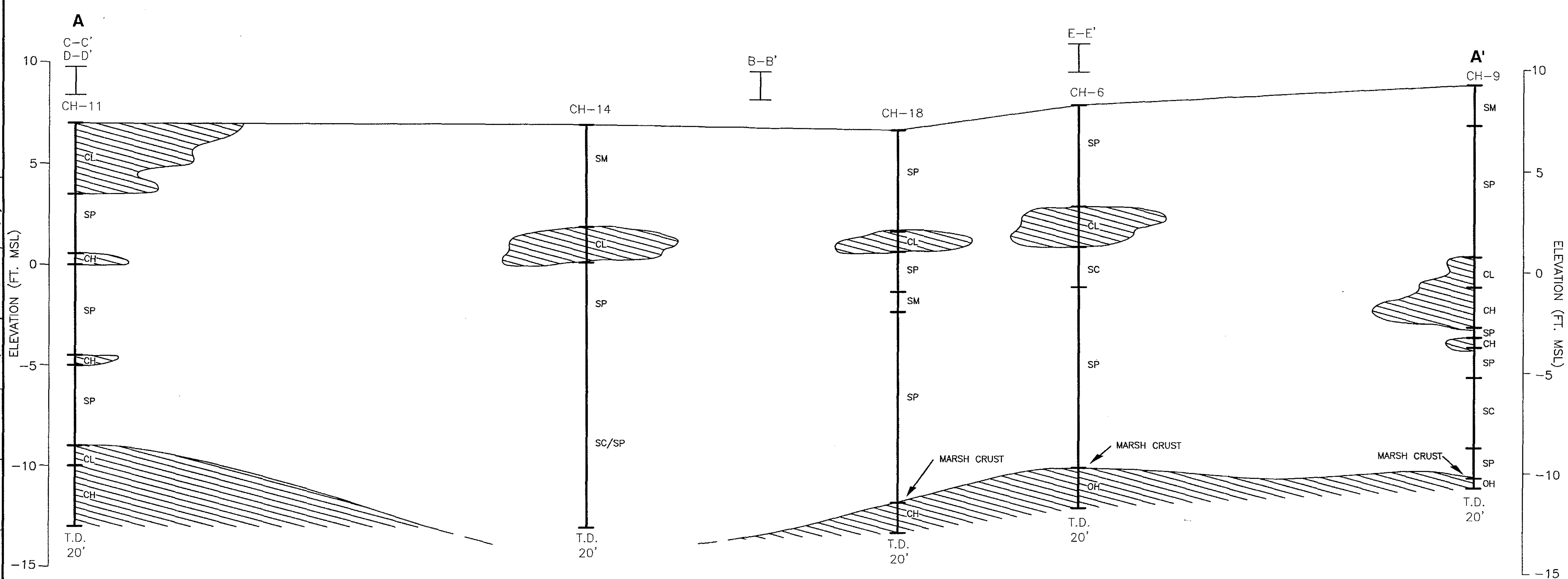
SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-1

CROSS SECTION LOCATION MAP



LEGEND

SW – WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SP – POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SM – SILTY SANDS, SAND-SILT MIXTURES

SC – CLAYEY SANDS, SAND-CLAY MIXTURES

CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

OL – ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY

CH – INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

OH – ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

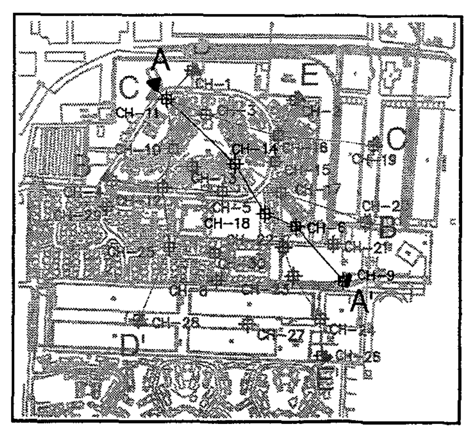
GEOLOGIC CONTACT

SAND OR GRAVEL DOMINATED UNIT

SILT OR CLAY DOMINATED UNIT

NOTES

1. T.D.s SHOWN ARE FOR COREHOLES
2. MARSH CRUST NOTED WHEN INDICATED ON BORING LOGS.



INSET

HORIZONTAL SCALE

0 150 300 FEET

VERTICAL SCALE

0 5 10 FEET

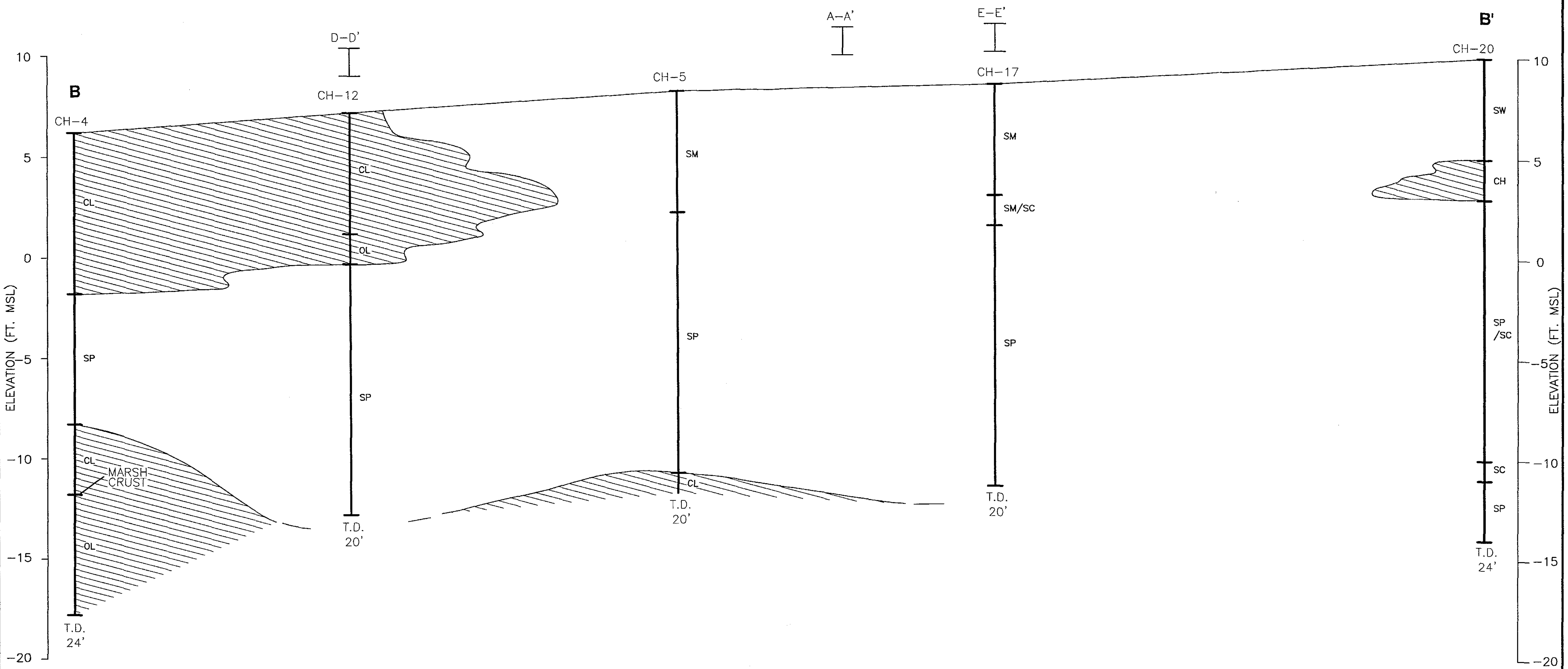
(VERTICAL EXAGGERATION = 30x)

ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-2

GEOLOGIC CROSS SECTION A-A'

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
--	ALA1BASE	CONCORD	SCHAEFFER 11-27-02	12/2/02	JES 12/2/02	819814-B65



LEGEND

SW – WELL–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SP – POORLY–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SM – SILTY SANDS, SAND–SILT MIXTURES

SC – CLAYEY SANDS, SAND–CLAY MIXTURES

CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

OL – ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY

CH – INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

OH – ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

GEOLOGIC CONTACT

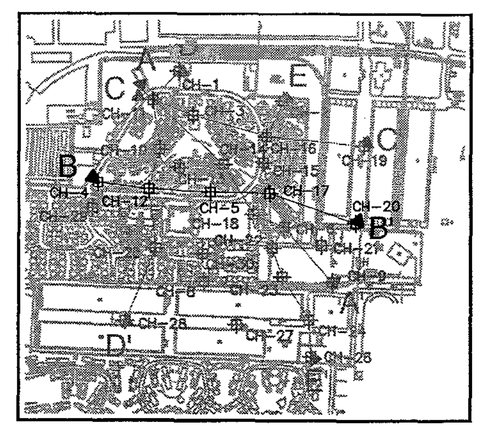
SAND OR GRAVEL DOMINATED UNIT

SILT OR CLAY DOMINATED UNIT

NOTE

1. T.D.s SHOWN ARE FOR COREHOLES

2. MARSH CRUST NOTED WHEN INDICATED ON BORING LOGS.



INSET

HORIZONTAL SCALE

0 150 300 FEET

VERTICAL SCALE

0 5 10 FEET

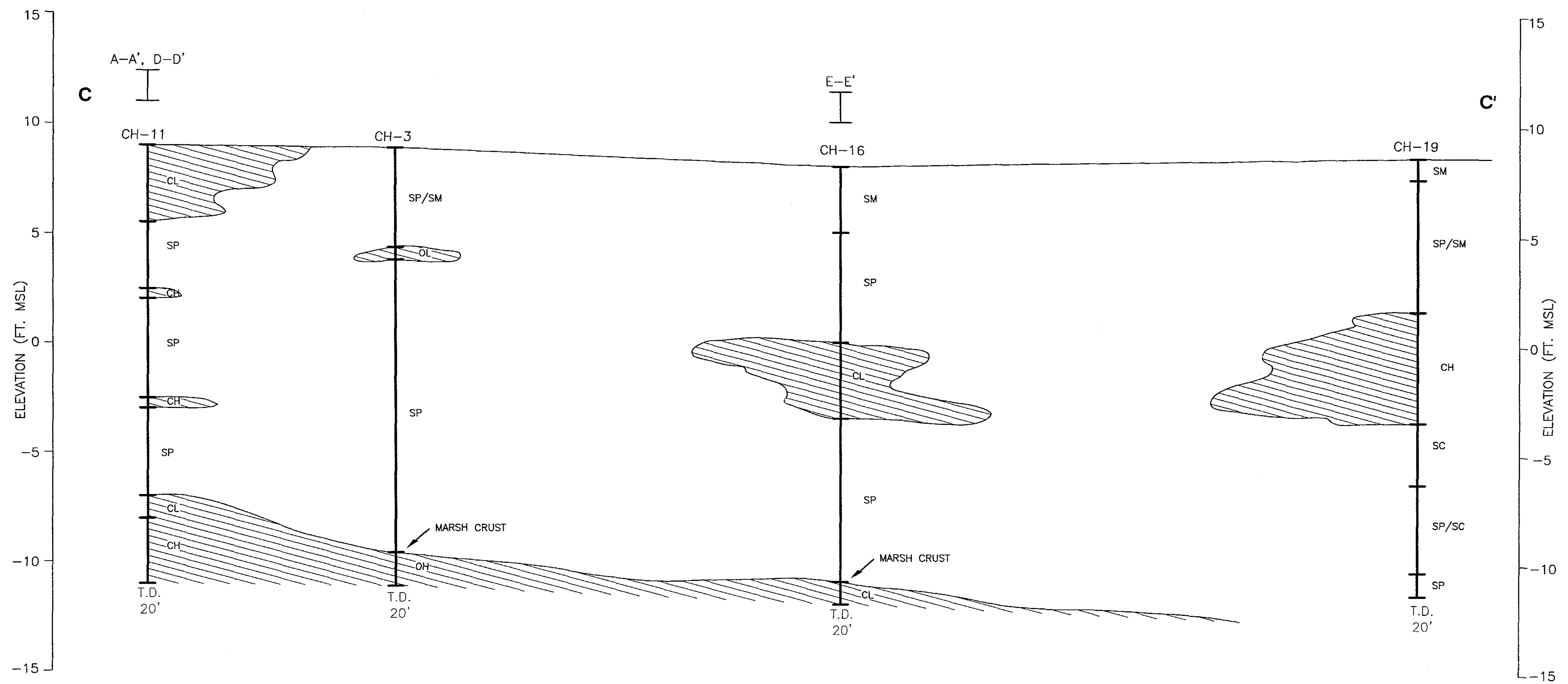
(VERTICAL EXAGGERATION = 30x)

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–3

GEOLOGIC CROSS SECTION B–B'

IMAGE	X–REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	SCHAEFFER 11–27–02	RDC 12/2/02	JES 12/2/02	819814–B66



LEGEND

SW – WELL–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SP – POORLY–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SM – SILTY SANDS, SAND–SILT MIXTURES

SC – CLAYEY SANDS, SAND–CLAY MIXTURES

ML – INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SAND, OR CLAYEY SILT WITH SLIGHT PLASTICITY.

CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

OL – ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY

CH – INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

OH – ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

GEOLOGIC CONTACT

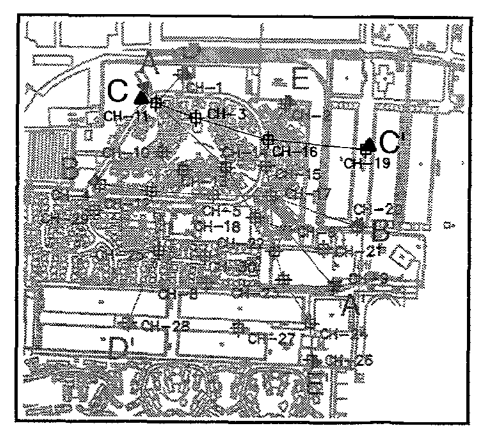
SAND OR GRAVEL DOMINATED UNIT

SILT OR CLAY DOMINATED UNIT

NOTE

1. T.D.s SHOWN ARE FOR COREHOLES

2. MARSH CRUST NOTED WHEN INDICATED ON BORING LOGS.



INSET

HORIZONTAL SCALE

0 150 300 FEET

VERTICAL SCALE

0 5 10 FEET

(VERTICAL EXAGGERATION = 30x)

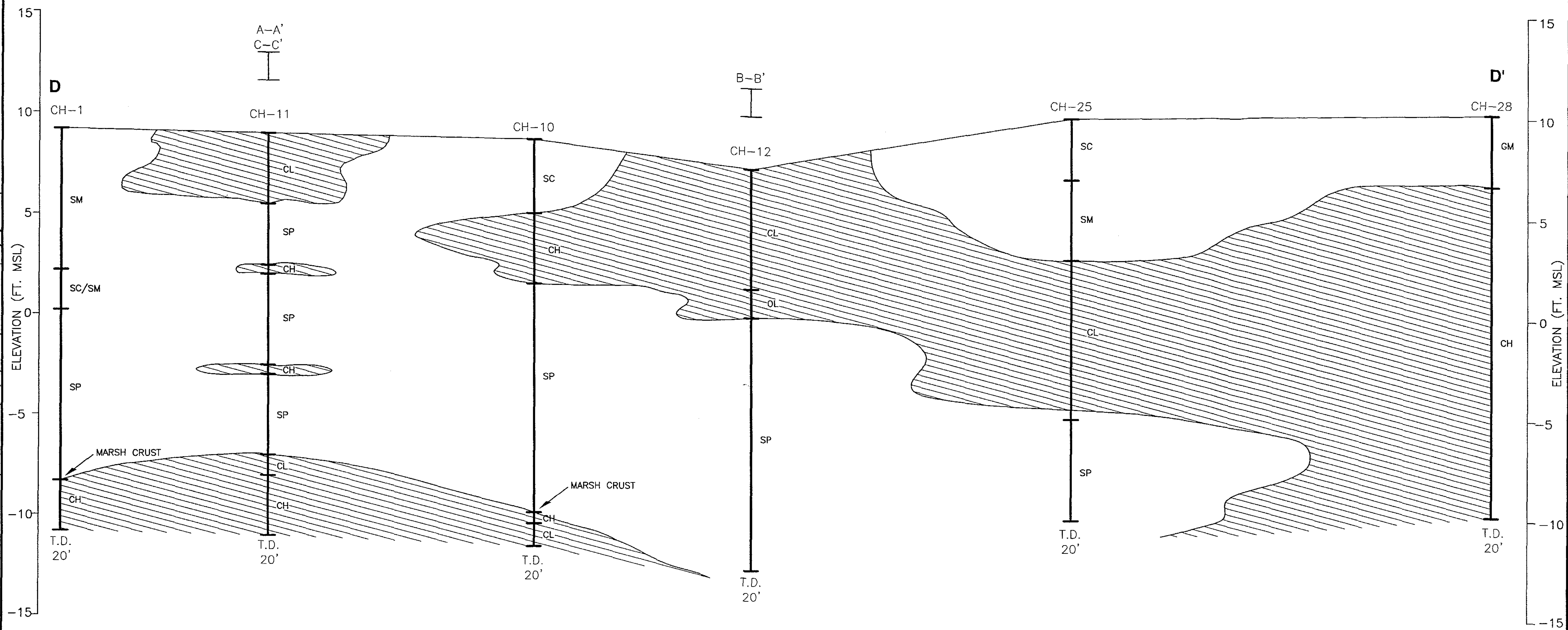
OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–4

GEOLOGIC CROSS SECTION C–C'

IMAGE	X–REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	SCHAEFFER 11–27–02	12/6/02	JES 12/9/02	819814–B76

DRAWING NUMBER 819814-B77
APPROVED BY JES 12/6/02
CHECKED BY 12/6/02
DRAWN BY SCHAEFFER 11-27-02
OFFICE CONCORD
X-REF ALA1BASE
IMAGE ---



LEGEND

GM – SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES

SW – WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SP – POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SM – SILTY SANDS, SAND-SILT MIXTURES

SC – CLAYEY SANDS, SAND-CLAY MIXTURES

CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

OL – ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY

CH – INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

OH – ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

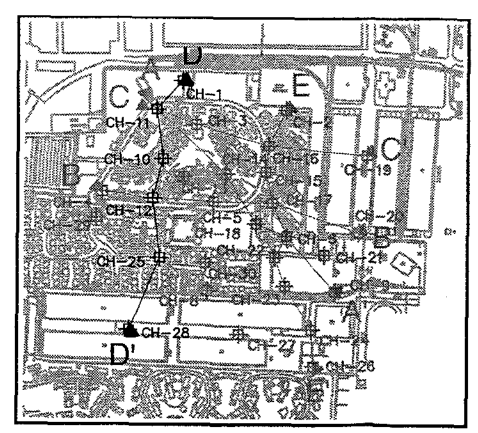
GEOLOGIC CONTACT

SAND OR GRAVEL DOMINATED UNIT

SILT OR CLAY DOMINATED UNIT

NOTE

1. T.D.s SHOWN ARE FOR COREHOLES
2. MARSH CRUST NOTED WHEN INDICATED ON BORING LOGS.



INSET

HORIZONTAL SCALE
0 150 300 FEET

VERTICAL SCALE
0 5 10 FEET

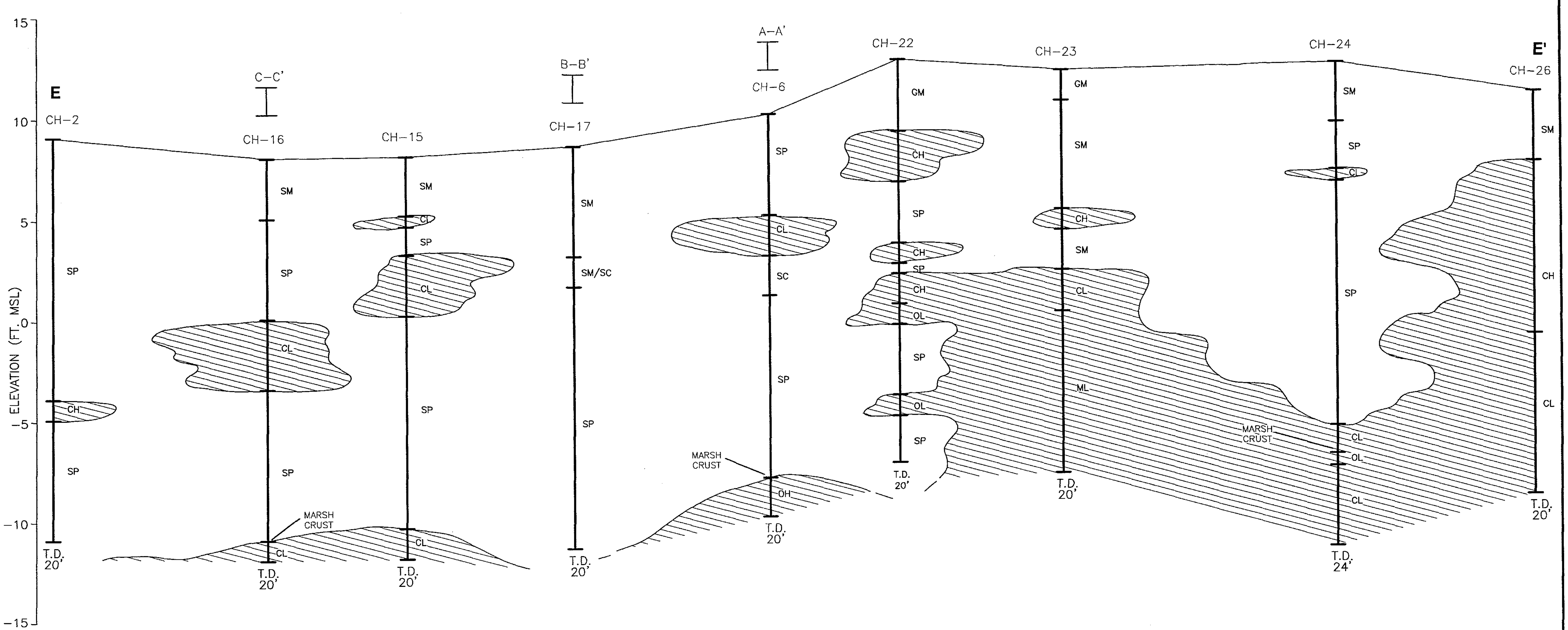
(VERTICAL EXAGGERATION = 30x)

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-5

GEOLOGIC CROSS SECTION D-D'

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	SCHAEFFER 12-2-02	12/02/02	JES 12/2/02	819814-B78



LEGEND

GM – SILTY GRAVELS, GRAVEL–SAND–SILT MIXTURES

GC – CLAYEY GRAVELS, GRAVEL–SAND–CLAY MIXTURES

SW – WELL–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SP – POORLY–GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES

SM – SILTY SANDS, SAND–SILT MIXTURES

SC – CLAYEY SANDS, SAND–CLAY MIXTURES

ML – INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY

CL – INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS

OL – ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY

CH – INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS

OH – ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

GEOLOGIC CONTACT

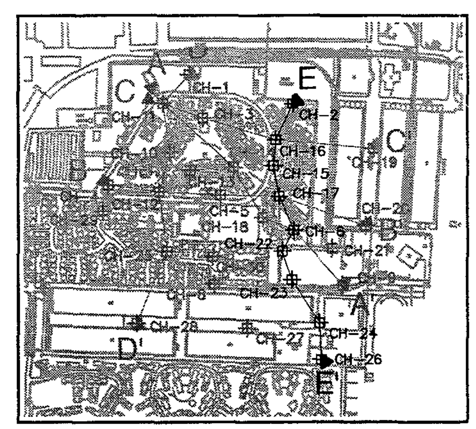
SAND OR GRAVEL DOMINATED UNIT

SILT OR CLAY DOMINATED UNIT

NOTE

1. T.D.s SHOWN ARE FOR COREHOLES

2. MARSH CRUST NOTED WHEN INDICATED ON BORING LOGS.



INSET

HORIZONTAL SCALE

0 150 300 FEET

VERTICAL SCALE

0 5 10 FEET

(VERTICAL EXAGGERATION = 30x)

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–6

GEOLOGIC CROSS SECTION E–E'

Table 4-1 (Page 1 of 4)
Summary Statistics of the Polynuclear Aromatic Hydrocarbons Soil Data by Depth

Analyte	Sample Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/kg)		Detected Concentrations (µg/kg)		Overall Mean (µg/kg)	Mean of the Detections
	Top	Bottom	Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum		
ACENAPHTHENE	0	0.5	168	158	10	6	26	11000	15	130	380	42
ACENAPHTHENE	0.5	2	167	155	12	7.2	26	5800	20	180	342	74
ACENAPHTHENE	2	4	165	151	14	8.5	26	3600	26	690	337	211
ACENAPHTHENE	4	8	59	54	5	8.5	29	120000	22	7800	2081	1820
ACENAPHTHYLENE	0	0.5	168	142	26	15.5	22	4400	15	1100	326	179
ACENAPHTHYLENE	0.5	2	167	137	30	18	21	2800	10	2000	330	197
ACENAPHTHYLENE	2	4	165	137	28	17	22	3100	29	1700	346	308
ACENAPHTHYLENE	4	8	59	53	6	10.2	24	11000	30	69000	1824	11935
ANTHRACENE	0	0.5	168	34	134	79.8	10	110	2	4600	146	178
ANTHRACENE	0.5	2	167	35	132	79	2.1	110	1	2700	180	223
ANTHRACENE	2	4	165	44	121	73.3	4.5	130	1	4100	198	262
ANTHRACENE	4	8	59	12	47	79.7	2.4	150	1	89000	2975	3728
BENZ(A)ANTHRACENE	0	0.5	168	4	164	97.6	26	52	4	8300	517	529
BENZ(A)ANTHRACENE	0.5	2	167	3	164	98.2	26	26	3.3	6300	580	591
BENZ(A)ANTHRACENE	2	4	165	10	155	93.9	11	33	2.4	6300	695	739
BENZ(A)ANTHRACENE	4	8	59	1	58	98.3	2.4	2.4	11	68000	3366	3424
BENZO(A)PYRENE	0	0.5	168	3	165	98.2	27	52	9.3	11000	971	989
BENZO(A)PYRENE	0.5	2	167	3	164	98.2	2.1	26	6.5	11000	1096	1115

Table 4-1 (Page 2 of 4)
Summary Statistics of the Polynuclear Aromatic Hydrocarbons Soil Data by Depth

Analyte	Sample Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/kg)		Detected Concentrations (µg/kg)		Overall Mean (µg/kg)	Mean of the Detections
	Top	Bottom	Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum		
BENZO(A)PYRENE	2	4	165	10	155	93.9	26	100	2.6	14000	1451	1542
BENZO(A)PYRENE	4	8	59	1	58	98.3	2.4	2.4	18	110000	5185	5275
BENZO(B)FLUORANTHENE	0	0.5	168	3	165	98.2	27	52	6.9	8700	672	684
BENZO(B)FLUORANTHENE	0.5	2	167	2	165	98.8	26	26	2	8000	767	776
BENZO(B)FLUORANTHENE	2	4	165	10	155	93.9	26	100	4.3	10000	1056	1122
BENZO(B)FLUORANTHENE	4	8	59	1	58	98.3	2.4	2.4	13	74000	3507	3568
BENZO(G,H,I)PERYLENE	0	0.5	168	4	164	97.6	11	52	10	8800	917	939
BENZO(G,H,I)PERYLENE	0.5	2	167	3	164	98.2	2.1	26	11	13000	1094	1114
BENZO(G,H,I)PERYLENE	2	4	165	14	151	91.5	2	100	6.8	10000	1408	1537
BENZO(G,H,I)PERYLENE	4	8	59	1	58	98.3	2.4	2.4	25	76000	3925	3992
BENZO(K)FLUORANTHENE	0	0.5	168	5	163	97	11	52	3.4	3200	291	299
BENZO(K)FLUORANTHENE	0.5	2	167	8	159	95.2	2.1	110	2.4	3200	334	350
BENZO(K)FLUORANTHENE	2	4	165	14	151	91.5	26	100	2.5	3800	398	432
BENZO(K)FLUORANTHENE	4	8	59	2	57	96.6	2.4	120	5.4	36000	1769	1830
CHRYSENE	0	0.5	168	6	162	96.4	26	110	6.1	9800	597	618
CHRYSENE	0.5	2	167	8	159	95.2	26	110	4.6	7000	656	687
CHRYSENE	2	4	165	16	149	90.3	26	100	4	7800	758	836
CHRYSENE	4	8	59	2	57	96.6	2.4	100	9.9	81000	3907	4043

Table 4-1 (Page 3 of 4)
Summary Statistics of the Polynuclear Aromatic Hydrocarbons Soil Data by Depth

Analyte	Sample Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/kg)		Detected Concentrations (µg/kg)		Overall Mean (µg/kg)	Mean of the Detections
	Top	Bottom	Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum		
DIBENZ(A,H)ANTHRACENE	0	0.5	168	51	117	69.6	21	2300	2.3	9900	561	724
DIBENZ(A,H)ANTHRACENE	0.5	2	167	53	114	68.3	5.2	5100	21	4200	523	593
DIBENZ(A,H)ANTHRACENE	2	4	165	58	107	64.8	6	4400	4.2	8500	642	823
DIBENZ(A,H)ANTHRACENE	4	8	59	23	36	61	5.9	24000	17	12000	1642	2060
FLUORANTHENE	0	0.5	168	3	165	98.2	27	52	21	53000	2377	2420
FLUORANTHENE	0.5	2	167	2	165	98.8	26	26	3	39000	2746	2779
FLUORANTHENE	2	4	165	11	154	93.3	26	100	9	58000	3311	3546
FLUORANTHENE	4	8	59	1	58	98.3	2.4	2.4	26	750000	22141	22522
FLUORENE	0	0.5	168	149	19	11.3	2.2	440	13	780	49	125
FLUORENE	0.5	2	167	141	26	15.6	2.1	280	2	1400	56	164
FLUORENE	2	4	165	143	22	13.3	2.2	280	5	1200	60	202
FLUORENE	4	8	59	42	17	28.8	2.4	740	12	36300	1534	5200
INDENO(1,2,3-CD)PYRENE	0	0.5	168	4	164	97.6	11	52	10	11000	859	879
INDENO(1,2,3-CD)PYRENE	0.5	2	167	4	163	97.6	2.1	26	7	13000	1042	1067
INDENO(1,2,3-CD)PYRENE	2	4	165	14	151	91.5	2	100	6.5	15000	1341	1463
INDENO(1,2,3-CD)PYRENE	4	8	59	1	58	98.3	2.4	2.4	16	94000	4158	4229
NAPHTHALENE	0	0.5	168	155	13	7.7	26	11000	18	120	380	49
NAPHTHALENE	0.5	2	167	147	20	12	26	5800	14	130	342	48

Table 4-1 (Page 4 of 4)
Summary Statistics of the Polynuclear Aromatic Hydrocarbons Soil Data by Depth

Analyte	Sample Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/kg)		Detected Concentrations (µg/kg)		Overall Mean (µg/kg)	Mean of the Detections
	Top	Bottom	Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum		
NAPHTHALENE	2	4	165	149	16	9.7	26	3600	24	500	332	129
NAPHTHALENE	4	8	59	51	8	13.6	29	19000	22	140000	6343	42026
PHENANTHRENE	0	0.5	168	5	163	97	26	52	5.7	20000	761	784
PHENANTHRENE	0.5	2	167	8	159	95.2	2.1	92	6	16000	931	976
PHENANTHRENE	2	4	165	16	149	90.3	14	100	3.1	28000	1055	1166
PHENANTHRENE	4	8	59	1	58	98.3	2.4	2.4	5	580000	16396	16678
PYRENE	0	0.5	168	2	166	98.8	52	52	14	36000	1986	2009
PYRENE	0.5	2	167	2	165	98.8	26	26	3	26000	2223	2250
PYRENE	2	4	165	11	154	93.3	22	100	6.8	35000	2888	3093
PYRENE	4	8	59	1	58	98.3	2.4	2.4	29	470000	16286	16566

bgs denotes below ground surface

µg/kg denotes microgram(s) per kilogram

The overall mean is based on both the detected and nondetected results (see Section 4.1.1).

calculated for each sample by normalizing the concentration of each carcinogenic PAH to the carcinogenicity of BaP, for which both EPA and California Environmental Protection Agency (CalEPA) have published separate cancer slope factors (CSF). The risk assessment was conducted using EPA and CalEPA toxicity equivalency factors (TEF) (differences between the two methods are noted) as follows:

- Benz(a)anthracene (0.1)
- BaP (1.0)
- Benzo(b)fluoranthene (0.1)
- Benzo(k)fluoranthene (EPA 0.01; CalEPA 0.1)
- Chrysene (EPA 0.001; CalEPA 0.01)
- Dibenz(a,h)anthracene (EPA 1.0; CalEPA 4.1/12)
- Indeno(1,2,3-cd)pyrene (0.1).

The detected PAH concentrations in each sample were multiplied by the applicable equivalency factor and summed to generate a BaP-equivalent value. In the case of a not detected result, one-half the detection limit was used as the result and multiplied by the equivalency factor. Estimated results (indicated with a J-qualifier) were accepted as a detect and were treated as a non-qualified result in the calculations.

Benzo(a)pyrene-equivalent concentrations for the four sampling intervals ranged from 4 micrograms per kilogram (µg/kg) at sample location OU5-036 in the 0.5 to 2 foot depth interval to 146,041 µg/kg at OU5-041 in the 4 to 8 foot depth interval. The minimum, maximum, and mean concentrations for each sampling interval are listed on Table 4-2, "Summary Statistics of the Benzo(a)Pyrene-Equivalent Concentration Soil Data by Depth." Complete soil analytical results and BaP-equivalent concentrations are provided in Appendix D.

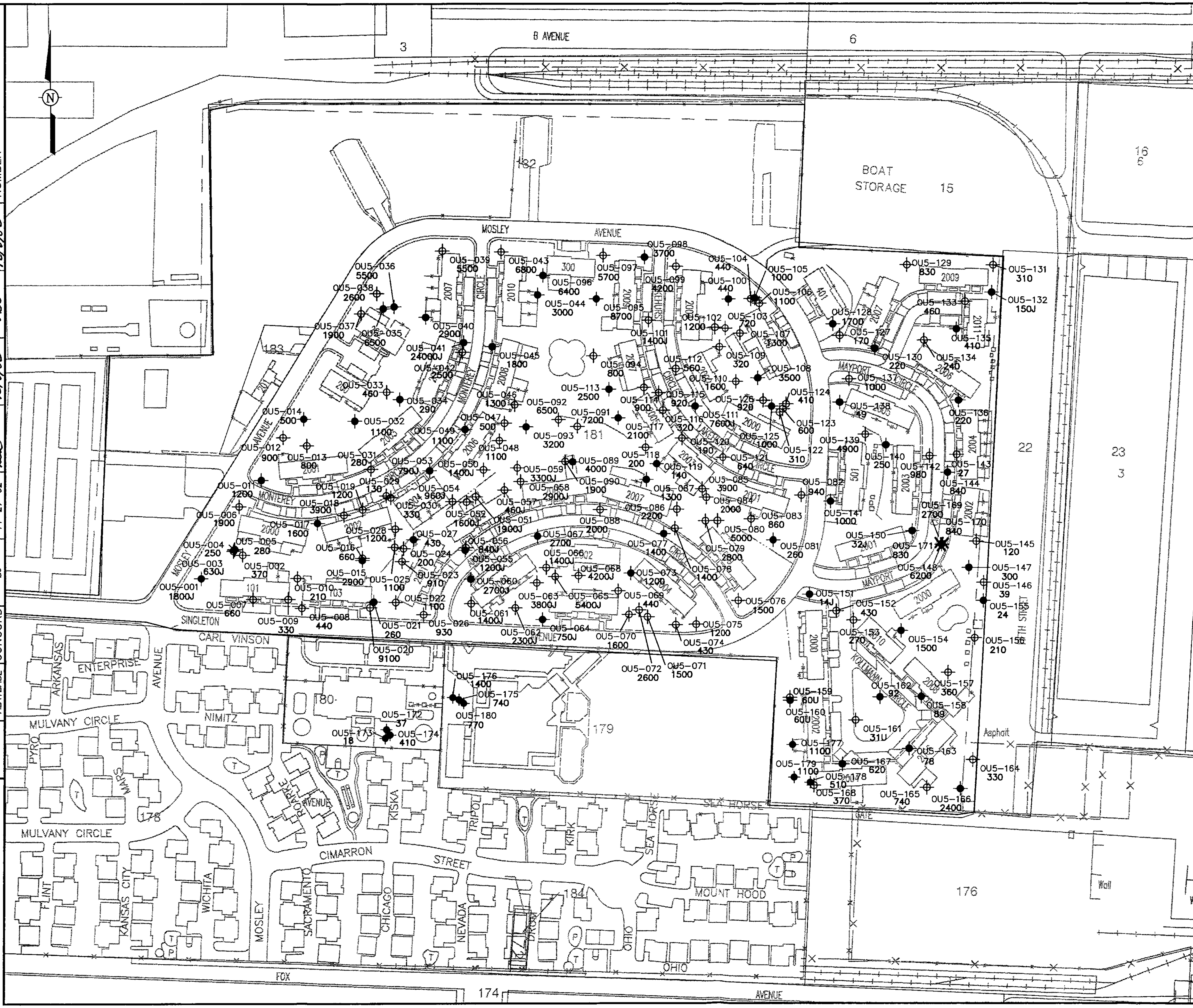
Figures 4-7 through 4-10 show the distribution of BaP-equivalent concentrations for the four depth intervals sampled (0 to 0.5 feet bgs, to 0.5 to 2 feet bgs, 2 to 4 feet bgs, and 4 to 8 feet bgs). In general, concentrations are higher in the area encompassed by Mosley and Singleton Avenues, with lower concentrations in the eastern portion of the Parcel 181 area, in the vicinity of Mayport and Kollmann Circles. Additionally, BaP-equivalent soil concentrations generally increase in the deeper intervals, particularly from north to south and from west to east across Parcel 181 as shown on Figures 4-7 through 4-10 and Table 4-2.

In addition to the large-scale patterns, BaP-equivalent concentrations were found to vary considerably at small scales, both across the site, and among depth intervals. For example, the distribution of BaP-equivalent concentrations show that samples collected from the same boring, but at different depths, may have markedly different concentrations. This is illustrated at boring OU5-015 where concentrations range from 340 µg/kg at the 0.5 to 2 foot bgs interval to 2,900 µg/kg at the 0 to 0.5 foot bgs sample interval. In addition, adjacent borings may also have markedly different concentrations at the same sample interval. For example, samples from the 2 to 4 foot bgs sampling interval at borings OU5-070 (17 µg/kg), OU5-071 (6,700 µg/kg), and OU5-072 (3,800 µg/kg) show a large range in concentrations, while the borings are only a maximum of 40 feet apart.

An example of small-scale heterogeneity is in the vicinity of sample location OU5-148 (located near 2002 Mayport Circle). A BaP-equivalent concentration of 6,200 µg/kg was observed at this location at a depth of 0 to 0.5 feet bgs. Three additional shallow soil samples were collected near boring OU5-148 after demobilization from the field (borings OU5-169, OU5-170, and OU5-171) (see Figure 4-7). These new borings were placed approximately 5, 7.5, and 10 feet laterally from boring OU5-148 and samples were collected from 0 to 0.5 feet bgs. The BaP-equivalent concentrations for the three new samples are 2,700 µg/kg, 840 µg/kg, and 830 µg/kg, respectively. The variability observed across the new borings and boring OU5-148 is consistent with that observed within samples and between adjacent samples across OU-5. The concentration of 6,200 µg/kg from OU5-148 is likely due to this inherent soil heterogeneity and probably does not reflect a "hot spot" in PAH concentrations.

Additional soil samples were collected at and in the vicinity of the Miller Elementary School (Parcel 179) and Alameda Child Development Center (Parcel 180) as described in Section 3.4.1. A total of 22 samples were collected at depths ranging from 0 to 8 feet bgs. Benzo(a)pyrene-equivalent concentrations were generally low in this area with only three samples from the 0 to 0.5 foot bgs interval and one sample from the 2 to 4 foot bgs interval exceeding 1,000 µg/kg. No samples from the other depth intervals exceeded 1,000 µg/kg. Figures 4-11 through 4-14 present the sample results for each depth interval.

Duplicate samples (homogenized splits of core intervals) were taken at 10 percent (54 duplicate samples) of the location/depth intervals across the entire study area. An analysis of these duplicates was conducted to evaluate small scale BaP-equivalent variability. The analysis revealed significant variation in BaP-equivalent concentrations within individual samples. Table 4-3, "Soil Sampling Field Duplicate Relative Percent Difference for Benzo(a)pyrene-Equivalent Results" lists the normal and duplicate sample concentrations and presents the relative percent difference between the two results. It is evident that a significant portion of the observed variability between depth intervals and adjacent samples is simply due to small scale



LEGEND

- OU5 BOUNDARY
- 181 — PARCEL NUMBER
- PARCEL BOUNDARY
- X OU5-169 — SURFACE SOIL SAMPLE LOCATION (0–0.5 FT. BGS)
- OU5-139 — SOIL BORING LOCATION (0–4 FT. BGS)
- OU5-138 — SOIL BORING LOCATION (0–8 FT. BGS)
- 260 — BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
- 120J — ESTIMATED VALUE
- 60U — NOT DETECTED ABOVE LISTED VALUE

SCALE

0 200 400 FEET

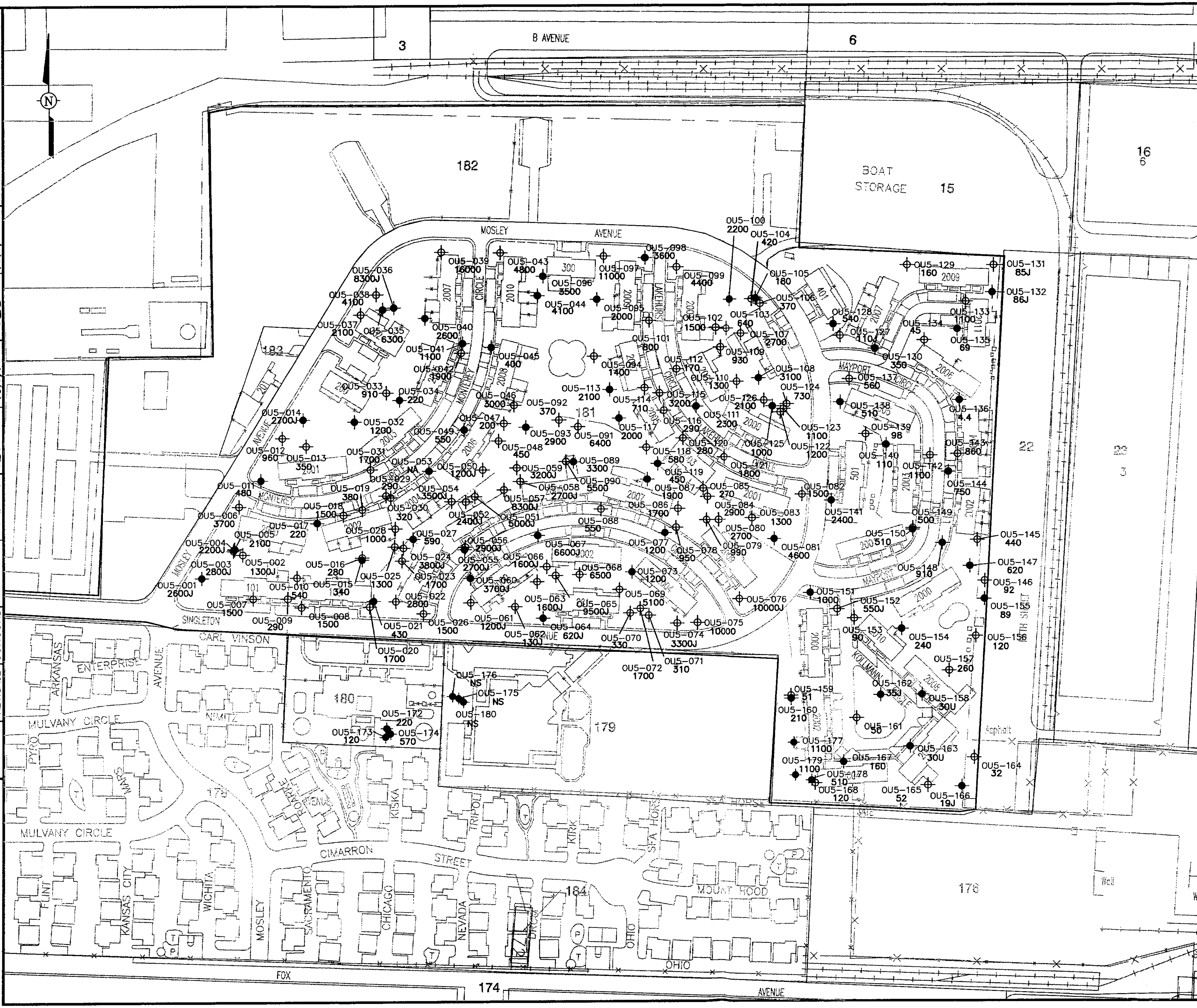
OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–7

BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS 0–0.5 FEET DEPTH INTERVAL

DRAWING NUMBER	APPROVED BY	CHECKED BY	DRAWN BY	OFFICE	X-REF	IMAGE
819814-B41	JES 12/6/02	12/2/02	BJ 11-27-02	CONCORD	ALATBASE	---

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
--	ALA1BASE	CONCORD	SCHAEFFER 11-21-02	12/4/02	JES 12/4/02	819814-B42



LEGEND

- OU5 BOUNDARY
- 181 — PARCEL NUMBER
- PARCEL BOUNDARY
- OU5-139 — SOIL BORING LOCATION (0-4 FT. BGS)
- OU5-138 — SOIL BORING LOCATION (0-8 FT. BGS)
- 260 — BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
- 120J — ESTIMATED VALUE
- 60U — NOT DETECTED ABOVE LISTED VALUE
- NA — SAMPLE NOT ANALYZED
- NS — INTERVAL NOT SAMPLED

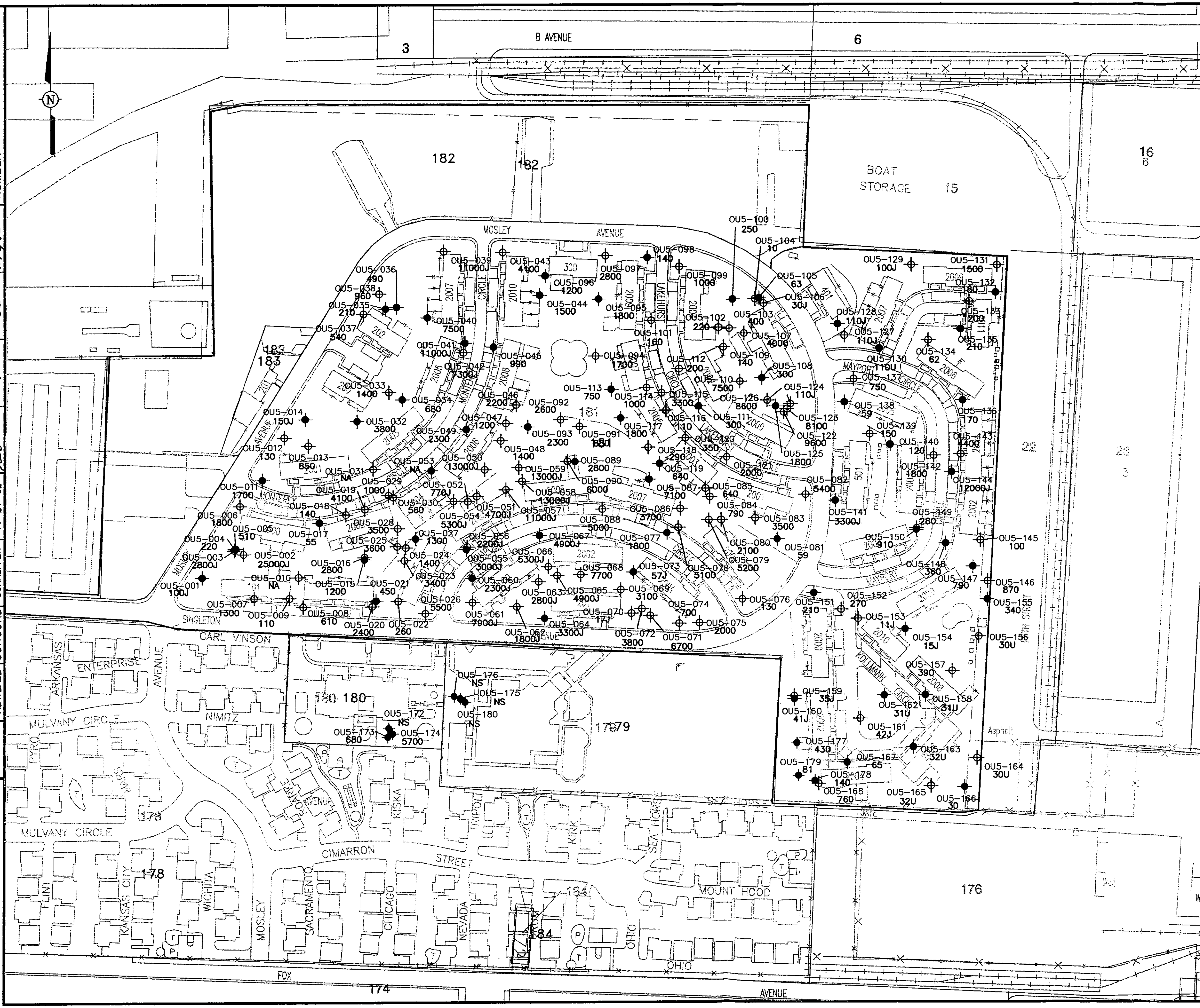
SCALE

0 200 400 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-8

BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS 0.5-2.0 FEET DEPTH INTERVAL



LEGEND

(thick line)	OU5 BOUNDARY
181	PARCEL NUMBER
(thin line)	PARCEL BOUNDARY
OU5–139	SOIL BORING LOCATION (0–4 FT. BGS)
OU5–138	SOIL BORING LOCATION (0–8 FT. BGS)
260	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
120J	ESTIMATED VALUE
60U	NOT DETECTED ABOVE LISTED VALUE
NA	SAMPLE NOT ANALYZED
NS	INTERVAL NOT SAMPLED

SCALE

0 200 400 FEET

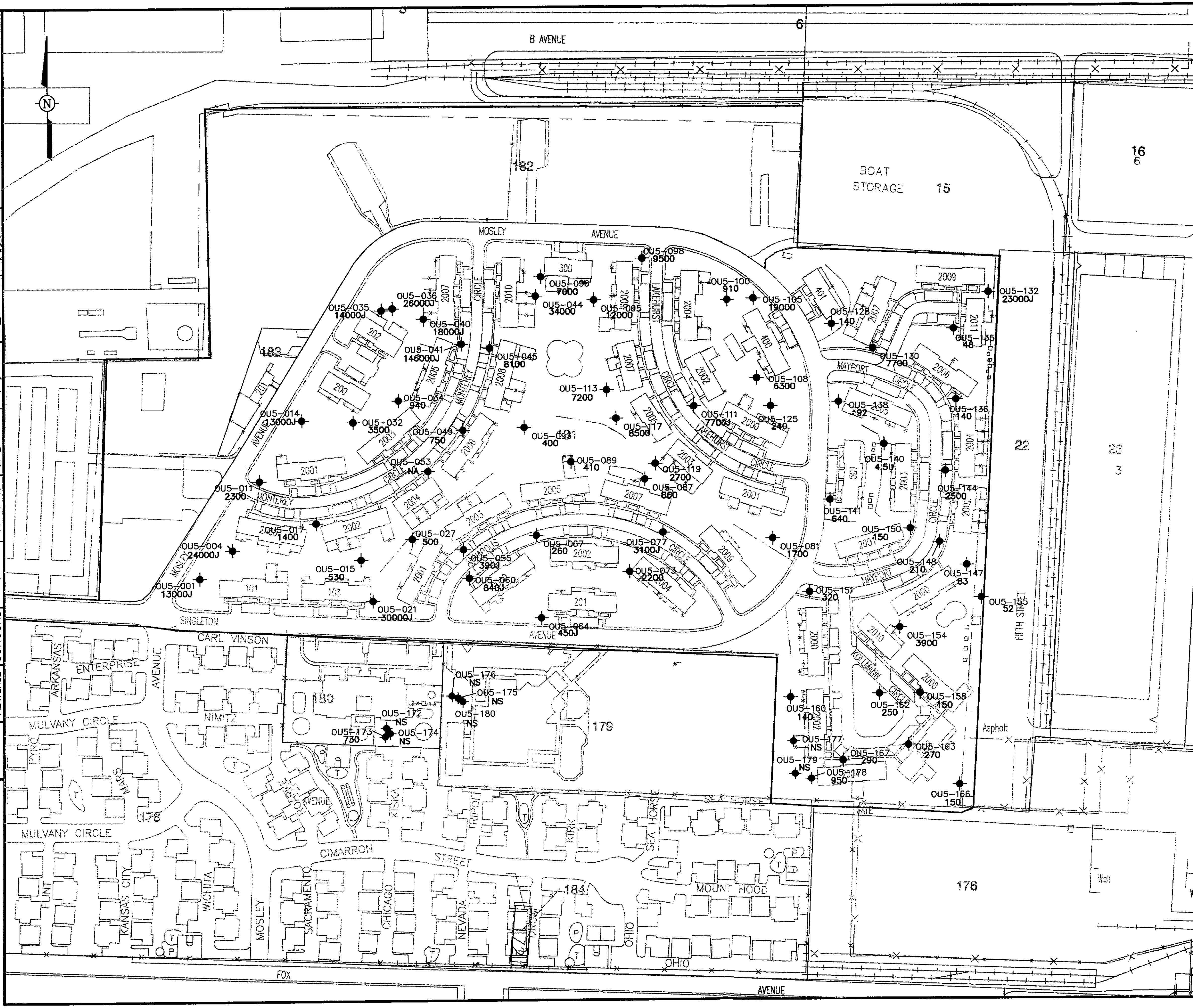
OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–9

BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS 2.0–4.0 FEET DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	SCHAEFFER 11-21-02	12/9/02	JES 12/9/02	819814-B43

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
--	ALA1BASE	CONCORD	BJ 11-19-02	[signature] 12/2/02	JES 12/2/02	819814-B44



LEGEND

▬▬	OU5 BOUNDARY
181	PARCEL NUMBER
——	PARCEL BOUNDARY
OU5-139	SOIL BORING LOCATION (0-4 FT. BGS)
⯁OU5-138	SOIL BORING LOCATION (0-8 FT. BGS)
260	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
120J	ESTIMATED VALUE
60U	NOT DETECTED ABOVE LISTED VALUE
NA	SAMPLE NOT ANALYZED
NS	INTERVAL NOT SAMPLED

SCALE

0 200 400 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-10

BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS 4.0-8.0 FEET DEPTH INTERVAL

Table 4-2
Summary Statistics of the Benzo(a)Pyrene-Equivalent Concentration Soil Data by Depth

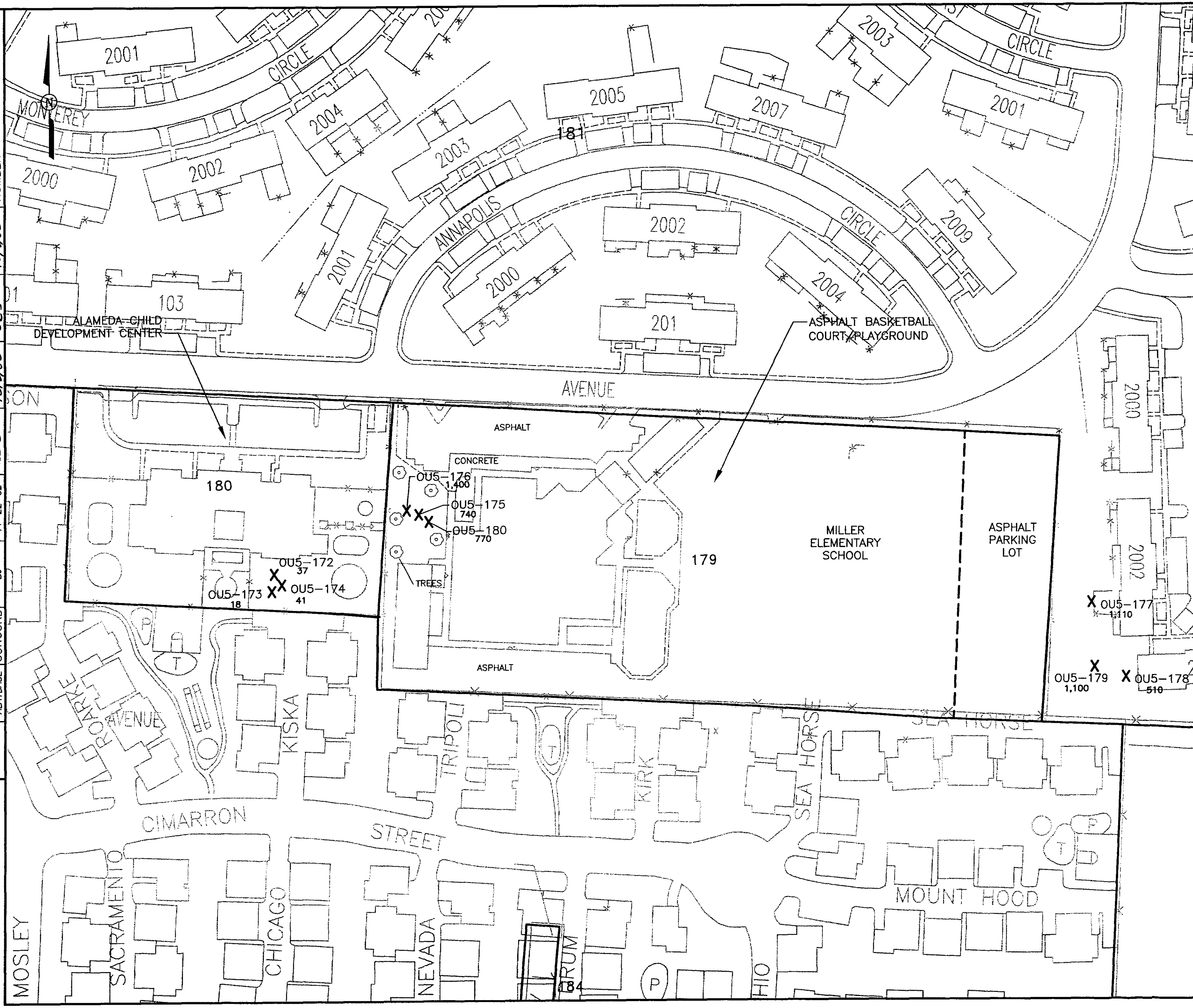
Sample Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (μg/kg)		Detected Concentrations (μg/kg)		Overall Mean (μg/kg)	Mean of the Detections (μg/kg)
Top	Bottom	Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum		
0	0.5	168	3	165	98.2	31	60	14	23742	1740	1772
0.5	2	167	2	165	98.8	30	30	4	16319	1861	1883
2	4	165	6	159	96.4	30	32	11	25416	2405	2496
4	8	59	1	58	98.3	5	5	48	146041	7952	8089

μg/kg denotes microgram(s) per kilogram

bgs denotes below ground surface

The overall mean is based on both the detected and nondetected results (see Section 4.1.1).

The detected polynuclear aromatic hydrocarbon concentrations were multiplied by an equivalency factor and summed to generate a benzo(a)pyrene-equivalent concentration.



LEGEND

—	PARCEL BOUNDARY
179	PARCEL NUMBER
X	SOIL SAMPLING LOCATION
37	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])

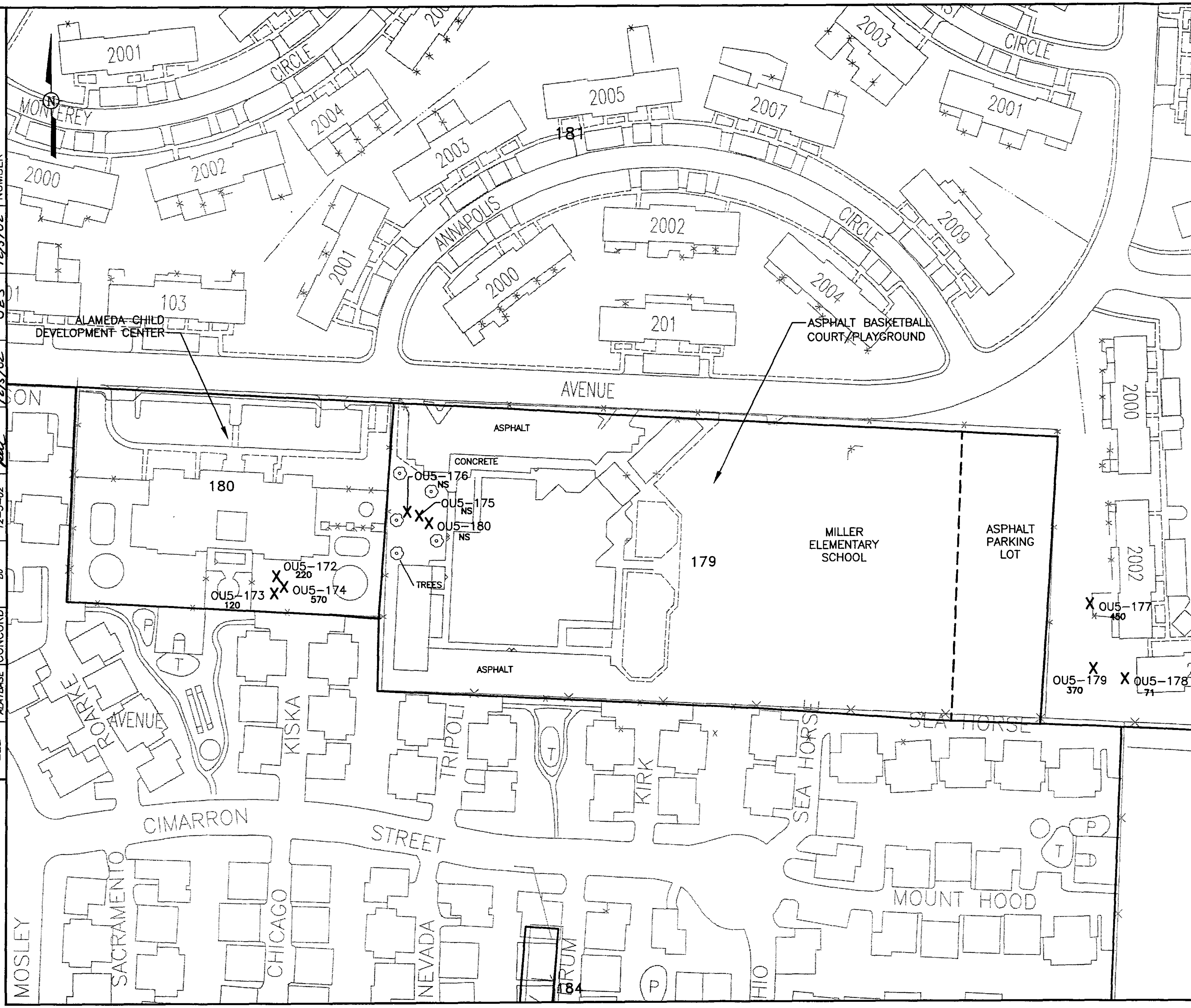
SCALE

0 100 200 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–11
MILLER ELEMENTARY SCHOOL AND ALAMEDA CHILD DEVELOPMENT CENTER BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS 0–0.5 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-22-02	RDC 12/2/02	JES 12/2/02	819814-B67



LEGEND

———	PARCEL BOUNDARY
179	PARCEL NUMBER
X	SOIL SAMPLING LOCATION
220	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
NS	NOT SAMPLED, HIT REFUSAL WHILE SAMPLING

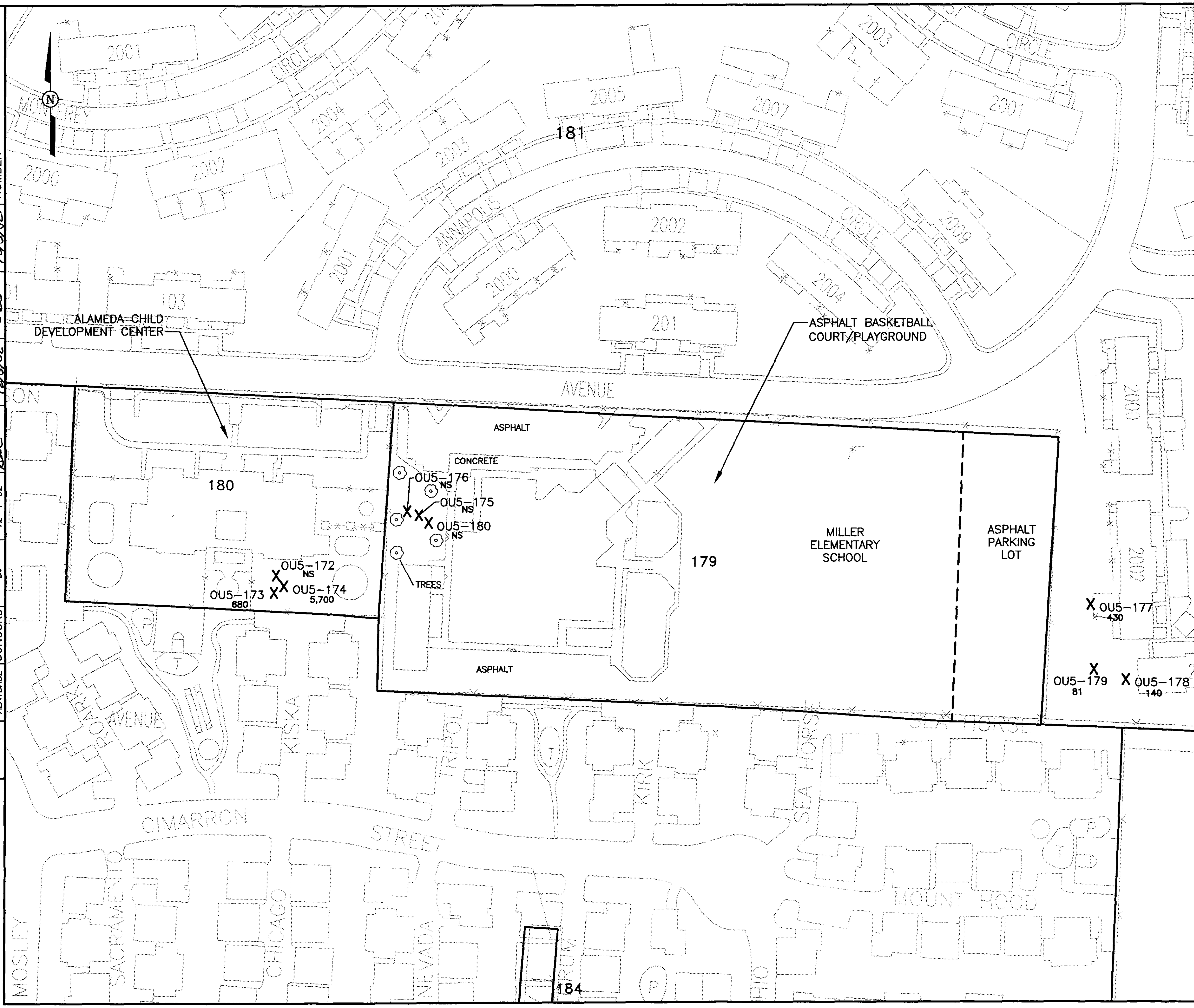
SCALE

0 100 200 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-12
MILLER ELEMENTARY SCHOOL AND ALAMEDA CHILD DEVELOPMENT CENTER
BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS
0.5-2.0 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-3-02	12/5/02	JES 12/5/02	819814-B68



LEGEND

———	PARCEL BOUNDARY
179	PARCEL NUMBER
X	SOIL SAMPLING LOCATION
220	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
NS	NOT SAMPLED, HIT REFUSAL WHILE SAMPLING

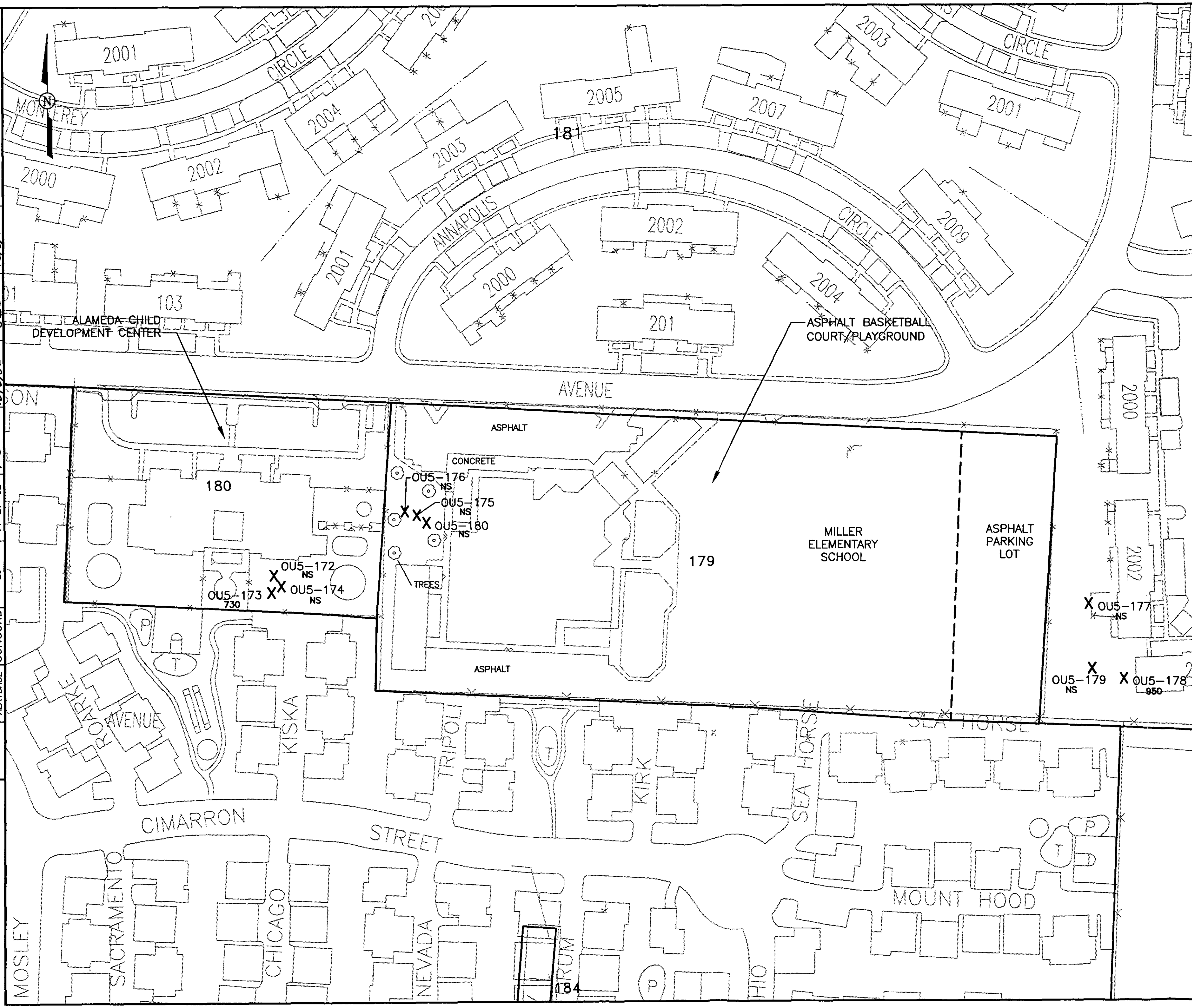
SCALE

0 100 200 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–13
MILLER ELEMENTARY SCHOOL AND ALAMEDA CHILD DEVELOPMENT CENTER BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS
2.0–4.0 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-4-02	12/5/02	JES 12/5/02	819814-B69



DRAWING NUMBER	APPROVED BY	CHECKED BY	DRAWN BY	OFFICE	X-REF	IMAGE
819814-B70	JES 12/3/02	12/3/02	BJ 11-27-02	CONCORD	ALA1BASE	---

LEGEND

———	PARCEL BOUNDARY
179	PARCEL NUMBER
X	SOIL SAMPLING LOCATION
730	BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATION IN MICROGRAMS PER KILOGRAM (parts per billion [ppb])
NS	NOT SAMPLED, HIT REFUSAL WHILE SAMPLING

SCALE

0 100 200 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–14
MILLER ELEMENTARY SCHOOL AND ALAMEDA CHILD DEVELOPMENT CENTER BENZO(a)PYRENE (BaP) EQUIVALENT CONCENTRATIONS
4.0–8.0 FT. DEPTH INTERVAL

Table 4-3 (Page 1 of 3)
Soil Sampling Field Duplicate Relative Percent Difference for Benzo(a)pyrene-Equivalent Results

Boring	Sample Depth Interval (ft bgs)	Normal Sample Concentration (µg/kg)		Duplicate Sample Concentration (µg/kg)		Relative Percent Difference (percent)	Soil Type
OU5-003	2 - 4	2,800	J	750		115	SP/CL
OU5-006	2 - 4	1,800		610		99	SP/CL
OU5-009	2 - 4	110		59		60	SM/CL
OU5-012	2 - 4	130		110		17	CL
OU5-015	4 - 8	530		7,800		175	CL/SW
OU5-018	2 - 4	140		190		30	ML/CL
OU5-021	4 - 8	30,000	J	49,000	J	48	CL/SW
OU5-024	2 - 4	1,400		3,800	J	92	ML/CL
OU5-027	4 - 8	500		1,200		82	CL
OU5-030	0.5 - 2	320		330		3	CL
OU5-033	0.5 - 2	910		660		32	SM
OU5-036	4 - 8	26,000	J	6,600	J	119	SW
OU5-039	2 - 4	11,000	J	860		171	CL/SW
OU5-042	2 - 4	7,300	J	9,000	J	21	GM/CL
OU5-045	2 - 4	990		1,700		53	SM/SW
OU5-048	2 - 4	1,400		1,300		7	SW/CL
OU5-051	2 - 4	4,700	J	3,300	J	35	SM/ML
OU5-054	2 - 4	5,300	J	10,000	J	61	SM/CL
OU5-057	0.5 - 2	8,300	J	2,800	J	99	ML/SW
OU5-060	2 - 4	2,300	J	2,000	J	14	ML./CL
OU5-066	0.5 - 2	1,600	J	2,000	J	22	SM
OU5-069	2 - 4	3,100		2,600		18	SM/CL/SW
OU5-072	2 - 4	3,800		4,600		19	ML/CL
OU5-075	2 - 4	2,000		1,200		50	CL
OU5-078	0.5 - 2	950		1,200		23	SM/SW
OU5-081	4 - 8	1,700		4,100		83	CL/SW
OU5-084	0.5 - 2	2,900		290		164	SM/SW
OU5-087	4 - 8	860		560		42	SW
OU5-090	2 - 4	6,000		7,200		18	SM

Table 4-3 (Page 2 of 3)
Soil Sampling Field Duplicate Relative Percent Difference for Benzo(a)pyrene-Equivalent Results

Boring	Sample Depth Interval (ft bgs)	Normal Sample Concentration (µg/kg)		Duplicate Sample Concentration (µg/kg)		Relative Percent Difference (percent)	Soil Type
OU5-095	0.5 - 2	2,000		2,000		0	ML
OU5-096	2 - 4	1,200		3,800		104	SM/GC
OU5-099	0.5 - 2	4,400		520		158	SM
OU5-102	0.5 - 2	1,500		320		130	SM
OU5-106	0.5 - 2	370		390		5	SW
OU5-108	2 - 4	300		230		26	SW
OU5-111	0.5 - 2	2,300		1,600		36	SM
OU5-114	2 - 4	1,000		500		67	SM/SP
OU5-117	2 - 4	1,800		2,000		11	SW/CL
OU5-120	0.5 - 2	280		440		44	SM/SW
OU5-123	0.5 - 2	1,100		590		60	SW/SM
OU5-126	2 - 4	8,600		4,700		59	SW
OU5-129	2 - 4	100	J	82	J	20	SW
OU5-133	2 - 4	1,200		2,500		70	CL
OU5-135	2 - 4	210		240		13	SW
OU5-138	4 - 8	92		45		69	SW
OU5-141	2 - 4	3,300	J	3,000	J	10	SM/CL
OU5-144	0.5 - 2	750		550		31	SM
OU5-147	2 - 4	790		1,100		33	SW/SM
OU5-150	4 - 8	150		170		13	SM
OU5-153	0.5 - 2	90		160		56	SW
OU5-156	2 - 4	30	U	30	U	0	SM
OU5-159	2 - 4	35	J	34	U	3	SW/CL
OU5-163	2 - 4	32	U	31	U	3	SW

Table 4-3 (Page 3 of 3)
Soil Sampling Field Duplicate Relative Percent Difference for Benzo(a)pyrene-Equivalent Results

Boring	Sample Depth Interval (ft bgs)	Normal Sample Concentration (µg/kg)		Duplicate Sample Concentration (µg/kg)		Relative Percent Difference (percent)	Soil Type
OU5-165	0.5 - 2	52		30	U	54	SW
OU5-168	2 - 4	760		74		165	SW

µg/kg denotes microgram(s) per kilogram
ft bgs denotes feet below ground surface
J denotes estimated concentration
U denotes not detected above the listed value

Soil Type:
GC - clayey gravels gravel-sand-clay mixtures
SW - well graded sands, gravelly sands, little or no fines
SM - silty sands sand-silt mixture
ML – inorganic silts and very fine sands, rock/ flour, silty or clayey fine sands
GM - silty gravels, gravel-sand-silt mixtures
SP - poorly graded sands, gravelly sands, little or no fines
CL – inorganic clays, gravelly clays, sandy clays, silty clays, lean clays

inherent variability associated with the soil matrix, which makes it impossible to completely homogenize a soil sample. Despite the variability observed within samples and between adjacent samples, a distinct pattern of BaP-equivalent concentrations was discernable, as described earlier in this text.

The PAH sample results show an area of high BaP-equivalent concentrations within the central portion of the North Village Housing Area. The area is roughly bounded by Mosley Avenue on the north, northwest, and east; Singleton Avenue on the south; and Monterey Circle on the west. During the development of the RI, a time-critical-removal action (TCRA) was performed in this area and in Parcels 182 and 183 (see Figure 2-9). Areas outside the proposed TCRA had lower BaP-equivalent concentrations and were not addressed in the TCRA but are evaluated in the risk assessment presented in Section 5.0.

The distribution of PAHs in soils supports the preliminary site conceptual model presented in Section 2.4, where the PAHs are thought to have been placed at OU-5 with the fill material that was used to create the present day land surface; and, not due to separate spills or leaks during operational activities by the Navy. If the source of the PAHs was due to a spill or leak at the site, small-scale variability such as that seen in closely spaced samples and homogenized duplicate samples would not be expected. What would be expected would be a very good agreement between nearby samples and sample duplicates. In addition, it would be expected that the vertical concentration profile would decrease with depth, not increase as is shown by the data.

The large-scale variation in PAH concentrations in soil are likely due to different fill sources. That is, the source for the soils within the northern, western, and central portion of OU-5 likely had higher concentrations of PAHs than did the soils placed in the vicinity of Mayport and Kollmann Circles.

4.1.2 Inorganic Chemicals

Metals and cyanide concentrations were evaluated at 60 locations across OU-5, and at the same depth intervals as for the PAHs, to determine if there was evidence of impacts to soil. Table 4-4, "Summary Statistics of the Metals Soil Data by Depth" lists the summary statistics for the 17 metals and cyanide analyzed. Analytical results show that arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc were routinely detected in soils across OU-5; whereas antimony, molybdenum, selenium, silver, and thallium were detected in less than 35 percent of the samples. Arsenic was the only metal measured at levels above its EPA Region 9 residential soil preliminary remediation goal (PRG), which is a risk-based soil screening value used for initial evaluation of a contaminated site. Cyanide was only detected in one sample at an estimated value slightly over the method detection limit. A complete listing of metal and cyanide analytical results is provided in Appendix D.

Figures 4-15 through 4-38 present maps of the concentrations at each depth interval for arsenic, cadmium, chromium, copper, lead, and mercury. Arsenic maps are provided because this metal was routinely detected at concentrations exceeding its PRG. The remaining five metals are mapped because they are commonly associated with industrial processes and were identified by the regulatory agencies as being of interest for this reason.

In the 0 to 0.5 feet bgs depth interval, concentrations of arsenic and copper appear slightly higher in the western and eastern portions of Parcel 181 than in the remaining areas. At deeper intervals (0.5 to 2 feet bgs, 2 to 4 feet bgs, and 4 to 8 feet bgs), concentrations of arsenic in the western portion of Parcel 181 appear higher than in other portions of Parcel 181. A similar pattern of higher concentrations in the southwestern portion of Parcel 181 was evident in the data from the deeper intervals for chromium and mercury.

Lead concentrations appear higher in the surface then at depth, with many of the highest values located in the southwestern portion of Parcel 181. Most cadmium data were reported as not detected by the analytical laboratory and no spatial patterns were discernible.

Box plots comparing the range of site concentrations of arsenic, cadmium, chromium, copper, lead, and mercury to the range measured in background data are presented in Appendix B, Figures B-14 to B-19. These plots include metals data from three Alameda ambient data sets ("pink," "yellow," and "blue") described in *Summary of Background Concentrations in Soil and Groundwater, Alameda Point, Alameda, California* (TtEMI, 2001). Data from all three data sets was used because, although samples from the "pink" data set were collected closest to OU-5, none of the three Alameda background data sets represent fill material deposited during the fill placement time period associated with the area presently occupied by the OU-5. The box plots suggest that five of the six metals (excluding cadmium) are elevated relative to the "pink" data set. However, none of the six metals are present at concentrations or in patterns that clearly indicate a release to the environment. For example, none are consistently higher then the other Alameda background data sets, or higher than sediment ambient data, or are present in a pattern that would denote a surface spill.

The relatively high degree of variability in metals concentrations among the background data sets is probably related to the fact that the fill that constitutes the sample media is of different pedigree for each data set. The pink data set represents fill material that was deposited over several fill events including 1916 to 1929, 1930 to 1939, and 1940 to 1944. The yellow data set

Table 4-4 (Page 1 of 5)
Summary Statistics of the Metals Soil Data by Depth

Analyte	Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (mg/kg)		Detected Concentrations (mg/kg)		EPA Region IX Residential PRGs (mg/kg)
	Top	Bottom	Total	Non-Detects	Detects		Minimum	Maximum	Minimum	Maximum	
ANTIMONY	0	0.5	58	49	9	15.5	0.5	12.5	0.15	4.98	31
ANTIMONY	0.5	2	29	23	6	20.7	5.2	13.2	0.16	6.81	
ANTIMONY	2	4	29	24	5	17.2	5.3	14.3	0.57	5.13	
ANTIMONY	4	8	30	29	1	3.3	5.6	16.1	4.57	4.57	
ARSENIC	0	0.5	58	0	58	100.0			0.63	8.5	0.39
ARSENIC	0.5	2	29	0	29	100.0			0.84	11.4	
ARSENIC	2	4	29	0	29	100.0			1.4	9.48	
ARSENIC	4	8	30	0	30	100.0			1.18	8.03	
BARIUM	0	0.5	58	0	58	100.0			15.8	186	5400
BARIUM	0.5	2	29	0	29	100.0			18.9	177	
BARIUM	2	4	29	0	29	100.0			16.4	231	
BARIUM	4	8	30	0	30	100.0			15.7	172	
BERYLLIUM	0	0.5	58	35	23	39.7	0.21	1.17	0.078	0.483	150
BERYLLIUM	0.5	2	29	20	9	31.0	0.21	1.09	0.076	0.486	
BERYLLIUM	2	4	29	19	10	34.5	0.21	1.16	0.048	0.781	
BERYLLIUM	4	8	30	21	9	30.0	0.23	1.47	0.0997	0.834	

Table 4-4 (Page 2 of 5)
Summary Statistics of the Metals Soil Data by Depth

Analyte	Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (mg/kg)		Detected Concentrations (mg/kg)		EPA Region IX Residential PRGs (mg/kg)
	Top	Bottom	Total	Non-Detects	Detects		Minimum	Maximum	Minimum	Maximum	
CADMIUM	0	0.5	58	30	28	48.3	0.2	0.598	0.058	0.44	9*
CADMIUM	0.5	2	29	18	11	37.9	0.037	0.661	0.099	0.37	
CADMIUM	2	4	29	18	11	37.9	0.2	0.714	0.064	0.39	
CADMIUM	4	8	30	21	9	30.0	0.2	0.803	0.065	1.7	
CHROMIUM	0	0.5	58	0	58	100.0			2.46	81.5	210**
CHROMIUM	0.5	2	29	0	29	100.0			21.1	71.2	
CHROMIUM	2	4	29	0	29	100.0			20.7	95.4	
CHROMIUM	4	8	30	0	30	100.0			16.1	121	
COBALT	0	0.5	58	0	58	100.0			1.2	16.9	4700
COBALT	0.5	2	29	0	29	100.0			3.7	12.9	
COBALT	2	4	29	0	29	100.0			2.66	23.1	
COBALT	4	8	30	1	29	96.7	2.34	2.34	3	25.3	
COPPER	0	0.5	58	0	58	100.0			4.3	71.1	2900
COPPER	0.5	2	29	0	29	100.0			4.9	42.8	
COPPER	2	4	29	0	29	100.0			3.14	70.5	
COPPER	4	8	30	0	30	100.0			4.6	63.6	
CYANIDE	0	0.5	58	58	0	0	0.5	2.9			NA
CYANIDE	0.5	2	29	29	0	0	0.5	3			
CYANIDE	2	4	30	29	1	3.3	0.5	3.6	6.8	6.8	

Table 4-4 (Page 3 of 5)
Summary Statistics of the Metals Soil Data by Depth

Analyte	Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (mg/kg)		Detected Concentrations (mg/kg)		EPA Region IX Residential PRGs (mg/kg)
	Top	Bottom	Total	Non-Detects	Detects		Minimum	Maximum	Minimum	Maximum	
CYANIDE	4	8	30	30	0	0	0.5	3.8			NA
LEAD	0	0.5	58	0	58	100.0			5.4	92.6	400
LEAD	0.5	2	29	0	29	100.0			2.95	51.7	
LEAD	2	4	29	0	29	100.0			4.65	77.9	
LEAD	4	8	30	0	30	100.0			2.2	49.5	
MERCURY	0	0.5	58	7	51	87.9	0.2	0.2	0.022	0.95	23
MERCURY	0.5	2	29	6	23	79.3	0.107	0.2	0.017	0.541	
MERCURY	2	4	29	8	21	72.4	0.11	0.2	0.022	0.884	
MERCURY	4	8	30	10	20	66.7	0.1	0.2	0.039	0.753	
MOLYBDENUM	0	0.5	58	51	7	12.1	0.21	6.26	0.903	1.91	390
MOLYBDENUM	0.5	2	29	29	0	0.0	0.21	6.61			
MOLYBDENUM	2	4	29	24	5	17.2	0.21	7.01	0.042	4.54	
MOLYBDENUM	4	8	30	27	3	10.0	0.23	8.03	0.25	2.45	
NICKEL	0	0.5	58	0	58	100.0			4.02	74.1	1600
NICKEL	0.5	2	29	0	29	100.0			18.9	61.2	
NICKEL	2	4	29	0	29	100.0			18.4	118	
NICKEL	4	8	30	0	30	100.0			9.59	135	
SELENIUM	0	0.5	58	40	18	31.0	0.53	1.25	0.22	0.68	390
SELENIUM	0.5	2	29	17	12	41.4	0.52	1.32	0.2	1.4	

Table 4-4 (Page 4 of 5)
Summary Statistics of the Metals Soil Data by Depth

Analyte	Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (mg/kg)		Detected Concentrations (mg/kg)		EPA Region IX Residential PRGs (mg/kg)
	Top	Bottom	Total	Non-Detects	Detects		Minimum	Maximum	Minimum	Maximum	
SELENIUM	2	4	29	20	9	31.0	0.53	1.4	0.24	1.2	390
SELENIUM	4	8	30	22	8	26.7	0.57	1.61	0.43	35.5	
SILVER	0	0.5	58	57	1	1.7	0.52	1.25	0.77	0.77	390
SILVER	0.5	2	29	28	1	3.4	0.51	1.32	0.463	0.463	
SILVER	2	4	29	29	0	0.0	0.53	1.43			
SILVER	4	8	30	30	0	0.0	0.56	1.61			
THALLIUM	0	0.5	58	37	21	36.2	0.52	53	0.633	2.12	5.2
THALLIUM	0.5	2	29	23	6	20.7	0.51	2.19	0.68	1.51	
THALLIUM	2	4	29	22	7	24.1	0.53	2.47	0.723	1.66	
THALLIUM	4	8	30	24	6	20.0	0.56	2.55	0.812	84.7	
VANADIUM	0	0.5	58	0	58	100.0			5.7	59.2	550
VANADIUM	0.5	2	29	0	29	100.0			17.7	50.2	
VANADIUM	2	4	29	0	29	100.0			14.6	71.5	
VANADIUM	4	8	30	0	30	100.0			11.4	84.5	

Table 4-4 (Page 5 of 5)
Summary Statistics of the Metals Soil Data by Depth

Analyte	Depth Interval (feet bgs)		Number of Samples			Percent Detects	Reporting Limits for Nondetects (mg/kg)		Detected Concentrations (mg/kg)		EPA Region IX Residential PRGs (mg/kg)
	Top	Bottom	Total	Non-Detects	Detects		Minimum	Maximum	Minimum	Maximum	
ZINC	0	0.5	58	0	58	100.0			19.2	168	23000
ZINC	0.5	2	29	0	29	100.0			20.5	129	
ZINC	2	4	29	0	29	100.0			12	237	
ZINC	4	8	30	0	30	100.0			11.7	139	

bgs denotes below ground surface
EPA denotes U.S. Environmental Protection Agency
mg/kg denotes milligram(s) per kilogram
NA denotes not applicable (there is not a PRG for total cyanide)
PRG denotes preliminary remediation goal
**California-modified PRG*
*** Total Chromium*

Figure 4-15
Spatial Distribution of Arsenic in the 0 to 0.5 foot Depth Interval

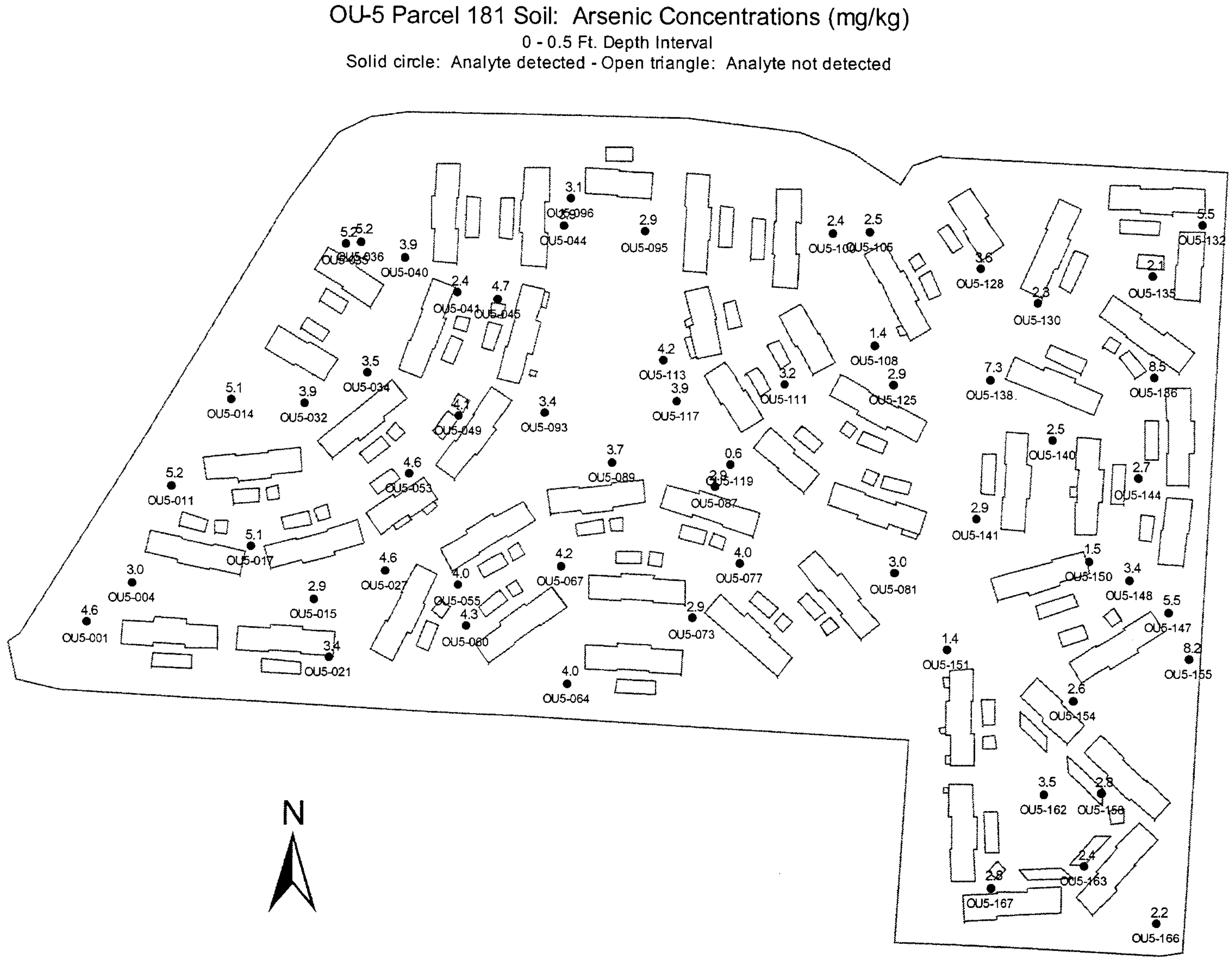


Figure 4-16
Spatial Distribution of Arsenic in the 0.5 to 2 foot Depth Interval

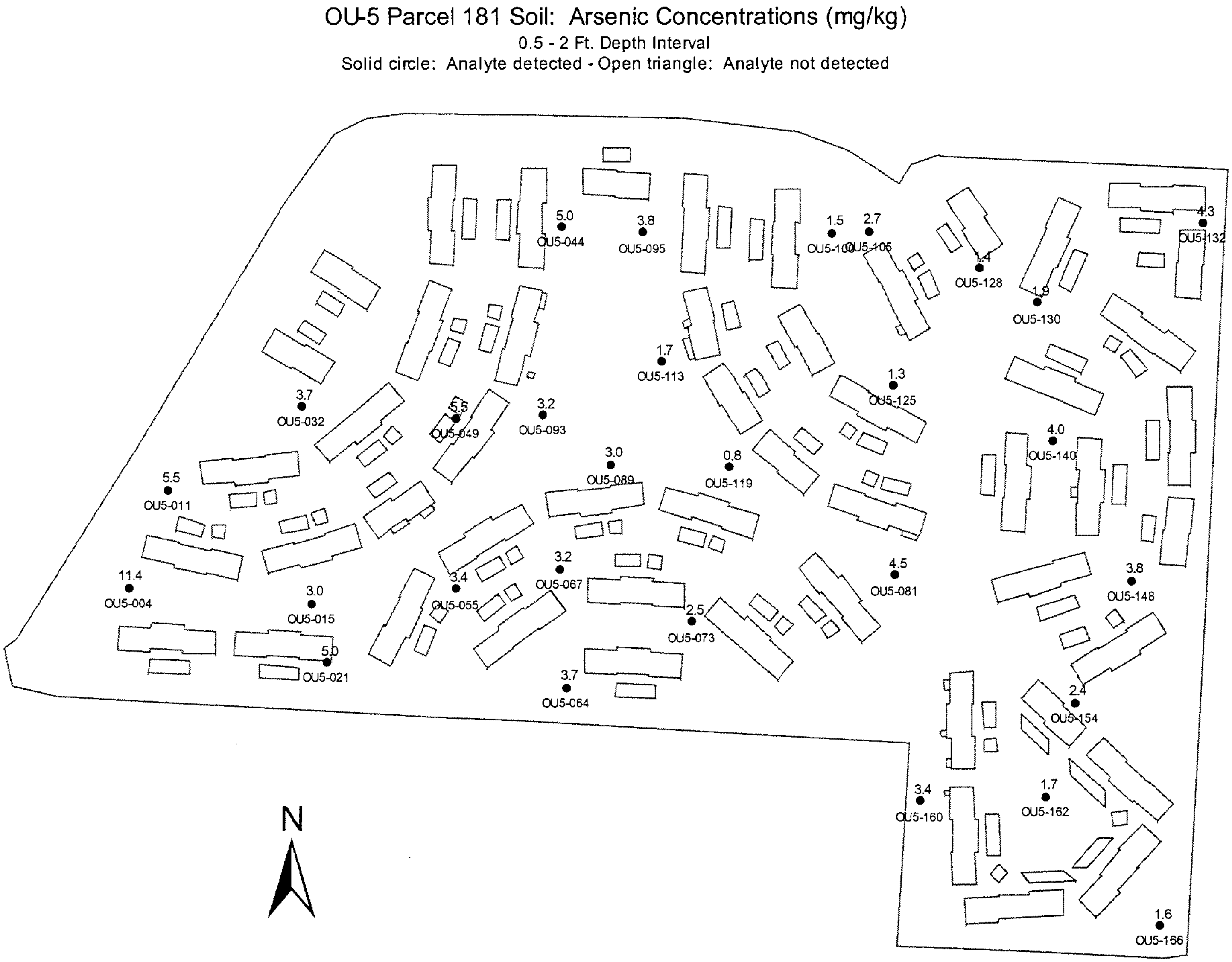


Figure 4-17
Spatial Distribution of Arsenic in the 2 to 4 foot Depth Interval

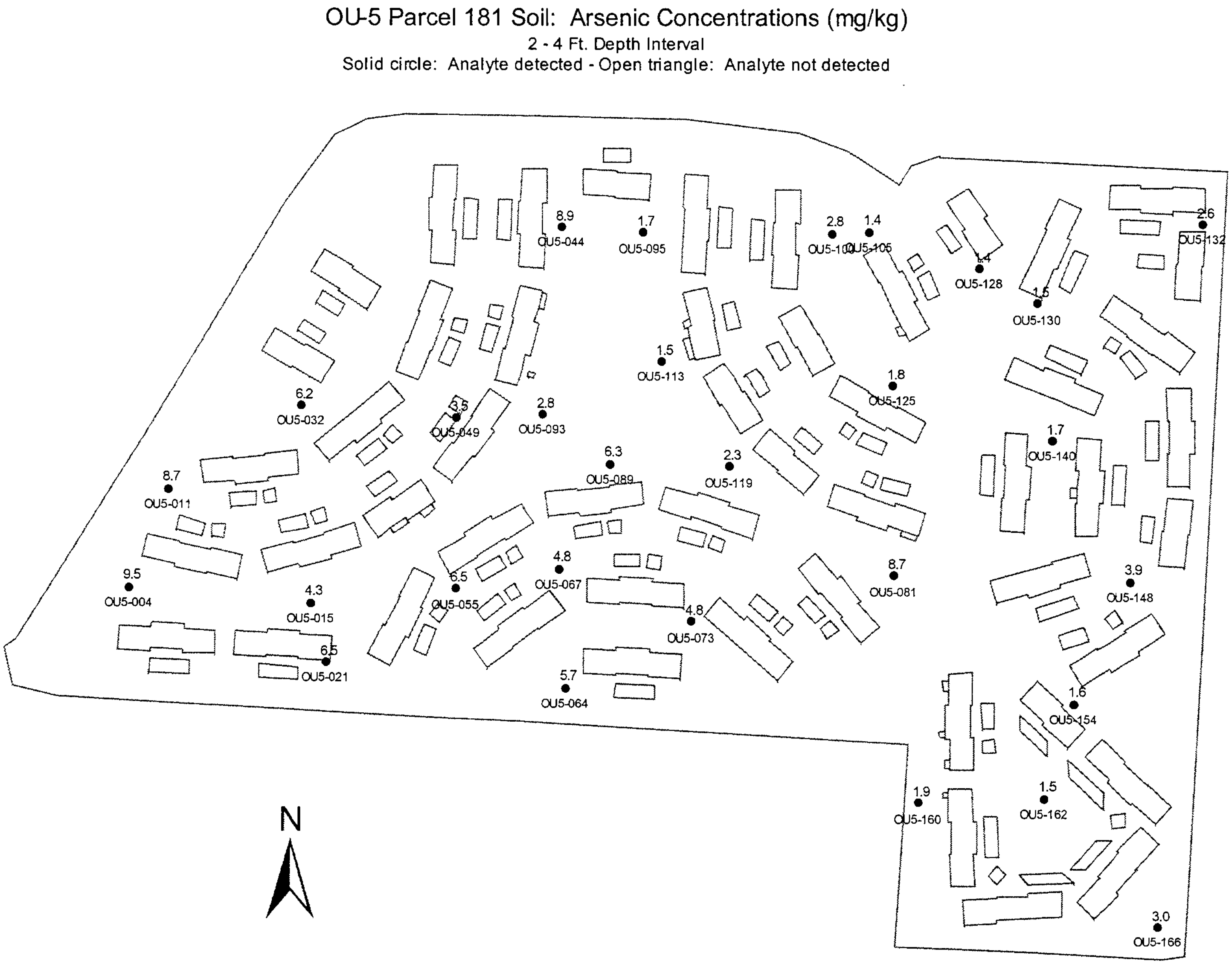


Figure 4-18
Spatial Distribution of Arsenic in the 4 to 8 foot Depth Interval

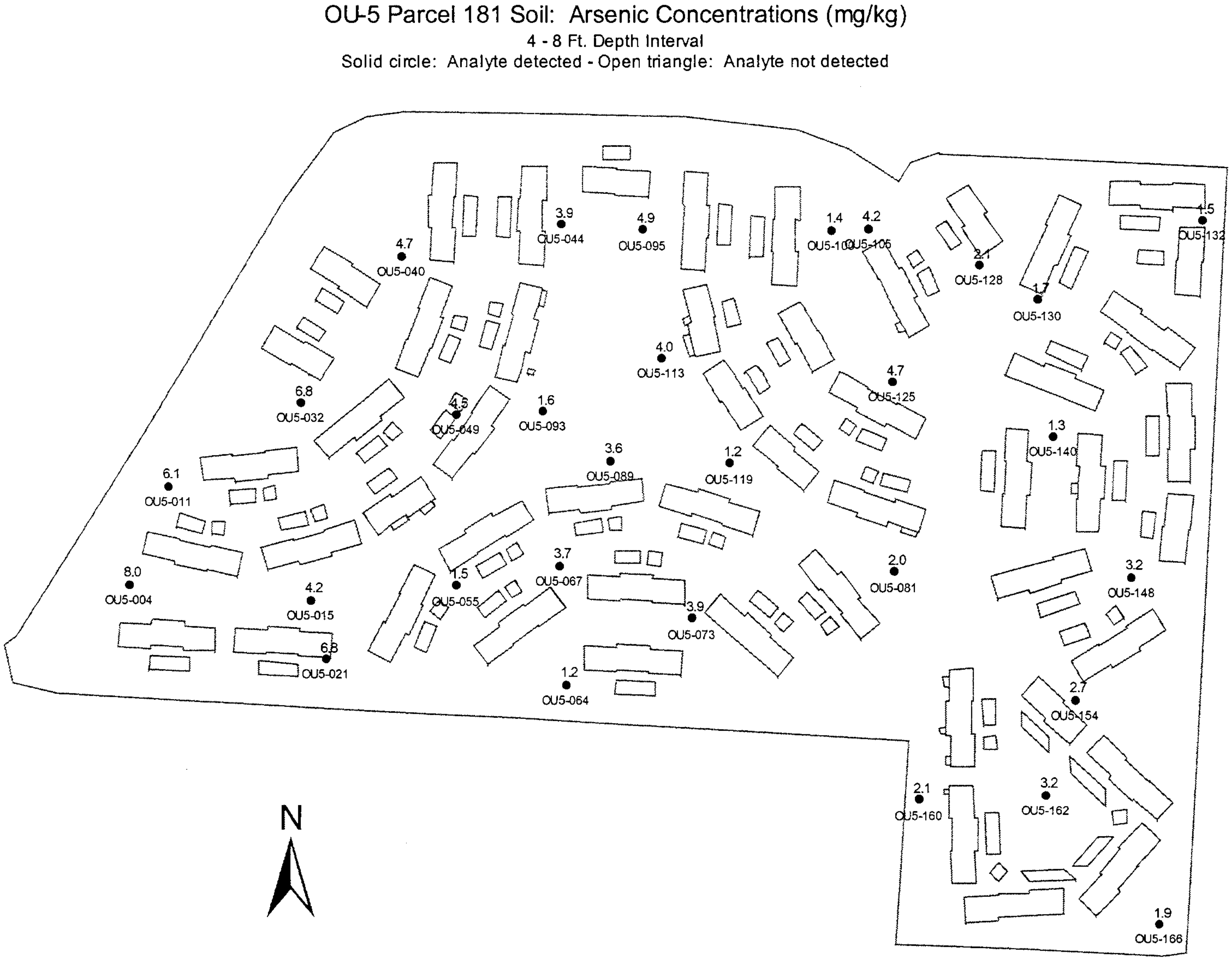


Figure 4-19
Spatial Distribution of Cadmium in the 0 to 0.5 foot Depth Interval

OU-5 Parcel 181 Soil: Cadmium Concentrations (mg/kg)

0 - 0.5 Ft. Depth Interval

Solid circle: Analyte detected - Open triangle: Analyte not detected

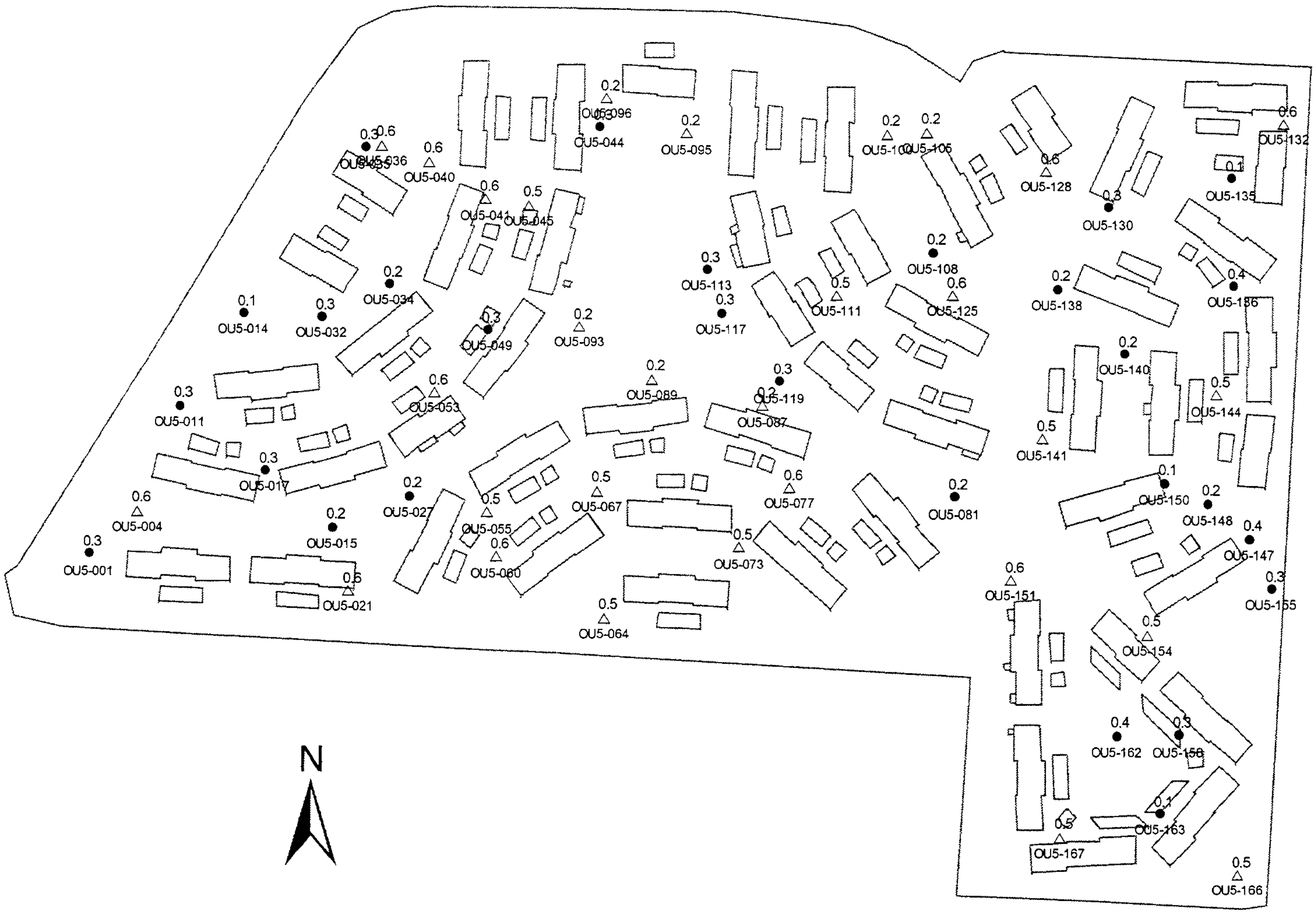


Figure 4-20
Spatial Distribution of Cadmium in the 0.5 to 2 foot Depth Interval

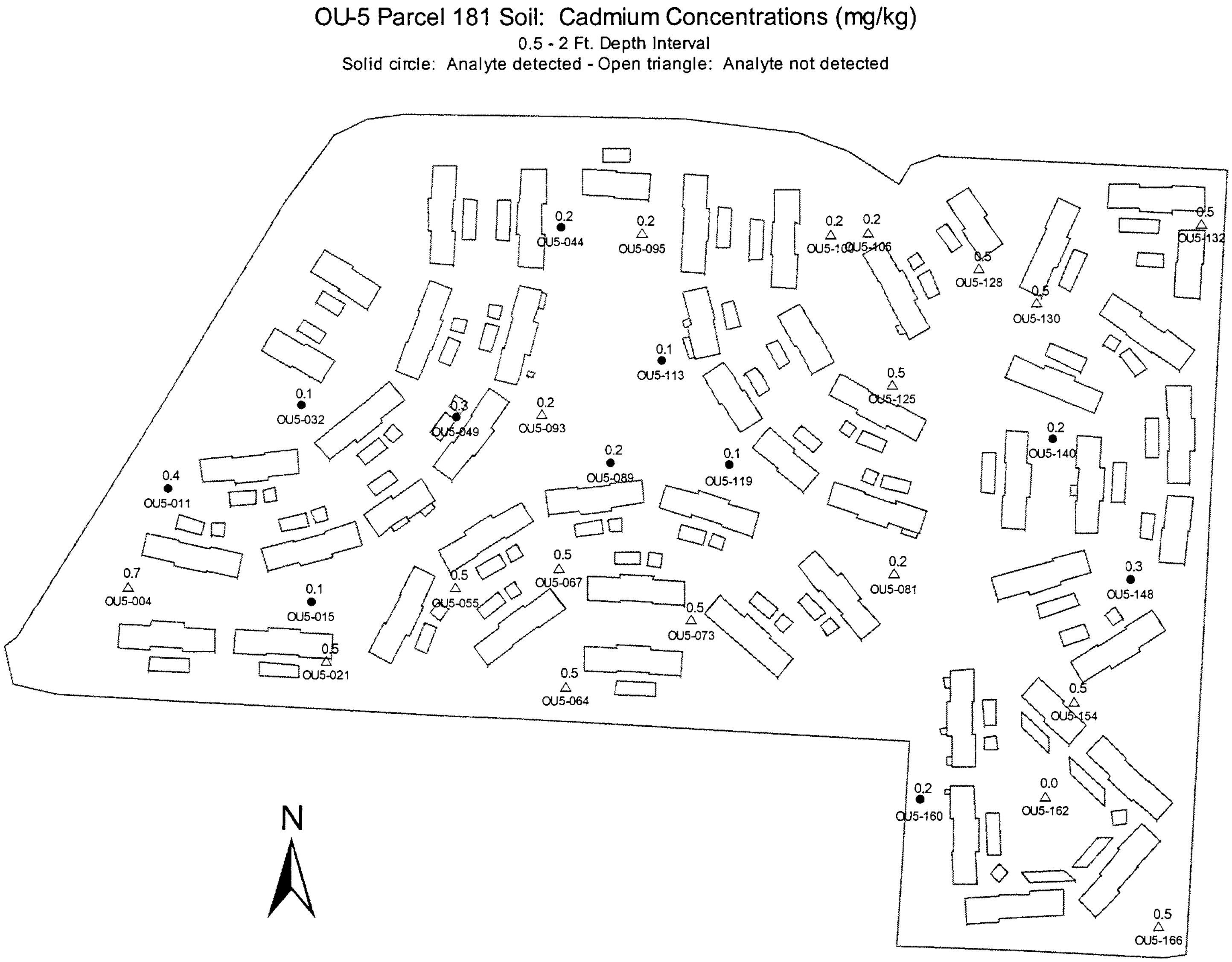


Figure 4-21
Spatial Distribution of Cadmium in the 2 to 4 foot Depth Interval

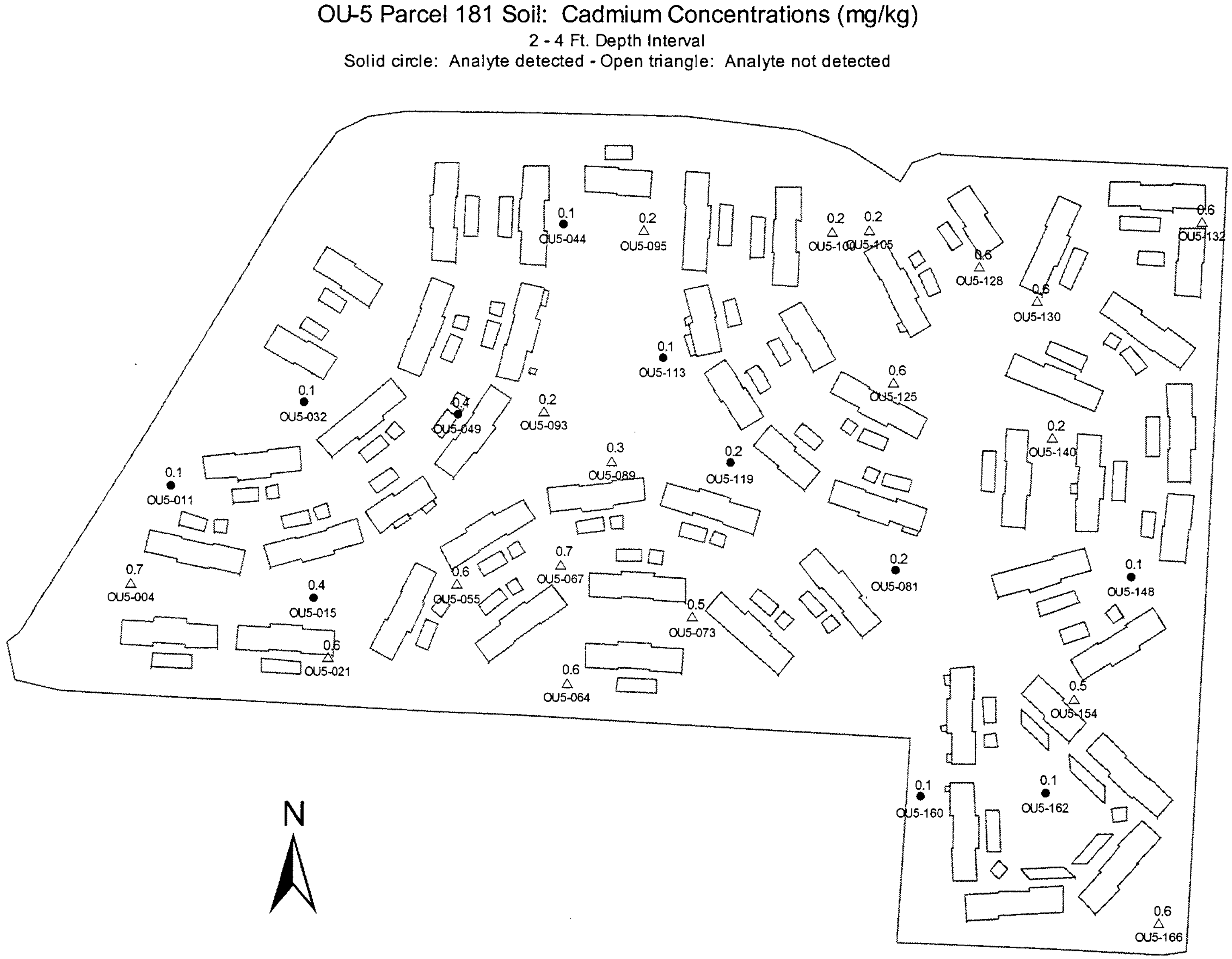


Figure 4-22
Spatial Distribution of Cadmium in the 4 to 8 foot Depth Interval

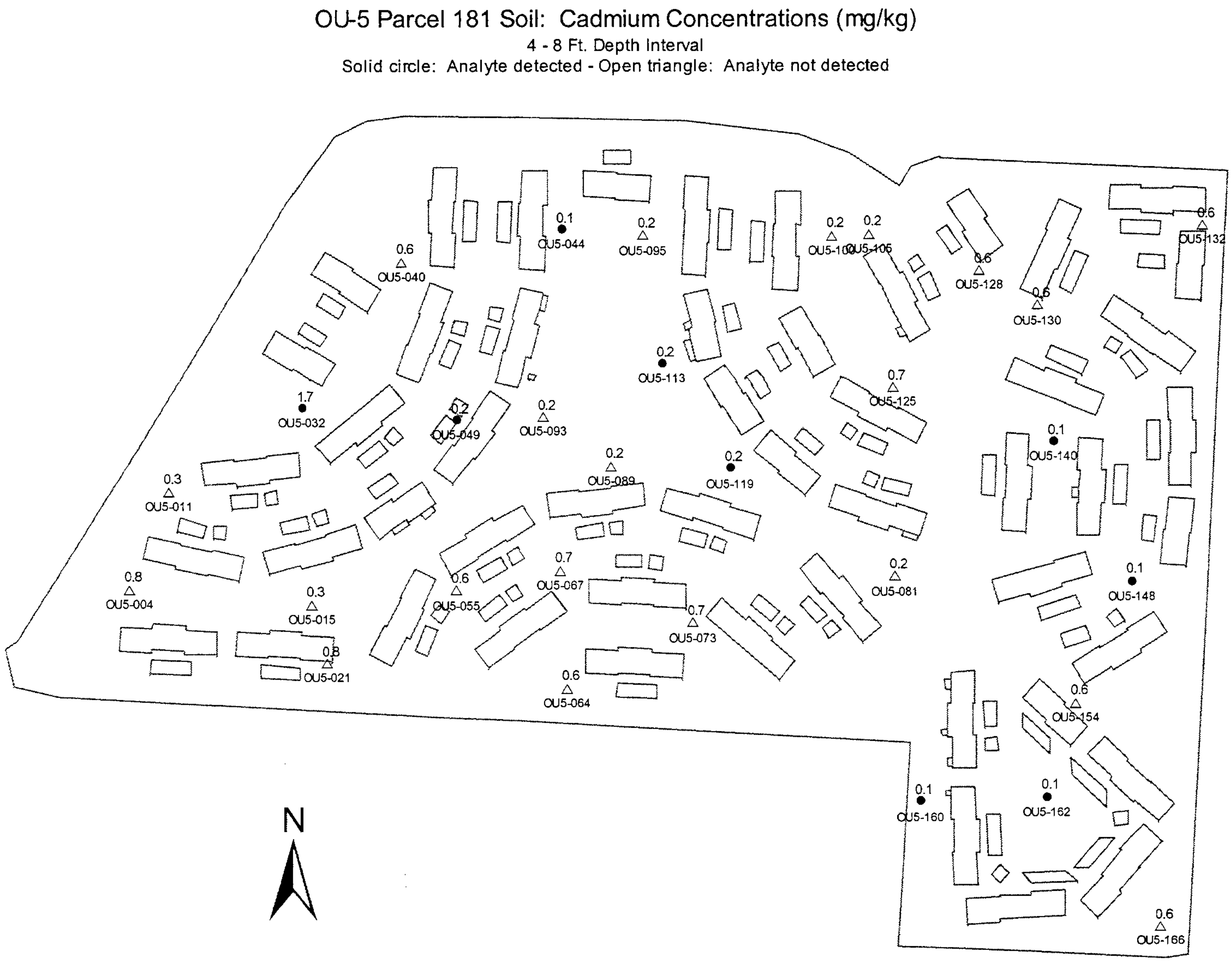


Figure 4-23
Spatial Distribution of Chromium in the 0 to 0.5 foot Depth Interval

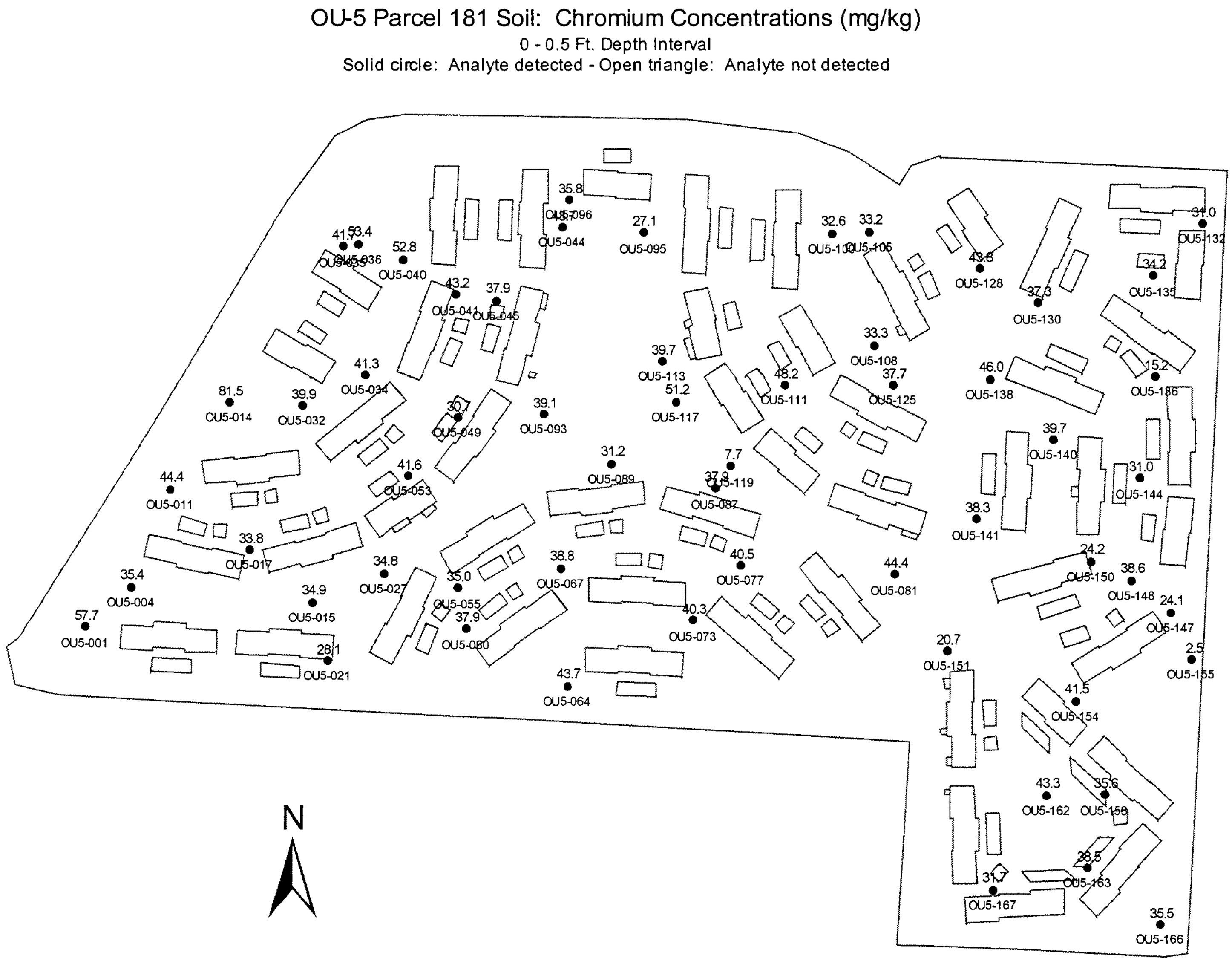


Figure 4-24
Spatial Distribution of Chromium in the 0.5 to 2 foot Depth Interval

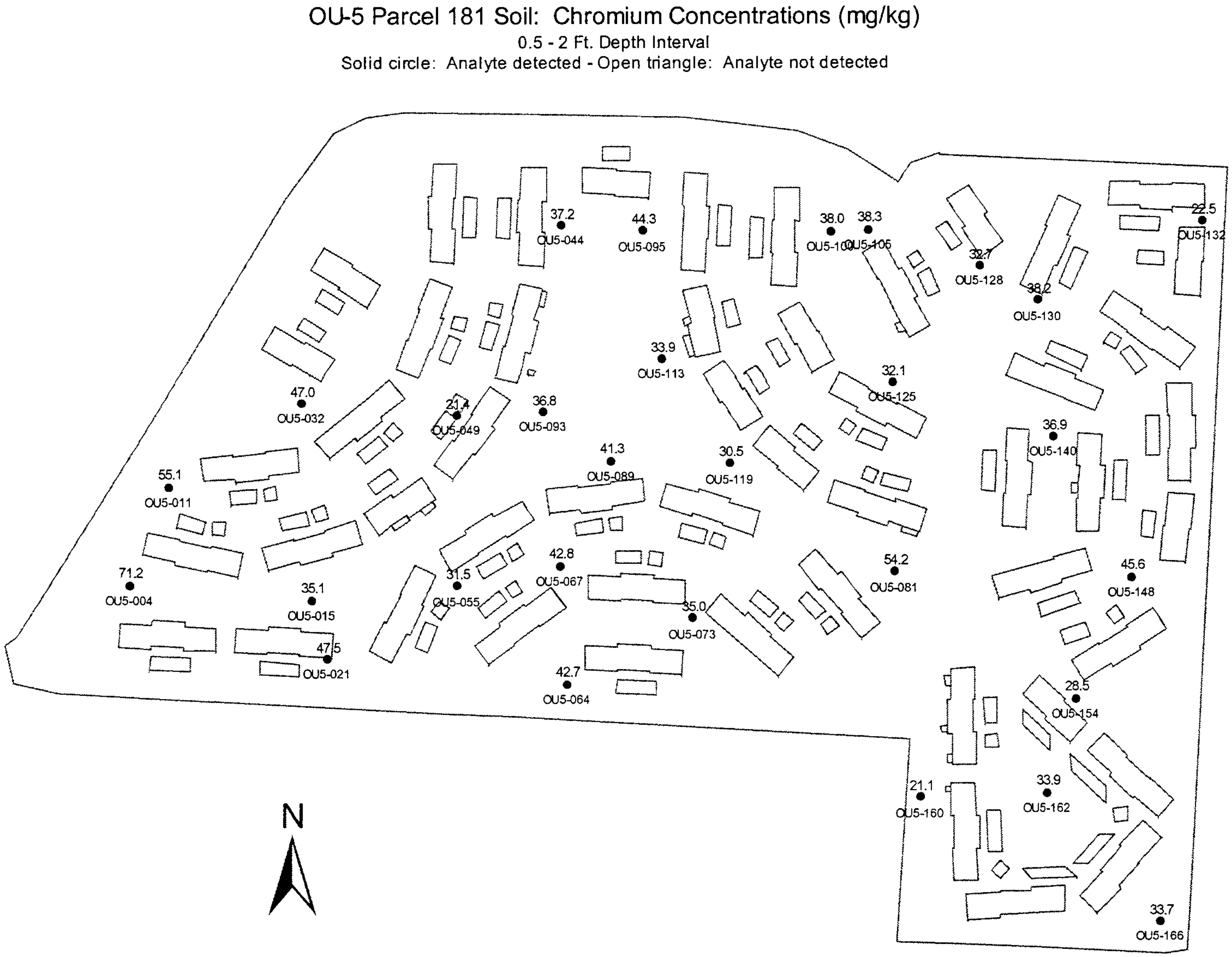


Figure 4-25
Spatial Distribution of Chromium in the 2 to 4 foot Depth Interval

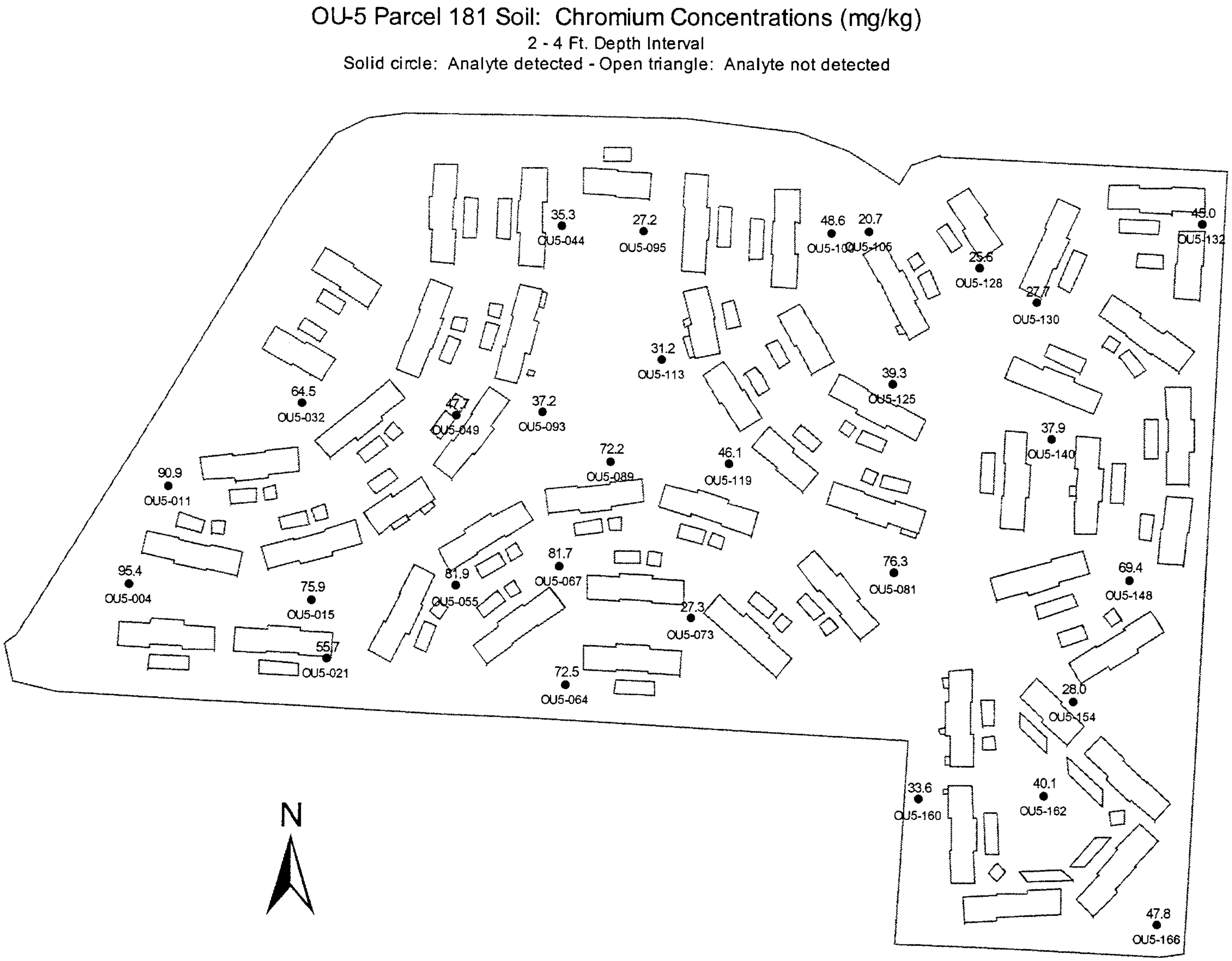


Figure 4-26
Spatial Distribution of Chromium in the 4 to 8 foot Depth Interval

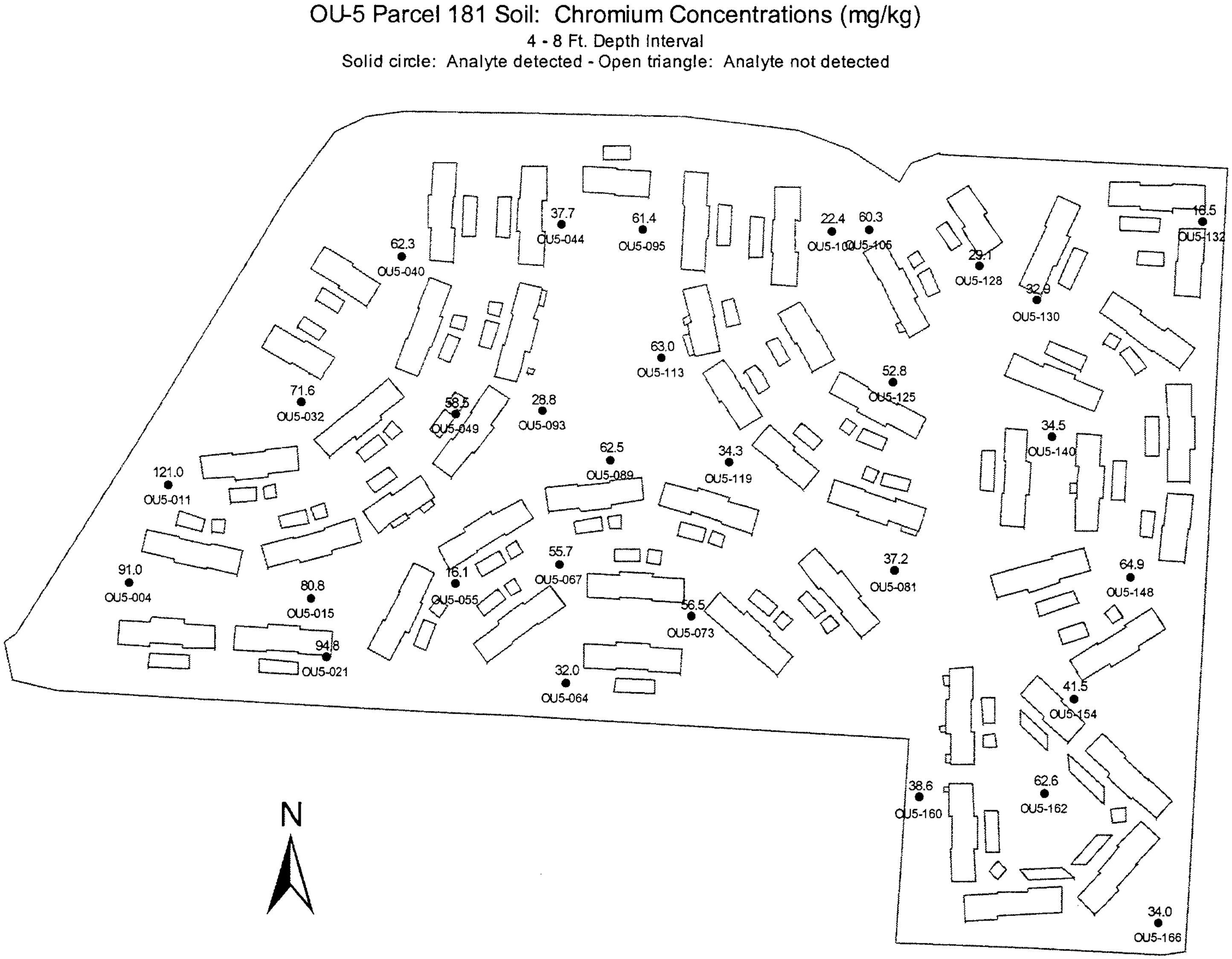


Figure 4-27
Spatial Distribution of Copper in the 0 to 0.5 foot Depth Interval

OU-5 Parcel 181 Soil: Copper Concentrations (mg/kg)
0 - 0.5 Ft. Depth Interval
Solid circle: Analyte detected - Open triangle: Analyte not detected

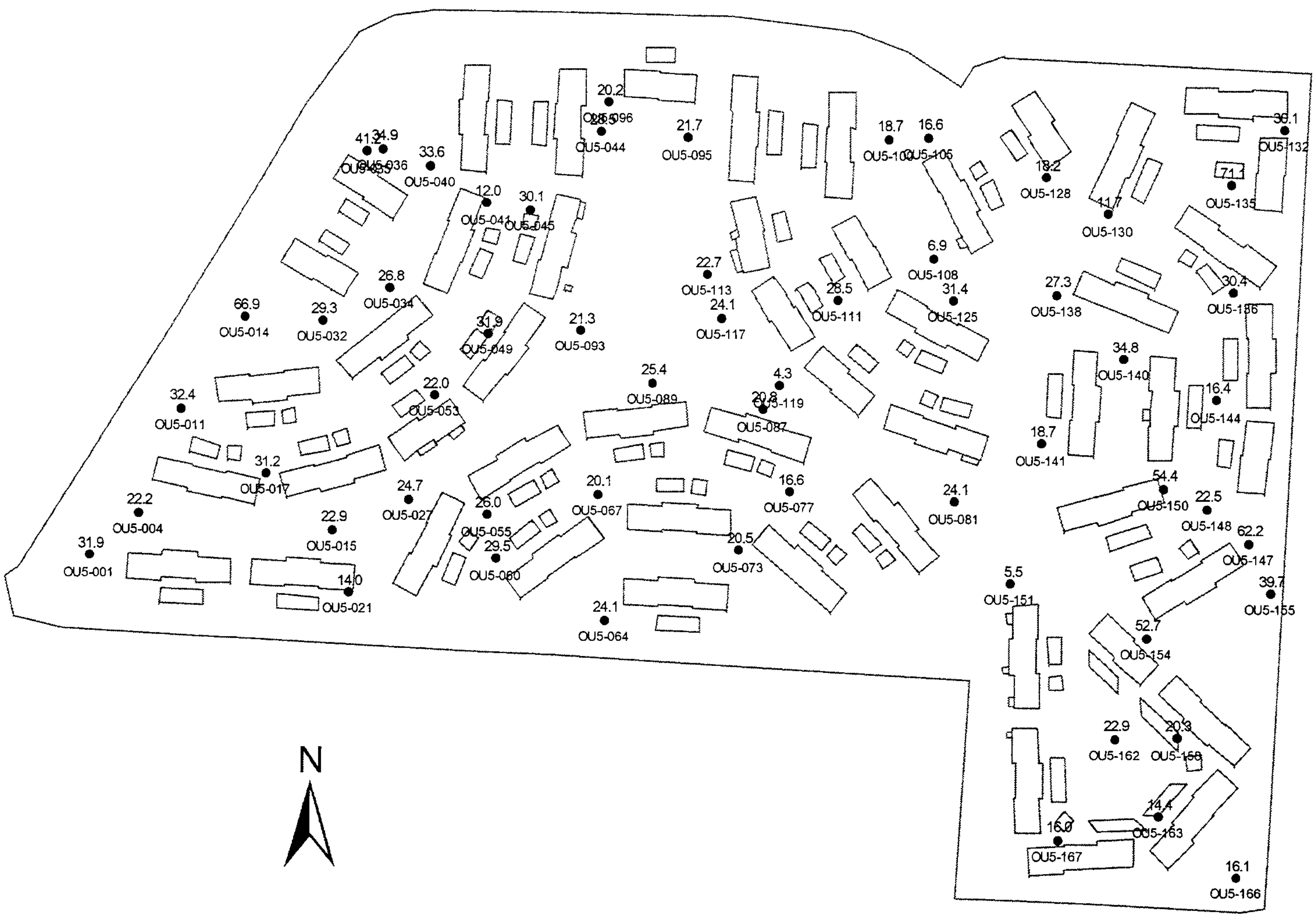


Figure 4-28
Spatial Distribution of Copper in the 0.5 to 2 foot Depth Interval

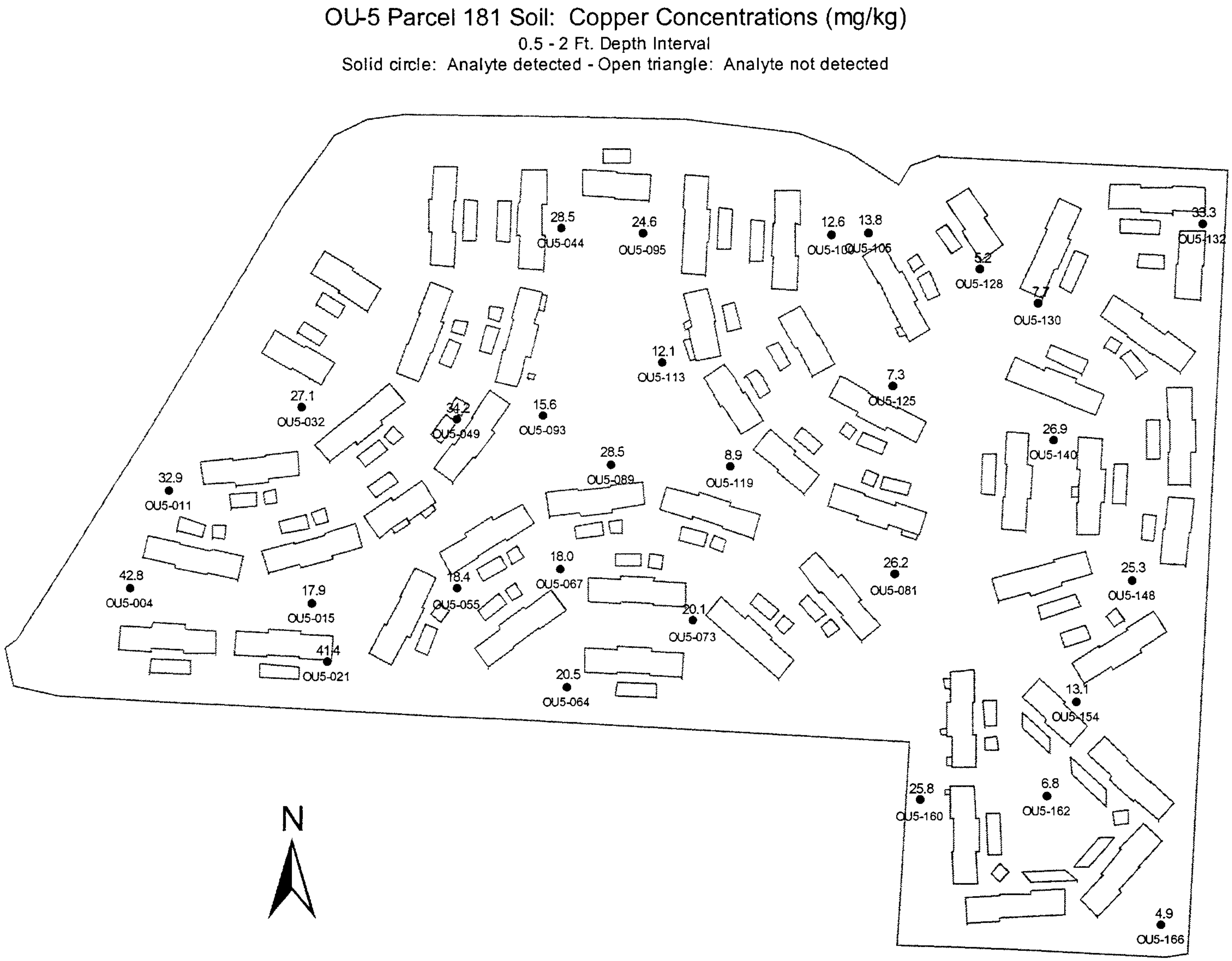


Figure 4-29
Spatial Distribution of Copper in the 2 to 4 foot Depth Interval

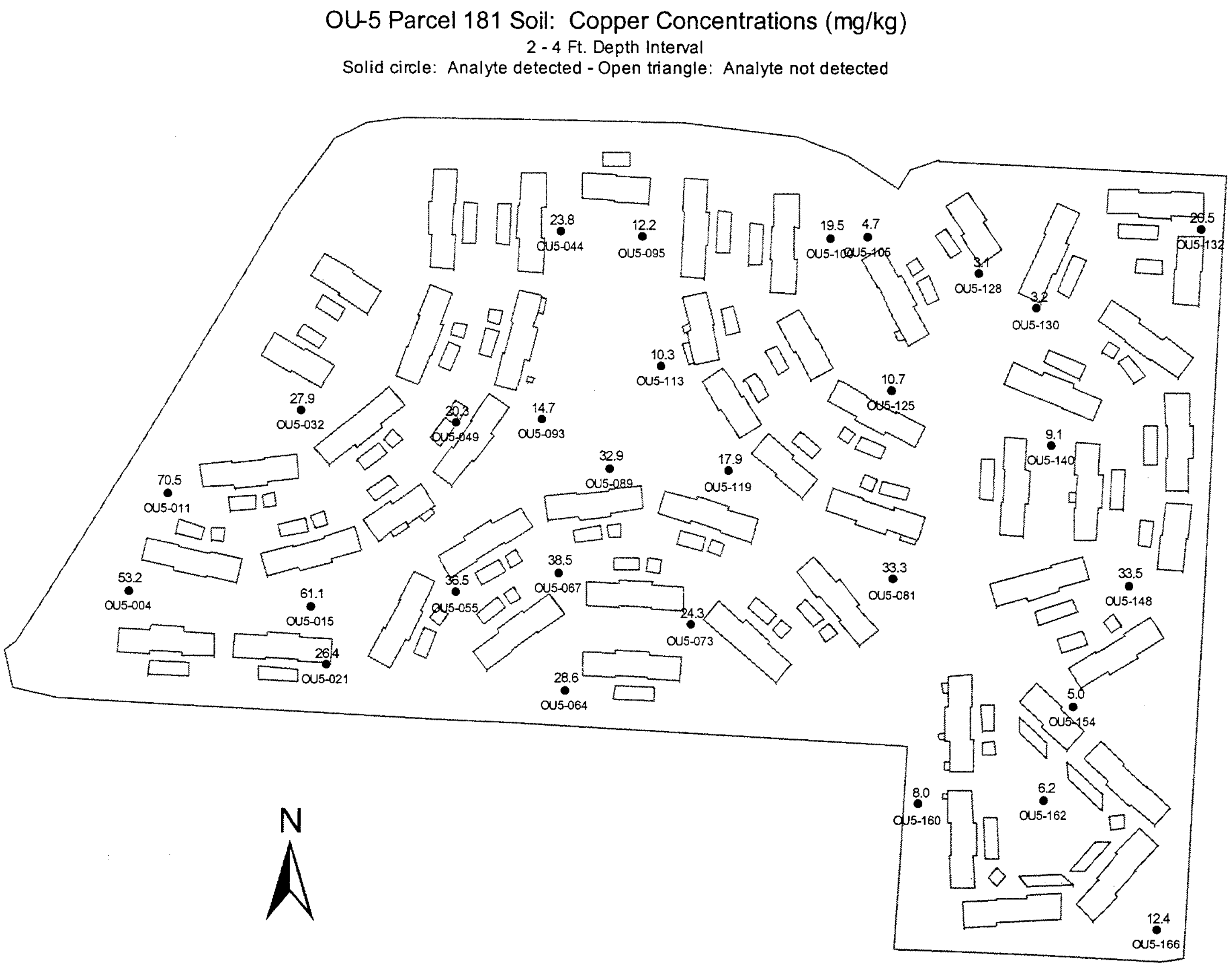


Figure 4-30
Spatial Distribution of Copper in the 4 to 8 foot Depth Interval

OU-5 Parcel 181 Soil: Copper Concentrations (mg/kg)
4 - 8 Ft. Depth Interval
Solid circle: Analyte detected - Open triangle: Analyte not detected

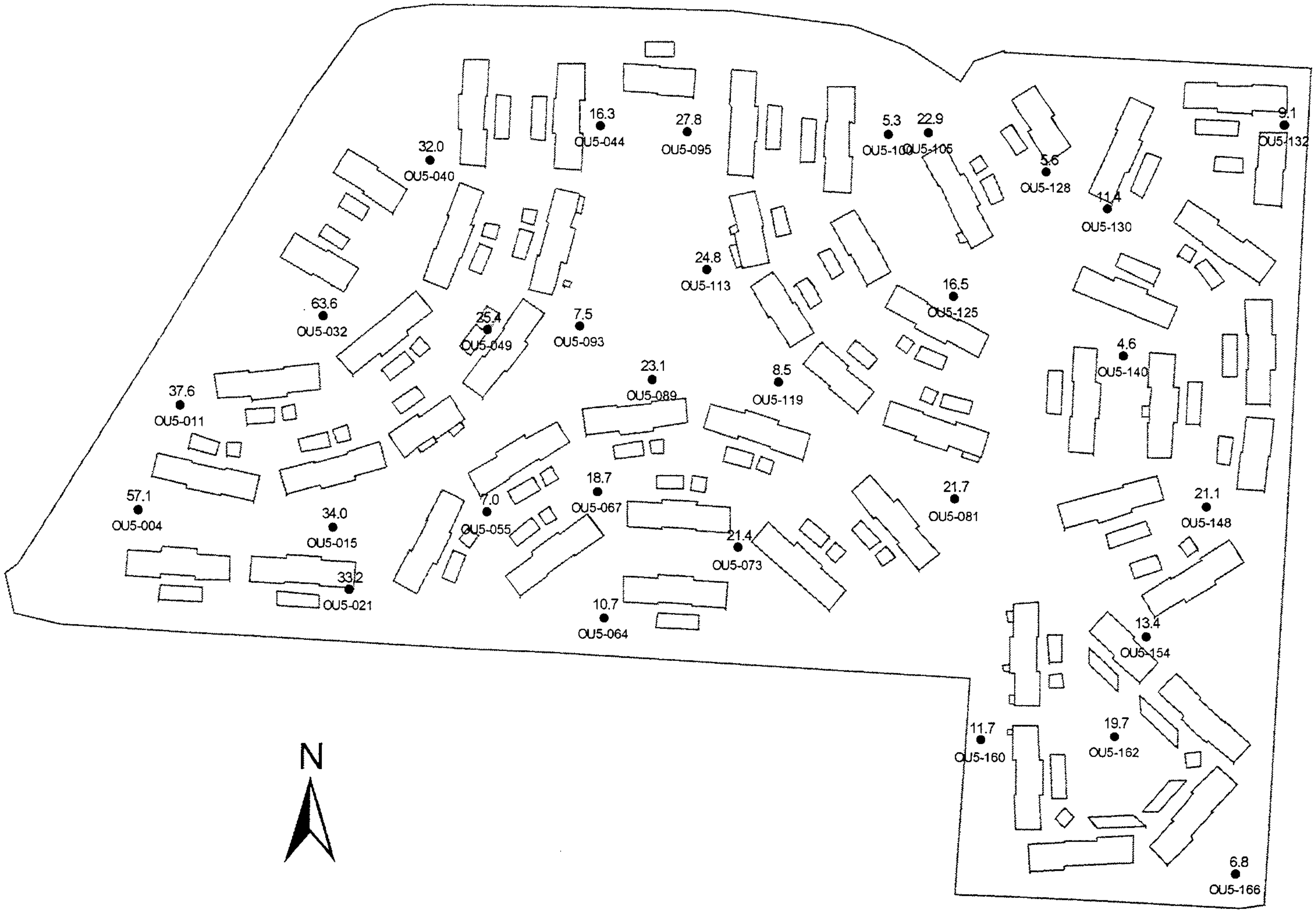


Figure 4-31
Spatial Distribution of Lead in the 0 to 0.5 foot Depth Interval

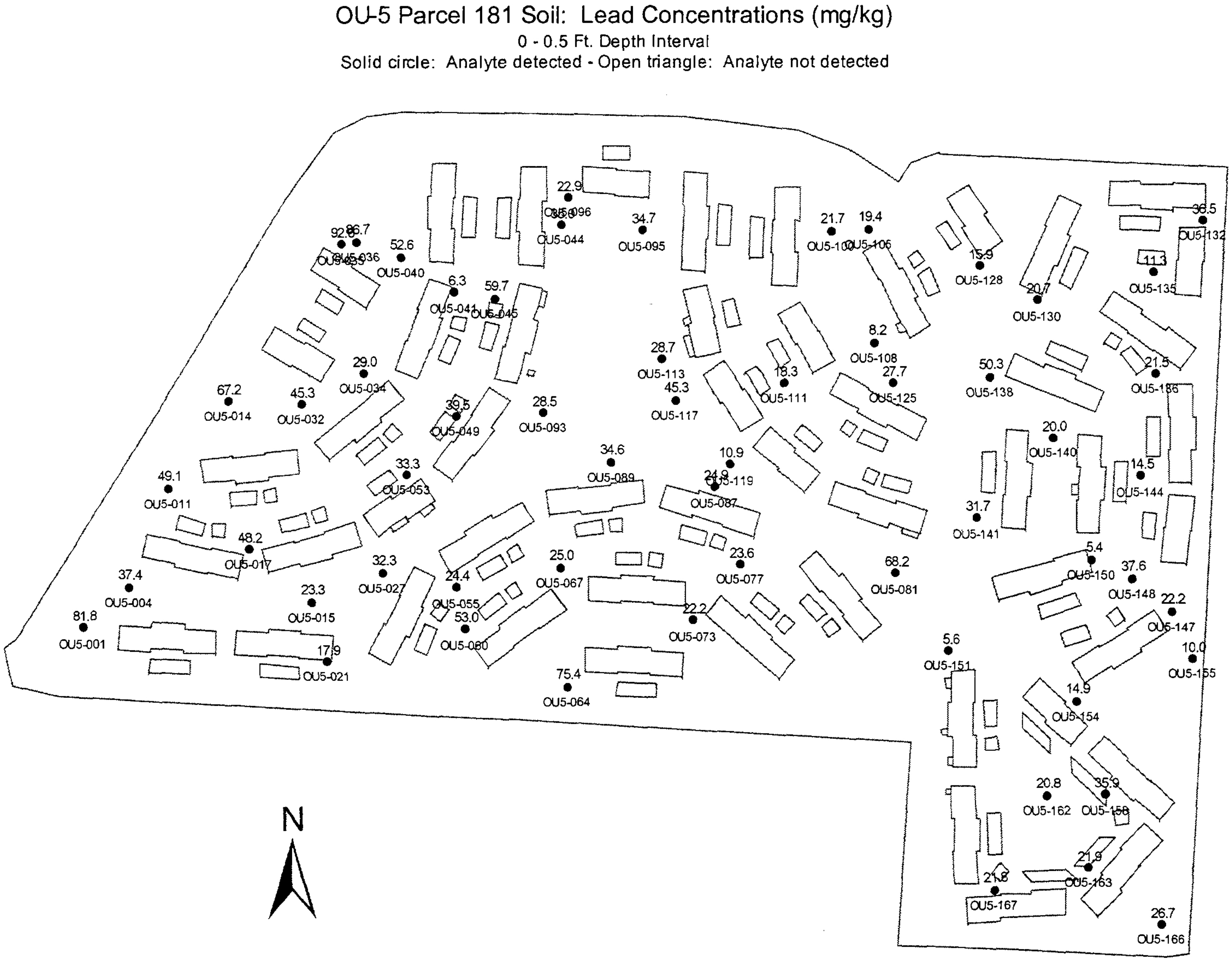


Figure 4-32
Spatial Distribution of Lead in the 0.5 to 2 foot Depth Interval

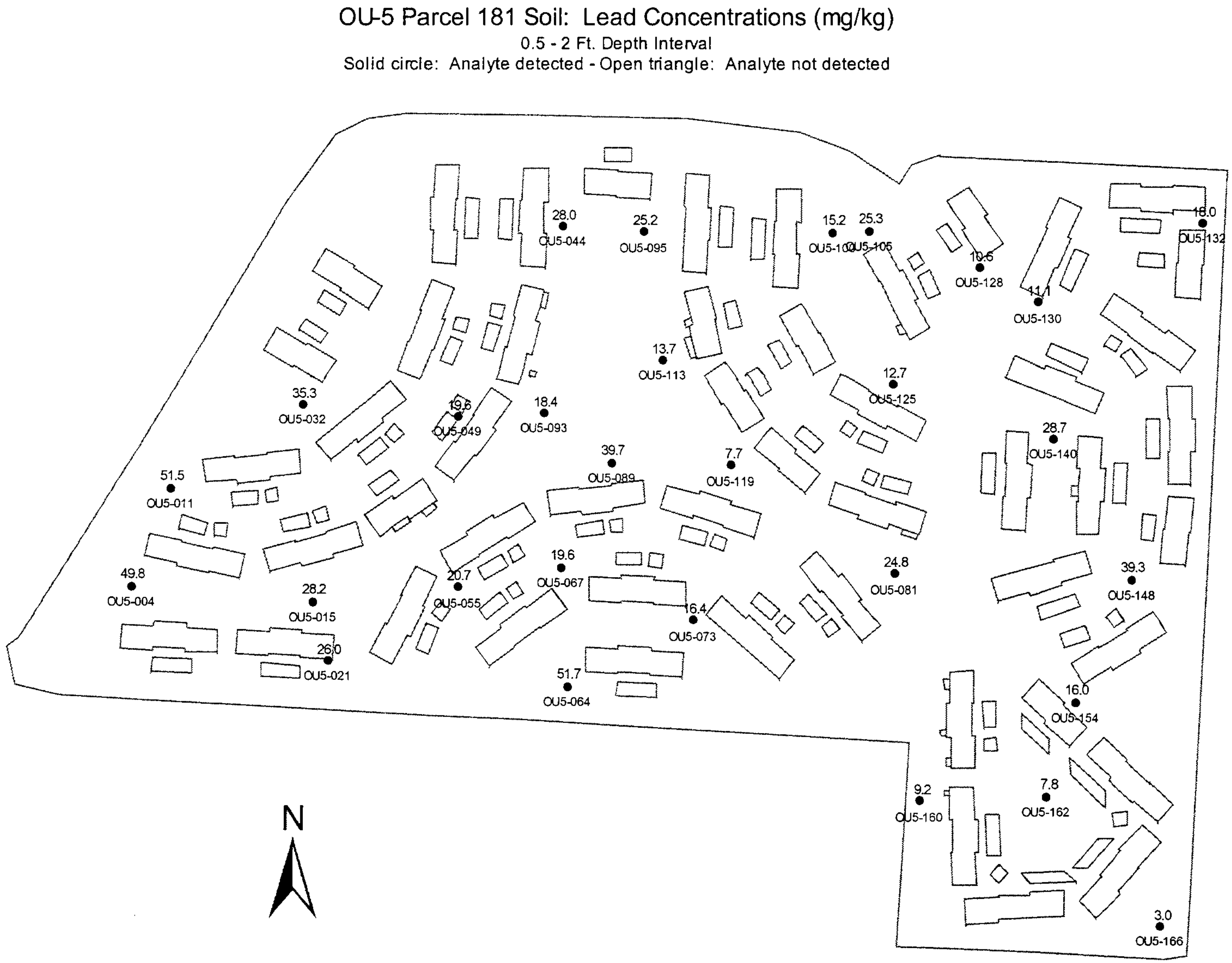


Figure 4-33
Spatial Distribution of Lead in the 2 to 4 foot Depth Interval

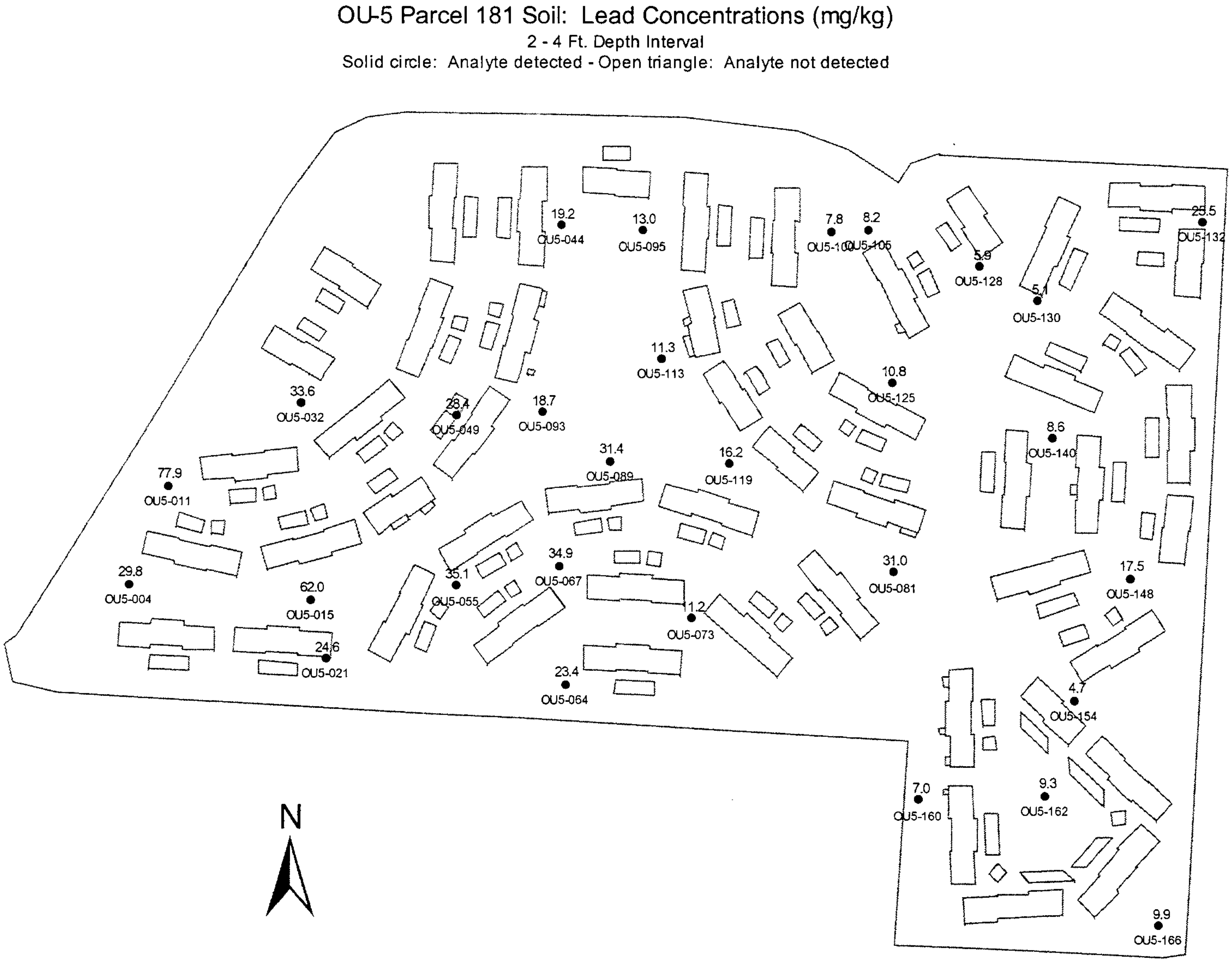


Figure 4-34
Spatial Distribution of Lead in the 4 to 8 foot Depth Interval

OU-5 Parcel 181 Soil: Lead Concentrations (mg/kg)
4 - 8 Ft. Depth Interval
Solid circle: Analyte detected - Open triangle: Analyte not detected

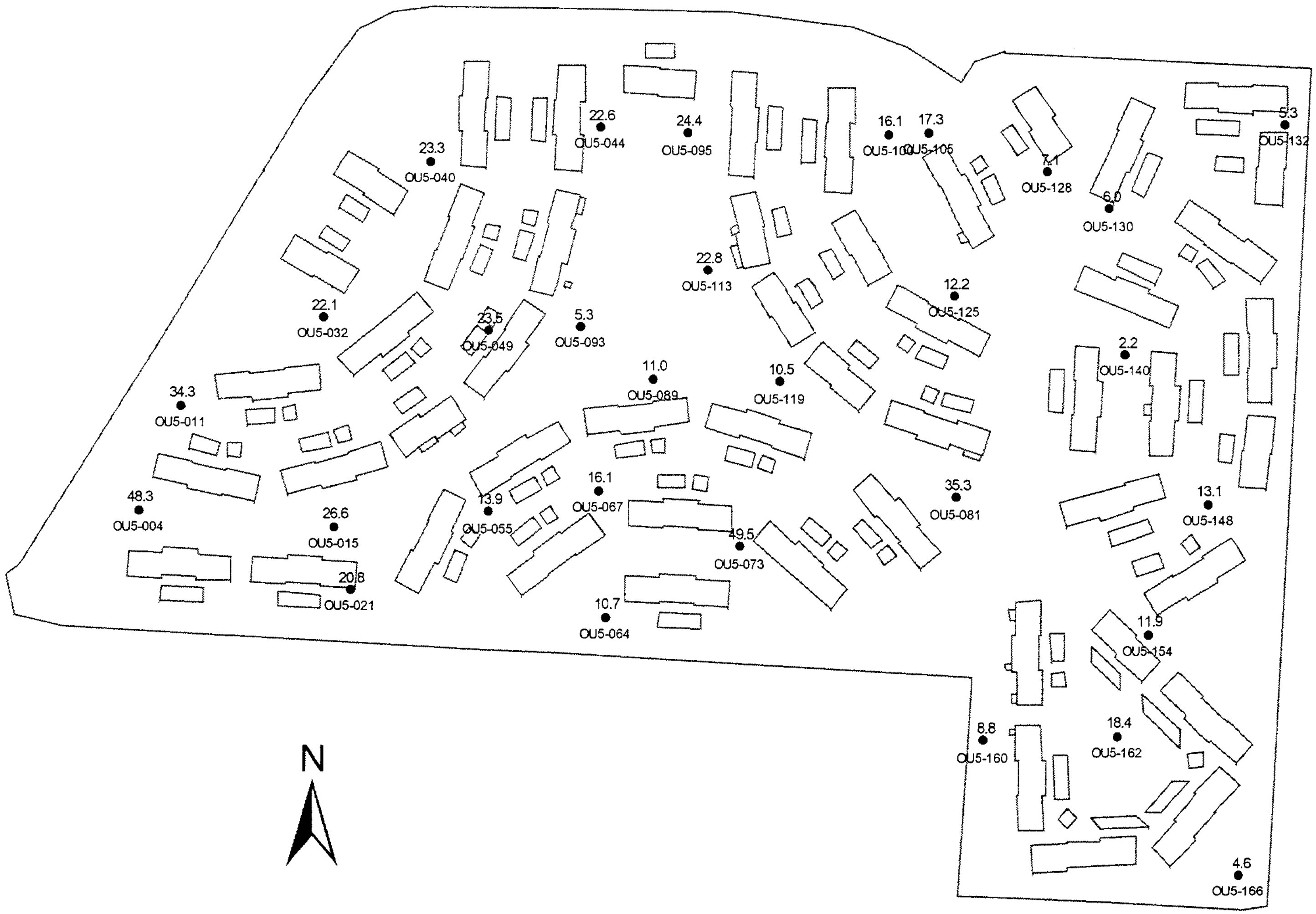


Figure 4-35
Spatial Distribution of Mercury in the 0 to 0.5 foot Depth Interval

OU-5 Parcel 181 Soil: Mercury Concentrations (mg/kg)
0 - 0.5 Ft. Depth Interval
Solid circle: Analyte detected - Open triangle: Analyte not detected

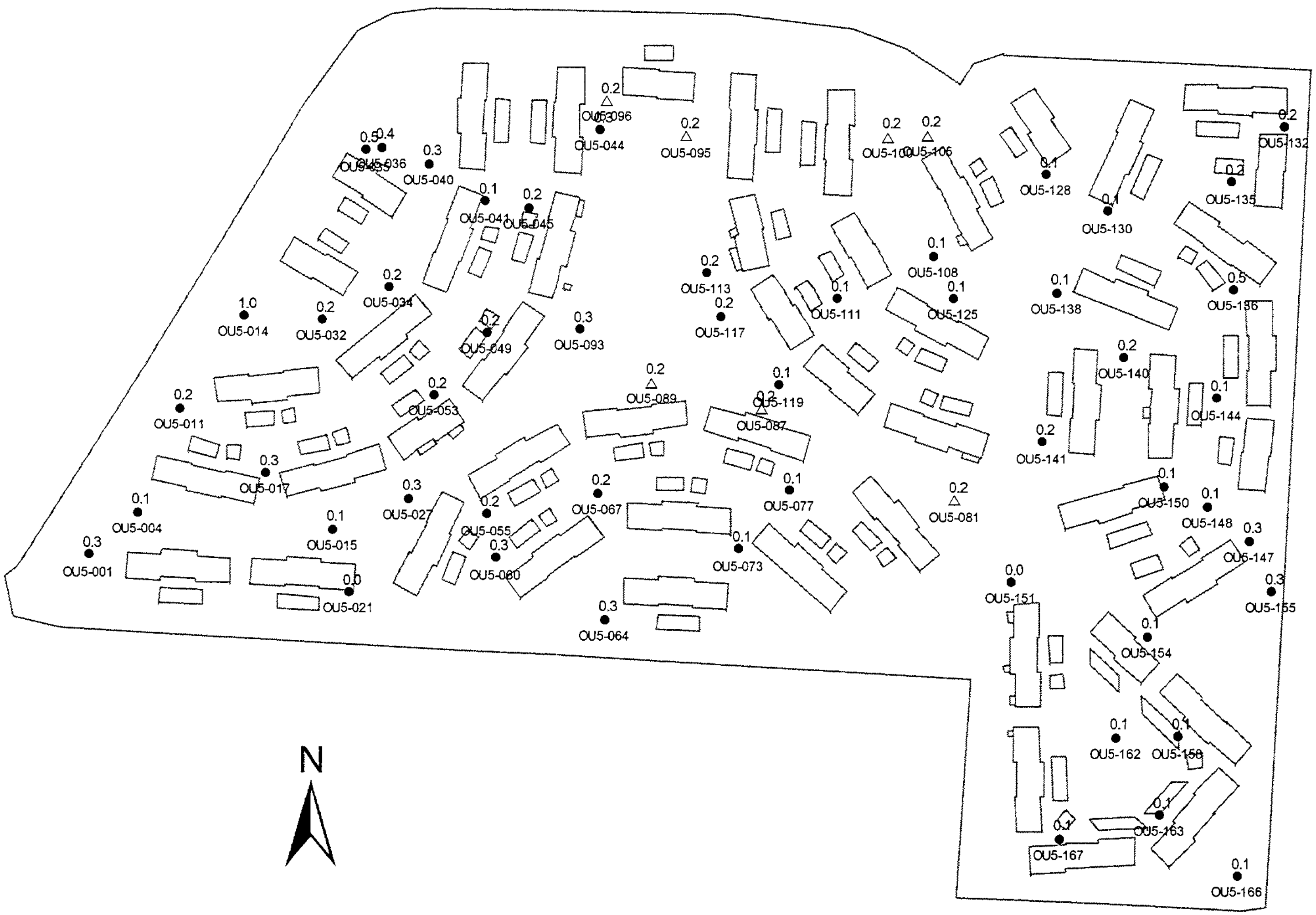


Figure 4-36
Spatial Distribution of Mercury in the 0.5 to 2 foot Depth Interval

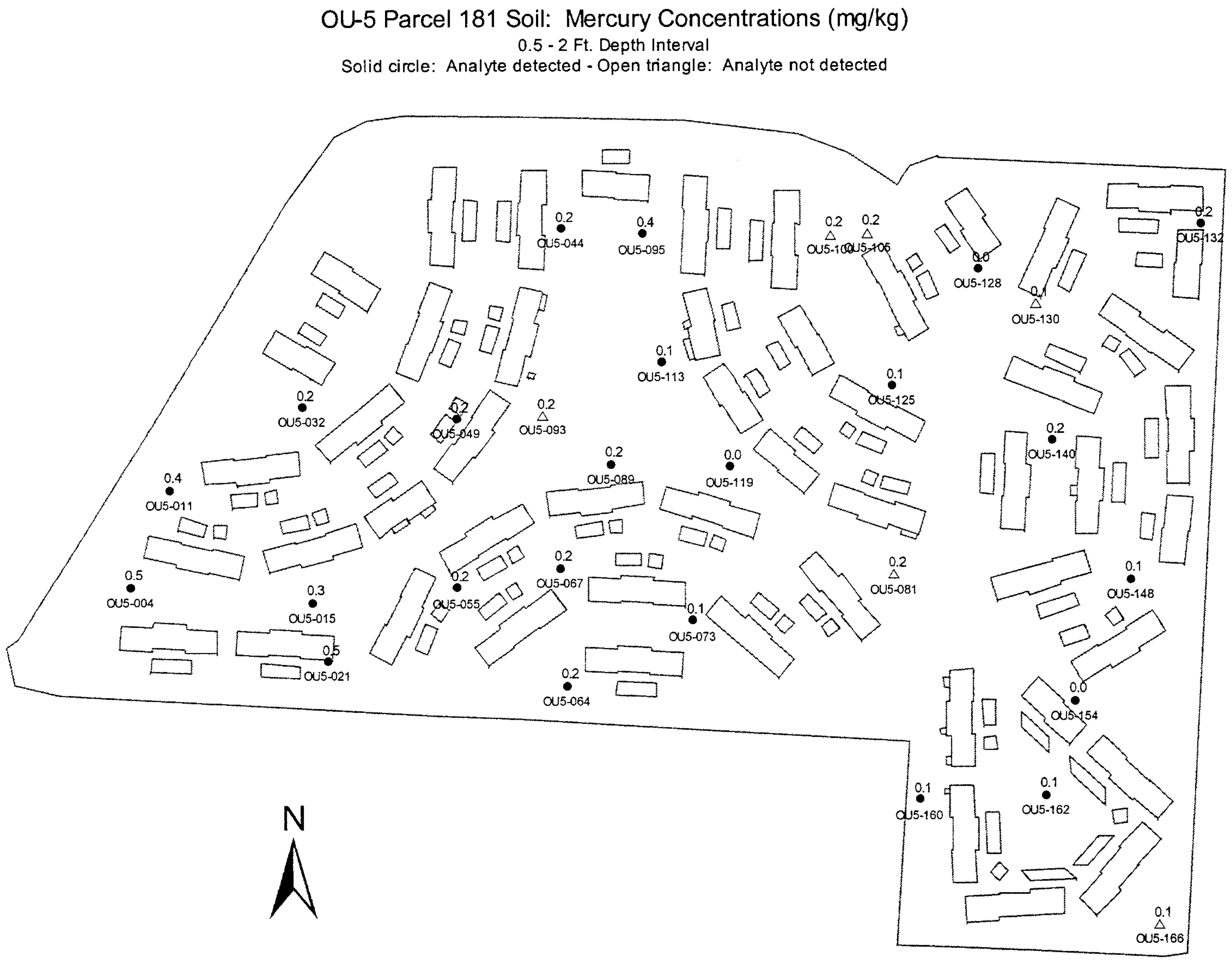


Figure 4-37
Spatial Distribution of Mercury in the 2 to 4 foot Depth Interval

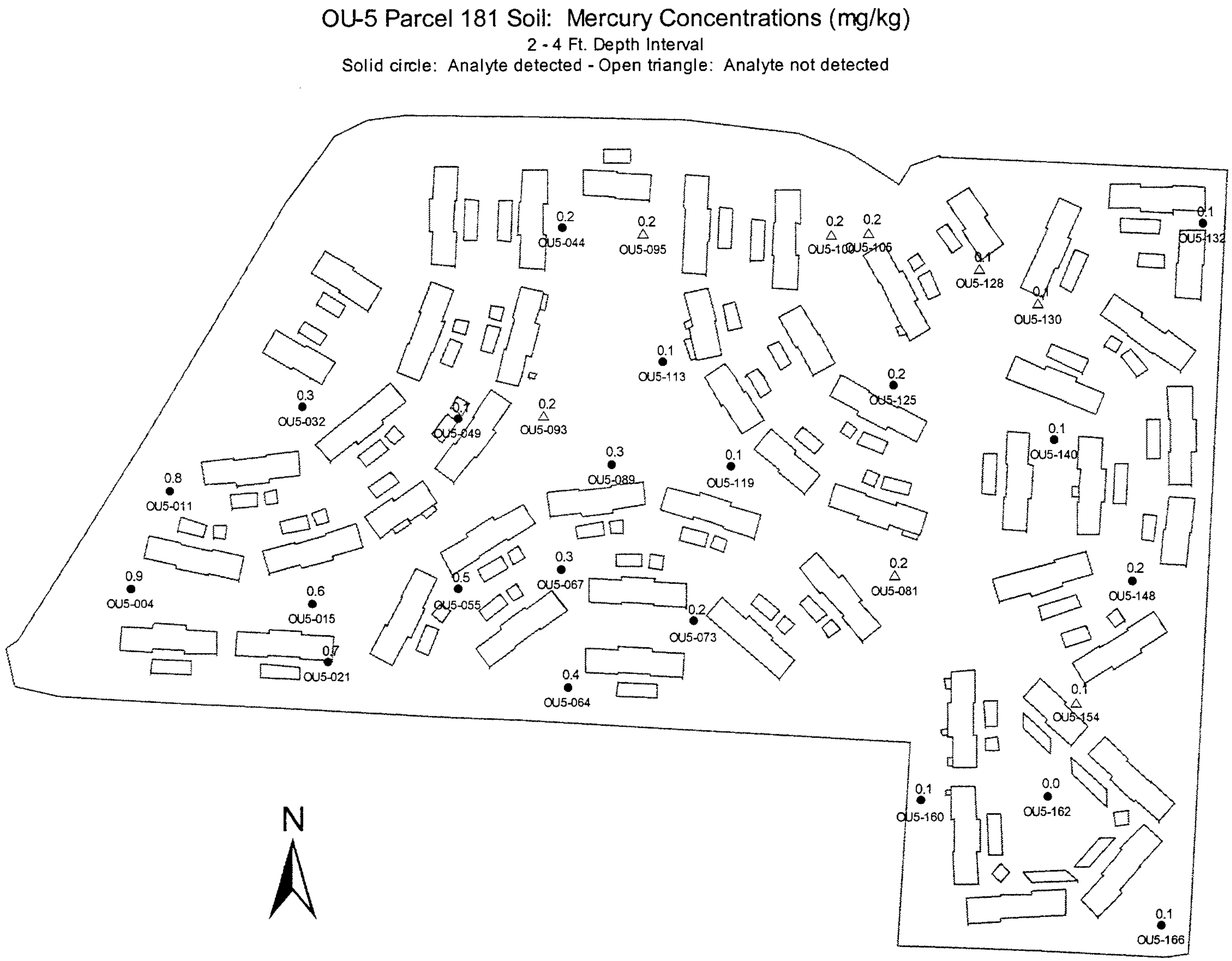
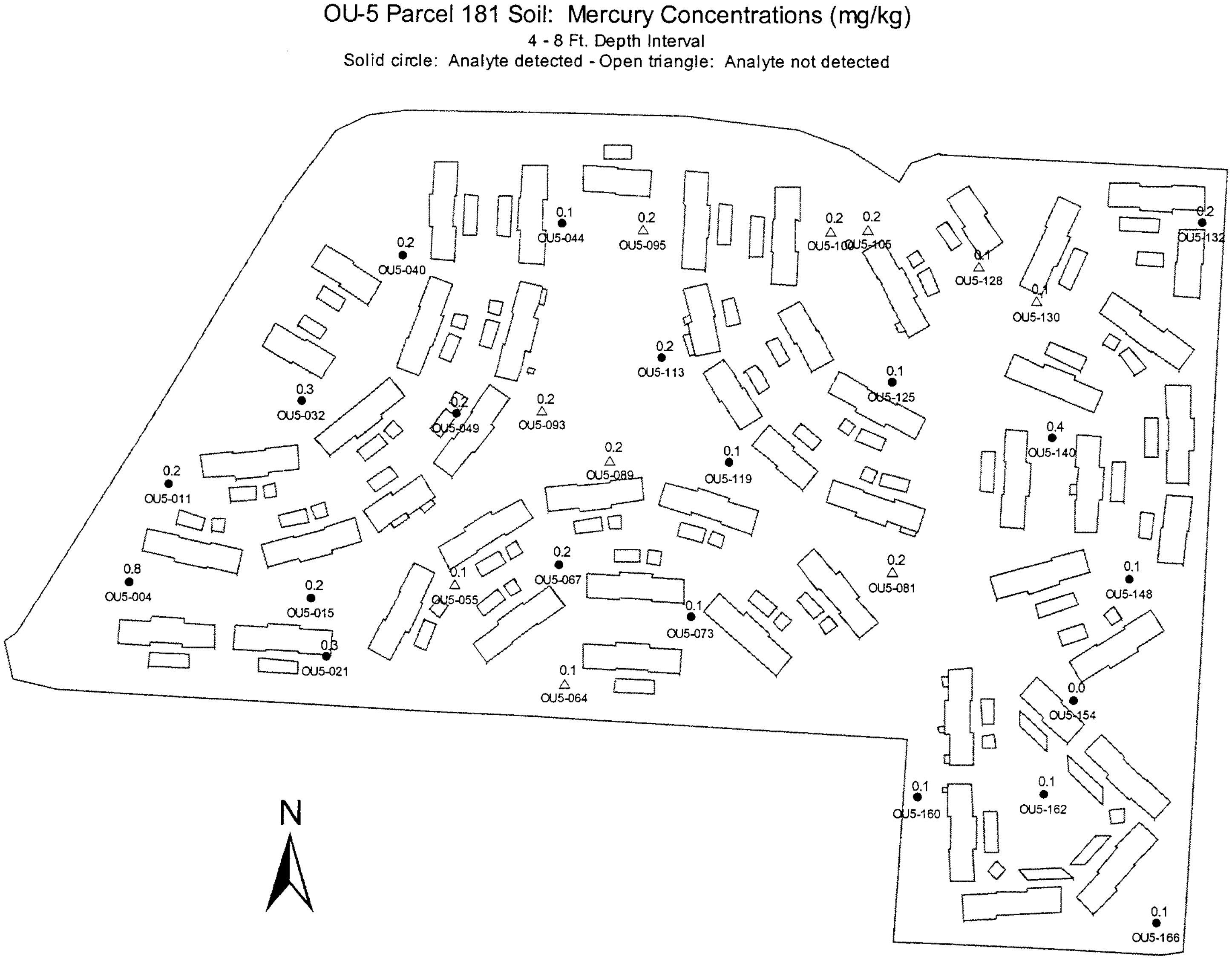


Figure 4-38
Spatial Distribution of Mercury in the 4 to 8 foot Depth Interval



represents fill material that was deposited in two fill events including 1930 to 1939 and 1947 to 1953. The blue data set represents fill material deposited during the 1942 to 1946 fill event. The region of Alameda Point where OU-5 is located was primarily created between 1887 and 1915, with the southeastern portion created in a later fill event between 1930 and 1939 (Section 2.1).

Therefore, it is evident that there is little temporal overlap in the fill events that comprise the sample media of the background and OU-5 data sets. Because the background and OU-5 data sets are representative of different fill events, the actual locations where background samples were collected among these data sets are also physically separated.

Concentrations of base metals such as aluminum, iron, and manganese were found to be significantly higher in the historical OU-5 data set compared to the three background data sets (these constituents were not measured in the RI). This relative homogenicity is an indication that the anthropogenic activities responsible for the distribution of PAHs in the site soils have not affected the concentrations of metals. Because base metal concentrations are commonly used to assess the comparability of soil concentrations of other metals, this finding calls into question conclusions regarding releases that are based on direct comparisons between OU-5 and Alameda background metal concentrations. As noted above, however, the spatial patterns observed in the six metals plotted in Figures 4-15 through 4-38 suggest the metal concentrations are not randomly distributed across Parcel 181 – they are slightly higher in the southwestern portion of this area. It is likely that this pattern is reflective of the concentrations of metals that were present in the dredge spoils deposited in this area, not to a surface spill or other site-related release at OU-5. The differences in the spatial concentrations of metals expressed by this pattern are generally smaller than the differences observed between OU-5 metal concentrations and concentrations in the three Alameda background metal data sets.

4.2 Spatial Distribution of Chemicals in Groundwater

This section discusses the spatial distribution of VOCs and PAHs detected in RI groundwater samples within and adjacent to OU-5. Hydropunch® groundwater sampling results show that a number of VOCs and PAHs were detected in the groundwater. Table 4-5, "Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth" and Table 4-6, "Summary Statistics of Polynuclear Aromatic Hydrocarbon Direct-Push Groundwater Data by Depth" list detected VOCs and PAHs, frequency of detection, and the minimum, maximum, and mean concentrations for VOCs and PAHs. The most frequently detected VOCs (i.e., greater than 35 percent) were:

- Benzene – 12 to 16 feet bgs and 16 to 20 feet bgs

- Methyl tertiary butyl ether (MTBE) – all sampling depths
- 1,2,4-Trimethylbenzene – 12 to 16 feet bgs and 16 to 20 feet bgs
- 1,3,5-Trimethylbenzene – 16 to 20 feet bgs
- 4-Isopropyltoluene – 12 to 16 feet bgs and 16 to 20 feet bgs
- Carbon disulfide – greater than 20 feet bgs
- Ethylbenzene – 12 to 16 feet bgs, 16 to 20 feet bgs, and greater than 20 feet bgs
- Isopropyl benzene – 12 to 16 feet bgs and 16 to 20 feet bgs
- Xylenes – 12 to 16 feet bgs, 16 to 20 feet bgs, and greater than 20 feet bgs
- Methane – all sampling depths
- N-propylbenzene – 12 to 16 feet bgs and 16 to 20 feet bgs
- Styrene – 12 to 16 feet bgs and 16 to 20 feet bgs
- Toluene – all sampling depths.

These detections occurred most frequently in the 12 to 16 foot bgs and 16 to 20 foot bgs sampling intervals, which is consistent with the sampling intervals that regularly produced sufficient water for sampling. Of these compounds, only benzene, ethylbenzene, and styrene exceeded the EPA maximum contaminant level (MCL) for drinking water. Maximum contaminant levels are used for comparison purposes only. In addition, the VOC 1,2-dichloroethane exceeded the MCL, although it was only detected in 17 percent and 27 percent of the samples in the 12 to 16 foot bgs and 16 to 12 foot bgs sample intervals, respectively. Figure 4-39 shows the direct-push groundwater sampling locations where VOC detections were above the MCL for drinking water. Complete groundwater analytical results are provided in Appendix D.

In addition to those frequently reported compounds listed above, the following compounds were also detected in one or more direct-push groundwater samples:

- 1,1,1,2-Tetrachloroethane
- 1,1-Dichloroethene
- 1,2,3-Trichloropropane
- 1,2-Dichlorobenzene
- 1,2-Dichloroethane
- 2-Butanone
- 4-Chlorotoluene
- Bromodichloromethane
- Carbon disulfide
- Chlorobenzene
- Chloroform
- Cis-1,2-dichloroethene
- Dibromochloromethane

Table 4-5 (Page 1 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
MTBE	0-12	32	17	15	46.9	5	50	0.2	1.2
MTBE	12-16	46	30	16	34.8	5	500	0.26	1.6
MTBE	16-20	40	27	13	32.5	2	5000	0.56	2.1
MTBE	>20	4	2	2	50	5	5	0.44	1.1
1,1,1,2-TETRACHLOROETHANE	0-12	32	32	0	0	1	10		
1,1,1,2-TETRACHLOROETHANE	12-16	46	45	1	2.2	1	100	2	2
1,1,1,2-TETRACHLOROETHANE	16-20	40	39	1	2.5	1	2000	200	200
1,1,1,2-TETRACHLOROETHANE	>20	4	4	0	0	2	2		
1,1,1-TRICHLOROETHANE	0-12	32	32	0	0	1	10		
1,1,1-TRICHLOROETHANE	12-16	46	46	0	0	1	100		
1,1,1-TRICHLOROETHANE	16-20	40	40	0	0	1	2000		
1,1,1-TRICHLOROETHANE	>20	4	4	0	0	2	2		
1,1,2,2-TETRACHLOROETHANE	0-12	32	32	0	0	1	10		
1,1,2,2-TETRACHLOROETHANE	12-16	46	46	0	0	1	100		
1,1,2,2-TETRACHLOROETHANE	16-20	40	40	0	0	1	2000		
1,1,2,2-TETRACHLOROETHANE	>20	4	4	0	0	2	2		
1,1,2-TRICHLOROETHANE	0-12	32	32	0	0	1	10		
1,1,2-TRICHLOROETHANE	12-16	46	46	0	0	1	100		
1,1,2-TRICHLOROETHANE	16-20	40	40	0	0	1	2000		

Table 4-5 (Page 2 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
1,1,2-TRICHLOROETHANE	>20	4	4	0	0	2	2		
1,1-DICHLOROETHANE	0-12	32	32	0	0	1	10		
1,1-DICHLOROETHANE	12-16	46	46	0	0	1	100		
1,1-DICHLOROETHANE	16-20	40	40	0	0	1	2000		
1,1-DICHLOROETHANE	>20	4	4	0	0	2	2		
1,1-DICHLOROETHENE	0-12	32	32	0	0	1	10		
1,1-DICHLOROETHENE	12-16	46	46	0	0	1	100		
1,1-DICHLOROETHENE	16-20	40	39	1	2.5	1	2000	5	5
1,1-DICHLOROETHENE	>20	4	4	0	0	2	2		
1,1-DICHLOROPROPENE	0-12	32	32	0	0	1	10		
1,1-DICHLOROPROPENE	12-16	46	46	0	0	1	100		
1,1-DICHLOROPROPENE	16-20	40	40	0	0	1	2000		
1,1-DICHLOROPROPENE	>20	4	4	0	0	2	2		
1,2,3-TRICHLOROBENZENE	0-12	32	32	0	0	1	10		
1,2,3-TRICHLOROBENZENE	12-16	46	46	0	0	1	100		
1,2,3-TRICHLOROBENZENE	16-20	40	40	0	0	1	2000		
1,2,3-TRICHLOROBENZENE	>20	4	4	0	0	2	2		
1,2,3-TRICHLOROPROPANE	0-12	32	32	0	0	1	10		
1,2,3-TRICHLOROPROPANE	12-16	46	45	1	2.2	1	100	1	1

Table 4-5 (Page 3 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
1,2,3-TRICHLOROPROPANE	16-20	40	40	0	0	1	2000		
1,2,3-TRICHLOROPROPANE	>20	4	4	0	0	2	2		
1,2,4-TRICHLOROBENZENE	0-12	32	32	0	0	1	10		
1,2,4-TRICHLOROBENZENE	12-16	46	46	0	0	1	100		
1,2,4-TRICHLOROBENZENE	16-20	40	40	0	0	1	2000		
1,2,4-TRICHLOROBENZENE	>20	4	4	0	0	2	2		
1,2,4-TRIMETHYLBENZENE	0-12	32	28	4	12.5	1	10	0.12	2
1,2,4-TRIMETHYLBENZENE	12-16	46	21	25	54.3	1	2	0.17	51
1,2,4-TRIMETHYLBENZENE	16-20	40	14	26	65	1	2000	0.18	55
1,2,4-TRIMETHYLBENZENE	>20	4	3	1	25	2	2	0.37	0.37
1,2-DIBROMO-3-CHLOROPROPANE	0-12	32	32	0	0	1	10		
1,2-DIBROMO-3-CHLOROPROPANE	12-16	46	46	0	0	1	100		
1,2-DIBROMO-3-CHLOROPROPANE	16-20	40	40	0	0	1	2000		
1,2-DIBROMO-3-CHLOROPROPANE	>20	4	4	0	0	2	2		
1,2-DIBROMOETHANE	0-12	32	32	0	0	1	10		
1,2-DIBROMOETHANE	12-16	46	46	0	0	1	100		
1,2-DIBROMOETHANE	16-20	40	40	0	0	1	2000		
1,2-DIBROMOETHANE	>20	4	4	0	0	2	2		
1,2-DICHLOROBENZENE	0-12	32	32	0	0	1	10		

Table 4-5 (Page 4 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
1,2-DICHLOROBENZENE	12-16	46	45	1	2.2	1	100	0.2	0.2
1,2-DICHLOROBENZENE	16-20	40	40	0	0	1	2000		
1,2-DICHLOROBENZENE	>20	4	4	0	0	2	2		
1,2-DICHLOROETHANE	0-12	32	32	0	0	1	10		
1,2-DICHLOROETHANE	12-16	46	38	8	17.4	1	100	0.2	16
1,2-DICHLOROETHANE	16-20	40	29	11	27.5	1	2000	0.22	50
1,2-DICHLOROETHANE	>20	4	4	0	0	2	2		
1,2-DICHLOROPROPANE	0-12	32	32	0	0	1	10		
1,2-DICHLOROPROPANE	12-16	46	46	0	0	1	100		
1,2-DICHLOROPROPANE	16-20	40	40	0	0	1	2000		
1,2-DICHLOROPROPANE	>20	4	4	0	0	2	2		
1,3,5-TRIMETHYLBENZENE	0-12	32	31	1	3.1	1	10	2	2
1,3,5-TRIMETHYLBENZENE	12-16	46	32	14	30.4	1	100	0.14	12
1,3,5-TRIMETHYLBENZENE	16-20	40	19	21	52.5	1	2000	0.26	29
1,3,5-TRIMETHYLBENZENE	>20	4	3	1	25	2	2	0.25	0.25
1,3-DICHLOROBENZENE	0-12	32	32	0	0	1	10		
1,3-DICHLOROBENZENE	12-16	46	46	0	0	1	100		
1,3-DICHLOROBENZENE	16-20	40	40	0	0	1	2000		
1,3-DICHLOROBENZENE	>20	4	4	0	0	2	2		

Table 4-5 (Page 5 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (μg/L)		Detected Concentrations (μg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
1,3-DICHLOROPROPANE	0-12	32	32	0	0	1	10		
1,3-DICHLOROPROPANE	12-16	46	46	0	0	1	100		
1,3-DICHLOROPROPANE	16-20	40	40	0	0	1	2000		
1,3-DICHLOROPROPANE	>20	4	4	0	0	2	2		
1,4-DICHLOROBENZENE	0-12	32	32	0	0	1	10		
1,4-DICHLOROBENZENE	12-16	46	46	0	0	1	100		
1,4-DICHLOROBENZENE	16-20	40	40	0	0	1	2000		
1,4-DICHLOROBENZENE	>20	4	4	0	0	2	2		
2,2-DICHLOROPROPANE	0-12	32	32	0	0	1	10		
2,2-DICHLOROPROPANE	12-16	46	46	0	0	1	100		
2,2-DICHLOROPROPANE	16-20	40	40	0	0	1	2000		
2,2-DICHLOROPROPANE	>20	4	4	0	0	2	2		
2-BUTANONE	0-12	13	13	0	0	1	100		
2-BUTANONE	12-16	18	17	1	5.6	1	200	3	3
2-BUTANONE	16-20	18	18	0	0	1	20000		
2-BUTANONE	>20	4	4	0	0	20	20		
2-CHLOROTOLUENE	0-12	32	32	0	0	1	10		
2-CHLOROTOLUENE	12-16	46	46	0	0	1	100		
2-CHLOROTOLUENE	16-20	40	40	0	0	1	2000		

Table 4-5 (Page 6 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (μg/L)		Detected Concentrations (μg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
2-CHLOROTOLUENE	>20	4	4	0	0	2	2		
2-HEXANONE	0-12	13	13	0	0	1	100		
2-HEXANONE	12-16	18	18	0	0	1	200		
2-HEXANONE	16-20	18	18	0	0	1	20000		
2-HEXANONE	>20	4	4	0	0	20	20		
4-CHLOROTOLUENE	0-12	32	32	0	0	1	10		
4-CHLOROTOLUENE	12-16	46	45	1	2.2	1	100	2.2	2.2
4-CHLOROTOLUENE	16-20	40	39	1	2.5	1	2000	5	5
4-CHLOROTOLUENE	>20	4	4	0	0	2	2		
4-ISOPROPYLTOLUENE	0-12	32	31	1	3.1	1	10	0.4	0.4
4-ISOPROPYLTOLUENE	12-16	46	29	17	37	1	100	0.13	20
4-ISOPROPYLTOLUENE	16-20	40	22	18	45	1	2000	0.15	11
4-ISOPROPYLTOLUENE	>20	4	3	1	25	2	2	0.24	0.24
4-METHYL-2-PENTANONE	0-12	13	13	0	0	1	100		
4-METHYL-2-PENTANONE	12-16	18	18	0	0	1	200		
4-METHYL-2-PENTANONE	16-20	18	18	0	0	1	20000		
4-METHYL-2-PENTANONE	>20	4	4	0	0	20	20		
ACETONE	0-12	13	13	0	0	1	100		
ACETONE	12-16	18	18	0	0	1	200		

Table 4-5 (Page 7 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
ACETONE	16-20	18	18	0	0	1	20000		
ACETONE	>20	4	4	0	0	20	20		
BENZENE	0-12	32	27	5	15.6	1	2	0.4	41
BENZENE	12-16	46	19	27	58.7	1	2	0.6	742
BENZENE	16-20	40	9	31	77.5	1	2	0.24	6000
BENZENE	>20	4	3	1	25	2	2	0.38	0.38
BROMOBENZENE	0-12	32	32	0	0	1	10		
BROMOBENZENE	12-16	46	46	0	0	1	100		
BROMOBENZENE	16-20	40	40	0	0	1	2000		
BROMOBENZENE	>20	4	4	0	0	2	2		
BROMOCHLOROMETHANE	0-12	32	32	0	0	1	10		
BROMOCHLOROMETHANE	12-16	46	46	0	0	1	100		
BROMOCHLOROMETHANE	16-20	40	40	0	0	1	2000		
BROMOCHLOROMETHANE	>20	4	4	0	0	2	2		
BROMODICHLOROMETHANE	0-12	32	31	1	3.1	1	10	0.22	0.22
BROMODICHLOROMETHANE	12-16	46	46	0	0	1	100		
BROMODICHLOROMETHANE	16-20	40	40	0	0	1	2000		
BROMODICHLOROMETHANE	>20	4	4	0	0	2	2		
BROMOFORM	0-12	32	32	0	0	1	10		

Table 4-5 (Page 8 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
BROMOFORM	12-16	46	46	0	0	1	100		
BROMOFORM	16-20	40	40	0	0	1	2000		
BROMOFORM	>20	4	4	0	0	2	2		
BROMOMETHANE	0-12	32	32	0	0	1	10		
BROMOMETHANE	12-16	46	46	0	0	1	100		
BROMOMETHANE	16-20	40	40	0	0	1	2000		
BROMOMETHANE	>20	4	4	0	0	2	2		
CARBON DISULFIDE	0-12	13	13	0	0	1	10		
CARBON DISULFIDE	12-16	18	15	3	16.7	1	20	0.13	0.96
CARBON DISULFIDE	16-20	18	14	4	22.2	1	2000	0.11	0.43
CARBON DISULFIDE	>20	4	0	4	100			0.18	0.56
CARBON TETRACHLORIDE	0-12	32	32	0	0	1	10		
CARBON TETRACHLORIDE	12-16	46	46	0	0	1	100		
CARBON TETRACHLORIDE	16-20	40	40	0	0	1	2000		
CARBON TETRACHLORIDE	>20	4	4	0	0	2	2		
CHLOROBENZENE	0-12	32	32	0	0	1	10		
CHLOROBENZENE	12-16	46	45	1	2.2	1	100	85	85
CHLOROBENZENE	16-20	40	39	1	2.5	1	2000	2	2
CHLOROBENZENE	>20	4	4	0	0	2	2		

Table 4-5 (Page 9 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
CHLOROETHANE	0-12	32	32	0	0	1	10		
CHLOROETHANE	12-16	46	46	0	0	1	100		
CHLOROETHANE	16-20	40	40	0	0	1	2000		
CHLOROETHANE	>20	4	4	0	0	2	2		
CHLOROFORM	0-12	32	32	0	0	1	10		
CHLOROFORM	12-16	46	46	0	0	1	100		
CHLOROFORM	16-20	40	40	0	0	1	2000		
CHLOROFORM	>20	4	3	1	25	2	2	0.75	0.75
CHLOROMETHANE	0-12	32	32	0	0	1	10		
CHLOROMETHANE	12-16	46	46	0	0	1	100		
CHLOROMETHANE	16-20	40	40	0	0	1	2000		
CHLOROMETHANE	>20	4	4	0	0	2	2		
CIS-1,2-DICHLOROETHENE	0-12	32	30	2	6.3	1	10	0.4	1.2
CIS-1,2-DICHLOROETHENE	12-16	46	46	0	0	1	100		
CIS-1,2-DICHLOROETHENE	16-20	40	39	1	2.5	1	2000	5	5
CIS-1,2-DICHLOROETHENE	>20	4	4	0	0	2	2		
CIS-1,3-DICHLOROPROPENE	0-12	19	19	0	0	1	10		
CIS-1,3-DICHLOROPROPENE	12-16	29	29	0	0	1	100		
CIS-1,3-DICHLOROPROPENE	16-20	23	23	0	0	1	250		

Table 4-5 (Page 10 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
DIBROMOCHLOROMETHANE	0-12	32	31	1	3.1	1	10	0.23	0.23
DIBROMOCHLOROMETHANE	12-16	46	46	0	0	1	100		
DIBROMOCHLOROMETHANE	16-20	40	40	0	0	1	2000		
DIBROMOCHLOROMETHANE	>20	4	4	0	0	2	2		
DIBROMOMETHANE	0-12	32	32	0	0	1	10		
DIBROMOMETHANE	12-16	46	46	0	0	1	100		
DIBROMOMETHANE	16-20	40	40	0	0	1	2000		
DIBROMOMETHANE	>20	4	4	0	0	2	2		
DICHLORODIFLUOROMETHANE	0-12	32	32	0	0	1	10		
DICHLORODIFLUOROMETHANE	12-16	46	46	0	0	1	100		
DICHLORODIFLUOROMETHANE	16-20	40	39	1	2.5	1	2000	20	20
DICHLORODIFLUOROMETHANE	>20	4	4	0	0	2	2		
ETHYLBENZENE	0-12	32	28	4	12.5	1	2	0.12	24
ETHYLBENZENE	12-16	46	18	28	60.9	1	2	0.18	266
ETHYLBENZENE	16-20	40	4	36	90	1	2	0.15	800
ETHYLBENZENE	>20	4	2	2	50	2	2	0.14	0.16
HEXACHLOROBUTADIENE	0-12	32	32	0	0	1	10		
HEXACHLOROBUTADIENE	12-16	46	46	0	0	1	100		
HEXACHLOROBUTADIENE	16-20	40	40	0	0	1	2000		

Table 4-5 (Page 11 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (μg/L)		Detected Concentrations (μg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
HEXACHLOROBUTADIENE	>20	4	4	0	0	2	2		
ISOPROPYL BENZENE	0-12	12	10	2	16.7	2	10	0.16	0.28
ISOPROPYL BENZENE	12-16	15	8	7	46.7	2	2	0.18	6.2
ISOPROPYL BENZENE	16-20	14	9	5	35.7	2	2000	0.24	7.4
ISOPROPYL BENZENE	>20	4	3	1	25	2	2	0.16	0.16
M/P-XYLENES	0-12	12	10	2	16.7	2	10	0.28	0.31
M/P-XYLENES	12-16	15	8	7	46.7	2	1000	0.24	27
M/P-XYLENES	16-20	14	8	6	42.9	2	5000	0.42	42
M/P-XYLENES	>20	4	3	1	25	2	2	0.55	0.55
METHANE	0-12	11	0	11	100			20	9200
METHANE	12-16	13	0	13	100			160	7200
METHANE	16-20	12	0	12	100			2100	10000
METHANE	>20	1	0	1	100			3200	3200
METHYLENE CHLORIDE	0-12	32	31	1	3.1	1	10	7	7
METHYLENE CHLORIDE	12-16	46	45	1	2.2	1	100	0.31	0.31
METHYLENE CHLORIDE	16-20	40	35	5	12.5	1	2000	0.22	180
METHYLENE CHLORIDE	>20	4	4	0	0	2	2		
N-BUTYLBENZENE	0-12	32	32	0	0	1	10		
N-BUTYLBENZENE	12-16	46	42	4	8.7	1	100	0.22	1

Table 4-5 (Page 12 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
N-BUTYLBENZENE	16-20	40	38	2	5	1	2000	0.5	1800
N-BUTYLBENZENE	>20	4	4	0	0	2	2		
N-PROPYLBENZENE	0-12	32	32	0	0	1	10		
N-PROPYLBENZENE	12-16	46	32	14	30.4	1	100	0.3	11
N-PROPYLBENZENE	16-20	40	25	15	37.5	1	2000	0.49	8.1
N-PROPYLBENZENE	>20	4	4	0	0	2	2		
O-XYLENE	0-12	12	12	0	0	2	10		
O-XYLENE	12-16	15	8	7	46.7	2	1000	0.25	29
O-XYLENE	16-20	14	9	5	35.7	2	5000	0.27	52
O-XYLENE	>20	4	3	1	25	2	2	0.32	0.32
P-ISOPROPYLTOLUENE	0-12	19	19	0	0	1	10		
P-ISOPROPYLTOLUENE	12-16	30	24	6	20	1	100	0.3	2
P-ISOPROPYLTOLUENE	16-20	25	22	3	12	1	250	0.2	1
SEC-BUTYLBENZENE	0-12	32	32	0	0	1	10		
SEC-BUTYLBENZENE	12-16	46	42	4	8.7	1	100	0.2	0.3
SEC-BUTYLBENZENE	16-20	40	40	0	0	1	2000		
SEC-BUTYLBENZENE	>20	4	4	0	0	2	2		
STYRENE	0-12	32	32	0	0	1	10		
STYRENE	12-16	46	30	16	34.8	1	100	0.3	81

Table 4-5 (Page 13 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
STYRENE	16-20	40	25	15	37.5	1	5000	0.4	186
STYRENE	>20	4	4	0	0	2	2		
TERT-BUTYLBENZENE	0-12	32	32	0	0	1	10		
TERT-BUTYLBENZENE	12-16	46	46	0	0	1	100		
TERT-BUTYLBENZENE	16-20	40	40	0	0	1	2000		
TERT-BUTYLBENZENE	>20	4	4	0	0	2	2		
TETRACHLOROETHENE	0-12	32	32	0	0	1	10		
TETRACHLOROETHENE	12-16	46	45	1	2.2	1	100	1	1
TETRACHLOROETHENE	16-20	40	40	0	0	1	2000		
TETRACHLOROETHENE	>20	4	4	0	0	2	2		
TOLUENE	0-12	32	20	12	37.5	1	2	0.18	3
TOLUENE	12-16	46	16	30	65.2	1	1000	0.16	150
TOLUENE	16-20	40	10	30	75	1	2	0.25	620
TOLUENE	>20	4	2	2	50	2	2	0.28	0.3
TRANS-1,2-DICHLOROETHENE	0-12	24	23	1	4.2	1	10	0.25	0.25
TRANS-1,2-DICHLOROETHENE	12-16	37	36	1	2.7	1	20	1	1
TRANS-1,2-DICHLOROETHENE	16-20	35	34	1	2.9	1	2000	1	1
TRANS-1,2-DICHLOROETHENE	>20	4	4	0	0	2	2		
TRANS-1,3-DICHLOROPROPENE	0-12	19	19	0	0	1	10		

Table 4-5 (Page 14 of 14)
Summary Statistics of the Volatile Organic Compound Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
TRANS-1,3-DICHLOROPROPENE	12-16	25	25	0	0	1	100		
TRANS-1,3-DICHLOROPROPENE	16-20	19	19	0	0	1	250		
TRICHLOROETHENE	0-12	32	32	0	0	1	10		
TRICHLOROETHENE	12-16	46	46	0	0	1	100		
TRICHLOROETHENE	16-20	40	40	0	0	1	2000		
TRICHLOROETHENE	>20	4	4	0	0	2	2		
TRICHLOROFLUOROMETHANE	0-12	32	32	0	0	1	10		
TRICHLOROFLUOROMETHANE	12-16	46	46	0	0	1	100		
TRICHLOROFLUOROMETHANE	16-20	40	40	0	0	1	2000		
TRICHLOROFLUOROMETHANE	>20	4	4	0	0	2	2		
VINYL CHLORIDE	0-12	32	31	1	3.1	1	10	0.79	0.79
VINYL CHLORIDE	12-16	46	44	2	4.3	1	100	0.3	0.9
VINYL CHLORIDE	16-20	40	40	0	0	1	2000		
VINYL CHLORIDE	>20	4	4	0	0	2	2		
XYLENES (TOTAL)	0-12	20	14	6	30	1	2	0.16	23
XYLENES (TOTAL)	12-16	31	8	23	74.2	1	2	0.2	175
XYLENES (TOTAL)	16-20	26	4	22	84.6	1	500	0.7	423

µg/L denotes microgram(s) per liter
bgs denotes below ground surface
MTBE denotes methyl tertiary butyl ether

Table 4-6 (Page 1 of 4)
Summary Statistics of Polynuclear Aromatic Hydrocarbon Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
BENZ(A)ANTHRACENE	0-12	31	6	25	80.6	0.19	0.2	0.09	5.4
BENZ(A)ANTHRACENE	12-16	44	7	37	84.1	0.2	20	0.1	13
BENZ(A)ANTHRACENE	16-20	35	4	31	88.6	0.19	4	0.07	26
BENZ(A)ANTHRACENE	>20	4	1	3	75	0.14	0.14	0.13	0.26
BENZO(A)PYRENE	0-12	31	8	23	74.2	0.19	0.2	0.057	14
BENZO(A)PYRENE	12-16	44	11	33	75	0.2	20	0.1	28
BENZO(A)PYRENE	16-20	35	8	27	77.1	0.19	4	0.083	60
BENZO(A)PYRENE	>20	4	0	4	100			0.25	0.33
BENZO(B)FLUORANTHENE	0-12	31	10	21	67.7	0.1	0.38	0.05	8.3
BENZO(B)FLUORANTHENE	12-16	44	10	34	77.3	0.2	20	0.05	16
BENZO(B)FLUORANTHENE	16-20	35	11	24	68.6	0.2	10	0.04	29
BENZO(B)FLUORANTHENE	>20	4	0	4	100			0.16	0.2
BENZO(G,H,I)PERYLENE	0-12	31	10	21	67.7	0.2	0.38	0.07	13
BENZO(G,H,I)PERYLENE	12-16	44	15	29	65.9	0.2	20	0.13	20
BENZO(G,H,I)PERYLENE	16-20	35	16	19	54.3	0.2	19	0.19	37
BENZO(G,H,I)PERYLENE	>20	4	1	3	75	0.38	0.38	0.25	0.37
BENZO(K)FLUORANTHENE	0-12	31	13	18	58.1	0.19	0.2	0.03	4.2
BENZO(K)FLUORANTHENE	12-16	44	12	32	72.7	0.2	20	0.03	7.6
BENZO(K)FLUORANTHENE	16-20	35	11	24	68.6	0.19	10	0.03	14

Table 4-6 (Page 2 of 4)
Summary Statistics of Polynuclear Aromatic Hydrocarbon Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
BENZO(K)FLUORANTHENE	>20	4	0	4	100			0.075	0.098
CHRYSENE	0-12	31	8	23	74.2	0.19	0.2	0.03	8.3
CHRYSENE	12-16	44	5	39	88.6	0.2	20	0.03	32
CHRYSENE	16-20	35	7	28	80	0.19	4	0.03	43
CHRYSENE	>20	4	0	4	100			0.2	0.38
DIBENZ(A,H)ANTHRACENE	0-12	31	27	4	12.9	0.38	3.8	0.4	3
DIBENZ(A,H)ANTHRACENE	12-16	44	41	3	6.8	0.38	50	0.3	0.6
DIBENZ(A,H)ANTHRACENE	16-20	35	34	1	2.9	0.38	25	0.3	0.3
DIBENZ(A,H)ANTHRACENE	>20	4	4	0	0	0.38	0.38		
FLUORANTHENE	0-12	31	3	28	90.3	0.2	0.38	0.22	47
FLUORANTHENE	12-16	44	0	44	100			0.07	190
FLUORANTHENE	16-20	35	2	33	94.3	0.38	38	0.05	280
FLUORANTHENE	>20	4	0	4	100			2	26
INDENO(1,2,3-CD)PYRENE	0-12	31	13	18	58.1	0.2	1	0.048	11
INDENO(1,2,3-CD)PYRENE	12-16	44	18	26	59.1	0.2	20	0.093	44
INDENO(1,2,3-CD)PYRENE	16-20	35	15	20	57.1	0.19	10	0.11	38
INDENO(1,2,3-CD)PYRENE	>20	4	0	4	100			0.14	0.26
PYRENE	0-12	31	1	30	96.8	0.2	0.2	0.1	38
PYRENE	12-16	44	1	43	97.7	10	10	0.04	120

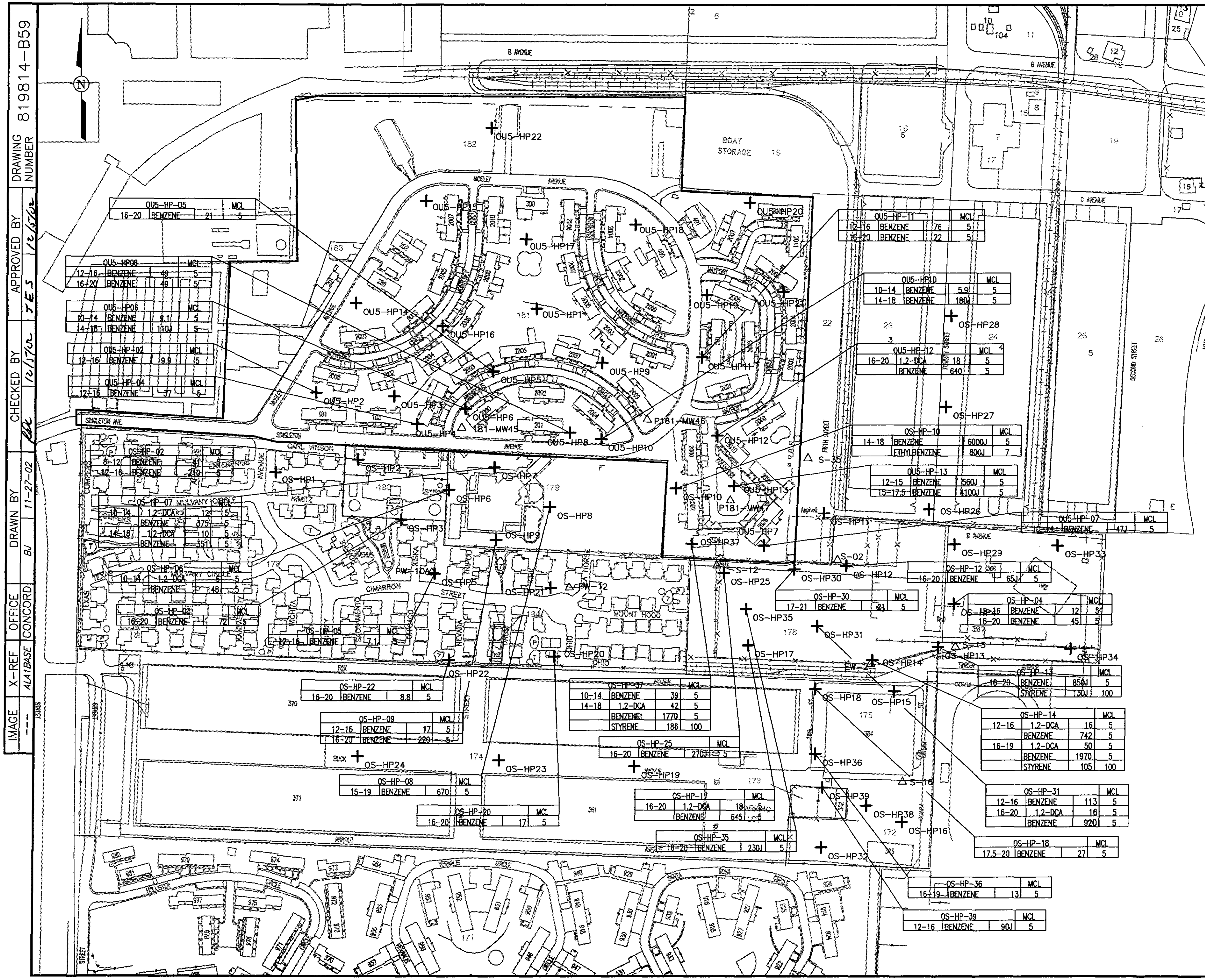
Table 4-6 (Page 3 of 4)
Summary Statistics of Polynuclear Aromatic Hydrocarbon Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
PYRENE	16-20	35	0	35	100			0.02	200
PYRENE	>20	4	0	4	100			1.2	14
ACENAPHTHENE	0-12	31	23	8	25.8	1.9	25	1	59
ACENAPHTHENE	12-16	44	19	25	56.8	1.9	500	0.5	120
ACENAPHTHENE	16-20	35	12	23	65.7	1.9	250	0.3	220
ACENAPHTHENE	>20	4	2	2	50	1.9	3.1	0.87	51
ACENAPHTHYLENE	0-12	31	26	5	16.1	2	38	0.2	40
ACENAPHTHYLENE	12-16	44	21	23	52.3	2	38	0.4	330
ACENAPHTHYLENE	16-20	35	12	23	65.7	2	20	1.6	800
ACENAPHTHYLENE	>20	4	3	1	25	3.8	3.8	1.7	1.7
ANTHRACENE	0-12	31	15	16	51.6	0.19	1.9	0.1	3.1
ANTHRACENE	12-16	44	12	32	72.7	0.19	1.9	0.09	47
ANTHRACENE	16-20	35	5	30	85.7	0.19	0.2	0.2	59
ANTHRACENE	>20	4	1	3	75	0.19	0.19	0.16	11
FLUORENE	0-12	31	25	6	19.4	0.38	5	0.1	0.9
FLUORENE	12-16	44	27	17	38.6	0.38	100	0.15	32
FLUORENE	16-20	35	11	24	68.6	0.38	10	0.1	70
FLUORENE	>20	4	3	1	25	0.38	0.38	3.4	3.4
NAPHTHALENE	0-12	32	14	18	56.3	1	2	0.79	270

Table 4-6 (Page 4 of 4)
Summary Statistics of Polynuclear Aromatic Hydrocarbon Direct-Push Groundwater Data by Depth

Analyte	Depth Interval (feet bgs)	Number of Samples			Percent Detects	Reporting Limits for Nondetects (µg/L)		Detected Concentrations (µg/L)	
		Total	Nondetects	Detects		Minimum	Maximum	Minimum	Maximum
NAPHTHALENE	12-16	46	6	40	87	1	2	0.6	5660
NAPHTHALENE	16-20	40	3	37	92.5	2	5	0.4	19000
NAPHTHALENE	>20	4	0	4	100			0.44	29
PHENANTHRENE	0-12	31	3	28	90.3	0.19	0.19	0.1	4.1
PHENANTHRENE	12-16	44	3	41	93.2	0.19	1.9	0.2	130
PHENANTHRENE	16-20	35	0	35	100			0.08	250
PHENANTHRENE	>20	4	0	4	100			0.21	54

µg/L denotes microgram(s) per liter
bgs denotes below ground surface



LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(line)	PARCEL BOUNDARY
+ OS-HP35	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
△ S-16	MONITORING WELL

OU5-HP-11			MCL
12-16	BENZENE	76	5
16-20	BENZENE	22J	5

- MAXIMUM CONTAMINANT LEVEL IN MICROGRAMS PER LITER (MCL)
- VOC CONCENTRATIONS IN MICROGRAMS PER LITER
- DEPTH INTERVAL IN FEET BELOW GROUND SURFACE
- 22J WHERE ESTIMATED BETWEEN METHOD DETECTION LIMIT AND PROJECT QUANTITATION LIMIT

NOTES:

1. GROUNDWATER DIRECT-PUSH OR MONITORING WELL LOCATIONS WITHOUT ANALYTICAL DATA INDICATES THAT THERE WERE NO EXCEEDANCES OF MCLs AT THAT SAMPLING LOCATION.
2. DCA MEANS DICHLOROETHANE.

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-39

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER EXCEEDING THE MAXIMUM CONTAMINANT LEVEL

- Dichlorodifluoromethane
- Methylene chloride
- N-butylbenzene
- P-isopropyltoluene
- Sec-butylbenzene
- Tetrachloroethene
- Trans-1,2-dichloroethene
- Vinyl chloride

Benzene, in groundwater was identified as a potential chemical of concern for the study area in the RI Work Plan (Neptune and Company, 2001). Analytical results for benzene are shown on maps on Figures 4-40 through 4-43. The distributions of other chemicals in groundwater are also of interest for evaluating the spatial characteristics and potential origin of the groundwater VOC plume. Groundwater concentrations for naphthalene, MTBE, toluene, total xylenes, ethylbenzene, and 1,2-dichloroethane are presented in Figures 4-44 through 4-65. Detection frequencies of MTBE and 1,2-dichloroethane are lower than those of the other chemicals.

Each figure provides the analytical results for a specific depth interval. The four sample depth intervals are:

- Shallow – 0 to 12 feet bgs
- Intermediate – 12 to 16 feet bgs
- Above or top of the marsh crust – 16 to 20 feet bgs
- Upper portion of the Bay Sediment Unit (BSU) – greater than 20 feet bgs.

These depth intervals are approximate and may contain samples that are slightly shallower. For example, one location may have the following four sampling intervals:

- 6 to 10 feet
- 10 to 14 feet
- 14 to 18 feet
- 18 to 22 feet

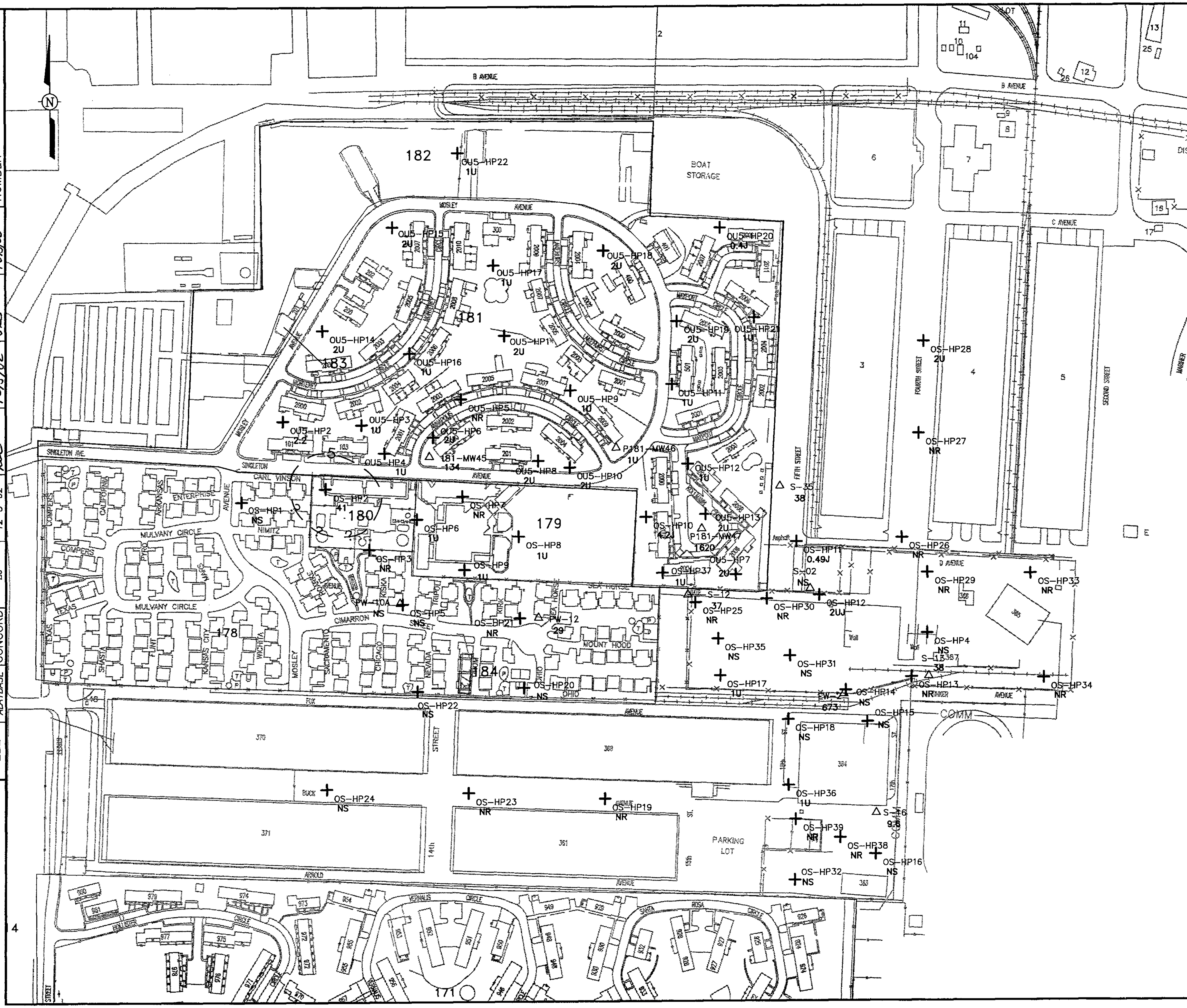
Isoconcentration contours were drawn from the benzene and naphthalene groundwater data on Figures 4-40, 4-41, 4-42, 4-45, and 4-46. Contours are only provided for the 12 to 16 foot bgs (intermediate) and 16 to 20 foot bgs (above or top of the marsh crust) sampling intervals because of relatively low or not detected concentrations or due to an insufficient number of analytical results for contouring from the upper and lower intervals. These contours are provided to assist the reader in visualizing the spatial distribution of these chemicals in groundwater. The analytical results from monitoring well sampling are also provided on these figures. However, in certain instances these results are not used for contouring because the monitoring wells are screened over multiple Hydropunch® sampling intervals. Consequently, the monitoring well results may not be representative of a single depth interval. Additional contour plots of benzene and naphthalene concentrations in groundwater that were developed using a statistical local regression-smoothing algorithm are also provided in Figures B-20 through B-23 in Appendix B. These statistically generated figures generally support the isoconcentration contours.

Benzene was reported as present in five groundwater samples collected from the shallow (0 to 12 feet bgs) depth interval. The maximum reported concentration was 41 micrograms per liter (µg/L) at OS-HP2 (see Figure 4-40), the other four reported concentrations were below 5 µg/L. The maximum detected benzene concentration within the intermediate (12 to 16 feet bgs) sampling interval was 742 µg/L at OS-HP14 (see Figure 4-41). The intermediate sampling interval results indicated that benzene was detected across Parcel 176, into Parcel 181, and at adjacent Parcels 179 and 180. The northern and eastern extents of the plume in this sample interval are bounded; however, the western and southern extent is uncertain. This is because of the limited number of analytical results caused by low sample recovery. The low sample recovery in part results from the predominance of silts and clays in the intermediate sampling interval.

Benzene detections in the sampling interval above and at the top of the marsh crust (16 to 20 feet bgs) were the highest of any of the four sampling intervals (see Figure 4-42). The maximum unqualified results was 1,970 µg/L at OS-HP14 (the maximum qualified result was 6,000J µg/L at OS-HP10). The areal extent of the benzene plume for this sampling interval is larger than that for the intermediate (12 to 16 feet bgs) sampling interval. The western, southern, and southeastern extents of the plume are uncertain due to a limited number of analytical results. The two high concentration areas, near OS-HP14 and OU5-HP13, coincide with a high concentration area noted in the intermediate sample interval.

Only four groundwater samples were recovered from the sampling interval at the upper portion of the BSU (i.e., greater than 20 feet bgs). Two of the samples were reported to contain benzene at estimated quantities and the other two samples were non-detect. Figure 4-43 shows the benzene results for this interval.

As mentioned above, benzene in groundwater was identified as a potential chemical of concern in the RI Work Plan (Neptune and Company, 2001). Benzene was, and is, of particular concern among the volatile petroleum hydrocarbons because of its relatively high toxicity and volatility



DRAWING NUMBER 819814-B45

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY
---	ALA1BASE	CONCORD	BJ 12-5-02	12/5/02	JES 12/5/02

LEGEND

- OU5 BOUNDARY
- 181 PARCEL NUMBER
- PARCEL BOUNDARY
- △ S-16 MONITORING WELL
- + OS-HP2 DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
- OS OFF SITE LOCATION
- OU5 OPERABLE UNIT 5 LOCATION
- 41 BENZENE CONCENTRATION IN MICROGRAMS PER LITER
- NR INSUFFICIENT VOLUME FOR SAMPLE
- NS INTERVAL OR WELL NOT SAMPLED
- 2U NOT DETECTED ABOVE LISTED VALUE
- 3.5J ESTIMATED VALUE
- — — 5 — — BENZENE ISOCONCENTRATION CONTOUR

NOTE:
MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-40

GROUNDWATER BENZENE RESULTS
0-12 FT. DEPTH INTERVAL

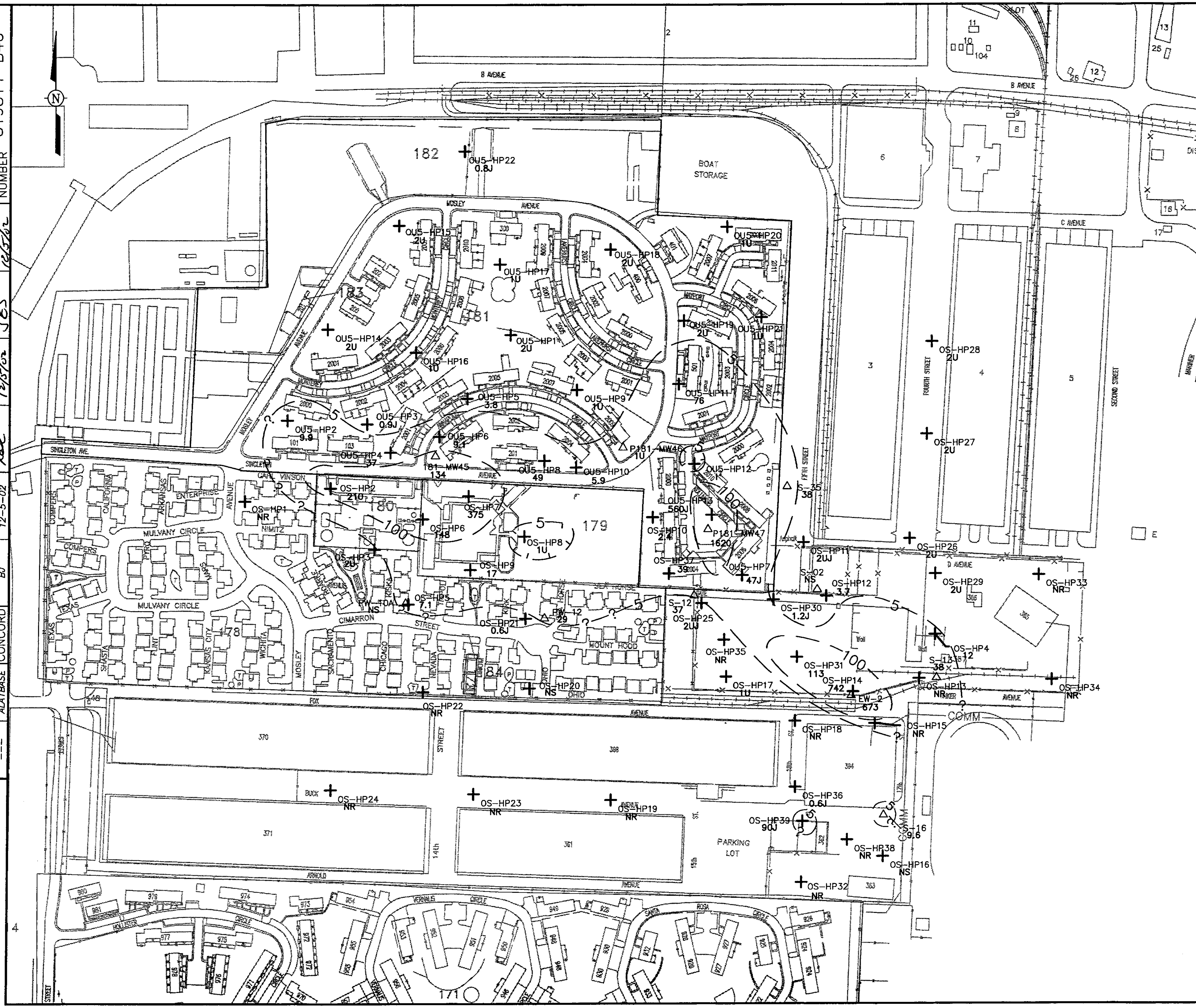


IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-5-02	12/5/02	JES 12/5/02	819814-B46

LEGEND

- OU5 BOUNDARY
- 181 — PARCEL NUMBER
- PARCEL BOUNDARY
- △ S-16 — MONITORING WELL
- + OS-HP2 — DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
- OS — OFF SITE LOCATION
- OU5 — OPERABLE UNIT 5 LOCATION
- 210 — BENZENE CONCENTRATION IN MICROGRAMS PER LITER
- NR — INSUFFICIENT VOLUME FOR SAMPLE
- NS — INTERVAL OR WELL NOT SAMPLED
- 2U — NOT DETECTED ABOVE LISTED VALUE
- 3.5J — ESTIMATED VALUE
- — 5 — — BENZENE ISOCONCENTRATION CONTOUR

NOTE:
MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

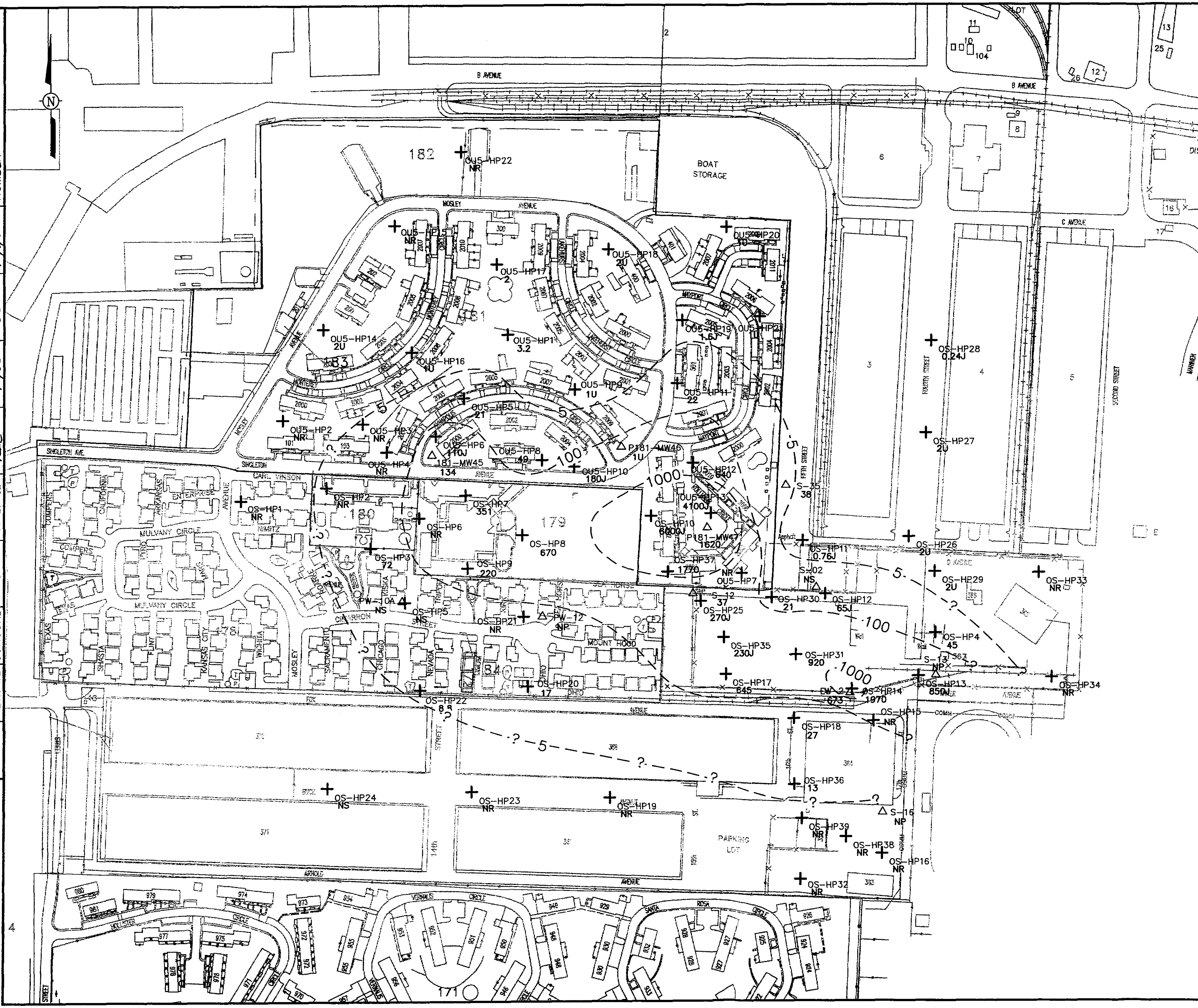
0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-41

GROUNDWATER BENZENE RESULTS
12-16 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-27-02	12/2/02	JES 12/4/02	819814-B47



LEGEND

Symbol	Description
———	OU5 BOUNDARY
181	PARCEL NUMBER
———	PARCEL BOUNDARY
△ S-12	MONITORING WELL
+ OS-HP4	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
45	BENZENE CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE
----5----	BENZENE ISOCONCENTRATION CONTOUR
NP	RESULT NOT POSTED, WELL NOT SCREENED IN THIS DIRECT-PUSH DEPTH INTERVAL

NOTE:
MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–42

GROUNDWATER BENZENE RESULTS
16–20 FT. DEPTH INTERVAL

LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(thin line)	PARCEL BOUNDARY
△ S-16	MONITORING WELL
+ OS-HP35	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
41	BENZENE CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE
NP	RESULT NOT POSTED, WELL NOT SCREENED IN THIS DIRECT-PUSH DEPTH INTERVAL

NOTE:
MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

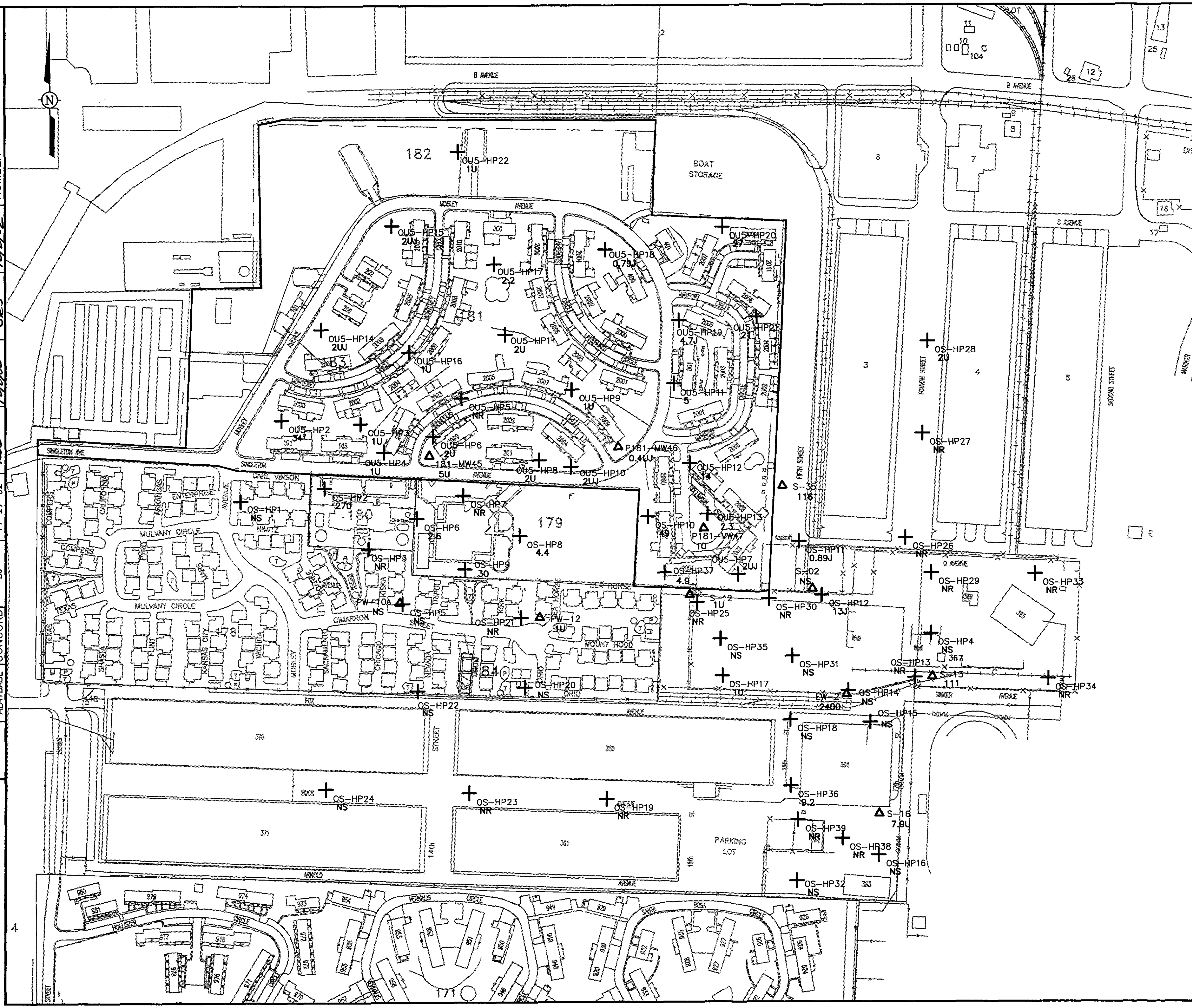
SCALE
0 300 600 FEET

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-27-02	12/2/02	JES 12/3/02	819814-B48

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-43

GROUNDWATER BENZENE RESULTS GREATER THAN 20 FT. DEPTH



LEGEND

(heavy line)	OU5 BOUNDARY
181	PARCEL NUMBER
(thin line)	PARCEL BOUNDARY
△ S-35	MONITORING WELL
+ OS-HP2	DIRECT-PUSH GROUNDWATER SAMPLING LOCATIONS
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
270	NAPHTHALENE CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE
4.5UJ	NOT DETECTED ABOVE LISTED REPORTING LIMIT, REPORTING LIMIT IS ESTIMATED.

NOTE:

1. NAPHTHALENE RESULTS ARE FROM EPA METHOD 8260B.
2. MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

0 300 600 FEET

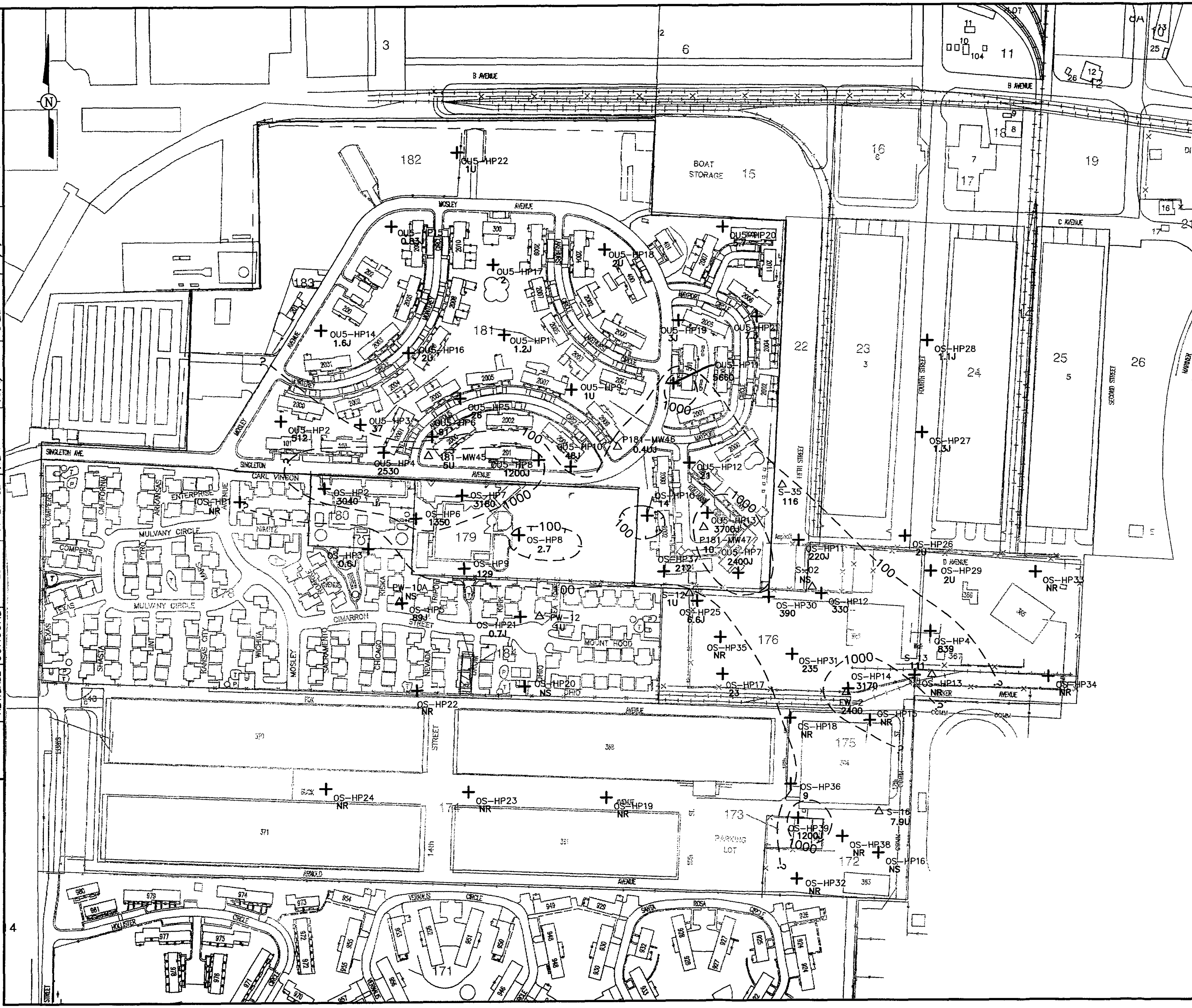
OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-44

GROUNDWATER NAPHTHALENE RESULTS
0-12 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-27-02	12/2/02	JES 12/2/02	819814-B49

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-27-02	12/2/02	JES 12/3/02	819814-B50



LEGEND

- ─── OU5 BOUNDARY
- 181 PARCEL NUMBER
- ─── PARCEL BOUNDARY
- △ S-35 MONITORING WELL
- + OS-HP2 DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
- OS OFF SITE LOCATION
- OU5 OPERABLE UNIT 5 LOCATION
- 3040 NAPHTHALENE CONCENTRATION IN MICROGRAMS PER LITER
- NR INSUFFICIENT VOLUME FOR SAMPLE
- NS INTERVAL OR WELL NOT SAMPLED
- 2U NOT DETECTED ABOVE LISTED VALUE
- 3.5J ESTIMATED VALUE
- ---100--- NAPHTHALENE ISOCONCENTRATION CONTOUR

NOTES:

1. NAPHTHALENE RESULTS ARE FROM EPA METHOD 8260B.
2. MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

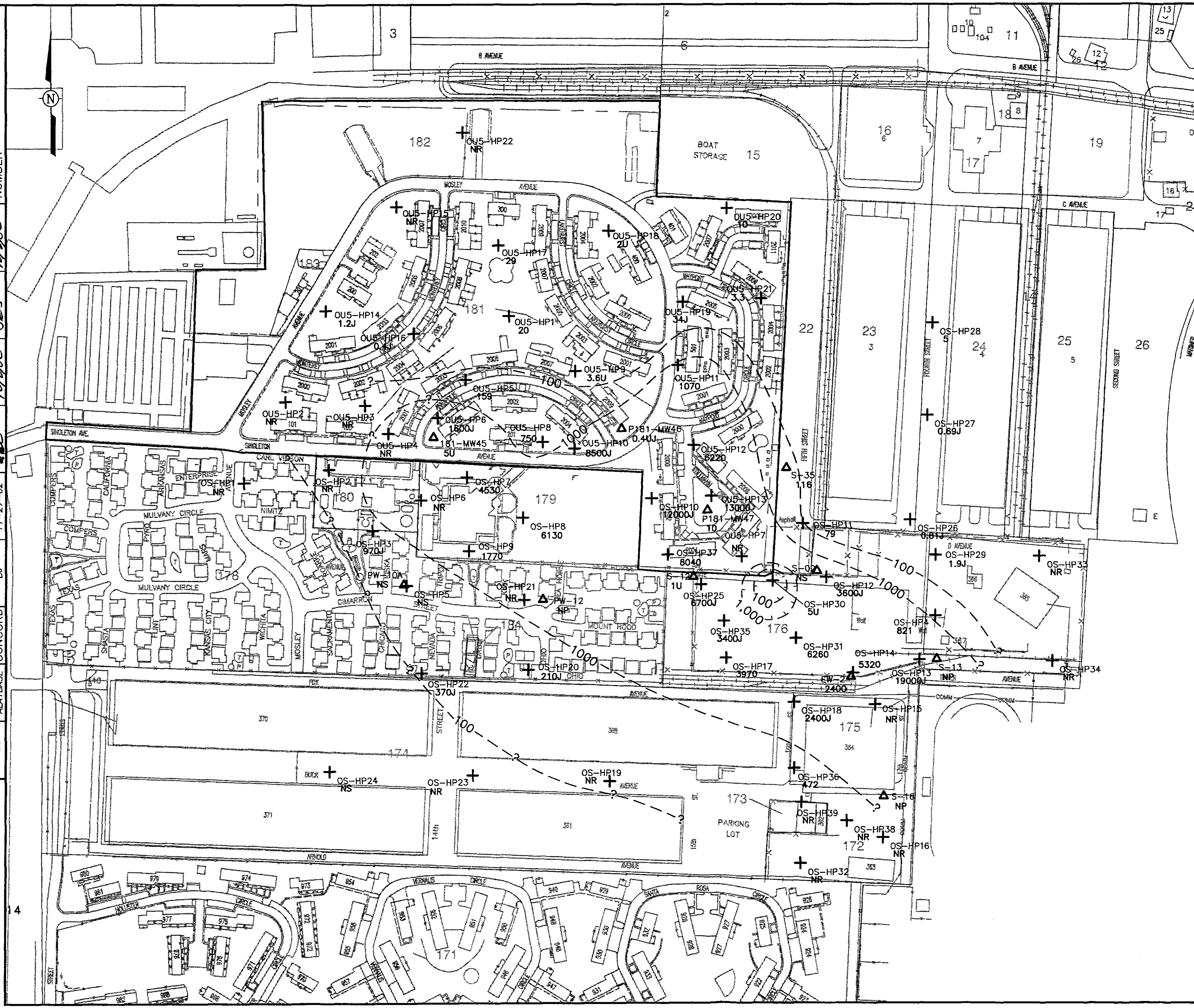
0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-45

GROUNDWATER NAPHTHALENE RESULTS
12-16 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-27-02	12/2/02	JES 12/2/02	819814-B51



LEGEND

———	OU5 BOUNDARY
181	PARCEL NUMBER
———	PARCEL BOUNDARY
△ S-35	MONITORING WELL
+ OS-HP28	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
5	NAPHTHALENE CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE
---100---	NAPHTHALENE ISOCONCENTRATION CONTOUR
NP	RESULT NOT POSTED, WELL NOT SCREENED IN THIS DIRECT-PUSH DEPTH INTERVAL

NOTES:

1. NAPHTHALENE RESULTS ARE FROM EPA METHOD 8260B.
2. MONITORING WELL CONCENTRATIONS NOT USED IN CONTOURING. MONITORING WELL CONCENTRATIONS MAY NOT BE REPRESENTATIVE OF THIS SAMPLING INTERVAL, BECAUSE THE WELLS ARE SCREENED ACROSS MULTIPLE DIRECT-PUSH SAMPLING INTERVALS.

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4–46

GROUNDWATER NAPHTHALENE RESULTS
16–20 FT. DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-5-02	12/5/02	JES 12/5/02	819814-B52

LEGEND

Symbol	Description
——	OU5 BOUNDARY
181	PARCEL NUMBER
——	PARCEL BOUNDARY
△ P181-MW46	MONITORING WELL
+ OS-HP35	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
0.7	METHYL TERTIARY BUTYL ETHER (MTBE) CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-47

GROUNDWATER METHYL TERTIARY BUTYL ETHER (MTBE) RESULTS
0-12 FT DEPTH INTERVAL

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 11-19-02	12/5/02	JES 12/5/02	819814-B53

LEGEND

Symbol	Description
———	OU5 BOUNDARY
181	PARCEL NUMBER
———	PARCEL BOUNDARY
△ P181-MW46	MONITORING WELL
+ OS-HP35	DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
OS	OFF SITE LOCATION
OU5	OPERABLE UNIT 5 LOCATION
0.7	METHYL TERTIARY BUTYL ETHER (MTBE) CONCENTRATION IN MICROGRAMS PER LITER
NR	INSUFFICIENT VOLUME FOR SAMPLE
NS	INTERVAL OR WELL NOT SAMPLED
2U	NOT DETECTED ABOVE LISTED VALUE
3.5J	ESTIMATED VALUE

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-48

GROUNDWATER METHYL TERTIARY BUTYL ETHER (MTBE) RESULTS 12-16 FT DEPTH INTERVAL

Continue

IMAGE	X-REF	OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
---	ALA1BASE	CONCORD	BJ 12-20-01	12/5/02	JES 12/5/02	819814-B54

LEGEND

- OU5 BOUNDARY
- 181 — PARCEL NUMBER
- PARCEL BOUNDARY
- △ P181-MW46 — MONITORING WELL
- + OS-HP35 — DIRECT-PUSH GROUNDWATER SAMPLING LOCATION
- OS — OFF SITE LOCATION
- OU5 — OPERABLE UNIT 5 LOCATION
- 0.7 — METHYL TERTIARY BUTYL ETHER (MTBE) CONCENTRATION IN MICROGRAMS PER LITER
- NR — INSUFFICIENT VOLUME FOR SAMPLE
- NS — INTERVAL OR WELL NOT SAMPLED
- 2U — NOT DETECTED ABOVE LISTED VALUE
- NP — RESULTS NOT POSTED, WELL NOT SCREENED IN THIS DIRECT-PUSH DEPTH INTERVAL
- 3.5J — ESTIMATED VALUE

SCALE

0 300 600 FEET

OPERABLE UNIT 5
REMEDIAL INVESTIGATION REPORT
ALAMEDA POINT
ALAMEDA, CALIFORNIA

FIGURE 4-49

GROUNDWATER METHYL TERTIARY BUTYL ETHER (MTBE) RESULTS
16-20 FT DEPTH INTERVAL